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The Correlation Between Brain Development, Language Acquisition, and Cognition

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There continues to be a debate whether educators should use brain research to their advantage in the classroom. This debate should not prevent educators from using their new found knowledge toward enhancing their students' learning. By understanding how the brain learns, educators are able to determine what developmental level the child is physically, mentally, socially, and cognitively. The more knowledge an educator has and applies, the better the children will learn, and our future leaders will be better educated.

KEY WORDS: brain research; cognition; neuroscience; language acquisition; early childhood education.

INTRODUCTION

Brain research began as far back with the Egyptians in 1700 BC. With each century, brain research was improved with thinking, observation, and testing. Since the 19th and 20th centuries, the advancement of technology has caused scientists and educators to rethink and redefine brain research. The 21st century has brought about many new technological advances that help to pinpoint specific areas of the brain that have difficulty and need to be improved to aid the education of the children within our classrooms. These difficulties in cognition and learning can be diagnosed early on in the child's life. It is hoped that eventually these discoveries can lead to a decrease of disabilities in students with use of early intervention and improved technology. This new information that is being gathered about brain research can really have an impact on education and learning as more facts are uncovered with each further testing.

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BRAIN CIRCUITRY

Everything a child sees, hears, thinks, and touches transfers into an electrical activity that is stored into the synapses within the brain. Each time the brain is stimulated, the experience rewires the brain. Information is carried to the brain in synapses. Each day thousands of synapses die off. Information that is not important or relevant will die off while other information that is relevant will be stored in the brain (Siegler, 2000). The brain has many synapses. Some will be preserved and others will be eliminated (Sousa, 2006). Children can lose over 20 billion synapses per day from early childhood through middle childhood and adolescence (Eliot, 2001). The brain is a complex, interconnected system that is connected to everything in the body. Due to its complexity, neuroscience has been able to delve further into the functions on the brain with the use of technology.

TECHNOLOGY AND THE BRAIN

Imaging technologies fall into two different categories: those that look at the structure of the brain and those that look at the function of the brain (Sousa, 2006). Many of these technologies were developed for medical usage such as detecting tumors. There are several different imaging technologies that can be used for diagnostic tools for

educators. One of the imaging machines used for seeing how quickly something occurs in the brain is the EEG (electroencephalography) where electrodes are attached to the scalp and electronic signals from the brain are recorded (Sousa, 2006). Another of the imaging technologies that has success for determining the differing areas within the brain is the functional magnetic resonance imaging (fMRI). The fMRI is a painless, noninvasive way to pinpoint specific areas in the brain. These are just two of the many types of technologies that are being used for diagnostic testing for cognitive neuroscience as well as medical advances.

Cognitive neuroscience is using new technology to determine specific questions about the brain. With this advancement, many cognitive neuroscientists are now able to pinpoint specific areas of the brain that cause reading difficulties and language difficulties, just to name two. They are also able to pinpoint all of the different areas of the brain and what hemisphere holds what types of information.

According to Goswami (2004) cognitive neuroscience can offer methods of early detection for those children with special needs. Goswami (2004) believes that much of the research is too specific and that a much wider range of information still needs to be addressed. The history of the brain shows that not all theories were correct and with the advancement of technology, many of the theories that we now believe to be true may in fact not be so accurate in the future (Bergen & Coscia, 2001).

The 1990s were declared the decade of the brain by President Bush (Slegers, 1997). The new theories that were developed in the 1970s about the two hemispheres of the brain that caused scientists to term people as left- brained or right-brained was no longer used (Saunders & Vawdrey, 2002). The knowledge gained from the 1990s has helped educators to understand the simplistic functions of the brain to provide students with strategies that make them learners for life.

THE LANGUAGE CENTER

The breakthrough of technology has helped to make it possible to visualize each part of the brain and what it does. The language center is located in a small area of the brain called the perisylvian region (Eliot, 2001). The perisylvian region surrounds a fissure known as the Sylvian fissure that separates the temporal lobe from the pariental and frontal lobe. These pariental and frontal lobes are located in the left hemisphere where the understandings of speech sounds are found (Eliot, 2001).

Montanaro (2001) states that there are two different stages involved in language acquisition: prelanguage that begins before birth and lasts until the age of 10 or 12 months, and the linguistic stage from the ages of 12 to 36 months. Babies have very little observable external hearing but are actually taking in everything that they hear and the information is hidden inside of them. Montanaro (2001) calls this period "silence" (p. 2). The window for opportunity for language is from birth until age 10 (Slegers, 1997). By the time a child is three years old 97% of children are able to connect 2–3 words to form phrases and simple sentences (Slegers, 1997). Montanaro (2001) states that this period is a "sensitive period for naming things" (p. 2). It is important for the child to learn the correct terminology of words. Baby talk will confuse the child in the long run and the child's vocabulary will not grow.

Language is broken into two categories: words and grammar. These two components are developed at different times and in different areas of the brain. In Eliot's (2001) research she determined that people are able to speak seven hundred speech sounds in one minute of normal speech. It is during this development that the plasticity of the brain continues. This learning window before the age of ten could be an excellent opportunity to teach the child a second language since the brain is already wired for language acquisition.

The brain when viewed with a fMRI shows that children who have normal language skills have lop sided brains (Slegers, 1997). That being the case, it is not surprising that the children with language disorders have brain sides of equal size. Children are born with equal sides of the brain (Slegers, 1997). The right side develops first and grows faster. This is the side of the brain that deals with emotion. The left side of the brain starts to grow later and is in charge of new learning (Slegers, 1997). Both sides of the brain can work independently and can work together.

Siegler (1978) believed that children's spoken language is based on the preoperational period that tends to be more representational rather than transformational. Even though children pass through different stages, it is their environment and specific experiences that affect each child's development. The child's short-term memory regulates the speed at which the child's sequencing progresses. "Memory grows from one unit at age one to two to five units at age four to five years" (Siegler, 1978, p. 54). The

predetermined theory is a theoretical based position that language acquisition is innate. The human brain is believed to be wired to master any language. This is the position that brain based researchers have come to believe and have proved to be correct through their many studies and research (Sousa, 2006).

CRITICAL OPPORTUNITIES FOR MAXIMUM LEARNING

The use of technology and research about brain development and its functioning has allowed for researchers to determine when critical opportunities for learning to take place within the different areas of the brain.

One such example of the importance of the windows of opportunity occurred in a preschool that involved a young child adopted from China. This is about a little girl who was adopted from China at age two. Generally the children, mostly girls, are well cared for in the orphanages. Many of these girls are adopted outside of China to parents who wish to have a child. A set of parents from the United States are awaiting the arrival of their precious little girl from China. For bureaucratic reasons, the paperwork to adopt her is tied up in China. China decides to put adoptions on hold for a period of time. The parents in the United States will have to wait longer than they had expected for their child.

Fast forward to the next year, as almost a year goes by; the little girl continues to live at the orphanage. The women that work in the orphanage do not communicate or interact much with the little girl since soon she will be going to the United States and will have a family who will dote on her where she will learn to speak English, which her caregivers do not. The women pay more attention to the others who are not scheduled to be adopted. By the time the waiting period is lifted, the little girl is just shy of her second birthday. The new parents bring home their new daughter to discover that she is unable to communicate with them. At first, it is understandable that there is a communication difficulty due to the fact that the child speaks Chinese. The parents had learned basic Chinese to make this transition less difficult for her when she arrived in the United States. The child is not able to respond to their Chinese.

The parents take her to a therapist that specializes in communication disorders and discovers that the little girl cannot speak Chinese. She is able to communicate with facial expressions and pointing, but she has no words. They try intensive therapy to teach her a few words to communicate. The little girl makes progress but only with her receptive language skills. She is taught sign language to communicate her needs. She is able to sign simple requests, but she still has no words. Why did this happen? What could be wrong?

The doctor determines that this little girl was not talked to as an infant in any language. Her lack of communication caused many of her brain synapses to wither away. Since they were not being used, they could not be developed during the critical window of opportunity. Even though initial language learning continues until age twelve, the child had not even the basic of information given to her for her synapses to develop properly. She is able to communicate with the use of a language board and sign language. As she continues to develop, her communication skills continue to flourish with the intensive language therapy she receives but she is still unable to communicate through spoken language.

This scenario is not typical, but a severe case of when a child is not stimulated with language at birth and does not have interaction with stimuli that would help to increase the windows of opportunity for optimal learning. This example of what happened to this child was written to help explain the importance of building synapses through environment and experiences from birth and what could happen in the absence of stimuli and not using the windows of opportunity for critical learning to take place.

NEW INSIGHTS FOR EDUCATORS

More knowledge about critical windows of learning will help educators develop timelines that concentrate on these windows. Brain research has led to the betterment of early childhood education. Many of the classic theories are still prevalent in today's classrooms. Learning is an individual process and many times it is constructivist in nature. The constructivist theories of Piaget and Vygotsky can be found in the foundations of many early childhood curricula today. Piaget's ages and stages theory of development can be identified with the cognitive growth of the brain. Many other programs and curricula were developed based on theories of the individuals who were popular at the time. For example the theories of Hunt, Skinner, and Piaget helped to bring about Head Start and High/Scope models. Gardner's theory of multiple intelligence is an example of brain based education that promotes whole language learning with the coordination of themes and units (Slegers, 1997).

What does the brain research mean to early childhood education? The advancement of brain research can help to identify at-risk students or children with special needs at a much earlier age than before. Having little or no knowledge of the way the brain functions in relation to learning is not beneficial for the education of the students. New neuroscience discoveries have now been found to disprove old assumptions of how students learn. It is up to the educator to incorporate some of these strategies into their teaching to make the most of the educational experience for the students. Educators can face problems with students' learning due to using old methods of teaching and not using brain research to target these windows of learning.

Learning is different for each child and the types of learning vary based on the age and stage of development the child is in. Until the age of five, children use the right hemisphere for almost all learning. Once the child has reached kindergarten, he is expected to learn in a different manner. Before age five, children learn through exploration and play, after age five, children are expected to sit still and learn at a desk or table. Sequential knowledge is harder for the brain to process. Nonlinear learning in bits and pieces is easier for the brain to process. Each side of the brain processes differently. When the brain is working as a whole, great potential can be achieved (Slegers, 1997). Teachers need to be aware of these processes of the brain to plan curriculum so that it best meets the needs of the children.

CONCLUSION

Each year more and more technological advancements determine new findings about the brain. Have scientists and educators found out all there is to know about the brain and how it functions? No, time will tell as to what new things will be learned about the brain and its functioning. Several years from now educators may find that some of the theories that were in place were not found to be correct or need to be improved upon. The brain is multifaceted, there is still so much more to learn and discover.

As the century continues, more brain research will bring about new and improved information that can be used to make education and learning better. Is it possible that we can even be able to pinpoint difficulties to the point of being able to fix them and see a decrease of disabilities in students? One cannot know the range of knowledge gained from studies and research but one would like to believe that it could be possible.

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