

# Principal's Research Review

Supporting the Principal's Data-Informed Decisions

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## Debunking Myths in Brain Research

by Amany Saleh

**T**he brain is the most complex physical entity in the universe (Gunn, Richburg, & Smilkstein, 2007). As our knowledge of brain functions increases and evolves so does excitement in the field of education about the implications for students' learning. Knowledge of how the brain learns is a great tool for helping educators design curricula and adapt teaching strategies to help students realize their potential.

### The Brain: Structure and Function

The brain is a three-pound mass roughly the size of a grapefruit. The exterior parts consist of the frontal lobes, which deal with planning and thinking; the temporal lobes, which deal with sounds, speech, and long-term memory;

the occipital lobe, which is in charge of visual processing; the parietal lobe, which deals with orientation, calculations, and some types of recognitions; and the motor cortex, which controls body movement (Sousa, 2006).

The brain is composed of over a trillion different types of cells. Nerve cells or neurons constitute one-tenth of all cells and are held together by glial cells that protect the neurons and regulate the rate of "firing." The neurons have tens of thousands of branches called dendrites that facilitate communication among neurons along fibers called axons. Each neuron has an axon. Between each neuron and axon, there is a small gap called the synapse in which neurons collect signals from other dendrites. The neurons send electrical impulses to the synapses, which release

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### Just the Facts

- Teaching students how to recognize and control their emotions is as important as teaching academic skills.
- Students have to feel safe in the classroom in order for learning to take place. Threats were found to impair brain cells and negatively affect learning (Jensen, 2006).
- Opportunities for students to practice their learning and experience success; clear directions and expectations; and precise, constructive feedback help students set reasonable goals for themselves (Tileston, 2005).
- Although there is adequate evidence of brain hemispheric specialization, our increased knowledge of brain processing has demonstrated that specialization does not mean exclusivity. Both hemispheres collaborate to process input.

chemicals called neurotransmitters. This process is referred to as “neuron firing.” Neurotransmitters can inhibit or accelerate the firing among neurons and affect students’ learning (Earlauer, 2003).

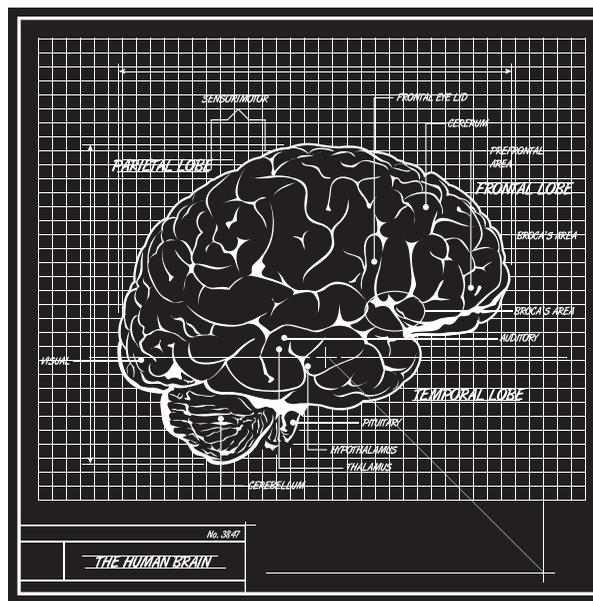
Neurons are the only cells in the body that are capable of producing an electrochemical impulse, which allows the neurons to communicate with each other (Given, 2002). The neurons’ activity depends largely on the perceived emotional value of the input received. If neurons don’t form enough synaptic contacts, they are pruned away in a process called apoptosis that protects the brain from being overloaded with its own cells and strengthens the exiting connections (Wolfe, 2001).

The hippocampus transfers information from the short-term memory to the long-term memory. The amygdala plays a major part in storing information in the long-term memory by attaching an emotional value. The cerebrum is the largest part of the brain and is divided into two halves called the cerebral hemispheres that are connected by a thick tissue called the corpus callosum. The frontal lobes are in charge of memory and higher-order thinking. The cerebellum, located in the rear of the cerebrum, is in charge of learning, performance, and timing of complex motor skills (Sousa, 2006).

### How the Brain Learns

Sprenger (2007) describes learning as an input of information through the senses. All information, except smell, is transmitted to the thalamus which sorts information to send to the various parts of the cerebral cortex. If information is perceived to be important, it is transmitted to the hippocampus. The information is analyzed and identified in terms of patterns or meaning by the neocortex.

The hippocampus is responsible for sending information from the short-term memory to the long-term memory and is affected by hormones and proteins that are released according to the emotional value attached to the information (Earlauer, 2003). Learning takes place when a dendrite from one neuron attaches to another neuron, forming a synapse. The synapse is strengthened by protein which settles around it and is a function of the emotions attached



to the information (Howard, 2000).

When individuals are exposed to new information, the thalamus and hypothalamus determine the action needed to process it. The thalamus might decide to downshift to the “fight or flight” state if it feels stressed or threatened or move the information to the amygdala and the cortex for further action. On the basis of the emotional value that the amygdala attaches to the information, the cortex will sort and classify the information to be stored in the long-term memory (Earlauer, 2003; Wolfe, 2001).

### Nutrition and the Brain

The brain consumes about 20% of our caloric intake. It needs oxygen and glucose as fuel. Drinking water and exercising can increase the level of oxygen flow in the blood and in turn to the brain. Fruits and vegetables are great sources of glucose.

A longitudinal study demonstrated that early intervention in the form of good nutrition to a group of three- to five-year-old children resulted in significant gains in math, vocabulary, and reading 10 years later. A follow-up study on the same group of children at age 26 showed improved socioeconomic status and fewer antisocial attitudes compared to the control group (Raine, Melligen, Liu, Venables, & Mednick, 2003).

Educators can have a positive impact on students' nutrition by providing students with healthy meals at schools. They should also emphasize the importance of good nutrition and its impact on school performance. Educators should also provide information to parents about healthy nutrition and the impact it can have on their children's education. In addition, schools should provide physical education classes to help students maintain a healthy, active lifestyle and increase oxygen flow to their brains.

### Emotions, Memory, and Learning

Sylwester (2000) stated, "Emotions derive attention and attention drives learning." Teachers should understand the impact of students' emotions on their learning. Students have to feel safe in the classroom in order for learning to take place. Threats were found to impair brain cells and negatively affect learning (Jensen, 2006).

Teaching students how to recognize and control their emotions is as important as teaching academic skills:

Stress causes the body to produce cortisol, which prepares the body to respond to danger, however, too much cortisol too often from the highly stressful emotions of powerlessness, fear, and anxiety can kill neurons. Thus, it is critical that students have metacognitive knowledge to help them understand how their emotions affect their brain and to empower them to understand what they are feeling. (Gunn et al., 2007, p. 60)

The limbic system is in charge of learning and memory and consists of the thalamus, hippocampus, amygdala, cerebrum, frontal lobes, and cerebellum. The hippocampus which consolidates long-term memory can be negatively affected by stress. Sprenger (2007) stated that "chronic stress can cause the hippocampus to lose cells and shrink. This could cause a student to have difficulties storing new memories and therefore have difficulty in school" (p. 11). Students suffering from long-term stress have high levels of cortisol that causes hippocampus shrinkage, which negatively affects memory and learning.

### Brain-Friendly School Environment

Providing a curriculum suitable for students of the 21st century is one of the biggest challenges facing school leaders. Sousa (2003) stated, "Educational leaders are in the unique position of making the appropriate adjustment to schools and classrooms that can accommodate these changing brains" (p. 66). Schools must offer rich and varied curricular programs that can stimulate students' brains and motivate them to learn. Students should have access to academic classes that cater to different abilities, such as AP, intermediate, and basic levels. Schools also need to offer classes in the arts, sports, and vocational training. Cocurricular activities should include not only sports but also science, math, literature clubs, and service learning.

The University of North Carolina at Chapel Hill conducted a 20-year, longitudinal study in which researchers measured the effects of early intervention and enrichment activities on a group of children ranging in age from infancy to five years old. This group was enrolled in several day care facilities and was divided into two sub-groups—an experimental group and a control group. The intervention included proper nutrition; medical care; and games and enrichment activities such as arts, foreign languages, and music. Results demonstrated higher standardized test scores and better language, reading, and math skills through the age of 21 for this group compared to a control group. The results also showed that these students stayed in schools at the age of 21. Over 40% of them went to four-year colleges as compared to 17% of students in the control group, and overall they had fewer encounters with the legal system (Jensen, 2006).

### Brain-Friendly Classroom Practices

Tileston (2005) outlined several conditions that help teachers provide brain-friendly environments:

- Create classrooms in which students feel accepted as valuable members of the class and school. Students need to feel that they are safe in their classes and that teachers care about them and their success.

- Provide a high level of expectations and support for students' achievement. These high expectations should be maintained throughout the school. The University of Alabama conducted a study in which researchers found that a positive learning environment that promoted high expectations resulted in elevating students' IQ as much as 20 points (Tileston, 2005).
- Foster a sense of empowerment in students. Students need to have input in the decisions that affect their daily routines, such as school and classroom rules. Students whose input is considered in formulating classroom rules tend to feel empowered to respect those rules.
- Provide more opportunities and choices in courses—such as AP, artistic options, and vocational classes—that meet the students' varied interests and abilities. Tileston also suggested providing variety in the curriculum by accommodating the different learning styles and multiple intelligences in classes.
- Teachers should become advocates for every student. Teachers and administrators need to know their students and respect their individual life experiences.

Students have to learn to be problem solvers and decisionmakers who are capable of transferring knowledge learned in the classroom to real-life situations. To achieve such a goal, teachers must give students the chance to practice such skills in the classroom. Gunn et al. (2007) argued that students' brains are capable of problem solving and critical thinking skills, but students are rarely given the chance to practice these skills in schools. Cooperative group projects, such as working on an environmental project to implement in their community such as recycling, or designing a brochure to promote tourism for a country that they are studying in seventh-grade geography, support these skills.

*The human brain is highly experience-dependent and continually reorganizes itself through a process called neuroplasticity that continues throughout our lives but slows as we grow older.*

Goal setting is one of the most important cognitive skills for students to master to be successful learners. It can be achieved if teachers help students set goals that are based on their interests and make them feel accomplished at tasks that are meaningful to them.

Learning will not take place unless students perceive the content to be important. Marzano, Pickering, and Pollock (2001) argued that learning would only take place if the content met one of two conditions: it either satisfied a basic need or was considered instrumental in achieving personal goals. Tileston (2005) adds that students also have to perceive that they can be successful in achieving the learning task or goal at hand. Opportunities for students to practice their learning and experience success; clear directions and expectations; and precise, constructive feedback help students set reasonable goals for themselves (Tileston, 2005).

Similarly, Sprenger (2007) advised teachers to enrich classrooms by giving students assignments that they were able to do and ensuring repetition of learning tasks to foster mastery. Teachers must give timely feedback and individualized instruction as well as design challenging assignments to engage the students' brains in the learning process.

Sprenger (2007) suggested that teachers should use rituals in their classrooms to provide students with predictability and structure, which also reduces stress. But rituals should not be confused with routines and boring teaching practices.

Examples of rituals are class starters, such as puzzles or journal writings and class enders, such as asking

students to write one thing they learned in class that day.

Teachers should also give overviews at the beginning of class each day to help put students' minds at ease and give them a clear picture of the tasks ahead of them. Giving students rubrics and

# Myths about the Brain

## **The brain doesn't grow new cells.**

The brain continues to grow new cells and dendritic connections throughout a person's life. The brain experiences its largest growth in the first few months of an infant's life. The second largest brain growth takes place during adolescence. The brain gains or loses dendritic connections based on the experiences to which it is exposed and the frequency of such experiences (Jensen, 2006). The human brain is highly experience-dependent and continually reorganizes itself through a process called neuroplasticity that continues throughout our lives but slows as we grow older (Jensen, 2006; Sousa, 2006).

## **Some people are left brained while others are right brained.**

Research has demonstrated that brain hemispheres tend to be specialized for certain tasks. The left hemisphere is more specialized for tasks that involve logic, reason, spoken language, arithmetic, and time-sensitive information. The right hemisphere is more specialized for holistic, intuitive, and rational thinking (Sousa, 2003). Although there is adequate evidence of brain hemispheric specialization, our increased knowledge of brain processing has demonstrated that specialization does not mean exclusivity. Both hemispheres collaborate to process input. Some research has demonstrated that right-brain damaged patients were able to perform tasks that involved creativity and intuition albeit in a diminished capacity, while left-brained damaged patients were able to conduct tasks that involved logic and reason in a limited capacity (Sousa, 2006). Such information demonstrated that both hemispheres are involved in processing incoming information.

## **Playing Mozart to babies increases their intelligence.**

There is no reliable evidence to demonstrate that playing Mozart to infants creates statistically significant differences in their intelligence. Research has demonstrated, however, that music causes the brain to release endorphins that produce a feeling of pleasure (Sprenger, 2007). Some studies showed that classical baroque music tends to slow respiration, heart rate, and brain waves. As a result, the body experiences a state of relaxation and reduction of stress that promotes learning. Playing other types of classical music by such composers as Mozart or Beethoven was found to increase students' alertness (Sprenger, 2007).

## **It's all in our genes.**

There is no credible evidence to suggest that humans are destined to have certain brain structures based on their inherited genes. Brain research has demonstrated that the brain continues to adapt and change its structure throughout life (Sousa, 2006). Life experiences change brain structure. For example, good nutrition, clean environment, and enriched life experiences that include travel, visiting museums, and sports have a positive impact on brain structure and the growth of dendritic connections. On the other hand, poor nutrition, domestic abuse, drug abuse, poor schooling, and lack of exercise have a negative impact on brain growth (Jensen, 2006; Sprenger, 2007).

## **Brain research is too new to be reliable.**

Brain research is based on solid, scientific research that enables educators to better understand students and the ways that they learn (Wolfe, 2001). But educators should be cautious about adapting practices that are based on misguided

## Myths about the Brain

interpretations of the research findings. For example, many teachers in the 1980s adopted curricula that claimed to be more suitable to address the right brain after the findings of brain hemispheric specialization were published. Some interpreted the research to prove that schools were ignoring the skills of the right hemisphere, and as a result, students were not using that part of their brains. Brain research more accurately supports the notion of providing balanced curricula that address both hemispheres to reach more students. Today, educators base their teaching practices on the findings of neuroscience because there is a better understanding of the impact of actions on brain activities through the use of MRI and neuro-imaging techniques. Knowledge of the activities that stimulate the frontal lobes and increase the neuron firing can guide teaching practices to better reach students.

### **Medication is the only evidence-based intervention for a number of brain-related problems.**

Although medications that address some brain-related problems such as depression, attention deficit, and hyperactivity disorders are effective, they are not the only interventions available to deal with those problems. Some research has demonstrated that meditation (Patoine, 2006), mental exercises, and cognitive games combined with good nutrition and exercise can be very effective in addressing some problems.

### **Playing games is a waste of time.**

Schools should attend to students' emotional, social, physical, and cognitive needs. Children have to be well developed in all these aspects to perform well on academic tasks. Sylwester (2000) contended that "pretend" games extend

consciousness, promote language and social development, and encourage creativity. Computer games, played in moderation, contribute to dendritic growth in areas that are not usually stimulated by academic tasks (Earlauer, 2003).

### **Enrichment activities will not work for students with special needs.**

Some educators contend that there is a need to focus only on basic skills for some students. Research has demonstrated great benefits from enrichment activities for infants with brain damage (Jensen, 2006). These results suggest that the environment can overturn some genetic constraints. Exposing students with disabilities to enriched curricula can help them adapt and grow new connections in the brain that may help to compensate for their disabilities.

### **If we teach to the test, we will help students better focus on the mandated skills and prepare them for the future.**

No research supports the notion that narrowing the curriculum will help students become better learners (Tileston, 2005; Sylwester, 2000). Enriching the curriculum and providing students with varied and challenging tasks will help students become better learners and problem solvers.

### **We cannot implement brain-based research because it requires time and expertise.**

Implementing brain-based teaching practices takes time and teacher training but the return in students' achievement can be substantial (Jensen, 2006). Students who are exposed to enriched school programs consistently outperform students from traditional school programs on academic standardized tests (Gunn et al., 2007).

sample assignments also helps relieve their anxiety about achievement (Sprenger, 2007).

## Conclusion

The recent contributions of neuroscience to the education field have been amazing, but there is much more to learn. Educators need to recognize the potential that neuroscience can have on their teaching practices and on students' learning. Knowledge of the brain and its processes is an essential element on which we should base all of our educational decisions in order to help students be successful in school and throughout their lives.

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