Early Childhood and Neuroscience - Links to Development and Learning

EDUCATING THE YOUNG CHILD

VOLUME 7

This academic and scholarly book series will focus on the education and development of young children from infancy through eight years of age. The series will provide a synthesis of current theory and research on trends, issues, controversies, and challenges in the early childhood field and examine implications for practice. One hallmark of the series will be comprehensive reviews of research on a variety of topics with particular relevance for early childhood educators worldwide. The mission of the series is to enrich and enlarge early childhood educators' knowledge, enhance their professional development, and reassert the importance of early childhood education to the international community. The audience for the series includes college students, teachers of young children, college and university faculty, and professionals from fields other than education who are unified by their commitment to the care and education of young children. In many ways, the proposed series is an outgrowth of the success of Early Childhood Education Journal which has grown from a quarterly magazine to a respected and international professional journal that is published six times a year.

Leslie Haley Wasserman • Debby Zambo
Editors

Early Childhood and Neuroscience - Links to Development and Learning

Springer

Editors
Leslie Haley Wasserman
School of Education
Heidelberg University
Tiffin, OH, USA

Debby Zambo
Department of Leadership and Innovation
Arizona State University
Glendale, AZ, USA

ISBN 978-94-007-6670-9 ISBN 978-94-007-6671-6 (eBook)
DOI 10.1007/978-94-007-6671-6
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2013939788

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Educational Neuroscience and the Double Entendre

As you read the following words, jot down or at least notice the meanings that automatically come to your mind. Ready? Here is the list: *attention, plastic, enrichment*, and *concept*. If you are a teacher, you may think of attention as a socially mediated process or of moments in a classroom when children lack it due to either pathology or boredom. Like a tax, it must be minded and paid. If you are a neuroscientist, you are likely to wonder what kind of attention (spatial, selective, orienting, or perceiving) and related to which cognitive process (response inhibition, cognitive control) are we talking about? The word "plastic" may bring images of picnic silverware or possibly your ID. Plastic is a noun, an adjective, and an artificial and sometimes toxic substance but also a fundamental functional characteristic of the body's most precious and necessary organ, the brain.

"Enrichment" is a word used to describe some programs for gifted students or something extra that teachers add to curriculum when the basics are mastered. It also describes the means by which Marian Diamond discovered that the brains of rats grew more robust dendritic connections when allowed to live in more physically complex environments, and that these connections change dramatically and quickly under different circumstances. Teachers hear the word "concept" and seek to link fact-based information in one domain (the quadratic equation, the parts of speech, cycles of war, photosynthesis, iambic pentameter, harmony) to another using "system" or "pattern" to link them and create higher-level meaning and deeper, more persistent learning. Neuroscientists hear the same word ("concept") and think of "chair," "face," "tool," and "house," which are some of the most basic functional elements detected in areas of the brain's visual system by the early application of functional magnetic resonance imaging (fMRI). Herein lies the story. The fields of education and neuroscience are crossing paths on the street, starting to dance, stopping to stare in each other's windows, and even looking for the occasional blue light special. We're interested, intrigued, nervous, and cautiously aware that we are in the age where we can observe learning and performance from the outside and from the inside.

These four seemingly simple words (attention, plastic, enrichment, concept) cascade in one's mind toward vastly different meanings depending on whether you are an educator or a neuroscientist. Fortunately, due to the early crossings of these fields and exchanges between and among renowned and hearty scholars such as Michael Posner, Stanislas Dehaene, Usha Goswami, Brian Butterworth, and others, we find ourselves, today, in this place of unintended *double entendre*. Here, the real work begins. The coin flips. Are there useful concepts within domains such as reading and mathematics that readily lend themselves to examination by neuroscience? How do you represent the true nature of learning in an artificial setting like a laboratory? The complexity of a classroom is daunting to the cognitive neuroscientist wanting to pare down a process to its ramparts. The restraints of this exercise to an educator are wholly unrecognizable as learning. What are we to do?

This volume is an attempt to enter the space of this *double entendre* between neuroscience and education on behalf of learners in the earliest parts of life, the time where informal processes of learning (imitation, emotional attachment and security, and social interaction) shape an individual and turn them toward the formal processes of school. In essence, early childhood is time of free-range learning and discovery. School, at its best, retains these qualities while introducing the structures, skills, and knowledge of disciplines. As fast as neuroscience is making discoveries in the lab, we, as humans, are eager to understand new knowledge and attempt ways to apply it to better the human condition. Education is a natural consumer. The fact that this knowledge advances at such a breathtaking pace, and that in our enthusiasm it ends up extended far beyond itself, challenges us to simultaneously negotiate ourselves out of the *double entendre*. We need to access each other's vocabulary and begin to establish a shared vocabulary. We need a set of ethics, knowledge, and first principles (OECD-CERI, 2007; Tomlinson & Kalbfleisch, 1998) that will keep us from the early adoption of myth and understand that nearly every new finding will be vulnerable to this possibility due to the subjective nature of our own minds and natural tendencies to predict and pattern-find.

Indeed, early cognitive neuroscience research aimed at education and the attempt to remediate basic processes such as how the brain reads (Temple et al., 2003) or multitasks (McNab et al., 2009) show that intervention changes the brain and changes behavior. The brain is plastic; it is designed to respond to experience. One would hope to observe changes in these instances, and science has shown that we do. The gold standard of this plastic change, however, has yet to be measured. Do these changes lead to higher achievement, social success, and quality of life? What are the gains beyond increased metabolism in specific areas of the cortex and a better response time from the learner? Will these technologies become the heart of enrichment, remediation, or cognitive enhancement (Kalbfleisch, 2012)?

Yet, neuroimaging has already given us confirmation of a few ways in which contributions from these methods will spur paradigm shifts across education, society, and medicine. First, exercise is one of the single best things we can do

for ourselves; it influences the efficiency of autonomic and neurochemical processes in the body and preserves the life and function of gray matter in certain parts of the brain that support memory across life (Erickson et al., 2011). Second, neuroimaging has shown us that the brains of bullies experience basic emotional processes differently (Viding, McCrory, Blakemore, & Frederickson, 2011) but also that a picture of a pathological process in a single individual predicts nothing (a neuroscientist who studies psychopaths measured that identical functional profile in himself despite the fact that he experienced a good upbringing and lives a productive, well-respected life). Finally, neuroimaging has also shown us that comatose individuals can and do respond in their minds to requests to imagine themselves performing different types of tasks (Coleman et al., 2007). Like Alice through the looking glass, we can measure the differential nature of the biological systems that give rise to behavior. In a 2008 article designed as a neuroprimer for education researchers, I call the nervous system an "endogenous heuristic," our template for understanding the nature of learning that is present in each one of us (Kalbfleisch, 2008).

The issues of learning in early childhood, how nature and nurture contribute to early skill development and individual differences, and the impact of extreme environmental factors on learning (poverty, emotional neglect) are just some of the questions being tackled by public policy, programming, education, and neuroscience research alike. Approaching from separate paradigms, we are interested in the same issues and the same gains in young lives. As much as the vocabularies of neuroanatomy and the methods of neuroscience are important to understand, so, too, are the research methodologies and the nature of the statistics used to examine the noisy signal in the brain. Most people do not realize that most of the computational power leveraged for data analysis is designed to quiet the irrelevant and prominent noise in the signal data we acquire during a brain scan more than to enhance meaningful signal. We seek simply to detect it. Most neuroscientists do not realize that teachers also seek to optimize the signal-to-noise ratio in a classroom to optimize learning. Teachers are engineers and experimentalists every day, but how they are currently trained does not propel them to see the profession in that regard. The methods of education researchers (action research, ethnography, and other qualitative methods) properly paired with neuroscience in the research enterprise will give deeper explanatory power and avenues for translation and application. Educators and neuroscientists have the same goal, to better understand both individual and social levels of learning and to master the transformative power to assess and characterize meaningful learning. The advent of educational neuroscience provides a new way to storyboard our efforts into the same space and onto the same page. This volume provides several avenues into that space and onto that page on behalf of learning in early childhood.

Krasnow Institute for Advanced Study and
College of Education and Human Development
George Mason University, Fairfax, VA, USA

Layne Kalbfleisch, M.Ed., Ph.D.

References

Coleman, M. R., Rodd, J. M., Davis, M. H., Johnsrude, I. S., Menon, D. K., Pickard, J. D., et al. (2007). Do vegetative patients retain aspects of language comprehension? Evidence from fMRI. *Brain, 130*(Pt 10), 2494–2507.

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., et al. (2011). Exercise training increases size of hippocampus and improves memory. *Proceedings of the National Academy of Sciences, 108*(7), 3017–3022.

Kalbfleisch, M. L. (2008). Getting to the heart of the brain: Using cognitive neuroscience to explore the nature of human ability and performance. *Roeper Review, 30*(3), 162–170. doi:10.1080/02783190802199321.

Kalbfleisch, M. L. (2012). Neurotechnology in education: Intervening, enabling, or enhancing? In J. Giordano (Ed.), *Neurotechnology: Premises, potential and problems* (A volume in the advances of neurotechnology: Ethical, legal, and social issues series). New York: Taylor & Francis.

McNab, F., Varrone, A., Farde, L., Jucaite, A., Bystritsky, P., Forssberg, H., et al. (2009). Changes in cortical dopamine D1 receptor binding associated with cognitive training. *Science, 323*(5915), 800–802.

Organisation for Economic Co-operation and Development -Centre for Educational Research and Innovation (OECD-CERI). (2007). *Understanding the brain – The birth of a learning science* (2nd ed.). Paris: Organisation for Economic Co-operation and Development Publication Office.

Temple, E., Deutsch, G. K., Poldrack, R. A., Miller, S. L., Tallal, P., Merzenich, M. M., et al. (2003). Neural deficits in children with dyslexia ameliorated by behavioral remediation: Evidence from functional MRI. *Proceedings of the National Academy of Sciences, 100*(5), 2860–2865.

Tomlinson, C. A., & Kalbfleisch, M. L. (1998). Teach me, teach my brain: A call for differentiated classrooms. *Educational Leadership, 56*(3), 52–55.

Viding, E., McCrory, E. J., Blakemore, S. J., & Frederickson, N. (2011). Behavioral problems and bullying at school: Can cognitive neuroscience shed new light on an old problem? *Trends in Cognitive Sciences, 15*(7), 289–291.

Acknowledgments

We would like to thank Mary Renck Jalongo for the opportunity to be a part of this amazing series. Her vision has made it possible for us to reach educators, researchers, and parents alike and set the record straight about neuromyths.

This volume would also not have been possible without its contributors. When this volume was conceived, there was a clear call to be scientific and realistic and to temper the glorious views of neuroscience too often seen. Revealing the truth and reality of applying neuroscience to education were the challenges, and to meet these, the contributors researched the best ideas and used their common sense and practical knowledge to ground neuroscience in the realities and needs of teachers, parents, and young children. Each contributor answered challenging questions, made multiple revisions, and met time demands. As editors, we remain in awe of the bounty and depth of their knowledge, appreciate their collegial spirit, and appreciate the hard work they did to turn a vision into reality.

I would like to thank my parents (James and Joan Haley), husband (David Wasserman), and children (Timothy-TJ, Haley, and Sarah) for their continued support as I follow my educational journey.

I would also like to thank Debby Zambo for her expertise and encouragement throughout this endeavor.

Leslie Haley Wasserman

I would like to thank my husband (Ron Zambo) and my family (Nikki and Perry Parmely). You are always there to listen, challenge, and support me.

I would also like to thank Leslie Haley Wasserman who out of the blue contacted me and asked if I would like to coedit a text on young children and neuroscience. How could anyone say no?

Leslie has been the driving force of this volume because of her vision to make things better for young children. Leslie's caring nature, commitment, and knowledge have been inspiring. It has been an honor to work with her.

Debby Zambo

Contents