OUR LEARNING/TEACHING BRAINS: WHAT CAN BE EXPECTED FROM NEUROSCIENCE, AND HOW? WHAT SHOULD NOT BE EXPECTED FROM NEUROSCIENCE, AND WHY?

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Educators and neuroscientists are now working together to understand how learning and the brain are related, and how this interconnectedness will better inform our educational policies and school systems. Bruno della Chiesa, visiting lecturer at HGSE and a senior analyst at the Organization for Economic Co-Operation and Development (OECD), has been a pioneer in the development of this field. Della Chiesa conducts educational neuroscience research, collaborates with researchers worldwide, and writes books and papers that synthesise the research that has been done to give us insight into why educational neuroscience is important to the future of learning, and where future directions might lie for the field.

A former diplomat and science-fiction editor, Bruno della Chiesa is a linguist trained at the universities of Bonn and Paris Sorbonne. After his studies in France and Germany, he lived in Egypt, Mexico, Austria, France again, and in the USA. A self-defined 'pluri-cultural European', he speaks (and writes in) English, French, German and Spanish.

After more than a decade in the French diplomatic service, he joined the OECD and – in 1999, within the Center for Educational Research and Innovation (CERI) – founded the Brain Research and Learning Sciences project, considered a seminal work in the field of educational neuroscience. This led to the publication of his book, *Understanding the brain: The birth of a learning science* (OECD, 2007).

He subsequently started teaching a yearly course entitled 'Learning in a globalizing world' at Harvard Graduate School of Education (HGSE). He created and directed the Globalization, Languages and Cultures program, an HGSE-CERI cooperation, culminating in the publication of *Languages in a global world – learning for better cultural understanding* (OECD, 2012).

Bruno della Chiesa continues to work in the field of neuroscience as an editor for the *Mind, Brain, and Education* journal, and has embarked on a new endeavour that deals with future international perspectives in math and science education as related to civics, while heading International Studies at Ulm University ZNL in Germany. His work on 'promoting and raising global awareness' links educational neuroscience, language didactics, sociolinguistics, international policy and the philosophy of ethics.

Understanding (and thus, in my view, learning) is an intense pleasure for the human brain, particularly in children, from a very young age … and even at school, if possible! Albert Einstein is said to have considered it a miracle that curiosity in young human beings survives school. Unfortunately, there seems to be at least some grain of truth to this pessimistic stance. Can neuroscience help us maintain or even develop this wonderful human characteristic? If yes, how? If not, why? If 'maybe', where to draw the line?

First of all, why take interest in neuroscience? Thanks to brain-imaging technologies, we have learned more about the functioning of our brain over the past two decades than during the whole of human history. Various important discoveries around two crucial notions – brain plasticity and 'sensitive' periods – cannot be disregarded when it comes to learning (della Chiesa, 2008). Given that we now also have a better understanding of the strategies developed by the brain to manage emotions and control higher order functions, it is no longer possible to ignore this new knowledge when making decisions on educational policies and practices (even if there is of course a lot more to discover about the brain, and even if neuroscience does not make other, more traditional knowledge from reference disciplines – social sciences – obsolete). Not taking into account what is known leads to missing out on potentially important insights (Fischer et al., 2007; OECD, 2007).

Back in 1999, it became obvious to some that a dialogue was necessary, on an international level, between the neuroscientific communities on the one hand and the education communities on the other in order to answer questions of technical and scientific, social and

economic, ethical and political natures. This is how the 'Learning Sciences and Brain Research' project (1999–2008), to investigate how neuroscience research could inform education policy and practice, was born within the Organization for Economic Cooperation and Development's (OECD) late Center for Educational Research and Innovation (CERI). This transdisciplinary project brought many challenges: within the political community, participation in the project varied, with some countries resisting approval of the project altogether, at least during the first years; in the neuroscientific community, participants struggled to represent their knowledge in a way that would be meaningful and relevant to educators; within the educational community, response to the project varied, with many educational researchers resisting it for fear that neuroscience research might make their work obsolete. Achieving dialogue between these communities was even more challenging. One clear obstacle was that participants had difficulty recognising tacit knowledge in their own field and making this knowledge explicit for partners in other fields (della Chiesa, Christoph & Hinton, 2009). Thanks to goodwill on most sides, after a necessary warming-up period of observation, the dialogue started off rather well – and as a two-way street, to crown it all (OECD, 2007). But there is of course still a lot more to do (to build a roundabout, an ascending spiral …), especially given that such an open dialogue is now even more necessary than 15 years ago. In the upcoming decades, we will be confronted more and more with the following question: how do we inform citizens (parents, teachers, policy makers and others) about arcane subjects of such complexity that they can hardly be understood by anybody (della Chiesa, 2010)?

A child is born with 100 billion neurons (1011), but it seems that only 10 per cent of the neuronal connections (synapses) already exist at birth. The other 90 per cent are developed throughout life. In an adult, 1 million billion synapses (1015) link these 100 billion neurons, with an average of 10 000 synapses per neuron. And yet only 6000 genes are involved in the development of the brain: they alone cannot be responsible for the generation of billions of synapses. What shapes the neuronal structure is experience: not only learning experience but also experienced emotions – in short, everything that makes an individual's history. Of course, synaptic constructions are very dependent on the environment, be it the family, the school or the society in general. All brains are extremely promising at birth – but the individual path will positively or less positively determine what follows (Toscani, 2012).

This plasticity not only turns the brain into a fabulous lifelong learning device (Neville & Bruer, 2001), but it also makes remediation of certain learning deficits possible, even if they are not diagnosed early (although in certain countries, it is possible today to diagnose children with, for instance, a risk of developing dyslexia before the age of 12 months, which of course makes things a lot easier). Because it is during infancy that the synaptic development is the most significant; this period of life is even more important than others in terms of brain development. But it is definitely not true that everything is determined by the age of three years (or six, or 10), as is said sometimes (Bruer, 2002; Toscani, 2012). This kind of 'neuro-myth' (OECD, 2007) make parents and educators feel anxious, if not guilty, for the (dubious) benefit of a few others. Fortunately for us all, the brain remains plastic way beyond childhood and adolescence. For example, it is now known that the functional maturity of the brain goes on until the third decade of life: the prefrontal cortex, involved amongst other things in managing emotions and planning, is generally not mature before the age of 25 (but there are great individual differences, as always). This biological phenomenon explains, in part, certain attitudes of adolescents, and reinforces the notion that there is hardly a worse time in life than adolescence to make long-term decisions, let alone decisions for life (OECD, 2007), yet our education systems (and our social functioning) usually require our young people to make such choices, that are often irreversible, especially in terms of orientation ('tracking') (Bergier & Francquin, 2011; Toscani, 2013).

Deterministic views still poison our understanding of the learning brain. As an example: intelligence is still often

evaluated by what is called IQ. What does the use we make of IQ tell us about our representation of the human development, or about our belief in human perfectibility (della Chiesa, 2013) and thus in educability (Toscani, 2013)? What exactly does IQ measure, and whom or what does it serve? Is it not a means to perpetuate the categorisation of human beings? Are we still prisoners of the equation IQ = intelligence = academic and professional success (Toscani, 2012)? IQ is an artificial creation supposed to measure 'intelligence', which allows a snapshot diagnosis of specific cognitive functions – at best, of one (maybe two) of our eight (or more) 'multiple intelligences' (compare Howard Gardner's work). Tracking 'choices' for students with cognitive difficulties are founded on such scales of measurement that say nothing about their potential to develop, and actually change, over time. In the same sense, many tend to think that a child with learning difficulties does not possess the cognitive capabilities required to treat information at an operational level. Therefore, the child is put into a more 'adapted' class, is given easier tasks, and thus the child's incompetence is confirmed, and even reinforced – even, and most importantly, in the child's own eyes: self-fulfilling prophecies follow. But today it should be possible to understand that an inadequate treatment of information at school is mainly due to external phenomena: the child does not speak the language of the school or does not have the same culture (Christoph, 2012), or does not use the forms of intelligence privileged by the school (logical-mathematical and logical-verbal intelligence).

All this, reinforced by an evaluating (often devaluating) look, does not motivate the child to develop adequate cognitive behaviour. Often this point of view is opposed by the argument that IQ tests have been further developed. But they are still tests based on more than doubtful calculations. Political decision-makers have a hard time with the subject of IQ or its more 'presentable' derivations or by-products (quantophrenia in all its forms), persisting to condemn generations of children with difficulties by tracking them on the sole basis of a 'fixiste' conception that amounts to denying any potential.

This leads us to the debates concerning existing or future policies. When we have ethical decisions to make, on an individual or on a collective level, these are situated on a good–bad axis. From ethics derives politics, which can be expressed on a desirable–not desirable axis. From politics derive policies that are situated on a feasible–not feasible axis. From policy measures derive practices that lie on an efficient–inefficient axis. This, how I see a decision-making process is, of course, extremely schematic. But science will not tell us what is good or bad, what is desirable or not, be it for a child or for any human being. That is the role of ethics, thus of politics and thus ultimately, in a democracy, the citizens' responsibility. It is not up to research to solve problems of policy and practice, not even to suggest solutions (della Chiesa, 2010). Yet research, be it in neuroscience or in other disciplines, is not useless, as it at least allows new light to be shed on old debates and new questions to be asked.

But using this new light causes another difficulty. When trying to get across a scientific message to politicians, practitioners or the general public, we are obliged to use the media, which due to its logic of discourse that is incompatible with the constraints of scientific discourse, oversimplifies to the point of distorting messages, often even completely misinterpreting what is being said (Bourdieu, 1996; Chomsky & Hermann, 1989; della Chiesa, 1993, 2010).

In no case must science replace ethics when making a decision. We know only too well – if history has taught us anything – where this leads. But we need enlightened citizens more than ever before (and educating a citizen starts from the youngest age, of course); our societies are confronted with enormous challenges, especially since the questions we need to answer are more and more complex. The survival of our democracies in the 21st century may actually depend on how we will manage to rise to these challenges, in living not only as responsible citizens, but as ethical human beings enlightened by a genuine cultural and global awareness (della Chiesa, 2012; Noddings, 2005; Stein, della Chiesa, Hinton & Fischer, 2011), thus becoming, as Goethe put it, 'who we are' ('*Werde, wer du bist!*').

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