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Brain-Friendly Strategies



INSIGHTS FROM A NEUROLOGIST AND CLASSROOM TEACHER



Brain-Friendly Strategies for the Inclusion Classroom

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INTRODUCTION

Historically, teachers in regular classrooms have not felt prepared to teach exceptional students, preferring to leave the job to trained specialists. But times and laws have changed, and most classrooms today have at least some inclusive aspects to them. Brain research has provided educators with a better understanding of instructional practices that not only are essential for students with special needs, but also benefit their peers. These new tools will both help teachers face the challenges of teaching an inclusion class and make teaching more fruitful and rewarding.

THE LEARNING BRAIN

It is only relatively recently that cognitive neuroscientists have begun to study how our brain structures support mental functions. The late 1960s saw the conception of computerized axial tomography (also called CT or CAT scanning), which offered neuroscientists their first opportunity to look inside a living brain. The CT scan uses a narrow beam of X-rays to obtain multiple two-dimensional images of the brain in the form of a series of slices, or cross-sections. From these images, a computer can generate a three-dimensional image of the brain, thereby allowing for analysis of the brain's internal structures.

Today, the three most important tools used in brain research are the positron emission tomography (PET) scan, functional magnetic resonance imaging (fMRI), and the quantitative electroencephalogram (qEEG).

PET scanning produces a three-dimensional image of functional processes in the body based on the detection of radiation from the emission of *positrons* (tiny particles emitted from a radioactive substance administered to the subject in combination with glucose). As the subject engages in various cognitive activities, the scan records the rate at which specific regions of the brain use the glucose. These recordings are used to produce maps of areas of high brain activity with particular cognitive functions.

The fMRI measures the metabolic changes that take place in an active part of the brain. The technology behind fMRI makes use of the fact that oxygenated blood shows up better on MRI images than does nonoxygenated blood. Because active regions of the brain receive more blood and more oxygen, scientists can use fMRI images to determine which areas of the brain demonstrate more activity.

The qEEG uses digital technology to measure electrical patterns at the surface of the scalp, which primarily reflect cortical electrical activity, or brain waves. This brain wave monitoring provides brain-mapping data based on the precise localization and timing of brain wave patterns coming from the parts of the brain actively engaged in processing information.

All of these tools can help educators grasp the series of steps that occur when students learn. This information pathway begins when students take in sensory data. Their brains generate patterns by relating new material with previously learned material or by “chunking” material into pattern systems it has used before. The patterned data then pass from sensory response regions through the emotional limbic system filters. The limbic system—a group of interconnected deep brain structures involved in olfaction, emotion, motivation, behavior, and various autonomic functions—has a strong influence on the formation of memory. After passing through the limbic system, the data go to memory storage neurons (short-term, relational, and, ultimately, long-term). From the memory storage neurons throughout the cerebral cortex (the surface layer of gray matter of the cerebrum that coordinates sensory and motor information), information can be activated and sent to the executive function

regions of the frontal lobes. These regions are where the highest levels of cognition and information manipulation—forming judgments, prioritizing, analyzing, organizing, and conceptualizing—take place.

GRAY MATTER



The basis of all memory is a chemical change that takes place in neurons. Most of the brain's neurons are located in the *cerebral cortex*, the outermost layer of the brain. This area is also known as *gray matter* because of the darker color of the neurons, compared with the lighter *white matter* made up primarily of the connecting and supporting cells, axons, and dendrites that bring information to and from the neurons. Every lobe of the brain is covered by its cerebral cortex packed with neurons. The lobe of the brain that the cortex surrounds determines which conscious activity the cortex's neurons will mediate, such as language, speech, perception, or voluntary motor activity. The neurons controlling such executive function processes as planning, problem solving, and analyzing are contained in the layer of cortex that covers the frontal lobes.

THE PROMISE OF BRAIN RESEARCH

Brain research has been a springboard for mind-blowing advances in teaching practices. We are learning to translate neuroimaging data into classroom strategies designed to stimulate parts of the brain that are metabolically activated during the stages of information processing, memory, and recall. My 25 years of experience in the field of child and adult neurology, as well as my background in education, have also helped me make connections between brain research and effective teaching practices.

We must, however, remain cautious about believing all claims made in the interpretation of functional brain imaging, especially those coming from special interest groups. In my medical practice, I often observe biased interpretations of medical research made by

representatives of pharmaceutical companies. Similarly, vested interest groups in the education field, such as curriculum sales departments, brandish colorful brain scans as proof that their strategy, program, or educational therapy is the best, even though critical analysis of these scans does not support their inflated claims. Although high-quality peer-reviewed brain research can provide hard biological data, educators need to be able to sort spurious claims from valid information.

GRAY MATTER



Reevaluations of some early PET scan research interpretations have given us reason to be cautious about which research is valid enough to connect with actual learning.

During my chief residency at UCLA in 1979, one of my senior residents, John Mazziotta, now chair of the UCLA Department of Neurology, was working with the new PET scanner and conducting research with Michael Phelps and Harry Chugani to evaluate the brain metabolism in patients with seizures and other disorders affecting neural activity. In 1987, this group published the first research evaluating brain development in children. In a study of 29 epileptic children ranging in age from 5 days to 15 years old, the researchers determined that the highest rate of glucose metabolism occurred at age 3 or 4, when the rate was twice that of adults. This high metabolism remained relatively unchanged until age 9 or 10, when it began to drop down to the adult range. By age 16 or 17, the metabolism had leveled off (Chugani, Phelps, & Mazziotta, 1987).

The researchers did not intend their findings to be used as proof that the age of high brain metabolism was an especially opportune time for teaching interventions, and problems arose when people assumed that this information implied more than it actually did. For example, it turned out that there is a correlation between the age when synaptic density is greatest (Huttenlocher & Dabholkar, 1997) and the age when glucose metabolism is greatest. However, this finding

does not prove that the reason for the greater metabolism is to maintain the greater density of synapses, or that either synaptic density or brain metabolic activity is the direct cause of any potential for greater learning during those years (Chugani, 1996).

In fact, Mazziotta and his colleagues never claimed that periods of high metabolic activity were the optimal periods for learning to take place. That may well be the case, but further cognitive research is necessary before we can make scientific claims linking brain synaptic density, metabolic activity, and potential for optimal learning

What we can recognize is that scientific evidence from genetic research and neuroimaging studies has demonstrated the neurobiological basis of learning disabilities. Understanding the differences in how brains process information is helpful in understanding that students with learning disabilities are not incapable of learning or performing tasks. Rather, their brain processing in certain brain regions and networks is often merely less efficient—slower or less precise. In fact, it is possible for slower-developing brain regions to catch up to normal growth, changing students' learning strengths dramatically. Therefore, the label of *learning disabled* should not be considered permanent, but rather a guide for students' states of brain readiness at a point in time. Keeping this distinction in mind, we can best help these students by putting in place strategies, accommodations, and interventions that cognitive and functional imaging studies have shown meet their specific needs (Fiedorowicz, 1999).

At this early stage, we must rely on our best interpretations of neuroimaging research to guide our teaching practice. By using research conducted according to objective scientific criteria and interpreted by researchers without personal stakes in the outcomes, we can greatly increase our ability to align instructional goals with the brain functioning patterns of our students. It would be premature and against my training as a medical doctor to claim that any

of the strategies I suggest in this book are as yet firmly validated by the complete meshing of cognitive studies, neuroimaging, and classroom research. For now, a combination of the art of teaching and the science of neuroimaging will best guide educators in finding the most neuro-*logical* ways to maximize learning.

BRAIN RESEARCH-BASED STRATEGIES IN THE CLASSROOM

As educators in inclusion classrooms, we want to support our exceptional students while not letting our focus on their learning differences diminish the quality of teaching for the rest of the class. Fortunately, brain research has confirmed that strategies benefiting learners with special challenges are suited for engaging and stimulating *all* learners. Each student is a unique learner with individual interests, talents, life experiences, and goals. Although standardized testing attempts to provide objective criteria for labeling students as special-needs, the designations remain arbitrary numbers on a grid. A more accurate picture is a continuum. Wherever students fall on this spectrum, they all differ from one another in various ways and to various degrees. Teachers who can engage and connect with the students at either end of this spectrum will be better prepared to connect with the students who fall in between.

For example, brain research has shown us the positive or negative effect that students' emotional states can have on the affective filter in their amygdalas (a part of the limbic system connected to the temporal lobe). Additional evidence now demonstrates the multiple benefits of the dopamine release that accompanies students' expectation of intrinsic reward. This research has given us techniques that, although originally designed for exceptional students, can be successfully adapted for all learners. It is becoming clear that special education students and general education students have more similarities than differences.

We can identify the practices that benefit all learners by looking at the skills most heavily emphasized in special education classes:

time management, studying, organization, judgment, prioritization, and decision making. Now that the brain imaging research supports the theory that students process these activities in their executive function brain regions, it appears that brain-compatible strategies targeting these skills will benefit all students.

Even high-achieving students do not appear to have equal strengths in all of the recognized executive functions. Many students at the top of the class academically may be using their superior intelligence or creativity to make the adaptations they need to compensate for a deficit in one or more of their executive functions. If these top students are so successful without instruction in the executive function strategies, consider how much more successful, more creative, and less stressed they might be if strategies to improve these skills were incorporated into the general curriculum. Research has borne this out: high achievers in inclusion classes that teach and practice executive function cognition strategies become even more successful in their academic, time management, analytical, and organizational skills (Stainback & Stainback, 1991).

In this book, I offer some background on the brain research examining how the “average” student learns, contrasted with exceptional students’ unusual brain responses to sounds, numbers, emotions, people, external stimulation, and written and spoken words. Most of the strategies I suggest in this book are compatible with research showing how the brain seems to preferentially respond to the presentation of sensory stimuli. Understanding this brain learning research will increase educators’ familiarity with which methods are most compatible with how students acquire, retain, retrieve, and use information.

CONTINUOUS GROWTH FOR ALL

Just as physicians are not specialists in all fields, general educators cannot become experts in all areas of exceptional student education. There will always be a need for specialists. Yet just as parents partner with their child’s physician concerning medical care, teachers