TRANSCRIPT OF THE KEYNOTE SEMINAR OF THE ALL-PARTY PARLIAMENTARY GROUP ON SCIENTIFIC RESEARCH IN LEARNING AND EDUCATION

‘BRAIN-SCIENCE IN THE CLASSROOM’

Attlee Suite, Portcullis House
Tuesday 15 May

The Institute for the Future of
the mind

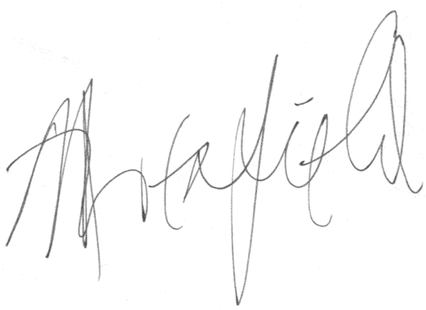
Forward by the Chair of the 'Brain-science in the Classroom' seminar

There is a cultural divide between political, societal and scientific sectors that is becoming ever more acute: increasingly, there is a need to have a working understanding of each other's perspective and activities. Nowhere is this more relevant than between brain-science research and education. Traditionally, this gap in terminology and agenda between education and science has meant the ideas which permeate into education are all too often uninformed by the best scientific evidence and input from educationalists.

This seminar was one of the first initiatives of the All-Party Parliamentary Group on Scientific Research in Learning and Education to explore how teachers, scientists, government and other stakeholders in education can collectively ensure that classroom practice is informed by the best evidence from the brain sciences.

The transcript highlights the scientific and educational rationale behind some of the current ideas and practices in education that claim to be based in the brain-science research, including enriched environments, Visual, Auditory and Kinaesthic (VAK) learning styles and Brain Gym. The wide-ranging discussion begins to explore how we generate co-constructed, ecologically-valid research and open channels to the classroom.

If you are interested in further activities of the All-Party Parliamentary Group please contact Dr Jonathan Sharples, Policy Officer, at the Institute for the Future of the Mind – jonathansharples@pharm.ox.ac.uk



Baroness Greenfield

TRANSCRIPT OF KEYNOTE SEMINAR

OF THE ALL-PARTY PARLIAMENTARY GROUP ON SCIENTIFIC RESEARCH IN LEARNING AND EDUCATION

'BRAIN-SCIENCE IN THE CLASSROOM'

PORTCULLIS HOUSE 15 MAY 2007

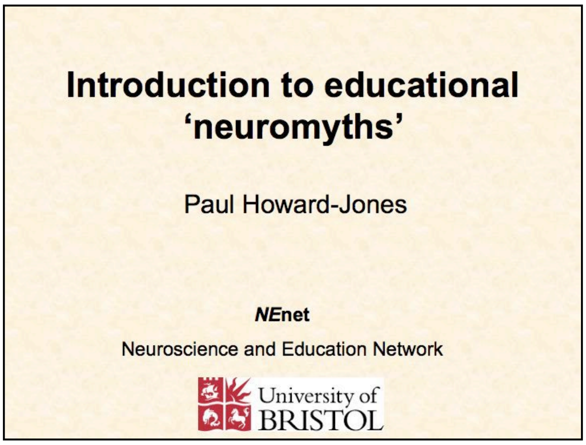
9.30 – 11.30 am

1. Welcome and introduction by Baroness Greenfield

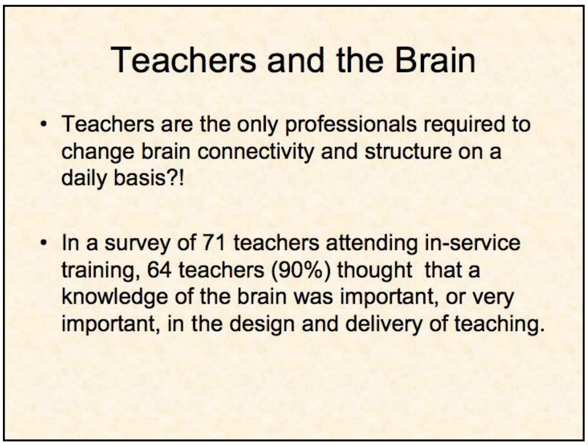
Good morning and welcome to the 'Brain-Science in the Classroom' seminar. I am Susan Greenfield, and I shall be chairing this exciting meeting which arose from the last session of the All-Party Parliamentary Group on Scientific Research in Learning and Education. At the end of that meeting it was decided that a wider debate was needed that would include as many different sectors as possible and that would also investigate ideas from neuroscience and from research activities in neuroscience that are currently influencing educational practice. There was a need for a wider discussion on the scientific and educational rationale for products and practices that claim to be based on such research. The questions for consideration this morning are therefore the wider ones that are concerned with how understanding the science of learning can be matched with teachers' existing expertise in the classroom.

The first speaker is Dr. Paul Howard-Jones, who is senior lecturer in education at the University of Bristol, and who will introduce us to educational neuromyths. His particular area of interest is the application of our understanding of cognition and neuroscience to advanced child and adult learning. He chaired the recent ESRC-TLRP seminar series on neuroscience and education, so I do not think that our session could be started by anyone better. Please welcome him.

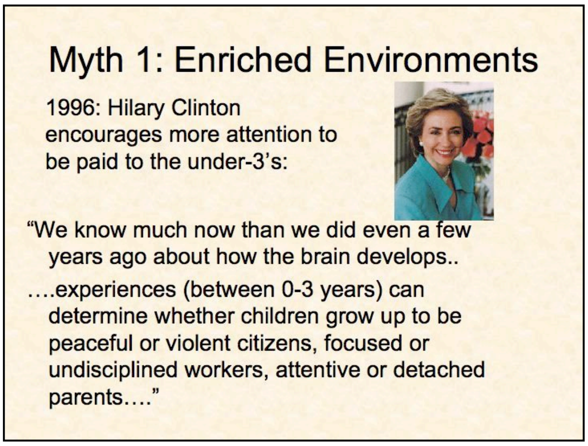
2. *Introduction to educational "neuromyths" — Dr Paul Howard-Jones, Lecturer in Education at the University of Bristol*



Good morning. I have been asked to talk to you today about educational neuromyths. As Susan just indicated, that is not my major area of research focus, but it is an area that I think is very important and that is worth thinking about in detail—not just in relation to the types of neuromyths that exist but also in relation to how they come about. So in the next few minutes I shall try to give you some impression of where neuromyths originate, and I hope that that might inform what we need to do about them.



There is a natural enthusiasm among teachers for things that are concerned with the brain. An interesting point that I have often heard is that teachers are the only professionals who are required to change brain connectivity and structure on a daily basis. We could argue about that for hours, but it is worth thinking about. Teachers *should* be interested in the brain. Indeed, in a recent survey of 71 trainee teachers that we carried out with funding from the DFES Innovation Unit, 64 of them—90 per cent.—thought that knowledge of the brain was important or very important in the design and delivery of teaching. That seems like a natural and common sense belief.

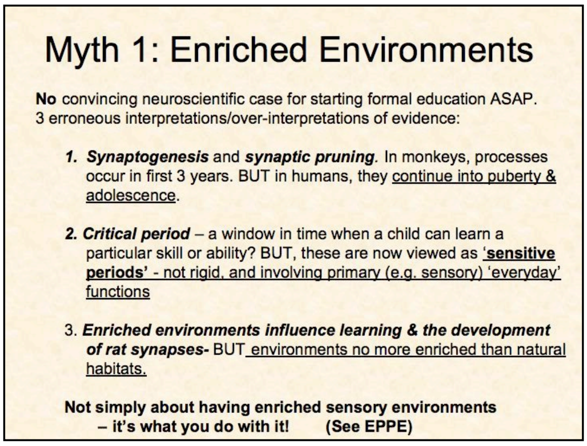


However, for neuromyths to form, there must be a seed as well as enthusiasm. We cannot blame all neuromyths on Hillary Clinton, but she may have had a role in one of them. In 1996, she encouraged more attention to be paid to the under-3s, saying:

"We know much more than we did even a few years ago about how the brain develops…experiences between 0 and 3 years can determine whether children grow up to be peaceful or violent citizens, focused or undisciplined workers, attentive or detached parents”.

She was encouraging us to think about neuroscience as something that can help determine outcomes.

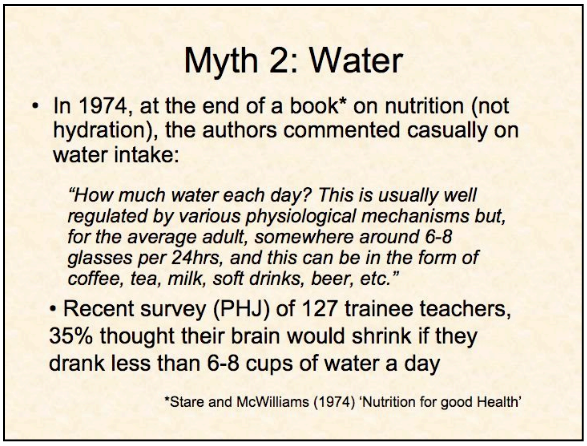
Skip on a few years and one finds that there is an awful lot of interest in the idea of enriched environments for children in the early years as a major factor in educational outcomes. However, scrutiny of the neuroscientific evidence does not support the case for starting formal education as soon as possible, nor for very enriched environments—an analysis that I owe chiefly to Sarah-Jayne Blakemore. One of the supporting arguments that was used in the past was that synaptogenesis and synaptic pruning—the formation and cutting back of synapses in the brain—occur in the first three years of life in monkeys. However, we now know that in humans those processes continue into puberty and adolescence. Another popular notion was that of the critical window—a window in time during which children can learn a particular skill or ability. Now, however, we tend to view those periods as sensitive, non-rigid periods that appear to involve chiefly primary functions—sensory functions—that can be learned in everyday environments.



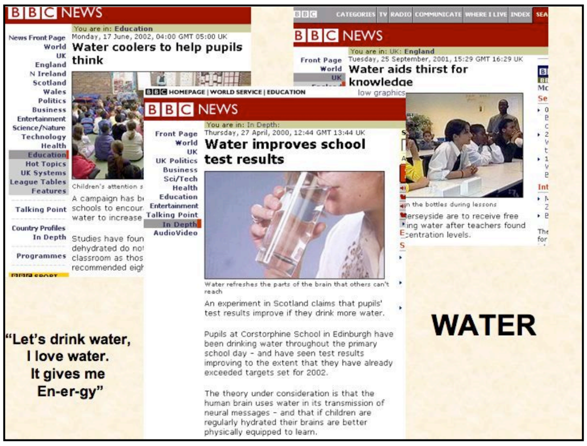
A further area of neuroscience research that contributed to the same myth was research with rats that showed that enriched environments influenced both learning and the development of rat synapses. However, detailed examination of those experiments shows that the environments were no more enriched than natural habitats. The environments were cages with things to play with, but they actually contained no more stimulus than rats would encounter in everyday life.

The conclusion is that the important factor is not *having* enriched sensory environments, but what is done with them. The outcomes of research in that area are very clear, and quite a lot is known about early learning environments from the EPPE project—an educational research project.

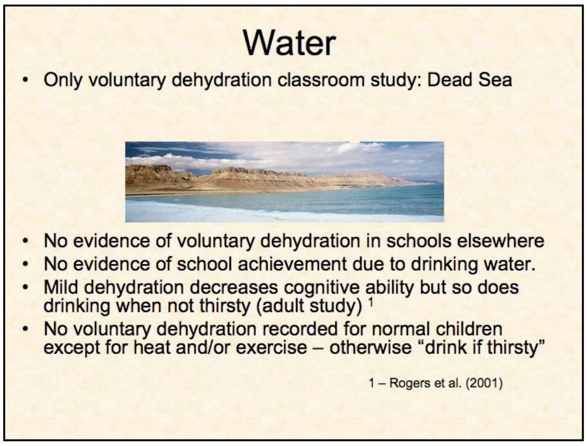
Another myth is that concerned with water. In 1974, a couple of authors – Stare and McWilliams - commented casually on water intake. Their book was about nutrition, without much focus on hydration, but at the end they answered the question of how much water people should drink each day by saying that intake is usually well regulated by various physiological mechanisms, but that the average adult should drink between six and eight glasses each 24 hours, which could be in the form of coffee, tea, milk, soft drinks, beer and the like.



If we skip on a few years to a recent survey that I undertook with trainee teachers, we find that some 35 per cent. of them believed that their brain would shrink if they drank less than six to eight cups of water a day. In the case of that survey I had the opportunity to correct the notion.



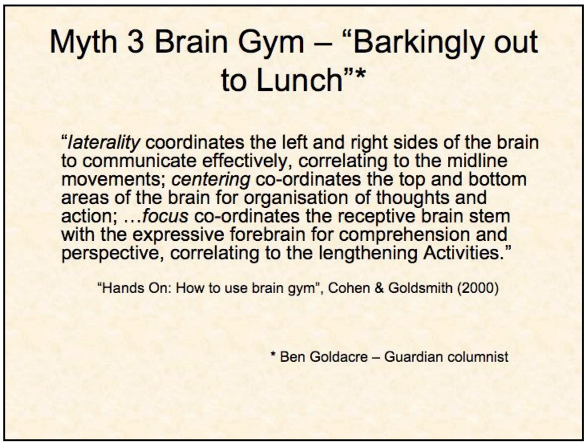
We can go further. There are plenty of stories in the media that mention the importance of water in boosting learning. As a parent, I had the opportunity to attend two open days this year at my children's primary and secondary schools, and within the first hour of being at each of them I was assured that the schools knew about the importance of water in learning. The PowerPoint slide shows a range of recent newspaper articles with headlines such as: "Water coolers to help pupils think", "Water aids thirst for knowledge", and "Water improves test results". There is also an extract from a book which contains some lines that children are encouraged to learn and sing to the tune of 'Frère Jacques'. I will not sing them myself; they are: "Let's drink water, I love water. It gives me, en-er-gy". Does it? Well, no, it doesn't. There are surprisingly few calories in water.

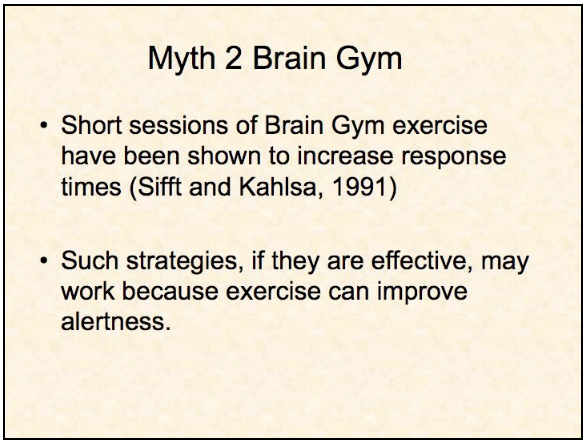


The only voluntary dehydration classroom study that I could find in the literature was undertaken in the Dead Sea— a very hot, dry place, and not an environment that resembles many school environments in the UK. There is no evidence from situations of voluntary dehydration, such as in the case of children just not drinking water, from any other schools. The only exceptions - instances in which there was indeed voluntary dehydration - are in the cases of heat and exercise. Neither is there any evidence of water causing achievement in schools. It is true that mild dehydration decreases cognitive ability, but a recent adult study at Bristol University showed that drinking water when not thirsty can also decrease it. So, apart from on school sports days or days when it is particularly hot or when exercise has been done, the message is: drink if thirsty.

Educators have an unsated desire for all things brain-like, which is understandable and justifiable. One can begin to see how that might become problematic, but one person's problem can be another's opportunity. To make things worse, a number of entrepreneurs have stepped into the vacuum.

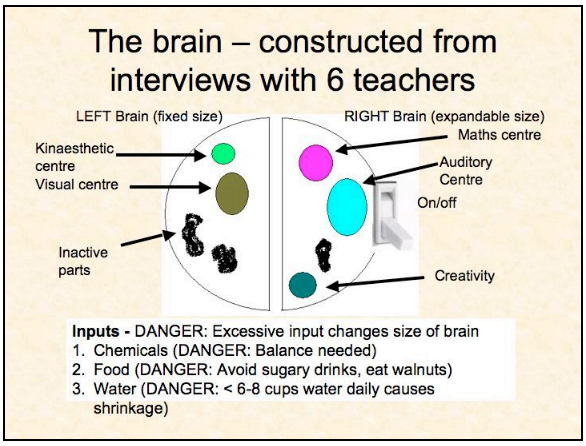
Let me give you some information about one of them: Brain Gym. Ben Goldacre of *The Guardian* recently called Brain Gym "barkingly out to lunch". An extract from a Brain Gym book says: "laterality coordinates the left and right sides of the brain to communicate effectively, correlating to the midline movements; centering co-ordinates the top and bottom areas of the brain for organisation of thoughts and action; focus co-ordinates the receptive brain stem with the expressive forebrain for comprehension and perspective, correlating to the lengthening activities." I do not understand that, and I do not think that many scientists would. It is complete bananas.





However, a bona fide scientific journal has reported that short sessions of Brain Gym exercise have been shown to increase response times, so perhaps there is a seed of truth in the idea that exercise can bring about additional alertness. Brain Gym exercises might therefore support learning and learners. So it is important not just to dismiss things; the message is that more research is needed.

Let me show you an image of a brain. It is not an image that I think the scientists in the audience will be able to help interpret. We did six in-depth interviews with practising teachers, from which we constructed an image of the brain—I could talk about it at length, but I shall try not to. There are two hemispheres, which are not connected. There is the left-brain, which has a fixed size, but the right brain is apparently expandable. There are inactive parts at the left rear, which are unused and essentially kind of dead. There are centres that are associated with creativity, and there is a maths centre. There are also three centres that relate to subjects that we will hear more about later: a kinaesthetic centre, a visual centre and an auditory centre. They are about learning styles. The subject of the image is an auditory learner, so the auditory part of his brain is bigger.



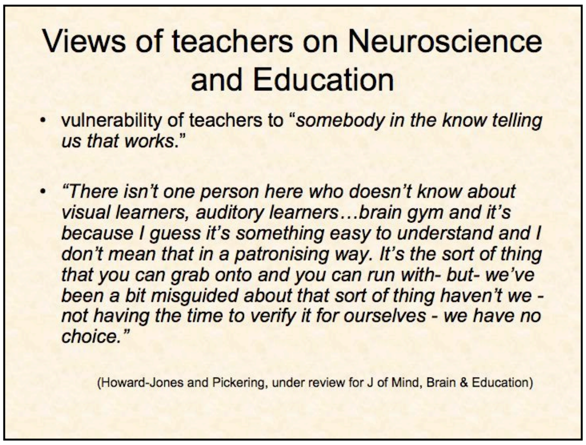
There is an on/off switch, because the brain can go on or off at any particular moment. The inputs are interesting—you have to be careful with them because excessive input can change the size of the brain in different areas. There is some slight truth to that, in fact, so I should be careful in what I say there.

There is also a potential danger with chemicals, because you need a balance of them. Sugary drinks should be avoided, but you should eat walnuts. The notion about walnuts needs some unpacking; apparently it arises from the fact that they are brain-shaped, with the surface looking like the cortical surface. I had never encountered that notion previously, but apparently it is quite well known. Lastly—we have already heard this one—the brain will shrink if you do not drink water.

It is easy to look at that image and have a laugh, but teachers are not stupid; they are very intelligent, organised human beings, so one has to ask oneself how such ideas have arisen. There is another argument, however, which is that it does not matter what model one has of the brain, provided the model works. If it works, who cares?

There are actually three issues contained in that question. The first concerns the word "if", because we need to consider whether there has been a proper evaluation, and in the vast majority of cases ideas about the brain have not been properly evaluated. However, a recent evaluation of learning styles, which I am sure that John Geake is probably going to mention, concluded that the effort was a waste of time.

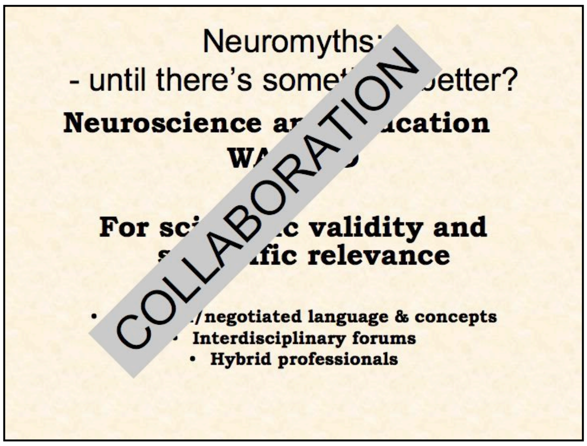
Secondly, if we understood more about when things worked, we could probably make them work better—without the accompanying mumbo-jumbo, and on the basis of something more scientifically credible. That leads on to the third point, which is that teachers really do care about the science that underlies what they are trying to do. It is the vacuum of proper ideas and knowledge—particularly co-constructed ideas that have been put together by educators and neuroscientists—that has allowed the myths to evolve.



Interviews with teachers that have been funded by the Innovation Unit have shown that there is a terrible vulnerability among teachers to instances of, as one of them put it, "Somebody in the know telling us, 'That works.'" At the moment, the people doing that are entrepreneurs, but in the future they could be neuroscientists, which might not necessarily be a good thing either, because we need the co-constructed ideas that I mentioned.

One teacher, speaking at a conference of many hundreds of teachers, said:

"There isn't one person here who doesn't know about visual learners, auditory learners…Brain Gym, and it's because I guess it's something easy to understand, and I don't mean that in a patronising way. It's the sort of thing that you can grab onto and you can run with, but we've been a bit misguided about that sort of thing, haven't we—not having the time to verify it for ourselves—we have no choice." That says a lot about the pressures that teachers are under to use the ideas, and about their difficulties in constructing knowledge and ideas. So there is intellectual work to be done.

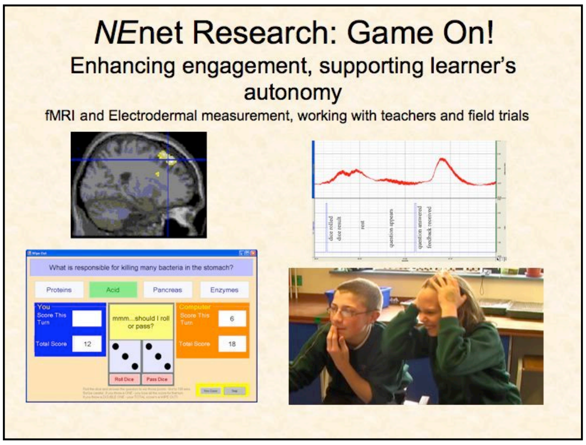


Where do we go from here? We shall be stuck with neuromyths until there is something better. However, I have a "wanted" poster—I have included it on the PowerPoint slide. It says that for scientific validity and educational relevance—not scientific relevance as it says on the PowerPoint slide—we need a common negotiating language and set of concepts. We need interdisciplinary forums and hybrid professionals. The only way in which we will get those is by collaboration.

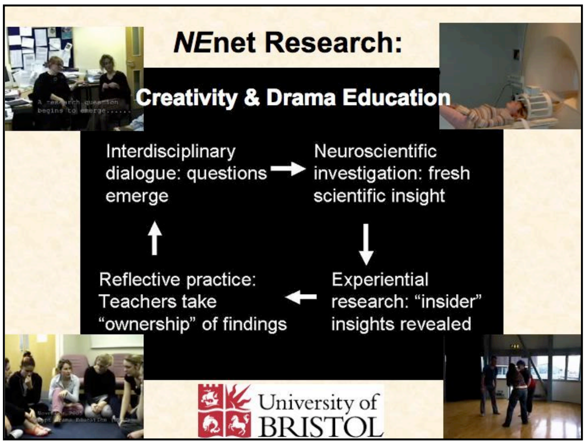
The good news is that collaboration has already started. Back in 2000 the Teaching and Learning Research Programme funded a consultation, and more recently it funded a seminar series attended by 400 people, including teachers, neuroscientists, educational psychologists and policy makers, which was all about supporting discussion. Their discussions have brought about the document that is being launched today: "Neuroscience and Education: Issues and Opportunities". I am very excited about it and I am very grateful to all of those 400 people—not just the TLRP, because the document is a co-construction that is very much the product of collaboration between neuroscience and education.

The document sets out lots of areas not just in which neuroscience *may* help education, and vice versa, but in which it is already beginning to do so, including developmental disorders, ADHD, dyslexia and dyscalculia. I have not been asked to discuss the details of the contents today, but there are many such areas, including also adolescence, memory, creativity, mathematics, motivation—all of which are possible areas for collaboration and interdisciplinary research that could produce the set of concepts that we need.

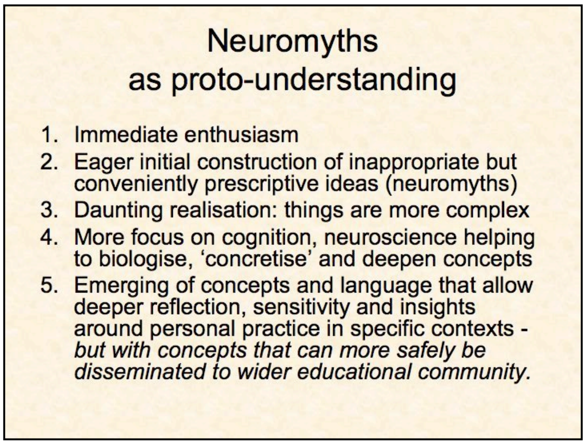
A couple of projects are happening at Bristol in which we are really boosting the engagement of children with learning-based computer games. They get very excited, darting in front of the screens while at the same time learning science, and we are able to use fMRI and physiological measurements such as measurements of electrodermal activity to understand such engagement much more deeply than previously.



I want to finish on the subject of the creativity and drama education project. That project has been funded by the Lifelong Learning Foundation, by Escalate and via the Wellcome SciArt initiative. We have been working with teachers and trainee teachers on fMRI research and psychological studies, and we have also considered experiential perspectives—what it is like actually to use some of the strategies that we have been analysing and understanding. The aim is to work with



teachers to develop their reflective practice and to co-construct the knowledge base that is so badly needed.



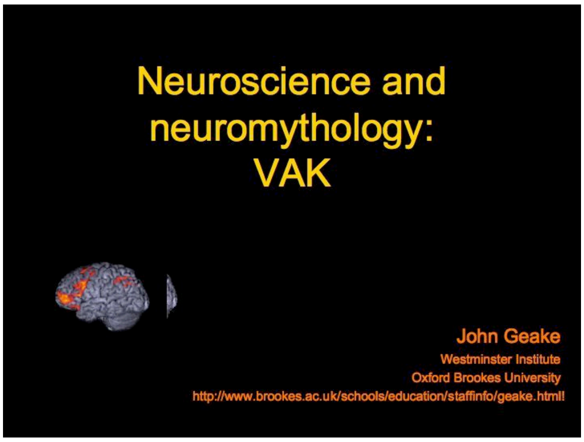
The last slide shows the very preliminary findings, which I want to share with you. I hope that it maps out what might happen more and more often. When we started work with the trainee teachers, there was immediate enthusiasm, and a common sense understanding of the brain's relevance to education. There was immediately an eager initial construction of what were convenient but quite often inappropriate and rather prescriptive ideas—the "Top tips for teachers" kind of thing. We saw neuromyths being generated in front of us.

By working with the trainee teachers and with their trainees, however, so that there was an interlink between science and education, we helped them come to the daunting realisation that things are actually more complex. We were able also to encourage more focus on cognition—I am afraid to say that neuroscience is actually irrelevant to education unless one includes psychology and cognition. The neuroscience helps to biologise and to some extent concretise—I use that word with caution—those rather abstract psychological concepts, and deepen people's understanding.

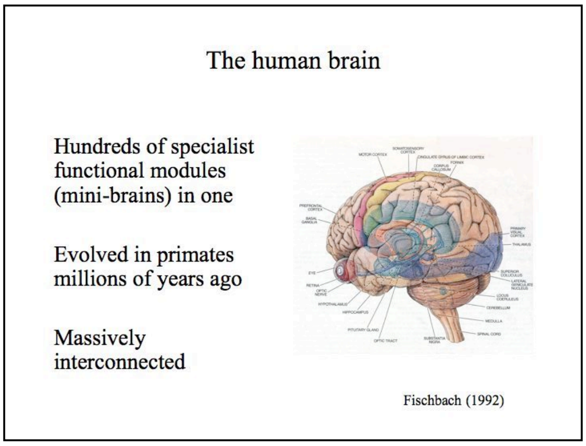
We were able to see concepts and language emerging that would allow the teachers to reflect more deeply and with more sensitivity and that gave insights in connection with their own personal practices and specific contexts. The concepts were useful ones, and I believe that they can be safely disseminated to the wider educational community. I hope that that route will be taken more often as we move away from neuromyths, and I hope that today's seminar will be an important milestone on that path.

Susan Greenfield: Thank you, Paul, for that wonderful introduction. Our next speaker is Professor John Geake, who is Professor of Education at the Westminster Institute for Education at Oxford Brookes University. His research interests include the neuroscience of the gifted and talented, creativity, and the implications of cognitive neuroscience for pedagogy and the curriculum. He will talk about visual, auditory and kinaesthetic learning styles.

3. Visual, auditory and kinaesthetic (VAK) learning styles — Professor John Geake, Professor of Education at the Westminster Institute for Education at Oxford Brookes University

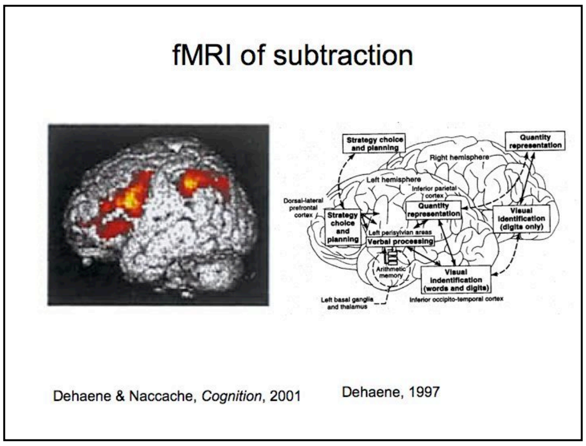


Thank you, Susan. Visual, auditory and kinaesthetic learning styles are one particular neuromythology that seems to have pervaded education. VAK was originally proposed by Dunn and Dunn as a way of describing learning styles, and it was intended to explain individual differences in learning abilities. It was suggested that some people are primarily visual learners, some are primarily auditory, and some are primarily kinaesthetic. Interestingly, that mythology is a complete misunderstanding, although it contains some important ideas about brain function processes and structures. The counter-position—that brains operate on the basis of essentially interconnected rather than separate processes—is quite a simple principle; one that could provide a much more informative basis for education and educational applications of neuroscience. VAK as a mythology needs some unpacking, however, and I have been asked to do that. In doing so, I want to demonstrate how thinking about interconnectivity as the principle of brain function is more productive educationally.



The basic story is one with which we are all familiar. It is that brains have a number of seemingly specialist functional areas or modules that evolved as part of primate evolution during millions of years, and that modern humans have appropriated many of those modules and attributes to do the things that we do. There is clearly no brain module for attending seminars in Portcullis House, yet here we are. There are none for running PowerPoint, but we seem to manage that too.

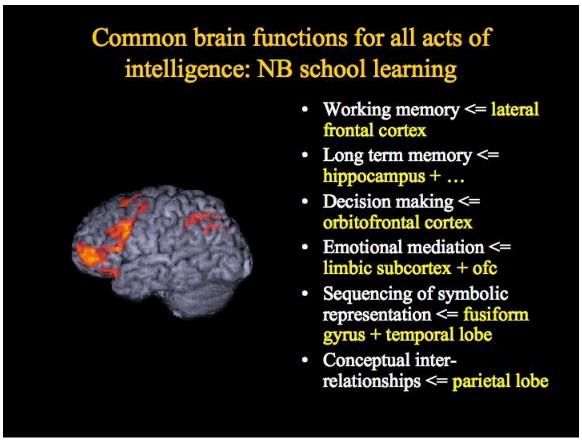
What is interesting is that the functional modules work only by virtue of their interconnectivity; they do not work in separation. An example was given by Staneslas Dehaene in Paris. He did repeated subtraction in a functional magnetic resonance imaging scanner. He lay there, saying to himself, “100 take away 7, take away 7, take away 7, and so on.” We all have the answer; those who have heard this talk before have definitely got it! However, what is interesting is that we have the answer at the click of a finger, even though no one has asked us that exact question in a long time. Yet when we look at the areas of significant brain activation—not all the activation, just the significant elements — we can identify 10 to 12 areas of the brain that are involved even in that simple calculation.



If we make a map of the brain and try to label the active areas by their functionality as derived from other experiments, we see that there is no one brain area dedicated to processes like subtraction. Rather, we do subtraction as a result of the integrating and interconnecting of a myriad of areas that evolved for other processes — not least avoiding lions and the like.

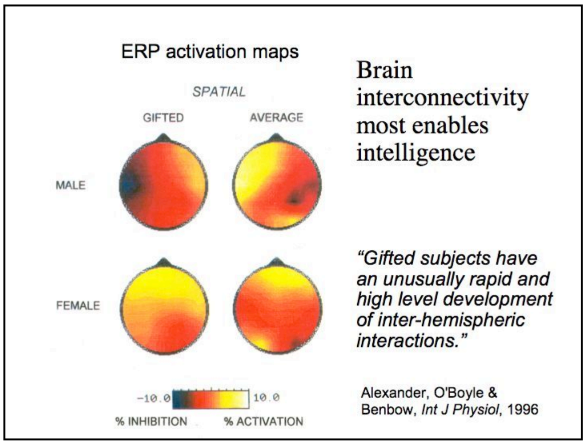
There are now brain imaging techniques such as diffusion tensor imaging that are starting to map the interconnections, and in future we will see fewer images of coloured blobs, and more images that look like road maps. As far as special education needs are concerned, there are many more connections than blobs, and the difficulties that many kids are having with formal learning might be due to bottlenecks in intercommunication between the various functional modules. If we could identify and diagnose those bottlenecks, that might enable us to devise interventionist pedagogies that might be more helpful for kids who, for instance, are struggling to achieve basic levels of numeracy or literacy—more helpful, that is, than a "more of the same" approach, which we know does not work and can become quite demotivating. There is a reasonable hope that that might happen in future.

The slide entitled "Common brain functions" is just a summary of many of the basic areas of neural function that are involved in all acts of intelligence, including attending school. The origin of some neuromythologies is in the way that data are reported. The left of the slide shows a rotating brain with some of my own fMRI data, and you can see the lovely coloured areas showing significant activation. You might get the feeling from that image that these are the only areas of the brain that are operating when the subjects do the tasks that they have been asked to do in the scanner. That is not true, however; nearly all of the brain is active. The point is that

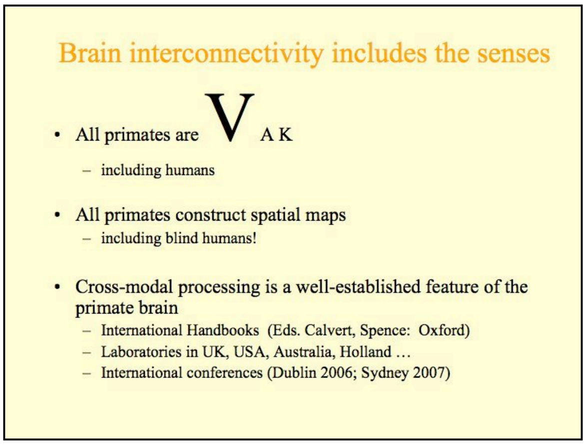


we are not so interested in many of those neural activities, and we want to find the peak ones.

The scans are like statistical maps, or like looking at an ocean and seeing which underwater mountains stick up above the surface. We see peaks here and there, such as the Hawaiian islands, and we say, “Aha, they are important”, and we ignore all that lies underneath. In educational terms, however, we are dealing with the whole mountain, so it is vital to realise that even the simplest educational tasks involve a whole load of activity.



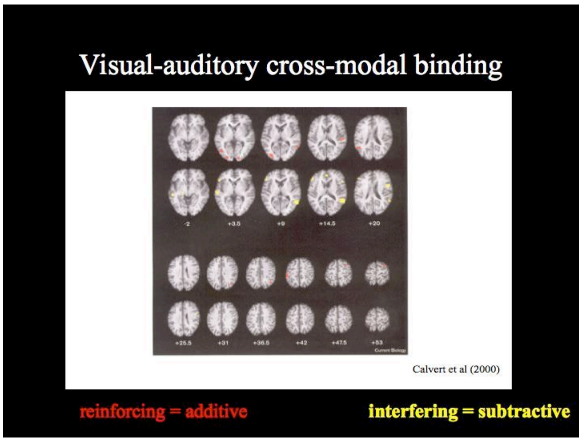
It is interesting that when we perform neuroimaging studies on gifted children, we find that the process of interconnectivity is enhanced in comparison with those of average cognitive ability. I shall not unpack the data, but we know from a number of EEG and fMRI studies that there is a consistent story that high intelligence seems, if anything, to be about brain interconnectivity—the more interconnectivity there is, and the more efficacious interconnectivity there is, the better. It is not a matter of having a particular spot somewhere that is firing away at a higher rate; it is about the assembly. For an educator, interconnectivity—joining up dots and ideas—makes a lot of sense. I still do some occasional school classroom teaching, and the good lessons are the ones that are about helping the kids to see connections and make conceptual leaps.



Let me come to the nub. Interconnectivity includes sensory inputs. Moreover, if we look at ourselves as primates in VAK terms, there is essentially a bloody great “V” and a little bit of “A” and “K”, because our brain processes are approximately 50 to 60% per cent. visual. What we do with that information is to construct spatial or quasi-spatial maps of the world so that we understand how things connect together.

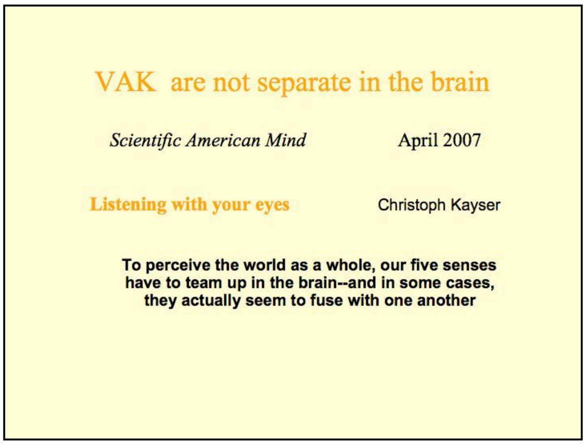
That is true even for people who are congenitally blind; they construct spatial maps too. Obviously, they do not get their initial information visually, they get it by tactile and aural means instead, but they do the same thing with it as sighted people; they construct maps of the world to understand where things are both actually and conceptually.

So there is a cross-modal process in which information, whether it arrives kinaesthetically, aurally or visually, is interrelated and becomes one information pack. At the last meeting that took place in Parliament, there was some discussion of whether that claim was a tentative area of understanding of the brain, so I want to make the point that cross-modal processing is actually regarded as an established feature of brain function. There are international conferences and handbooks about it, and there are laboratories around the world that are studying it. We have a pretty good idea that that is how the brain works.

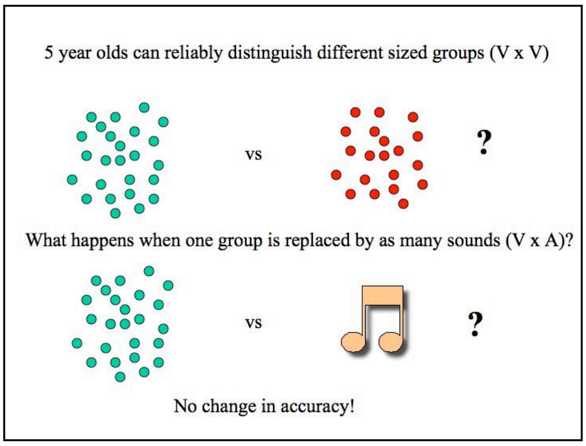


This slide shows data from the fMRI lab in Oxford which compares people looking at and listening to in-sync and out-of-sync speech/lip movements. There are dedicated areas in both visual and auditory cortices that show both a super-additive and a super-subtractive effect that shows that we really do notice when things are in-sync and when they are not. If we watch a news feed from a reporter in which the visual is out of sync with the sound, we readily notice.

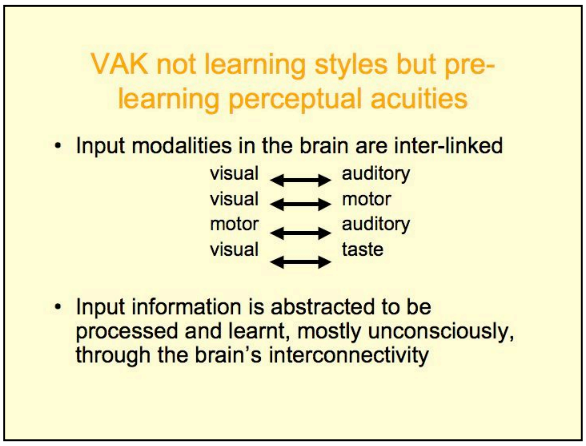
We can tell an evolutionary story about that, because it makes a lot of sense that if you are walking along at night and you hear a click, you have to be able to locate the source of the auditory information and make sense of it in terms of the spatial map. There are two fairly important reasons. The first is that the noise might be your dinner, and the second is the fatal converse.



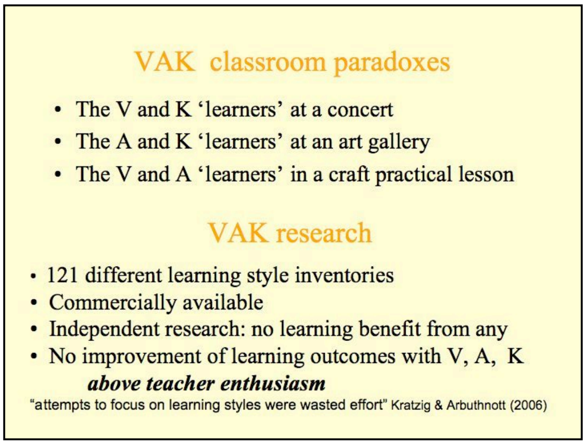
Even *Scientific American Mind* had a feature article entitled “Listening with your eyes” in its April edition, which was dedicated to neuroscience in this area. I recommend it. The slide shows a quote from the article: “To perceive the world as a whole, our five senses have to team up in the brain - and in some cases they actually seem to fuse with one another”. It is interesting that the article mentions five senses. VAK should really have a gustatory and an olfactory element added to it, if we were being consistent—so that we would have “VAKOG” or something. However, we all know what kids in a classroom would make of it if they were told that they have olfactory abilities.



Let me cite a simple example of sensory fusion. We can do an experiment with estimation abilities that is designed to help understand our capacity for estimating. In it, we ask kids to look at a couple of groups of dots or other objects in which there are too many items to count exactly. If we ask kids as young as five to say which group has more, they can give a pretty accurate answer. The interesting experiment is where we replace one of the groups of dots with a series of rapid sounds that again are too quick to count, so that the comparison is between a visual and an auditory input. What happens to the accuracy of the response? The answer is that there is no change; the kids are just as good. It does not matter how the information has arrived, because what we do with it is to send it 'upstairs' and abstract it.



Neuroanatomical studies and neuroscience interconnectivity imaging studies show that there is massive interconnectivity between all the sensory areas. And we can say that the type of data to which I have referred supports earlier sorts of models and conjectures which postulated learning as a process of abstraction: however we receive the information, we abstract it to make sense of it and to decide what to do about it, before committing to some kind of motor action and response.



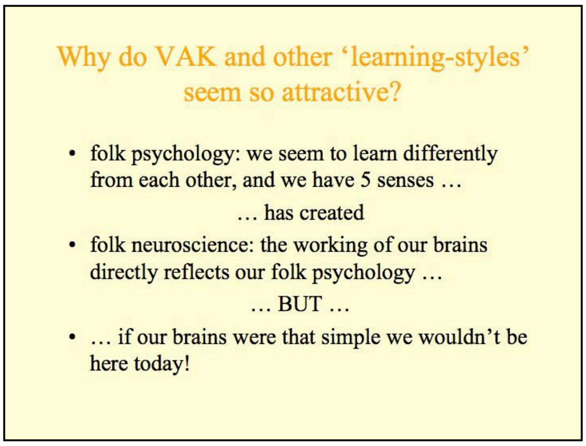
A good example is the history that we have learned. We all have a lot of knowledge (in this audience, probably much more than I have) about British Government processes and history — but the information on whether that knowledge was acquired by reading, hearing, or by being seen in a documentary has mostly faded from memory, and is in fact irrelevant.

Steve Higgins is going to talk about the fact that teachers have discarded the idea of VAK as separate learning styles. Instead, they see VAK as an opportunity for multi-modal teaching, and I think that they are smart to do so, because otherwise contradictions appear.

Teachers who speak to me about this area say that kids change the emphasis that they give to their senses depending on the type of lesson, and so the kids should. In an art lesson we want a lot of visual attention, and it would be okay in many instances for kids to shut their eyes in a music lesson—I often shut my eyes at concerts to enhance the auditory experience.

The research into individual learning styles is interesting. A couple of years ago, a big study by Coffield et al. examined 121 different learning style inventories. So VAK is not the only one around—120 others are available if you just hit Google, type "learning styles" and have your credit card details handy. However, no independent research has found learning benefit for *any* of them. I emphasise "independent", because nearly every page of the materials that you pay for says that research has of course shown them to be wonderful, but when you look at who did the research you find that it is published by the same organisation that is selling the product.

There has been research on VAK in particular, and the only caveat to what I have said seems to be that of teacher enthusiasm. There is always an effect if you bring something new into a classroom and get teachers enthused. However, we need to know whether there are effects that are sustainable, because we cannot ask teachers forever to take on new things for the sake of an enthusiasm effect.



Paul Howard-Jones asked why we should find VAK appealing. Intuitively, the idea that if I remove my glasses I will not be such a good visual learner feels like common sense—although maybe "sense" is the key word. I think that there is an explanation for that. We all operate with folk physics and folk psychology; that is what gets us through the world without having to do study. But study is needed if we really want to find out how the world works. In physics, we discover that things are quite counter-intuitive, and that the world does not work in the Aristotelian way we thought. Psychology also turns out to be pretty counter-intuitive in many ways.

I think that we have developed folk neuroscience that reflects a comfortable and simple way of doing things. We know that we have five—or possibly seven—senses, so we think that maybe our brains work that way, and the brain diagram that Paul showed us would be very consistent with that approach. However, a brain that was that simple would not let us do any of the things that we are currently doing. There would be nothing there to appropriate for the purposes of running schools, learning in classrooms, or having conferences in the House of Lords.

I could not agree more with Paul's view that to advance educational neuroscience there needs to be an interdisciplinary, co-operative venture between educators and neuroscientists. I have convened a forum in Oxford for the past six years. We meet two or three times a year, and we have educators, psychologists and neuroscientists sitting round the table, looking at potential research ideas. Sometimes the scientists come along with some research and tell us that they think that it will have applications to, for example, the learning of reading, and we consider whether there is some sort of educational validity to that. Alternatively, someone might come along with some interesting educational research and tell us that they think that there is a neuroscientific explanation for it, and suggest some studies on kids' brain function while the kids are, say, learning French—or not learning it. The studies might then examine whether there is an explanation for the results of a widespread national study of shortcomings in second language learning. We are trying to advance things in that way. Second language learning is an interesting area to study with reference to sensitive periods and critical periods. There is evidence that learning second languages by immersion needs to be done when we are very young, unlike other subjects that we seem to learn better when we are older. If we are going to learn a second language in later life, we might need to take a more "top down" approach.

What about differences between girls and boys? Teachers encounter that question constantly. There are co-ed schools, but do we need co-ed classes? In Australia, kids are voting for separate classes with their feet. The girls do not like the boys, because they muck up too much and hog the equipment, and the boys do not like the girls because they are too articulate and conscientious. Those are stereotypes, but they are not stereotypes that are being repeated by me—it is the kids who are making those choices.

Importance of involving educators in helping set the educational neuroscience research agenda

- Is there a critical period for learning a second language? Music? Physics?
- Should boys and girls be taught separately in some subjects?
- Are the brains of children today different from those of previous eras due to high levels of IT usage?
- Are there any predictive correlations between differences in brain structure and school outcomes?

The other day I heard from someone who heads up a big London education project, having come out of the BBC to do it. He was saying that kids these days spend such incredible amounts of time in front of a screen—either a computer screen or a television—although computers are rapidly replacing television as the object of focus, that there could be a demonstrable effect on ability to sustain attention. Hence more kids are being diagnosed with ADHD, and that could be a direct consequence of the fact that we are now entering an IT society with brains that evolved for primates in trees. In order to be able to manage, we are desperately trying to appropriate the brain functions that we evolved. However, we sure as heck did not evolve for the purposes for which our brains are now being used.

I was in The Hague at the weekend, and I talked with a computer scientist whose son had dyslexia. He had devised a computer model of information processing, and he was wondering whether a number of other increasingly prevalent psychological syndromes might be explained by the high information-load demands that we now make of our brains when compared with the era of a couple of generations ago. Those are interesting speculations, especially given that our only current treatment for ADHD is to hand out the Ritalin, or do behavioural interventions in schools, some of which are not terribly effective. It would be great to find out exactly what the underlying neural processes are, and discover which areas of brain connectivity are involved in sustained attention.

The piece of research that I would really like to do, which would provide a good base for all the investigatory lines that I have mentioned, is: what relationship exists between differences in brain structure and school outcomes? At the moment, the available data mostly includes only children who have been involved in a few, limited experiments—maybe a dozen or thereabouts, or kids with some kind of clinical diagnosis. We have no large database of data on normal children that would facilitate controls based on socioeconomic variables. We would need a database of several thousand kids from across the formal education age span—say from 5 to 25.

There are plenty of neuroimaging machines in the western world, so the exercise could be done, and quickly—though it would be a bit costly. We would not need any special testing; we have got school outcomes, most of which are normalised to population bases, so we could cross-normalise internationally without difficulty. That would provide a really useful basis on which to proceed and investigate differences, threats, and the effectiveness of types of educational intervention.

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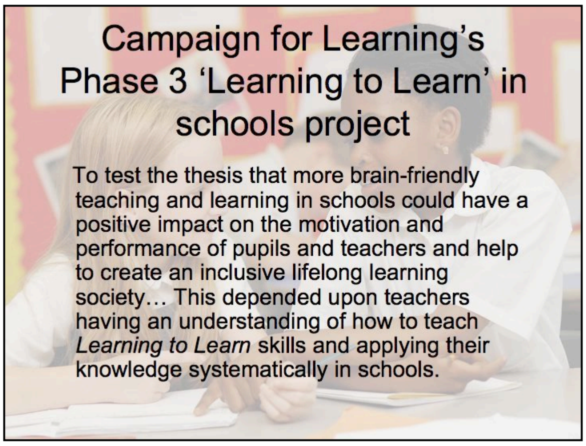
Susan Greenfield: Thank you, John. Our last speaker is Steve Higgins, who is Professor of Education at Durham University. His research focuses on the effectiveness of information and communication technologies in schools, and on understanding how children's thinking and reasoning develops. He also looks at how to support teachers in developing teaching and learning in the classroom. The subject of his talk is VAK learning approaches in the classroom.

4. VAK learning approaches in the classroom – Professor Steve Higgins, Professor of Education at Durham University

My starting point is the opposite one to that which the previous two speakers have taken, in that my research is based very much in classrooms. I am interested in the effects that teachers' practices have, their reasons for adopting new ideas, and why certain ideas are sustained, while others do not survive so well.

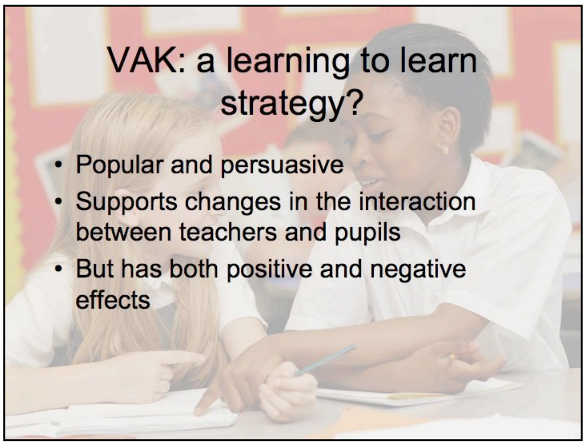
We have just seen the end of a four-year project in which I was involved that was funded by the Campaign for Learning. Its findings will be launched next week. The project was about trying to understand how findings from brain science or neuroscience could be interpreted and applied in the classroom. We supported teachers' own investigations of that, and we tried to collect the most rigorous possible evidence in order to examine the differences made by various approaches.

I have chosen a few examples from the project to illustrate what we have seen with regard to VAK in classrooms, how VAK has had an impact on practice, and the issues that surround those questions. I shall finish with a couple of points about knowledge transfer and translation, which I think is at the heart of this seminar.

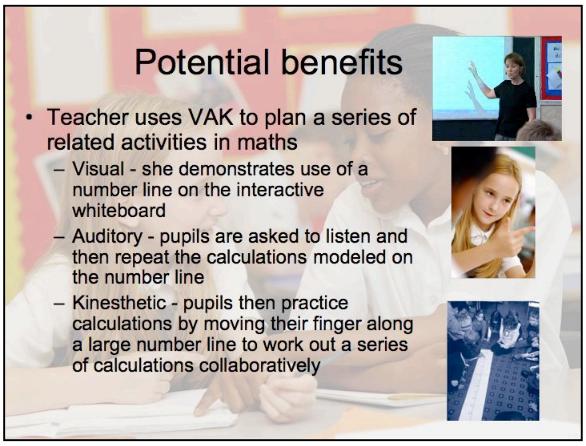


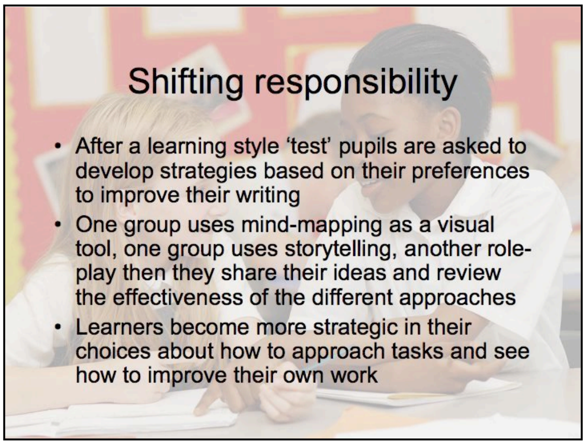
The Campaign for Learning's starting point was that learning in schools needed to change and evolve, particularly in the light of what we are learning about the brain. The project was a relatively small-scale one, so it depended on the teachers enquiring into aspects of learning in the classroom, but it included investigation of a wide range subject matters—from what Paul Howard-Jones might describe as the 'wackier' end, such as Brain Gym, through to Assessment for Learning with rigorous educational research evidence of effects on improvement of learning in classrooms. We deliberately did not take any stance on whether the basis for teachers' actions was justified; we were more interested in what actually happened when these ideas were used in the classroom.

We have already heard quite a lot about VAK, but its persistence in the classroom interests me. There was a review in 1973 by Ysseldyke that showed fairly clearly that targeting learning styles was not an effective way to improve performance. Yet the idea of learning styles has remained a powerful support for teaching practice in classrooms over the past 30 or 40 years. Whether the idea has benefits is, of course, an issue. John Geake has described the huge industry that exists around the promotion of learning styles, assessments and tools, so that might be one of the drivers, but the learning styles approach seems to have something that makes it popular and persuasive. My thesis is that it supports changes and interactions between teachers and pupils, and that this can be beneficial, although there are both positive and negative effects.



Let us look at the actual classroom and consider a teacher who wants to use VAK approaches to plan a series of related activities in mathematics. She might demonstrate the use of a number line on an interactive whiteboard—number lines are a strong visual model in maths that display the relational value of numbers to each other, rather than quantity. As part of the structure of a numeracy lesson, the pupils might be involved in listening and repeating calculations, saying what they see to start with, and then seeing what they can remember. Next, they might practise that skill on a number line. If the teacher were planning a VAK lesson, that would be a classic of the type.



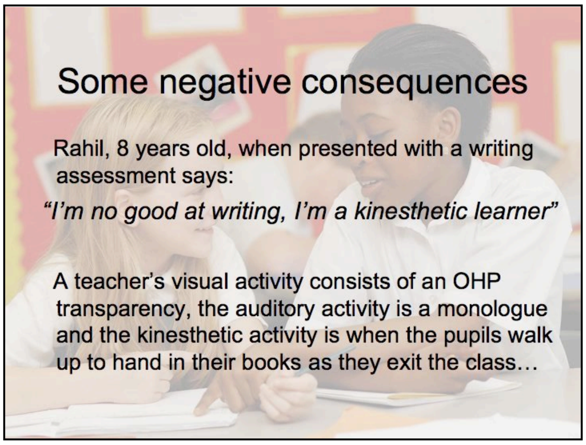


It is also, however, a really good multimodal lesson, with presentation of information in different forms that help children to make connections. It is also about repetition, with the same activities being performed in three different ways. To begin unpicking what is actually beneficial about that lesson is therefore quite difficult. From the teacher's perspective, there is a positive impact on pupils, who can show their enthusiasm in undertaking the different activities. The feedback reinforces the belief that VAK is effective and powerful.

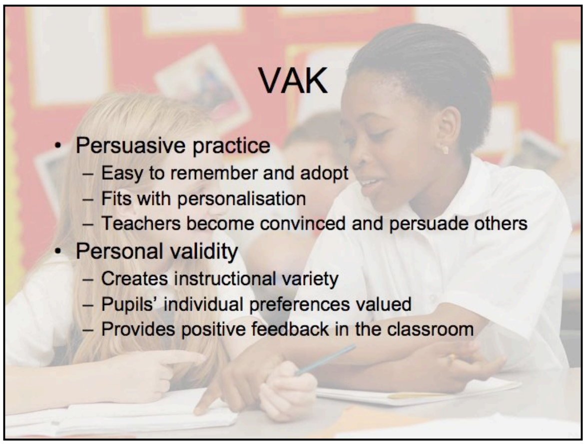
Another example in which I have been involved followed what I agree was a spurious, or at least an unreliable and invalid, VAK learning style test. Based on their preferences, the pupils were asked to develop strategies to improve their writing. They were organised into different groups, with one group using mind mapping as a visual planning tool to examine the structure of their writing, and another group—the auditory group—using story telling. In another group there was role-play. At the end of the lesson, they shared their ideas and talked about which techniques were effective.

I may have serious doubts about the reliability of the test, but what followed was a series of interconnected activities in which pupils were encouraged to think about where they were likely to be effective or less effective. The lesson also gave them a range of strategies from which they might be able to draw in the future. The lesson went well, so again the teacher's belief in VAK was reinforced. That might not have been the analysis of an outsider, but one can understand why the belief retains its power.

I am not at all claiming that all there are only benefits. An eight-year old child in Enfield made a comment that was thoroughly depressing. He said: "I'm no good at writing, I'm a kinaesthetic learner." So at that age the child had already decided that there were things that he could not do, of which writing was one, and he had a nice excuse based on his perceived need for kinaesthetic learning activities.



The final example might go a too bit far, although remarkably similar situations have actually been observed. It is the example of the teacher who claims to be using VAK without actually having changed practice at all. He or she uses an overhead transparency as the visual element, the auditory activity is the class listening to the teacher, and the only kinaesthetic part is when the children get up and hand in their books before leaving. That is an example of a teacher who does not want to change practice and who is unaffected by VAK ideas, whereas the earlier examples were examples of teachers interpreting an idea professionally and applying it creatively with the use of their professional knowledge to enhance—I would argue—the quality of their teaching.



VAK is not complex; it is just three things to remember. It is a nice, handy acronym that is easy to recall and think about when you are doing your planning; it prompts a range of activities. I believe that one of the drivers that is currently sustaining it in classrooms is the drive towards personalisation. Teachers see it as a way to 'personalise' learning.

Despite all the caveats that I might have about learning styles as a concept, the feedback from teachers who plan for different learning styles is that they have more interesting and livelier lessons, with different children preferring different parts of the lessons. That encourages them to continue, and they become personally convinced and go on to persuade others, with the result that there is growth on a professional level.

There is a therefore a level of personally validity; and in terms of the language of educational research, instructional variety is created. Some of our teachers investigated Brain Gym, or "Educational Kinesiology", as it is also sometimes known. Having looked at it in the classroom, they became convinced that it did not necessarily alter deep, underlying brain structures, as the overhead we saw earlier might have implied, but that it was a really good way of getting a break, and of getting the class to focus. Children who were perhaps less successful on the academic side could be leaders or demonstrators for the rest of the class, which meant that they had a role that they did not have previously. So the kids were more “on task” after their break; they had had permission to stop for a bit, and they went back with renewed enthusiasm. They told the teachers that they liked the approach, and some of them responded particularly well because they had not succeeded so much in other areas. All of that encourages maintenance of the belief that Brain Gym works, although how it works and what one means by “works” are complex questions.

There is another area—one that we have not yet touched on. Most teachers know that they have to compromise between individual needs and the demands of the class, and VAK is one way to help them achieve a balance from that terrible dichotomy: “What can I do that will benefit the majority, and what can I do to support individuals?”

Belief in the learning styles approach has managed to survive 30 years of educational research that has shown that it does not work—at least in a laboratory sense, with neuroscientific evidence now supporting this too. Yet something works in the classroom to maintain the practice, and I think that the notion of positive feedback is important.

We would like more rigorous, useable, and applicable evidence for what works in classrooms. However, I agree with Paul that that is a complex process. We need to look at the translation and application of research findings in the classroom. We discuss knowledge transfer, but I am not sure how easy it is to ‘transfer’ knowledge. We also need to take knowledge that was created in a scientific context, for a particular purpose, and use it for a different purpose in a different context, which, in the present case, is that of professional education. Like Paul, I would argue that we need two-way communication, because we do not want new neuromyths to start and grow. We need feedback to teachers, and feedback from them to the neuroscientists about how to make sense of the ideas in context.

Professionals, of course, apply and interpret their ideas—creatively and professionally. It is extremely exciting to walk alongside a dedicated group of teachers who are trying to understand and shape the development of practice to make their teaching more effective. It was a real privilege to do that in our project, and I am sure that the same has been true for others as well.

I emphasise the notion of translation rather than transfer; that is why two-way communication is necessary. We need to consider the sense that teachers derive from neuroscience, and how that then fits into a retranslation of the derived messages back into neuroscientific language. It is a bit like using Google translator—if you don’t quite understand the phrase, you want to run it back through the translator. That way, you might find out why it did not quite make sense.

An enquiry-based approach that supports professional judgment is the only way forward. We should look at the claims of neuroscience for what might be interesting to explore, and do that exploration on the basis of a rigorous evaluation of the potential benefits for teaching and learning, including the mechanisms of those benefits. I echo Paul's desire for more effective communication between researchers and professional educators.

5. Discussion

Susan Greenfield: I thank our speakers for so admirably setting the scene for our discussion. I am sure you will agree that there is a wide range of issues to discuss, and we have just less than an hour to do that. I suggest we structure the discussion in three parts, with the first specifically on VAK, the second on practical engagement of teachers with neuroscience and psychology, and the third on the contribution of the Teachers Development Agency to the kind of ideas that we have been hearing about. Phil Willis has kindly agreed to wind up at the end so that I do not have to.

Phil Willis MP: I had, but unfortunately I will have to leave shortly. However, my assistant, Baroness Morris, has agreed to stand in. Before I leave, I would very much like to ask a question.

Susan Greenfield: By all means. I would like to turn first to the audience members who have already identified themselves as wanting to contribute, and afterwards we can open up the discussion to the floor in each of the three areas. Doug Brown of the DFES is present. Doug, could you clarify your Department's position on the VAK learning style?

Doug Brown (Department of Education and Skills): I think one of the points that has emerged is the difficulty that we have in understanding exactly where the academic and the education communities are. From the Department's point of view we are exceedingly interested in understanding the issues, and over time we must address what comes out of a whole variety of areas. If academic communities—wherever in the world they are—begin to say that a difference is being made in education, then we are interested; we want to know about that and see what actually happens.

The problem with research in this field is that there is a whole cohort of children who are going through the process, and we cannot use them just as experimental fodder. On the other hand, if things appear to be working, it is challenging to ask people to wait until we find out whether they really are working, not least because that means that another whole cohort of children passes through the process without getting the support that they could get. The Department is very keen to understand what really does work, and to try to help teachers to become researchers themselves and to become part of the debate that has been articulated today, because their engagement is important.

I want to mention context as well, because the things that happen in the classroom and the lab' are living processes, and I have questions even about what has been said in today's speeches. For example, in relation to water one might say that the simple conclusion is, "Drink when thirsty". Structurally, however, that has not been possible—in the past, we did not allow children to drink when thirsty. So if it is true that children should indeed drink when thirsty, we need to ask questions about how to structure the educational environment to enable children to do so, and avoid recreating myths in the process.

Some time ago, Baroness Greenfield mentioned to me that there was recent research that showed possible effects of light on dyslexia. The Baroness then had some discussions with other people, and by the time she and I spoke again the message that I had received was that she had solved dyslexia! That was entirely the result of interpretation, and I was being told that our whole policy on dyslexia needed to change because the solution had been found. So it is easy for myths to grow, and the reason is that everybody in the profession wants to help to change children's lives for the better. We need better understanding, and I want to encourage the greater engagement of the type that has been mentioned, in which there are more professionals in the education sphere working with those in neuroscience and psychology and other areas.

Susan Greenfield: We have heard a lot about the personalised learning agenda. Would you like to comment on that?

Doug Brown: I am a bit disappointed if people are reading the VAK approach into personalised learning, although I can see why they might. I have to hold my hands up and say that I was one of those who went out to talk to teachers to challenge them to think about VAK. However, it is true that good teachers have personalised learning, although maybe not consciously, for years; it is what they do. They get to the point where they see a child, and ask themselves, "If the child is not understanding it this way, what can I do to help them understand?" They pick up a pen and say, "Look at it this way." That has always happened.

From the point of view of personalisation, we have to look at what happens in a class of 30 children, and at the needs of each individual in that class. Again, teachers have done that for many years, but we have now tried to articulate that there has been a pendulum swing away from treating people as large groups that just go through the system. We should articulate clearer strategies for supporting individuals within those groups.

I emphasise that that is not a matter of individualised learning; it might be that the best way for an individual to learn is to work with a group. Neither is it a matter of "one size fits all". That is true right from the Department to the classroom; we are arguing not for personalisation that only ever happens in the exchange between teacher and child, but for a structure that enables diversity, choice, different ways of learning and teaching, and different subjects. That all needs to be on the agenda, because we are seeking the best way to create an environment in which teachers and learners can perform at their best.

Susan Greenfield: I now want to open the discussion to the floor, starting with VAK.

Vito Anzalone (Advanced Skills Teacher): It is encouraging that Mr. Brown is in favour of collaborative enquiry between academics and teachers. Does that mean that the Government will loosen the straitjacket of assessment and of a "one size fits all" national literacy strategy so that we can try to respond more to the children in front of us?

Susan Greenfield: Phil Willis has his hand up. Perhaps he would like to respond.

Phil Willis MP: First of all, let me say that the presentations this morning have been fantastic. I am a former teacher who began his career working with slates and chalk, and I go back a long way. When I was being trained we looked particularly at the models proposed by the two educational psychologists, Skinner and Piaget. That never meant a great deal to me when I was teaching; it was just a matter of ticking the boxes and moving on. However, Skinner spoke about the importance of rewarded small steps in learning. In my humble view—actually I am not humble, so I should just say, "In my view"! —the research should include research on that essential element. I wondered what an MRI brain scan might show about brain functioning when children receive a positive reward, and whether part of the brain might light up. If so, that is surely at the bottom of what VAK is about—creating a rewarding outcome for the efforts that children make in gaining learning.

John Geake mentioned a question on mathematics, and I suppose that it is obvious that parts of the brain light up when someone is asked to answer a maths question. However, do we all have the same interconnectors? Does everyone's brain work in the same way? If not, there is an interesting piece of research to be done.

John Geake: I think I tried to address that somewhat in my closing remarks. The honest answer is that we do not know. The assumption is that the basic anatomical pattern of connectivity is the same, but if one makes the analogy with an electrical circuit or with plumbing, there can be pipes that let through small amounts of water, pipes that let through a lot, pipes with blockages and so on. That might be a good model of our individual differences. Until there is a database that examines those differences in a range of normal kids, we cannot really address the question.

On your earlier point, self-esteem turns out to be far more complex on the brain level than we had thought at the psychological level. There are separate brain processes for the positives and for the negatives, and the negatives have privilege. One can see from an evolutionary point of view that attending to and avoiding negatives is what has enables our ancestors to survive. That evolutionary legacy is why when we lie awake at night we are usually thinking of negative things rather than positive things.

There was a big study in California, where they are very keen on self-esteem, and the conclusion was that self-esteem comes from successful achievement, not the other way round. There is certainly some circularity, but basically it is success that is needed—that is what leads to self-esteem.

Drama teacher: I was interested in what Phil Willis said. I also agree that we are missing a common language—that is one of the problems with VAK and so on. I am a bit annoyed with presentations in which I can see great gaping holes, and whose meaning I do not understand. We need to build up a mechanism and some solid brickwork—I hate to use the word concretivity—that can actually be *used*, and then maybe some of the problems can really be solved.

The policy makers need to realise that teachers should have some of the pressure on them taken away, so that they can properly understand the language and the concepts, and have time to reflect. My colleagues are working in a pressured environment and are trying to find means and materials that will really make things happen.

Aidan Prior (Steljes Ltd.): My first point relates to Francesca Happe's work on autism and brain function, where they showed that children with autism often employ different areas of the brain to solve a problem than non-autistic children. There are quite different processes going on, even though the answer is the same.

The second point might merit inclusion in further investigative work. We are working with Professor Miguel Nussbaum of the University of Santiago, whose work you appear to know well, Steve. I liked the part of the presentation that dealt with the surprising impact in the classroom of certain factors. Professor Nussbaum has introduced a system in Chile that we are trialling in the UK. It groups children into random groups of three, and they have to self-police in a series of questions. There are various technologies to allow that to happen, but the basic point is that they co-operate as a group, and the collaboration is a stage that would not normally occur. The first thing that is surprising is that the children can be grouped in ways that teachers could never manage—the computer says they are in a group, so they accept the grouping. The second thing is that they go through a series of stages in which they get to know the answer instantly without the teacher telling them. If their answer is incorrect, that forces them through another stage of collaborative discussion, which forces them through some high-level thinking. The programme then randomly picks out a child to speak to the answer.

I have heard a number of myths in earlier meetings of this group. Sometimes, the social impact in the classroom is as important as other aspects of what technology can do.

Andrew Pollard (Teaching and Learning Research Programme): The way in which VAK has been tied in to personalisation is important. The recent Gilbert review—"2020 Vision"—does not lead on VAK, and I think that we have reached a tipping point at which there is greater understanding of the problems that VAK can cause. They were well summed up by the example that Steve Higgins cited of a child saying, “I am no good at writing, I am a kinaesthetic learner.” Any form of teaching that shuts off potential is a major problem.

A different approach emerges from concepts such as “engagement”, “pupil voice”, “assessment for learning” and so on that are used in the Gilbert review. Those concepts underpin work on children’s disposition to learn and on the building of positive learning identity, with development of a range of strategies to deploy for different learning objectives. They give a far greater sense of urgency, with pupils using their native intelligence and potential to tackle new opportunities.

The concepts provide a way to think about possibilities, rather than closed entities and capacities that are inherently limiting. Whenever we see a way of thinking in education that appears to shut things down, we should be deeply suspicious. I do not think that the personalisation agenda intends to do that, and we should all collaborate—teachers, researchers and policy makers—to ensure that the personalisation agenda and other initiatives are directed towards opportunity and building young people’s potential.

John Crookes (Qualifications and Curriculum Authority): To give the QCA perspective on personalisation, we certainly do not promote VAK as a set of distinct learning styles but do encourage teachers to use a variety of approaches to teaching that engages the learner in different ways. We find the concept of “zone of proximal development” helpful as the means to engage with what children should do next, together with assessment for learning as a means for teachers to diagnose improvement needs, and student voice as key element in the approach to pesonalisation.

The QCA is engaged with partners on a major programme of curriculum reform that emphasises the concepts of flexibility and adaptability for young people who are growing up in a changing world. There is less emphasis on content and on acquiring isolated skills, and more on the interplay between knowledge and understanding, and skills, attitudes and attributes. One area in which neuroscience could help is in understanding how the brain looks in complex situations—not just when it is subtracting seven from 100, but when it *wants* to subtract seven from 100 and understands that once it can do one subtraction calculation, it can do any. How can neuroscience show us how a brain looks when it is mastering concepts or persuading someone of a complex idea? We want children to learn and master those complex activities and we do not want the research to continue to focus on reductive approaches as it has to too great an extent in the past.

Maria Robinson: I teach social workers, health visitors, teachers and trainee teachers in early development. I wonder why the amount of time spent in teacher training in the area of child development is being reduced. Also, why is it that, despite all the brain research of the past 15 years, we still have school starting ages of 5, 4, 3 or even—in a case about which I heard recently involving a girl being sent to a supposedly very good preparatory school—2 and a half? In addition the age for application of the national numeracy and literacy targets appears to be being pushed down. Europe has starting ages of 5 to 6 and 6 to 7.

Lastly, how much collaboration exists between neuroscientists and people engaged in early years research? There is much to do on VAK learning. When I read the brain research I do not see much about whether links have been established between the findings about children who learn in a particular way at 10 or 11 and the findings in relation to two or three-year-olds, despite the various brain surges that happen between birth and the age of five years and the importance of play as the medium through which this early learning takes place. While there is debate about the developments that occur before the age of three, the early years remain a massive base for learning and for understanding later learning attitudes and motivation.

Susan Greenfield: We shall have some more comments from the floor and then the panel will give their summing-up.

Martin Westwell (Institute for the Future of the Mind): I was asked to comment generally on the collaboration between neuroscience and education. We have been running a pilot programme with a group of advanced skills teachers from Gloucestershire that has been as teacher-led as we were able to make it. It might be useful if a number of the teachers from that project who are present were to reflect on the experience and say whether it has had an impact on their practice.

Liz Pratten (Advanced Skills Teacher): I am an AST primary school teacher. We have had quite a bit of input on brain function from the project, which I shared with my year 5 class. They were fascinated. We used the image of a forest for the brain, and we talked about clearing the brain pathways of weeds by concentrating and focusing. Next Tuesday I have a meeting with a group of about eight parents to discuss what they can do at home to help dispel some of the toxicity in children's lives. I encouraged them to read "Toxic Childhood" by Sue Palmer, and they were keen to help.

I have done a questionnaire with my class to try to find out how they go to bed, and what they like to eat and drink and so on, which was quite an eye opener for them because they helped me to produce the results graphs. That was a cross-curricular activity that involved lots of IT.

At the end of last term, we had a wonderful speaker who told us to go out and create "awe and wonder". I decided that, because we had organised a fantastic music group and had played gamelans, we should study Indonesia. We are now in contact with an Indonesian school, and the children write to their counterparts at that school on a daily basis. That brings in lots of the curriculum including RE, citizenship, literacy and so on, and we will do some videoconferencing too. The kids are thrilled about it, which is the main thing, because if I have them on board we will go places.

Jeremy Wright MP: I am the MP for Rugby and Kenilworth. I have a question, and a concern.

My question is whether, given all the fascinating discussion that we have had on interconnection, we need to think more about ways to broaden the school curriculum and teach across different subjects instead of teaching in our present, very compartmentalised way, as well as doing what we have primarily discussed, which is to teach in different ways within subjects.

My concern is connected with the speed at which our knowledge of neuroscience is developing and how we factor that into collaboration between the teaching profession and neuroscientists. I hear a lot from teachers about their unwillingness to deal with a permanent state of revolution in education. They are perfectly content to learn new ways of doing things and to adapt their teaching procedures, but I believe it would be rejected and resisted if there were a notion that, every time there is a new piece of neuroscience research, there should be a radical change in teaching methods. I wonder how we can manage to develop our knowledge of neuroscience into a rather steadier development of teaching practice.

Paul Gwilliam (Headteacher): I am a headteacher at Hamstel junior school in Southend. The neuroscience research tells us the parts of the brain that are sparking at any one time, but as a teacher I want to know what I need to do to promote the development and interconnectivity of those brain parts—whether it be in teaching reading or maths. That is my challenge as a teacher to you, the neuroscientists.

Michelle Dodson (Economic and Social Research Programme): I too was going to mention the fast-moving nature of neuroscience. I am a research development leader at the ESRC, working on various areas. I lead on the commissioning of work in areas of psychology and neuroscience and understanding of individual behaviour. My perspective on the need to build connections is that of a social scientist. There is a real need to rebuild the connections that used to exist between education and psychology and to include scientists working in newer fields—especially in fields such as neuroscience which elicit such interest in improving the quality of life and education of children and adults.

ESRC has set itself a number of research challenges for the next five to 10 years, two of which are strongly allied to the seminar. One is education for life—an area in which TRLP is forging ahead. Another is in understanding both individual behaviour and the mechanism of co-operation of different social and biological determinants in that behaviour.

We are well aware of the issues on education and learning and of the need to bring scientists together. Among matters that are coming up within the portfolio of the ESRC is the commissioning of capacity clusters in the UK to look at building capacity of interdisciplinary-skilled researchers in areas such as learning and neuroscience. That will take place later in the year. There will also be a new TLRP phase on technology-enhanced learning that has recently been commissioned.

I am not sure whether the MRC is represented today, but the different research councils are keen to build multidisciplinary connections across the sciences. This area, and psychology in particular, are hugely influenced by the way in which the research councils commission their research, and we recognise the possibilities for silo effects on funding across such fields. The ESRC and the other research councils are therefore working collaboratively and have joint funding agreements to fund research that works across different sciences and communities.

The need for inquiry that builds in the various different groups has been mentioned already, and all the research councils are considering that. It is disappointing that education has not been a big element in past investment in brain sciences, which runs to millions of pounds. Every time that the ESRC has had a workshop or seminar, the same request comes up on the need for multidisciplinary working in education and learning.

I recently ran a workshop in Edinburgh on the new research challenges and on our understanding of individual behaviour, and learning was one of the key issues to emerge. So we are working towards collaboration, but we want the scientists to want to work together too.

Susan Greenfield: A forest of hands is going up, but as we have only 20 minutes left, I shall call first upon Alison Atkinson.

Alison Atkinson (Teacher Development Agency): An earlier contributor asked why child development is being reduced as an element in teacher training. It is not! — though it might appear that that is the case. The way in which the TDA works is that we set standards that teachers have to reach—and that applies throughout career stages, including for AST as well as initial teachers. How those standards are reached for initial teacher training is very much down to the providers of the training. For instance, we do not specify that neuroscience or VAK should be part of initial teacher training, but we do specify that teachers should be up to date with knowledge on teaching and that they should engage with educational research, the idea being that standards are thereby to some degree future-proofed. I think that that partly answer the question.

We hope that the standards that we set generate demand for CPD from teachers, such as on whether VAK works and why. I do not think that we see ourselves as including brain science in any format within the standards under that very name, but we hope that teachers engage constantly with what is happening in educational research.

Susan Greenfield: I want to come back to Andrew Pollard, after which we can have five minutes discussion, and then the panel round-up and a round-up from Estelle.

Andrew Pollard: I wanted to emphasise the point on interdisciplinary collaboration. We are poised to do it, but we probably need a bit of help in actually putting together the funding consortium. We need some groundswell from teachers—probably from Gloucestershire, although from elsewhere too, and we need the support of people in high places and of the funding councils and so forth.

The crucial need is for a transformation of the different forms of knowledge, each of which have validity in their own sphere, so that they are connected. We have tried to do that with the booklet, and we have put a lot of effort into its design, which includes examples and illustrations, and explanations of terminology. Doing the science is not the same as communicating it, nor indeed as having a proper conversation about it, and a careful approach is needed.

I appeal to everyone present to help to give this sort of initiative a fair wind. By the way, if anyone wants more copies of the booklet, please leave your name on the order forms that I will leave. The last booklet was on teaching and learning, and hit directly on the personalisation agenda. It has been downloaded 60,000 times now, so we know that there is a market and an interest. The teaching profession is a wonderful group of people who are interested in such things, as was said by our colleague from the TDA.

Susan Greenfield: One of the reasons why we very much enjoy organising the meetings of the All-Party Group is that it brings so many different sectors together. Let us take a few minutes for some concise questions from the floor.

Linda Siegle (Campaign for Learning): I am loth to say anything too academic when the leader of my organisation's "Learning to Learn" project is here. Gender difference is a topic that tends to be skated over. The "Learning to Learn" project involves both Newcastle University and Durham University and a number of cluster schools, and some of the classes that are involved are the subject of research into the differences between boys and girls. I am sure that there is more to that subject than preference alone. There are questions around whether separation is a good thing, where neuromyths and neuroscience meet, and what policy to adopt.

Kathy Robinson (Open University): I attended some of the TLRP series meetings, which were very good in starting to bridge the void. Paul Howard-Jones started his talk with something with which I totally agree, namely that teachers spend all day, every day, working on brain connectivity—a phenomenon that makes us uniquely human. Professor Geake then spoke about interconnectivity. My question is whether the panel would view connectivity and interconnectivity as the same. After a period during which we tended to look at the theories, I feel that there has been a refocusing on the pressure points in the classroom. That is understandable, but I believe that we also need to move out and consider some broader questions on which neuroscience and education can collaborate.

Richard Churches (Campaign for Better Teachers): I work for CfBT Education Trust, which delivers a number of large UK Government programmes. I was an Advanced Skills Teacher myself before I left teaching to work as a consultant.

My observation is that we do already know a lot about what highly effective teachers do, and there is a lot of excellent research from education departments, but I suspect that there is very little neuroscience to support any of it. That does not mean that there is not truth in what is suggested works in the classroom. Rather the different schools of research perhaps represent different types of knowledge. My question is therefore: is it worth spending time considering what we mean by 'learning?' Clearly there are different definitions at play here and I suspect that teachers, neuroscientists. psychologists and education researchers are perhaps talking about slightly different things. I believe that what we are often really doing in effective classrooms is not necessarily affecting students' learning directly (according to a neuroscience definitions) but rather creating an environment in which there is a high level of positive compliance from a large group of children, so that they feel motivated and want to learn. In that context, I personally found VAK very useful - although I am aware that there is no evidence from neuroscience to support how VAK is explained by many - if I planned my lessons to engage everybody though a variety of activities, they were motivated to learn—and somehow learning happened.

Susan Greenfield: I suggest that we hear now from each panel member on the issues that we have heard. Some of them, broadly and non-exhaustively are: curriculum, confidence, excitement and emotion in learning, reward, the meaning and limitations of scans, and gender.

Paul Howard-Jones: I was asked about whether I can tell educators anything helpful about gender, and the answer is that I cannot. I am not ashamed to say that; I believe that sometimes people have to admit that they are outside of their area of expertise.

The point that was made about dyslexia and light illustrates a general question that I think we should be asking all the time; namely, "Is this something that I should be doing in the classroom?" Do we ask the neuroscientists about that, despite them having no idea about pastoral context, or do we ask the educators, who have probably not had time to look at the literature? That sums up the whole problem, and echoes the concerns expressed by the MP for Rugby. How do we factor in the rapidly accelerating body of knowledge that we have about the brain so that teachers can use it? Personally, I feel that that will only come about through dialogue, because we do not want to ask educators or neuroscientists if they are not talking to each other.

The sorts of project that will initiate, support and produce co-constructive concepts are research projects. That ties in with the point made by Michelle Dodson about research councils, which I think hold the key to the issue at the moment. The message that I have for them might not be considered a comfortable one, however. Let us imagine that someone submits a research proposal for a fantastic collaborative project, which should include communication with teachers. Communication has to be a part of the project—there has to be co-construction and communication of useful, educationally relevant and scientifically valid concepts.

The first thing that happens to the proposal when it arrives is that someone asks whether it is going to be any good. Whom do we ask: a neuroscientist, or an educator? One of them knows nothing about pastoral context, and the other knows less than they would like to about neuroscience. We come back to the same problem, and it might be that the research councils need to reconsider their processes, because we might need a review panel that contains both disciplines. That should be one of the first forums to be set up.

No neuroscientist wants to give an alpha-plus to a proposal if they feel uncertain about the educational elements, and vice versa. One of the most common comments that I have seen about research proposals involves neuroscientists—you can always tell which review comes from which source—saying, "What is this business about learning? I don't recognise the way in which the term is being used in this proposal." The educator says exactly the same thing—and that is in relation to a fundamental term! So if we are going to transform the processes by which we produce the relevant concepts, we might need to transform the processes at the heart of our institutions.

John Geake: I certainly agree about educational pragmatism being the driver. On dialogue processes, we need to get people round a table to discuss the issues, as we have done for six or more years in Oxford. The discussion needs to be at that level as much as at policy level and at the level of seminars such as this one. Today's seminar is one of 20 forums that I have attended on educational neuroscience this year alone—the topic has become explosively interesting.

Nevertheless, we are still in the early days. In fact, we are still in the early days of neuroscience itself. Imaging has been around only for 15 years or so. So far, we have discovered that the brain is a hell of a lot more complex than we had thought. Quelle surprise! There are serious implications, however. So it would be erroneous to think that as research comes in bit by bit it will necessarily drive policy changes. The fact that we are still in the early days means that there is a great opportunity for educators to contribute to the research agenda.

For example, when we obtain structural brain data on reading deficits, it turns out to be very interesting. The hemispheres of the brain are asymmetrical. It seems that too much asymmetry predicts severe reading deficits, but too much symmetry produces them as well. There is a classic psychological U-curve. So even something as simple as that does not necessarily produce straightforward predictions.

I have an action research model that is the subject of another talk. My suggestion is that we take an educational issue as a starting point, refine it into research questions, refine those into neuroscience research questions, and then look at the neuroscience that could be relevant and informative. After that, we could expand it out to see how it looks in terms of educational application, put it back into the classroom, trial it, and put the results back into the consideration of the next question. I know that that would take a while, but we have no choice. It might be that kids in today's classrooms do not benefit, and that it will be the kids being born now who will benefit instead, but that is fine with me.

Developmental neuroscience is an interesting challenge. You cannot necessarily get anything useful from putting six-year-olds into scanners. You can get away with it with straight structural scans, if you show them their favourite DVD so that they do not move, but it is a problem with functional scans. There are baby labs, and there are new techniques on the way that involve wireless links to scanning apparatus. We might get to the stage of using a class headset—it would not be that expensive, although who would analyse such complex data?

That brings us to experimental design, which poses some of the most interesting questions. I am trying to do some interesting neuroscience about analogical thinking, and obviously I am trying to work with more complex and interesting concepts than just subtraction. The experimental design aspect of that is very difficult, however, because all neuroimaging requires a control for all the other brain activities. What is the control in the case of something so complex?

Educators could help with those challenges, because they can tell us about kids' behaviour, and that can give us clues about experimental design. The discussions in Oxford have helped in that way.

Steve Higgins: I have three points, and I shall start by trying to answer Linda Siegle's point on gender. My understanding of the psychology literature is that if we think in terms of bell curves for boys and girls, the overlap of those bell curves is greater than the difference, so most strategies will work equally for both, whereas if there was a big separation, we would be justified in taking different approaches for the two sexes.

That is not the whole story, however. There may be affective motivational or sociological reasons why certain approaches are effective, particularly, I would guess, in the early teens. Separate gender strategies might be useful, but understanding why that is the case can be a complex matter. I do not think it is about neuroscience and brain difference; I think it is more likely to be sociological and about cultural difference.

How do we deal with changing knowledge? I think we have to equip professional teachers with the skills to undertake what I call critical professional inquiry, and doing that should be a focus of the teaching profession. In that way, they can deal with new knowledge as it comes on board, make sense of it, and inquire into whether it improves things or not. A small degree of healthy change is probably a good thing in any educational system, but the extent of it is perhaps the issue.

The third and final point is that I do not think we should underestimate the challenge of multidisciplinary work. *Why* you need to know something changes *how* you know it, and afterwards—at least to some extent—it affects *what* you actually know. Multidisciplinary work and the development of a common language are always going to be problematic if things are being approached from different perspectives and for different purposes.

Susan Greenfield: I feel sad and frustrated that I have to curtail the discussion. May I ask Baroness Morris to wrap things up?

7. Round-up comments — Baroness Morris

I should like to thank our speakers for their presentations. As you said, Susan, the All-Party Group had a shorter version of this meeting that lasted for an hour. As we were being pushed out of the door of the meeting room to make way for the next group, we realised that our discussion that day was worthy of a wider debate with a wider audience. Today's event has been great, so thanks are due to Susan for organising it, and I hope that it is the first of a number of keynote seminars that will take things forward.

It is difficult to summarise what has been said in the time available, but I shall offer some 'disconnected' thoughts. In the decade before I trained to be a teacher in the 1970s, society and the education system in general thought that girls could not do woodwork and boys could not do cookery, and that working class kids could not go to university. No one here thinks that now. And what happened 30 to 40 years ago was that, within sociology, research was done as a result of which the whole world changed. That shows what is possible, and that the teaching profession and society as a whole can use research and knowledge and can change their teaching.

The changes that took place were driven by teachers in schools. And the fact that black children are now improving their educational attainment, that girls have overtaken boys in what they want to achieve, and that working class parents have high aspirations for their children could, in a crude way, be the result of the fact that the education system took on board the knowledge that came through sociology, and changed teaching.

I am a social scientist rather than a scientist by background. The problem is that a lot of us feel unable to use the language of psychology, because it is a scientific language, and as a nation we perceive scientists as specialists. We believe that we have to pass our exams before engaging with the science world. If we want to achieve, through psychology and brain science, what the previous generation achieved through sociological research, there must be a common language of understanding. One thing I loved about today, therefore, was that I understood what the panel said. Do not underestimate that—the only psychology studies that I have ever done were as part of my teacher training. I have learned that we can all engage with experts and academics about brain science, and understand it and relate it to our knowledge of teaching. Brain science will not replace what we know about teaching; it is additional to what we already do in classrooms. We do not necessarily need to unlearn loads of things; it is additive.

As has been said, it is only 15 years since resonance imaging started to be used seriously in brain science. The unanswered questions scare me a bit, so I feel myself to be somewhat back in the shoes of the sociologists of 40 years ago. We do not know what brain science will say about gender and a whole host of other things, nor do we know whether it can make a contribution to the big debate on social class and educational attainment. Does it make it irrelevant? Is there more predetermining of what children can learn than I imagined? Our headteacher colleague challenged us to ask what brain science means and how to use it to make better learners of our children. We need to understand that that can be scary for teachers, because it makes them less certain of what they are doing. We need to stay with the process, but the academics have to understand that they sometimes ask awkward questions of professionals in the classroom.

Finally, the big thing for me is the woeful relationship between research and practice in education. When I was at the Department we did not get that right, because there are so many other pressures on politicians when they make policy. I will not start talking about the *Daily Mail* and so on, but people should understand the range of pressures on politicians. It is not just about policy makers and researchers collaborating more, it is about practitioners too. That should be a three-way relationship.

The answer has to be to get teachers doing research. But to go back to the point made by the Member of Parliament for Rugby and Kenilworth, the UK education system has 240,000 teachers—let alone the classroom assistants—in 24,000 schools. When we know what something about what works, how do we change? Whenever we have found an answer, the failure has been in implementing it nationwide. How do we have language that policy makers, researchers and practitioners can use, and how do we make the laggards adapt to it as well as the eager AST teachers from Gloucestershire?

This morning has been enthralling, and I have a learned a lot. I hope that we can find ways to make progress, partly as an All-Party Group but definitely by way of the wider audience here. Let us get talking to some of the practitioners who did not choose to come today because they are not interested. Only when we get to them will we enable the knowledge that comes from brain science to benefit children.

Susan Greenfield: That was exactly the conclusion that I was going to articulate, but Estelle has done my job for me. The lessons and combined expertise that have demonstrated themselves today are too valuable to allow us to stop here, and I hope that people will take things forward in the ways that they believe to be best.

I want to introduce Martin Westwell and Jonathan Sharples, who should take the credit for organising today's event. I am sure that they would love to receive feedback. I hope that the parliamentarians will tell us how they envisage the All-Party Group serving the aims that have been set out. It is valuable for the parliamentarians to sit down with the practitioners, scientists and other people, so I hope that we can continue. I hope that we can organise what people want.

It remains only for me to thank Steve, John and Paul for making the subject so clear and for giving such exciting presentations. Thank you for coming and I hope to see you all again soon.

End of seminar

List of delegates:

Vito	Anzalone	Gloucestershire Advanced Skills Teachers
Geraldine	Atkins	Gloucestershire Advanced Skills Teachers
Alison	Atkinson	Training and Development Agency
Naomi	Austin	Gloucestershire Advanced Skills Teachers
Jonathan	Barnes	Canterbury Christchurch University
	Baroness Cox	Crossbench Peer
	Baroness David	Labour Peer
	Baroness Greenfield	Crossbench Peer
	Baroness Howe	Crossbench Peer
	Baroness Morris	Labour Peer
	Baroness Sharp	Liberal Democrat Peer
Chris	Bradley	Oxford County Council
Doug	Brown	Department of Education and Skills
Simon	Buck	Assessment and Qualifications Alliance
Geoff	Carr	Gloucestershire Advanced Skills Teachers
Richard	Churches	Centre for British Teachers
Ros	Clow	Oxford Brookes University
John	Crookes	Qualifications and Curriculum Authority
Ian	Devonshire	Institute for the Future of the Mind
Anne	Diack	Department of Education and Skills
Michelle	Dodson	Economic and Social Research Council
Ellie	Dommett	Institute for the Future of the Mind
Tony	Eaude	University of Oxford
Lynn	Erler	University of Oxford
John	Geake	Oxford Brookes University
Rebecca	Goodbourne	Campaign for Learning
Paul	Gwilliam	Hamstel Junior School
Ros	Hearne	Open University
Steve	Higgins	Durham University
Janet	Holloway	Assessment and Qualifications Alliance
Rosy	Hosking	Medical Research Council
Paul	Howard-Jones	Bristol University
Barbara	Imrie	Gloucestershire Advanced Skills Teachers
Martin	Ince	Teaching and Learning Research Programme
Sylvia	Kaniewski-Smith	Gloucestershire Advanced Skills Teachers
Sally	Law	Gloucestershire Advanced Skills Teachers
	Lord Dearing	Crossbench Peer
	Lord Stone	Labour Peer
Andrew	Pollard	Teaching and Learning Research Programme
Liz	Pratten	Gloucestershire Advanced Skills Teachers
Aidan	Prior	Steljes Ltd
Maria	Robinson	Early Development Advisor
Kathy	Robinson	Open University
Francesca	Rutter	Gloucestershire Advanced Skills Teachers
Stephen	Scoffham	Canterbury Christchurch University
Jonathan	Sharples	Institute for the Future of the Mind
Sarah	Shaw	Gloucestershire Advanced Skills Teachers
Linda	Siegle	Campaign for Learning
John	Spellar	Labour MP
John	Sweeney	Gloucestershire Advanced Skills Teachers
Zsuzsanna	Takacs	Gloucestershire Advanced Skills Teachers
Stephen	Tommis	National Association for Gifted Children
Poppy	Turner	Educational Consultant
Eva	Tutchell	Gloucestershire Advanced Skills Teachers
Mike	Walker	King Edward VI Grammar School
Martin	Westwell	Institute for the Future of the Mind
David	Whitebread	Cambridge University
Phil	Willis	Liberal Democrat MP
Jeremy	Wright	Conservative MP