The Emerging Field of Educational Neuroscience Is Changing the Landscape of Dyslexia Research and Practice

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Educational neuroscience (AKA mind, brain and education [MBE] or neuroeducation) is an emerging scientific field that brings together researchers from neuroscience, psychology, and education to explore the neurocognitive processes underlying educational practice and theory (Ansari & Coch, 2006; Goswami, 2006; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009). The field's ultimate goals are to improve teaching methods and curricula and to maximize children's ability to thrive. The field has quickly gained momentum, especially over the past six to seven years, as evidenced by the rise in the number of related national and international initiatives, funding opportunities, and graduate programs.[1] In this brief article, we explore trends in neurocognitive research of dyslexia, some trends in the field of educational neuroscience, and how this field can influence the landscape of dyslexia research and practice.

Debate Among Traditional Cognitive Neuroscientists

Dyslexia researchers from various disciplines are discovering the neurobiological bases of reading acquisition, how it interacts with brain development, and how culture and writing systems constrain the neurocognitive processes of reading. These dyslexia researchers, who include psycholinguists, cognitive psychologists, cognitive neuroscientists, geneticists, and computational neuroscientists, may not identify themselves as educational neuroscientists. Many of these researchers now are debating whether there is a functionally specialized reading network in the human brain, or whether reading relies on one or more domain-general networks (e.g., visual attention), especially since reading is a recent cultural invention, developed only 6,000 years ago (Dehaene & Cohen, 2007; Vogel et al., 2013).

The "neuronal recycling hypothesis" falls under the functionally-specialized-reading-network category and suggests that the reading network utilizes and "recycles" existing brain circuitries evolved originally for other purposes (Dehaene & Cohen, 2007). Advocates of the domain general theory, however, suggest that there are no reading-specific networks since the brain regions shown to be important for reading are not functionally connected (i.e., do not form "communities;" Vogel et al., 2013). Finally, there is a third perspective: More and more it is believed that higher-level cognitive functions, such as reading, may rely on dynamic interactions between domain-specific and general networks (Cole et al., 2013; Fedorenko & Thompson-Schill, 2014).

[1]**Large-scale organizations** such as the Organisation for Economic Co-operation and Development (OECD; http://www.oecd.org/edu/ceri/centreforeducationalresearchandinnovationceri-brainandlearning.htm) and the American Association for the Advancement of Science (AAAS; http://www.aaas.org/event/educational-neurosciencelab-classroom); **professional organizations** focused on education such as the American Educational Research Association (AERA; http://www.aera-brain-education.org) and the European Association for Research on Learning and Instructions (EARLI; http://www.earli.org/special_interest_groups/22._Neuroscience_and_Education); on **neuroscience,** such as the Society for Neuroscience (SFN; http://www.sciencedirect.com/science/article/pii/S0896627310006380) and the Cognitive Neuroscience Society; **funding agencies,** such as the Dana Foundation (http://www.dana.org/news/neuroeducation/) and the National Science Foundation (NSF; http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5567); and **graduate programs** at universities such as Harvard (http://www.gse.harvard.edu/academics/masters/mbe/) and Vanderbilt (http://peabody.vanderbilt.edu/research/pro/vanderbilt_research/educational_neuroscience.php).

While these and other basic cognitive neuroscience questions may seem irrelevant to educational neuroscience, these questions are not only relevant but even central in providing critical information that is pertinent to understanding learning, dyslexia, and developing interventions and curricula. We now turn to major themes in educational neuroscience, especially as it relates to dyslexia.

Educational Neuroscientists and Translational Research

Educational neuroscientists, on the other hand, typically examine issues that are more translational to education in comparison to traditional cognitive neuroscientists, such as the dyslexia researchers mentioned above (Gabrieli, 2009). These researchers, as they examine dyslexia, are discovering how the brain changes with differing environments, that successful reading interventions influence reading-related networks, and that neuroimaging can play a complementary role in predicting reading outcomes. Researchers are also working to devise more sound identification criteria for dyslexia based on neuroscientific evidence.

While there are differences in the orientation of the research techniques described (i.e., basic vs. translational), both lines of work contribute to improving the identification of and interventions for dyslexia, to better understand how people with dyslexia learn, and how to best teach them. Many of those who were essential to establishing the field of educational neuroscience are researchers investigating reading, dyslexia, and related academic abilities. Hence, dyslexia research has always been central to the field of educational neuroscience.

Looking into the future, where is educational neuroscience headed, and how might it change the landscape of dyslexia research and practice?

Looking Into the Future

In the past several years, it appears that there has been a clear shift in integrating more educationally relevant theories and constructs with sophisticated neuroscientific research approaches. For example, research on reward processing has used monetary incentives and punishments historically as primary sources of motivation for a desired outcome (Liu, Hairston, Schrier, & Fan, 2011). Researchers now are translating this traditionally popular topic in cognitive science to relate to education by examining the neural circuitry underlying intrinsic motivation, and how extrinsic motivators (e.g., money, grades) may undermine intrinsic motivation and learning (Murayama, Matsumoto, Izuma, & Matsumoto, 2010). Researchers also are starting to examine the neural circuitry and affective and cognitive processes involved in stereotype threat (the belief or fear of confirming a negative perception of a particular social group, such as a racial minority group, with which one identifies), how it affects learning, and how it can be reduced (Derks, Inzlicht, & Kang, 2008; Schmader, Johns, & Forbes, 2008). These two constructs, motivational impact on learning and stereotype threat, currently do not fit into any particular field of neuroscience, such as cognitive or affective neuroscience, and represent perfect examples of research suited for the field of educational neuroscience.

Reading is a challenging skill that must be explicitly taught and learned. Learning to read can be compromised if children lack proper motivation or are impacted negatively by stereotype threat—and children with dyslexia may be particularly vulnerable. Thus, it is important that these children develop a positive “internal environment.” We define positive “internal environment” as socio-emotional characteristics and beliefs (e.g., adopting a growth mindset) that persist toward long-term goals (i.e., grit) and foster a strong sense of self that supports active participation in a supportive school climate. This is also consistent with the goals of socio-emotional learning (SEL; http://www.casel.org/), currently a buzzword in education.

None of this diminishes the importance of traditional research on reading, dyslexia, and the practice of reliable, high quality reading instruction/interventions, which always should be the top priority. However, when coupled with traditional techniques, interventions focused on engendering a positive internal environment within a nurturing external environment could be of tremendous importance in improving the future well-being of individuals with dyslexia.

In summary, educational neuroscience will continue to be an integral contributor in producing and translating neuroscientific knowledge relevant to educational practice and theory. By examining the interaction between the neurobiology of learning and its disorders—such as dyslexia, the internal environment (i.e., socio-emotional health), and the external environment—it is likely that we will see large and immediate impacts on the way we identify and provide support for children with learning challenges. This will improve both academic outcomes and socio-emotional well-being. Ultimately, our hope is that policies, standards, and curricula will be based on the best scientific research and be sensitive to evidence-based practice (www.SantiagoDeclaration.org).

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