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Brain Development and Early Childhood Education: What is the connection?

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Brain research: excitement and caution: Interest in brain research has peaked in the last decade. Exciting discoveries in neuroscience led to new theories about brain development. In particular, public interest focused on relating findings from neuroscience to educational contexts with an emphasis on the effects of early experiences on the development of young children's brain. Despite the popularity of brain research findings, some scholars are wary of interpretations made from brain research that made their way to the popular media (Byrnes, 2001, Bruer, 1999, and MacNaughten, 2004). They caution the public to resist the temptation to make simplistic and linear connections between neuro-scientific findings and learning. Instead, they encourage parents and educators to become critical 'consumers' of brain research.

Some facts about brain structure:
The human brain is a complex and intricate structure that is composed of different regions. It is now believed that the different regions perform specific functions. For example, **the cortex,** the uppermost structure in the brain, sometimes called the "thinking brain" is associated with 'higher level' functions, such as the ability to make decisions and judgment, plan and organize, reason, process emotions, make sense of experience, and reflect on one's own learning. The **limbic system**, the "emotional brain" situated beneath the cortex, is linked with emotional responding and aspects of attention and memory. The lower part of the brain consists of the **brainstem** and **cerebellum** which control automatic functions, such as heart rate, breathing, coordination and balance. All brain areas are connected to each other through a complicated inter-communication system of brain cells, called **neurons**.

Basic facts about brain processes:
Neurons send messages to neighboring neurons in the form of electrical pulses across a synapse (a small gap separating neurons). A neuron is built up of the cell body, the **dendrites,** and the **axons**. Dendrites bring information **to** the cell body and axons take information **away** from the cell body. These connections, or 'wiring' in the brain is what gives the brain its unique structure and what allows the brain to operate in a coordinated way. While we are born with a complete set of neurons and some genetically 'wired' connections, many connections between neurons are determined by a *learning process;* learning organizes and reorganizes the brain (Catterall, n.d., Bransford et al, 1999). Hence, brain development is related to the ongoing process of connecting neurons. The number of neurons seems to be less crucial than the strength of the connections between neurons. Learning and memory are believed to result from long-term changes in synaptic strength.

Theories emerging from Brain Research:
Perhaps the most exiting finding of brain research is the notion of **brain plasticity**. The idea that brain structure, in particular the connections between neurons in the cortex, are constantly modified and that the brain changes physiologically and psychologically throughout our lives; our brains continually rewire themselves in response to passing experience. This finding gives increased value to the environment within which the brain interacts. It may also hint that IQ is not fixed at birth. Furthermore, this fact suggests that no two human brains are exactly alike and that brain diversity is infinite. Finally, it supports the idea that education is a life-long project!

Although scientists recognized the ability of the brain to change continually, they suggest that in order for particular motor, sensory, and language functions to develop fully one needs certain kinds of experiences at specific times during development. This implies that there are **sensitive periods in development**, sometimes referred to as **'windows of opportunity.'** However, 'windows of opportunity' in brain development do not close abruptly for most functions. Sensitive periods are shorter for skills that are learned through the natural environment (i.e. vision) than they are for skills learned through cultural and social encounters (i.e. language).

Another intriguing finding from brain research is **excessive and rapid neural connectivity in early life**. Following birth, the infant brain begins a process of synapse overproduction, as it forms synapses far in excess of adult levels. By age 4, synapses densities peak in many brain areas. This process continues until age 10. Around puberty, a 'pruning' process begins to eliminate synapses, reducing synapses density to adult level. Scientists believe that pruning is a process of selection by which the most useful (perhaps the most used) neurons, synapses, and dendrites are preserved. Later in life the brain continues to 'grow' through synapse addition which occurs in a more controlled manner (Bransford et al, 1999).

Finally, neuroscientists have demonstrated **the effects of different environments on brain development.** By comparing brains of rats that were placed in isolation in small cages with those of rats which were placed in larger group cages that contain novel objects and obstacles, neuroscientists found that rats raised in 'complex' environments have more synapses per neuron in some brain areas.

<u>Brain functions related to learning:</u>

The brain has an innate predisposition to **search for meaning**. It wants to make sense of experience and shows a natural inclination to learn and understand, as well as an inexhaustible capacity to create (Caine & Caine, 1991).

In order to make meaning, the brain seeks patterns, connections, and relationships between the new and the known, among facts, events, and experiences. The brain is a **pattern detector**.

In our brain, attention, memory, and emotions are closely linked to each other. Emotions help connect experiences with memories and knowledge. Jensen (1998) states, "Our emotional system drives our attentional system, which drives learning and memory" (p.25). Thus, **emotional and social connections and responses are essential elements for learning.**

<u>Inferences for educators:</u>

Implications from brain research support long held beliefs about early childhood education philosophy and practice. For example, the belief that **knowledge is not transmitted but rather constructed by children through a process of modification of prior knowledge corresponds to the idea** that existing neural networks and connections change via learning processes.

Thus, responsive educators seek ways to relate what is being learned (experienced) to what the learner already knows and values (Caine and Caine, 1991). They ask themselves, what do I know and what can I learn about the children I care for? What ways of 'knowing' do they bring to the classroom? What 'theories' do they have about different phenomenon and how can I extend or invite them to rethink these theories?

The 'interactive' nature of brain development assumes the need for a **responsive environment**. Early childhood educators have long-established that the environment plays a crucial role in growth and development. However, creating responsive environments does not mean adopting a "one-size fits-all" paradigm, or that an abundance of multi-colored toys and materials are sufficient to stimulate thinking and learning. Rather, it is the kinds of interactions children's minds have with these materials and our ability to be attuned to and respond to the *particular needs, curiosities, and inclinations* of the unique group of children we care for that fosters learning.

Brain's first contact with the environment is through the senses. When designing responsive environment educators can ask, does the environment engage the senses?

When all answers and outcomes are predetermined then children do not have an opportunity to think innovatively. Do materials and activities provoke thinking, invite questions, engage creativity, and allow for uncertainty? Do learning experiences challenge the ability of the brain to formulate new ideas, to integrate information, and to respond actively?

Learning becomes meaningful when students *care* about what they learn. Do children have opportunities to make personal connections with what they are learning? Is the learning experience joyful?

In conclusion, keeping in mind that due to the complexity of brain functioning brain research is far from being conclusive, we must hold a critical perspective when interpreting its findings. Some questions remain highly relevant: How can we embrace a view that brain development in the early years is significant 1) without minimizing the importance of brain development in middle childhood and adolescence;

2) without causing undue stress to parents by suggesting that all is lost if certain kinds of experiences do not take place during the early years; and

3) without assuming that brain research findings can be generalized beyond consideration to the role of diversity and culture in learning?

References and resources:
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McNaughten, **G**.(2004) The politics of logic in Early childhood research. *The Australian Educational Researcher*. 31, (87-104).
Further readings: Collection of online articles about neuroscience and learning can be found at: http://www.newhorizons.org/neuro/front_neuro.html