The Future of Education is Science… Neuro-science

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Abstract

The idea of this endeavour came from the experience of "home-working" with kids. I was (and still am) surprised by the huge gap between the pupils' needs and the offer of the educational system. At a first glance, this gap was the consequence of the politics we were forced to accept, as a communist country (promotion of equity / equality / uniformity), but a deeper insight showed me that education is in a crisis in many countries, not necessary under the same political system. My conclusion, after a years-long research, is that the main problem of the school, as an institution, consists in keeping the pace with the always changing mental frame of the human being. Pupils have acquired already the information, and this is the result of the so-called revolution of technology, which made possible the free access to the open-sources and to the social networks all around the world.

The main goal of this study is to formulate the ideas that could allow the development of an educational system that addresses humans as whole beings – artists and scientists, poets and mathematicians as well; this education system should sustain the growth of the human being on all its dimensions, leaving behind the Cartesian classifications like "humanists" versus "scientists". In my opinion, the science of education should be more connected with the research in the fields that could offer the basis for understanding the processes that undergo learning. There are theories and methods in the science of education built on the so-called neuromyths – debunking them and involving neurosciences in the theory and practice of education could mean a leap forward to keeping the pace with the real world.

In this paper, the practical aspects of data collection, analysis, interpretation, and the management of large data sets are considered, in order to adopting of neuroimaging into a new science of education. This could be entitled the "neuroscience of education", based on some of the current issues associated with bioinformatics or neuroinformatics and neuroimaging. During a neuroimaging session, thousands of images are usually acquired, images that are then interactively post processed offline to produce an activation map. This map may be viewed and interpreted by clinicians. The neuroimaging methods could be valuable tools in the process of understanding the cortical processes that undergo learning.

Introduction

In some circumstances, our level of understanding nature is still in the tenth century, observes Richard Conn Henry, professor at the John Hopkins University, USA. One thousand years ago, Ibn al-Haytham stated that light comes from a source, travels inside the eye and is perceived. This theory is still what most people think about vision – just try to ask common scientific question to common people on the street, people virtually licensed in something after spending at least 10 years in school. Which is the reason why education – that is supposed to be a science – is so far from science? More than one hundred years passed since the theory of quantum mechanics was formulated, and we still think and teach in Cartesian terms. We still think that knowledge is the sum of the information we have, we still consider our cells like bags filled with weird things that bear sophisticated names. "The world is quantum mechanical: we must learn to perceive it as such", says Richard Conn Henry, because "one benefit of switching humanity to a correct perception of the world is the resulting joy of discovering the mental nature of Universe".

Methodology

The practical aspects of data collection, analysis, interpretation, and the management of large data sets are considered, in order to adopting of functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and single-photon emission computed tomography (SPECT) into a new science of education. Psychological functions have been assigned to certain brain areas using electroencephalography

(EEG), magnetencephalography (MEG), PET or fMRI. There are no inactive areas in the brain – even asleep, no brain area is completely inactive.
FMRI uses BOLD (blood oxygen level dependent) contrast to map neural activity in the sensory regions of the brain, and even its cognitive functions. FMRI relies on the paramagnetic properties of the more or less oxygenated haemoglobin to offer images of the blood flow in the brain, a flow that varies with the activation of the neurons.
PET uses a radiotracer (a radiolabelled compound) which is injected into the bloodstream. Sensors in the PET scanner detect its radioactivity, and the emissions of the radiotracer are processed by a computer to produce two or three dimensional images. The most common radiotracer is a labeled form of glucose (glucose is the best "fuel" for the brain, hence when a specific cerebral region becomes active, it requires more glucose).
SPECT is similar to PET – it uses gamma ray emitting radioisotopes. A radioactive tracer (SPECT agent) is injected into the bloodstream, a gamma camera records data, and a computer produces two or three dimensional images of the brain regions which are active. Compared to PET and fMRI, SPECT offers a snapshot of the cerebral flow, but a poor resolution.
The images acquired during a neuroimaging session are then interactively postprocessed to produce an activation map. This map may be interpreted by clinicians. The neuroimaging methods could be a valuable tool in the process of understanding the cortical processes that undergo learning.

A neuroscience of education

The idea of connecting cognitive neuroscience and teacher education is not new, but a forgotten one – the idea of "neuroeducators" was proposed in the 80's, when the study of brain / behaviour was considered a way to enhance the pedagogical practice [1].
To connect classroom experience and cognitive neuroscience, inter-, intra-, trans- disciplinary – holistic – approach is needed. Lately, "mind, brain and education" (MBE) has became an option. I would take a step forward in order to study the influence of the hormones during the development of the human being as a whole, not only as a brain.
The recent advances in neuroscience and the educational research may work together – a neuroscientific perspective adds a new dimension to the study of learning, and educational knowledge could direct the neuroscience research towards relevant areas. Researchers and trainers can work together to identify educationally-relevant research goals and discuss potential implications of research results. Educational neuroscience is necessary for defining a real learning science.
An effective education system has to address each individual, not only groups, and to take into account the different brain structures. In order to do this, there are some so-called neuromyths that have to be debunked:

1. "People are either right or left brained", hence, people are either logical, or creative – this is the most common neuromyth. What means "logical" or "creative", though? How do you measure creativity? If we discuss about math skills, the theory of education says that the left hemisphere – the "logic" one – will deal with it. But there are different kinds of math skills and the ability to deal with numbers comes from processing that undergoes in both hemispheres. The left hemisphere seem to be more involved in counting and reciting multiplication tables, which rely on memorized verbal information (which is considered as "logical"), and the right hemisphere is "better" in estimating. Both hemispheres make critical contributions for most of cognitive skills. "It takes two hemispheres to be logical / creative" [2].
2. "The first three years of a child are decisive for later development and success in life, because the brain is only plastic for certain kinds of information during specific critical periods" – this idea originated from studies of animal behavior, like Konrad Lorenz's critical period of imprinting in birds. But the critical periods are not so sharply delineated and are influenced by many factors. A large body of research in vision, audition and language show that different brain systems display very different amounts and types of changes with experience – a quality named plasticity (the capacity to form synapses). Some systems keep changing with experience throughout life whilst the ability to learn the sounds and the grammar of a language appears to be optimal in the early and middle childhood years, but plasticity is not limited to the first three years of life. Any kind of stimulation induces new connections between neurons, and this ability is conserved throughout whole life.

3. “Enriched environments’ enhance the brain’s capacity for learning”, hence, one of the theories of educations states that if a child has not been fully exposed to an enriched environment, it will not recover later on in life and his capacities that could be accomplished early in life are lost. The idea comes from a research on rats – those raised in an enriched and stimulating environment could solve and learn complex maze problems compared to rats raised in a deprived environment, which never recovered after moving them in an enriched environment. Human brain shows plasticity throughout the whole life and is not limited to an “enriched” environment phase during the first three years of life [3]. The concept of “enriched environment” is, by the way, arguable, as long as the beings – human or not – fully develop in their natural environments. There is a full body of research in the field of animal cognition, which shows that animals can learn to talk in human language if necessary…
4. “There is a visual, auditive and a haptic type of learning” – this is the ‘type of learner’ theory, and was formulated by Frederic Vester in his book, *Thinking, Learning, Forgetting*, first printed in 1975. This theory states that learning occurs through different ‘channels of perception’, and the type of learner – biologically determined – can be characterized by the predominant use of one channel of perception. As scientist stated, a step beyond perception is necessary – the learner needs to process the input of his senses and give this input a meaning, and this is the essential step in understanding and learning. Another Cartesian approach is Howard Gardner’s theory of multiple intelligences – although useful in stimulating people to “unpack their gifts”, it may block the fully manifestation of the intelligence itself, as a result of the human potential as a whole.
5. “We only use 10% of our brain” – one of the most stated brain myths, is still in use. All existing data shows that we use a 100% of our brains. There are more than one sources of this myth: the ratio of glia cells to neurons in the brain (10:1); the studies of Karl Lashley, who explored, at the beginning of the XX-th century, the function of certain brain areas using electric shocks. Many brain regions did not react, hence, he concluded that these regions did not have any function; it seems that Albert Einstein told to a journalist that he only used 10% of his brain, as an answer to a question concerning his intelligence, but there is no official record of this statement...
6. Myths about multilingualism: two languages compete for resources – the more one language is learnt, the more the other language is lost; knowledge, acquired in one language, is not accessible in the other language – the two languages lie next to each other in separated brain areas, with no points of contact; knowledge acquired in one language cannot be transferred to the other language; the first language must be spoken well, before the second language is learnt.

There are brain areas specialized to deal with language, and which are crucial for performing language tasks, but different parts of both right and left brain hemispheres are active during language production as well. In multilingual individuals, there is a great deal of similarity in the brain areas used for each of the languages they use. Bilinguals monitor continuously their languages in order to avoid unwanted language interferences from the language not in use and this, in turn, induces plastic neural effects. This may be the reason why bilinguals are faster than monolinguals on many control tasks that involve attention [4].

Conclusions

The contribution of the neuroscientific community to a better understanding of the human activity of learning for educational purposes is crucial, and it applies for all – gifted or disabled, young or old. These contributions may help for a better understanding of:

- optimal timing for different forms of learning, especially in relation to adolescents and older adults.
- neurobiological mechanisms which underlie the impact of stress on learning and memory. A specific question concerns the adolescent’s emotional brain interactions with different kinds of classroom environments.
- mechanisms nutrition / physical exercise / sleep / art impact on brain development;
- types of learning and cultural differences;
- multi-dimensional pathways to competences – in reading, for instance;
- “mathematics anxiety” and other barriers human being raise itself in en educational environment;
- different brain activity – neural networks, role of cognitive function and memory.

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