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EDUCATIONAL NEUROSCIENCE FOR ALL

> Teaching without an awareness of how the brain learns is like designing a glove with no sense of what a hand looks like. If classrooms are to be places of learning, then the brain—the organ of learning—must be understood and accommodated.
>
> —Leslie A. Hart, *Human Brain and Human Learning*

Early in our work with the science of learning, how the brain learns, we hit a cultural firewall. Anytime we found ourselves talking about the brain and learning, parents often construed that such science was only good for the struggling student, students who might be diagnosed with learning disabilities. However, what we quickly realized is how critical neuroscience is for all: the most advanced student, the often-overlooked "just fine student," *and* the struggling student. As an example, executive functioning, which is the ability to plan, organize, and execute, is critical for every person. It takes place in the frontal lobes of the brain, a region that is last to become highly developed, not until the mid-twenties at least. However, in the world of education, executive functioning is usually only connected to students as a "disorder."

All the way through schooling—through elementary school, through secondary school, through college, through a master's degree, and into a PhD—the prefrontal cortex is still developing. While there is a genetic component, this development, all the way through, will be affected by the

environment, by experiences that student has, and by how the student reflects upon and unpacks those experiences. This is the concept of neuroplasticity, and it is something in which schools, for better or for worse, whether they sign up for it or not, play a role.

Look more closely at the executive functioning skills that schools can influence the development of: "problem-solving, prioritizing, thinking ahead, self-evaluation, long-term planning, calibration of risk and reward, and regulation of emotion."[1] These are skills that *all* students—the most advanced students, the often-overlooked "just fine students," *and* the struggling students—can benefit from being as good at as they possibly can be.

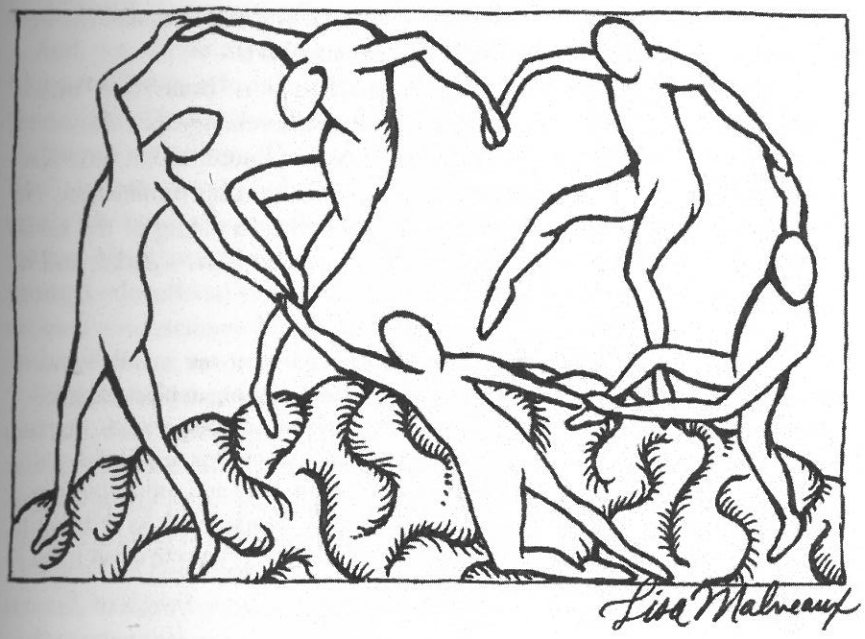

Figure 1.1. Educational neuroscience for all.

So executive functioning, a suite of skills crucial for learning, for jobs, and for life, a suite of skills from which all students can benefit at excelling, a suite of skills that schools can help grow by their deliberate actions, is relegated to something that schools dare not talk about for fear of, at best, the discussion being labeled as all about learning-disabled students, or, at worst, the school itself being labeled as an institution for learning-disabled students.

Schools have a window, in the case of executive function, at least a twenty-year window, where they can influence the rewiring of students' brains. The sad thing is that most schools either ignore or are ignorant of

the research and just leave this neuroplastic brain development to chance. We tend to start this task pretty well in early elementary education, then we tend to drop the ball monumentally, more so the older students get, thinking they will just pick up this stuff as they go. So the real nugget of gold that is "educational neuroscience for all" is that we can help *all young people, at all ages of schooling*, the most advanced student, the "just fine student," *and* the struggling student; we can help them all to rewire their brains to become better learners and higher-achieving students. By deliberate actions we take as to how we teach, how we assess, how we guide learning, we can make this happen—for all students. The first step in jimmying this nugget free to see the light of day is being able to talk about it in public without the crucial words "*for all*" being summarily dismissed, and the horribly oversimplistic label "learning disabled" attached.

First, it is critical to differentiate between the terms "brain" and "mind." In our early experience, we used these terms interchangeably. However, when we finally had the chance to listen to Nobel Laureate Dr. Eric Kandel, well known for his work on memory, speak about his publication, *The Age of Insight*,[2] we recognized our inaccurate interchanging of the terms "mind" and "brain." So what did we do? We emailed Dr. Kandel, and he brought clarity to our thinking:

> This new science of mind is based on the principle that our mind and our brain are inseparable. The brain is a complex biological organ possessing immense computational capability: it constructs our sensory experience, regulates our thoughts and emotions, and controls our actions. It is responsible not only for relatively simple motor behaviors such as running and eating, but also for complex acts that we consider quintessentially human, such as thinking, speaking, and creating works of art. Looked at from this perspective, our mind is a set of operations carried out by our brain.[3]

As educators in this field, we sound a lot more believable when we say, "our mind is a set of operations carried out by our brain."

Second, we have found that discussions go much better when you talk about "excellent teaching" rather than "helping students learn best." One begets the other, but the former is something that every parent in the world wants—the best teaching that it is possible to get, regardless of school type, geographical location, or tax base. Whereas the latter tends to bring about a reactionary, "My child doesn't need any help with that; what are you implying?"

Third, there is a lot of research in the field of mind, brain, and education (MBE) science about what excellent teaching entails, and what it most

definitely does not include as laid out in "the unconscionable list" and "top twelve" lists in chapter 3. The research is emerging, and the lists are not complete, but teachers, acting as teacher-researchers (which we discuss in chapter 12, "Teachers Are Researchers"), will play a crucial collaborative role in helping the lists evolve.

So we are at a point when we can start explaining educational neuroscience for all. We can help all students rewire their brains to increase how their minds can perform. We can do this through excellent teaching. And "excellent teaching" is not just a nebulous statement; it involves teachers doing *these* practices and not doing *those* practices. The exact nature of these practices will look different, varying with the contexts of each individual classroom, but there is now sufficient MBE research to create these lists.

And, yes, we do mean all students: all ages, all abilities. However high a flier a student is, educational neuroscience for all can make that student fly even higher (it can also help the student fly in interesting new directions, and, as an added benefit, get more sleep as he or she does so). The "just fine" student, the one who, well, is doing just fine, who "falls through the cracks" in most schools, the one whom education books typically are not written about, can increase his or her skills, knowledge, and confidence through educational neuroscience for all. For the struggling student, educational neuroscience for all can help increase his or her skills, knowledge, and confidence, too.

Educational neuroscience for all involves teachers doing *these* practices and not doing *those* practices. Educational neuroscience for all involves school and political leaders setting a bar that requires doing *these* practices and not doing *those* practices with students. Educational neuroscience for all involves parents demanding schools do *these* and not do *those* practices. The goals of this book are thus twofold: first, to convince you this is true; second, to show you what these practices are.

Assuming that we are now able to engage in a dialogue about how neuroscience really can benefit all students, the high flier, the "just fine," and the struggling student, we can start thinking about how this might be done. The first step is training teachers in a neurodevelopment model, which research says is a key step in improving student performance.

As of 2016, four neurodevelopmental training models exist: Neuroscience and the Classroom,[4] The Brain Targeted Teaching Model,[5] All Kinds of Minds,[6] and Brain and Learning/The NEA Foundation.[7] They have different levels of research, and different levels of practical application, but all have been important steps in showing that it is possible to get ideas from the world of academic research into a form where it is usable by teachers.

Furthermore, research by Professor Mariale Hardiman of the Johns Hopkins University School of Education, and creator of *The Brain Targeted Teaching Model*, suggests that doing so improves students' learning.[8] In *Neuroteach*, we want to build on this work to meet the needs of teachers who want to implement research-based strategies to transform their practice, assess the impact of what they try, and do so in a sustainable way.

One of the most important things these models give a teacher is a neurodevelopment lens through which to view each student, their course, or class on a thirty-thousand-foot overhead-view level, and the week-to-week or day-to-day implementing in the classroom level.

For example, let's juxtapose All Kinds of Minds[9] and Howard Gardner's theory of multiple intelligences. Research suggests that a common misinterpretation of Gardner's theory of multiple intelligences—that teachers should be tailoring instruction to meet each individual student's strengths (linguistic; logical-mathematical; bodily-kinesthetic; musical; interpersonal; intrapersonal)—is actually a neuromyth[10] (as is the idea that people are either left-brained or right-brained).[11] Teachers should not be tailoring instruction to meet each individual student's strengths. Instead, research suggests although each student has individual learning preferences, all students learn best when taught in a variety of modalities. The best modalities to use will vary from concept to concept. Teachers should differentiate based on content, not learning style.[12] This misrepresentation of Gardner's work is, unfortunately, quite pervasive.

A more correct interpretation of Gardner's theory of multiple intelligences is that individual differences exist—each person is better at some of them, worse at others. The All Kinds of Mind framework provides three levels of categorization to provide finer distinctions in a similar vein to Gardner's multiple intelligences, but this time in terms of neurodevelopment demands that might be placed on the brain; its eight broadest categories (called "constructs") are memory, attention, language, spatial ordering, temporal sequential ordering, neuromotor functions, social cognition, and higher-order cognition.

It was originally conceived as a way to characterize the strengths and weaknesses of struggling students with an eye to helping students identify their strengths and leverage them to address their weaknesses—a way to identify and address individual differences. This is good, and it definitely works as a tool to do this, but we found a much more powerful use for it that benefits all students.

Whenever we give All Kinds of Mind workshops, there is a real "aha!" moment—teachers realize that the greatest power of this framework is as a

lens through which to see and manipulate their courses at the day-to-day, week-to-week, and thirty-thousand-foot level. Each academic discipline and each content area within a subject has neurodevelopmental demands that are germane to it. The All Kinds of Mind framework allows teachers to align the neurodevelopmental demands inherent in the material they want to teach with the neurodevelopmental demands of how they teach it and the neurodevelopmental demands of how they assess it. When they do this, it benefits all learners, not least because there is a "fairness" that students see and appreciate.

But it goes deeper than this. Viewing their classes through this lens tends to unleash innovative, creative teaching and assessing, which tends to foster student motivation and engagement, and it leads to teachers differentiating more, which helps all learners. It also helps teachers balance out the neurodevelopmental demands they are placing on their students day to day and week to week. For instance, this way, memory storage and retrieval and language processing do not get hit day after day after day.

Instead, *these* demands might be placed on a student for a while, before the teacher deliberately switches to placing *those* demands, all the while bearing in mind the demands inherent in the subject. Furthermore, by adding variety to the demands they are placing on their students, teachers are making their class more challenging while at the same time fostering engagement—more challenging because in order to get a top grade, students now have to master a greater variety of neurodevelopmental demands.

Struggling students may be asked to do things that they find themselves better at; the best and brightest might be made to struggle for a while; the "just fine" students will not be coasting along in a comfortable groove, but rather moving from tasks that they find easier to tasks that they find more challenging. Teaching teachers a neurodevelopmental framework both inspires and equips them to vary modalities of teaching and assessment, and differentiate based on content rather than learning style—all these, as we mentioned before, are factors that research says lead to increased learning.

By equipping teachers with a neurodevelopmental framework, a new lens through which to view their craft, we have made one step along the path of educational neuroscience for all. Two more steps come by using methodologies from the Top Twelve list and avoiding one on The Unconscionable List. More steps are outlined in the following chapters. But we want to end by taking one further look at how educational neuroscience for all applies to the best and the brightest, the highest of fliers, and thus to everyone.

Think of students who are good at listening to their teacher, reading their textbooks, and remembering what they hear and see. Typical school tests, that staple of grading, are pretty easy for them. How do you push these students? How do you build their resiliency? You could give them more to read, more to memorize, and maybe a shorter time in which to do it. But is this really stressing them? It might cause them stress, yes, but they fundamentally know that the task ahead of them is something that they are able to do. Maybe they are self-aware enough to know that it is even something they are good at.

The crunch of "not enough time!" to do something that you know you could do if you had a bit longer is different than the stress that comes from knowing that the task ahead is something that you are not good at, that failure, absolute failure, is a possible outcome. Don't worry; tolerable stress, as we learn in chapter 7, can be a good thing if it occurs in short duration and in a supportive community. How do we get the best and the brightest out of their comfort zone? How can we put them in situations where they realize that to succeed they will have to build new competencies, knowledge, and confidence? Knowledge of a neurodevelopmental framework gives a teacher a great toolkit to do this.

To answer this question fully, we need to explore another tendril of "educational neuroscience for all!"—the nature of intelligence. Humans have long attempted to define what intelligence is. Contemporary views see psychometric intelligence, the intelligence of IQ and standardized tests, as an important component of intelligence, but not the only component (this was the major theme of the 2014 Learning and the Brain conference in New York). A broader definition of intelligence certainly includes creativity[13] and maybe a category that we could call personality or social intelligence, which includes factors like resiliency, motivation, curiosity, and social cognitive ability.

Furthermore, intelligence does not reside in one spot in the brain, nor does creativity, but rather involves networks of parts of the brain, all working together. Scientists have now mapped out the brain network responsible for psychometric intelligence and also the brain network responsible for creative intelligence—and, unsurprisingly, they are different. The brain network for social intelligence is different still. This means that being good at one of these three forms of intelligence does not necessarily mean you are good at the others.

One of the huge ideas to come from the field of MBE science is that intelligence is not fixed at birth. The nature versus nurture debate has been settled; the answer is that it is a combination of both. Genetic differences and environmental effects, particularly in early childhood, lead to individual differences. We are all stronger or weaker in one form of intelligence than others. But neuroplasticity means that as we work with children in schools, we have the potential to help students rewire their brains to improve their performance, to some, but significant, degree, in all three of these intelligence areas.

Psychometric intelligence, creativity, and personality/social cognitive ability: which of these does traditional schooling emphasize and incentivize? We suggest that schools put too much of their emphasis on psychometric intelligence at the expense of the others, and it is time to redress that imbalance. If intelligence is a three-legged stool, it will always be able to sit there no matter how different the lengths of the legs are—but would you want to stand on it? So part of "educational neuroscience for all!" means developing a broader definition of intelligence in all students; for example, just because a student has high test scores doesn't mean he or she is creative. Neuroplasticity means we can address that, and a look at the work world students will one day enter means we should address that.

To emphasize why this is important, consider Tony Wagner's list of seven critical competencies, compiled following interviews with hundreds of business leaders to discover what skills young people need to be successful, to close what he calls "the global achievement gap."[14] These are the skills that are needed, but that are, Wagner amongst many others argues, too rare in those entering the workforce:

- Critical thinking and problem solving
- Collaboration across networks and leading by influence
- Agility and adaptability
- Initiative and entrepreneurship
- Effective oral and written communication
- Accessing and analyzing information
- Curiosity and imagination

Which of Wagner's "seven survival skills" rely exclusively on psychometric intelligence? Which don't? Where does creativity come into play? What about personality and social cognitive ability? Remember, there are different brain networks at work here, and having high psychometric intelligence does not necessarily mean you are strong in other forms of intelligence. Schools put a lot of focus on psychometric intelligence; but what about other forms of intelligence?

Think again of those students who are good at listening to their teacher, reading their textbooks, and remembering what they hear and see. Most assignments in most schools are pretty straightforward. School is challenging, but mostly because of the gargantuan quantity of work—particularly homework—that students have to do, as we discuss in chapter 10, not because of the cognitive complexity of individual tasks. They are getting good grades. But isn't their education selling them short? Think of all the other amazing, challenging, deeply engaging cognitive tasks we could be putting in front of them.

Imagine you were given the chance to design a school that really sought to develop students in the most critical knowledge, skills, and mindsets. What would it look like? What would you incentivize? What kinds of tasks would students do? Would it look like most schools today?

In chapter 10, "Homework, Sleep, and the Learning Brain," we introduce the toxic effect that Dr. Denise Pope at Stanford University calls "doing school." Educational neuroscience for all means changing our practice so that we make the fundamental shift from "doing school" to learning. Look at a kindergarten classroom. Intellectual curiosity and intrinsic motivation abound. The children here are not "doing school." There tends to be a palpable energy and passion around learning. Where does this go? How do we get it back at every grade level? What a fabulous challenge that would be.

Without looking back from this page, what are the *three* most salient points you take away from this chapter of *Neuroteach*?

What are *two* things you would like to do "tomorrow" with the information you learned from reading this chapter?

What is *one* question you have after reading this chapter?

NOTES

1. "Young Adult Development Project," retrieved from http://hrweb.mit.edu/worklife/youngadult/brain.html (accessed October 13, 2014).
2. Eric Kandel, *The Age of Insight: The Quest to Understand the Unconscious in Art, Mind, and Brain, from Vienna 1900 to the Present*, first edition (New York: Random House, 2012).
3. Eric Kandel, personal communication.
4. "Neuroscience and the Classroom," retrieved from https://www.learner.org/courses/neuroscience/.
5. "Mariale Hardiman's Brain-Targeted Teaching Model," retrieved from http://braintargetedteaching.org/.
6. "All Kinds of Minds," retrieved from http://www.allkindsofminds.org/.
7. "Online Courses // The NEA Foundation," retrieved from http://www.neafoundation.org/pages/courses/.
8. R. M. JohnBull, M. Hardiman, and L. Rinne, "Professional Development Effects on Teacher Efficacy: Exploring How Knowledge of Neuro- and Cognitive Sciences Changes Beliefs and Practice" (paper presented at the AERA conference, San Francisco, CA, 2013); M. Hardiman, R. JohnBull, L. Rinne, J. Pare-Blagoev, E. Gregory, and J. Yarmolinskaya, "How Knowledge from the Science of Learning Influences Teaching Practices and Attitudes" (in preparation).
9. Since 2007, 100 percent of St. Andrew's teachers have been trained in the All Kinds of Mind neurodevelopmental framework, which explains our choice here.
10. Paul Howard-Jones, *Introducing Neuroeducational Research: Neuroscience, Education, and the Brain from Contexts to Practice* (New York: Routledge, 2010).
11. Mariale Hardiman, *The Brain-Targeted Teaching Model for 21st-Century Schools* (Thousand Oaks, CA: Corwin, 2012).
12. Mariale Hardiman, presentation to CTTL Neuroeducation Leadership Institute, 2013.
13. Rex Jung, presentation at Learning and the Brain Conference, New York, 2014.
14. Tony Wagner, *The Global Achievement Gap: Why Even Our Best Schools Don't Teach the New Survival Skills Our Children Need—And What We Can Do About It*, first trade paper edition (New York: Basic Books, 2010).