

# EARLY BRAIN DEVELOPMENT

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The media is full of news about Early Brain Development (E.B.D.) For the past few years, we have been constantly bombarded with one new study after another as well as the many interpretations of each.

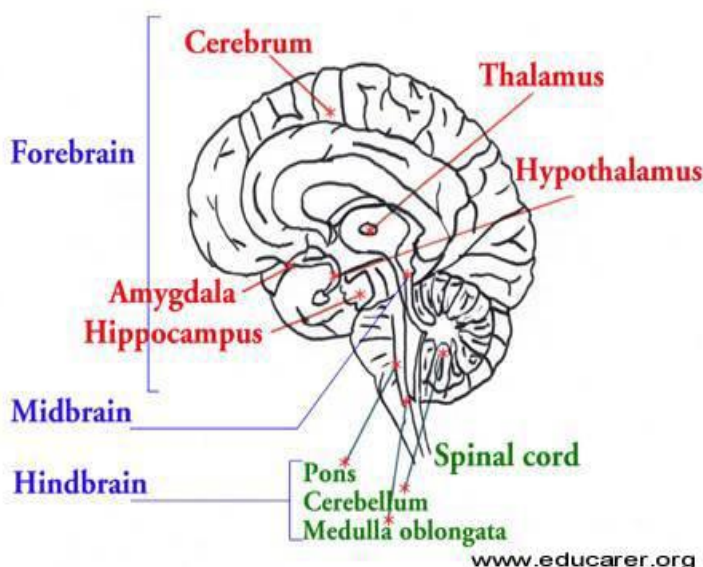
This article will present the facts about EARLY DEVELOPMENT that parents and educators need to know in order to guide their relationships with babies.

There is a four-year period of "potential" growth, which is the most critical period of human development. This time is from conception until about the third birthday. During this time, all things are possible - learning to walk, learning to talk, learning how to "fit in" to society. There is a need for many experiences in order to master skills. (Families and Work Institute, 1996). ...

Before one can discuss EARLY DEVELOPMENT, there needs to be a basic understanding of the brain. Here is a rather condensed version of brain functions. (Skip to page 3 if the science of it is confusing to you.)

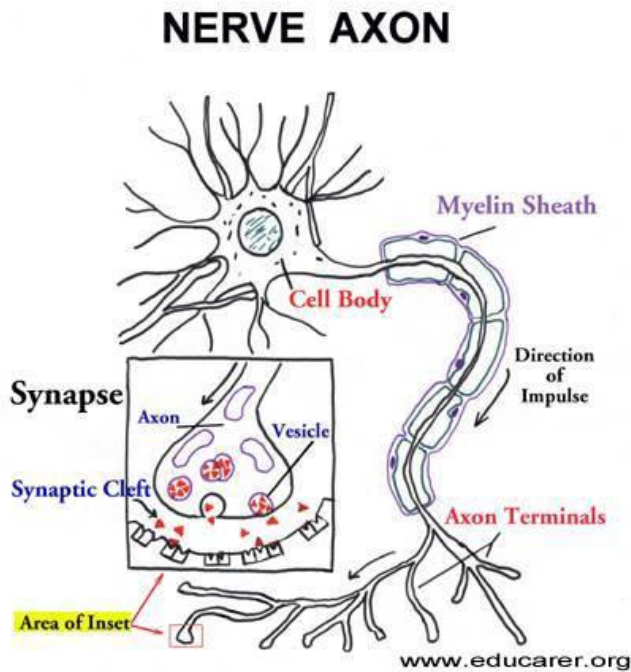
## BRAIN COMPONENTS & FUNCTIONS

### Brain



The cells of the brain are either neurons or glia. Neurons are connected. They pass electrochemical signals to each other. The following diagram illustrates this activity.

## DIAGRAM OF A SYNAPSE



Information is integrated within the cell body, which, in turn, sends out "action potentials" (the electrochemical signals). These signals travel along the axon to the end of the axon (dendrites) at which point a synapse may occur. Synapses are the paths or avenues that allow individual nerve cells to connect with each other. (Willis, 1998). Conducted velocity is faster for mylenated axons. One can

consider axons to be like electrical wires. Without insulation (myelin), signals go astray (short out).

When an electrochemical signal reaches the dendrite, several things may happen (see inset above).

1. Neurotransmitters may diffuse, i.e., float up and out of the synaptic cleft.
2. Degradation occurs when enzymes break it down.
3. Reuptake occurs when the neuron takes back the neurotransmitter for later action.
4. The information is communicated to the next axon, i.e., a synapse occurs.

Only number four above is a "successful" transmission of this electrochemical signal.

Glia cells are often called the "worker" cells, or support cells. Their role is to clean up and digest parts of dead neurons. There are no chemical synapses between glia. However, research is currently investigating calcium waves, which might be used in processing information.

(Start here if the science of it is confusing)

**By the 17th week of pregnancy, the fetus already has 1 billion brain cells, more than the adult brain. These cells are proliferating at a rate of 50,000 / second. These cells are not in the right place and only after they are formed will they travel (cell migration). At birth, the distinct areas of the brain are all in place, however, much growth will still occur. The brain is the only body organ incomplete at birth.**

**Within each brain area are millions of neurons (nerve cells) that are connected to each other by synapses. These trillions of synapses and the pathways they form make up the wiring of the brain. The number and organization of these connections influence everything, from the ability to recognize letters to the maintenance of relationships. Neurons develop rapidly before birth. After birth, brain development consists of wiring and rewiring the connections (synapses) between neurons. ([www.iamyourchild.org](http://www.iamyourchild.org))**

**New synapses are formed while others are pruned away. Between birth and eight months, the synapses are formed more quickly. There may be 1,000 trillion synapses in the brain at 8 months.**

**After the first birthday, pruning occurs more quickly. By 10 years a child has nearly 500 trillion synapses, which is the same as the average adult. Pruning occurs for about 12 years but the brain maintains flexibility for future learning.**

**Early experiences, both positive and negative, have a dramatic effect on this formation of synapses. The brain operates on the "use it or lose it" principle. Only those connections and pathways that are frequently used are retained. This is not a cause to panic however. Most of us keep enough synapses to do very well in life. Learning language is an example of this principle.**

**At 3 months the brain has the potential to distinguish several hundred spoken sounds. Over the next few months the brain organizes itself to recognize only the sounds it hears. During early**

**childhood the brain retains its ability (plasticity) to discriminate sounds it has discarded (i.e., not yet organized). As an analogy, think of putting something into the "trash" on your computer. You can still retrieve that information out of the trash as long as it has not been deleted. This is why young children can easily learn foreign languages accent-free. After age ten, this plasticity is lost (the trash was emptied). Children can still learn foreign language but more effort is required.**

**It is from early infancy to early childhood that these vital connections are made permanent. As we mature, the brain physically changes due to outside experiences. The first three years see the most rapid changes of all of life due to the bombardment of experience (everything is new!). At this time, the brain is most flexible and prepared to learn.**

**Touch, talking, and things an infant sees and smells all build connections if done with continuity in a loving, consistent, and predictable manner. These connections die if not maintained. If there are no experiences, the connections are pruned back and the brain remains small.**

**Children raised in environmentally deprived facilities (such as the Romanian orphanages) experience fewer sounds, colors, pictures, interactions and sights. Their brains are smaller than those of children who grow up in sensitive rich environments within meaningful relationships. When doctors have studied the brains of children from deprived environments, there is a strong resemblance to brains of Alzheimer's patients. Animals raised in zoos have brains that are 20-30% smaller than animals raised in the wild.**

**Studies done on over 1,000 abused and neglected children found that children who were rarely touched or spoken to and who had little opportunity to explore and experiment with toys, had brains that were 20-30% smaller than most children their age. In over half of these cases, parts of the brains appeared to have literally wasted**

**away. (There was no allowance in this study for the possibility that these children were affected by F.A.S.) (Ounce of Prevention,1996).**

**Other studies have found that childhood trauma, such as being repeatedly abused or witnessing a murder, can directly affect the way the brain functions. It was found that these traumatized children continue to show physical symptoms of fear even in the absence of threatening stimuli, almost as if their brains are "stuck" in their reaction to the traumatic experiences. (In this article's later discussion of cortisol, the reason for this will be explored). These children have very high resting heart rates, high levels of stress hormones in their blood, and problematic sleep patterns, all of which suggest that their experiences have left their brains in a permanent state of "high alert". Unless an intervention occurs, these children will likely develop emotional, behavioral and learning problems.**

**One of the most fundamental tasks an infant undertakes is determining whether and how he can get his needs met in the world in which he lives. He is constantly assessing whether his cries for food and comfort are ignored or lovingly answered, whether he is powerless or can influence what adults do. If the adults in his life respond predictably to his cries and provide for his needs, the infant will feel secure. He can then focus his attention on exploring, allowing his brain to take in all the wonders of the world around him.**

**If, however, his needs are met only sporadically and his pleas for comfort are usually ignored or met with harsh words and rough handling, the infant will focus his energies on ensuring that his needs are met. He will have more and more difficulty interacting with people and objects in his environment and his brain will shut out the stimulation it needs to develop healthy cognitive and social skills.**

**One may ask about the affect of genetics on brain development. There is mounting evidence that early experiences can dramatically**

**alter the way genes are expressed in the developing brain. Good experiences help any brain develop well. (Lally, 1998).**

## **#1 Interaction**

**There are two myths that are often told about babies. The first is that "a newborn is not capable of interacting right away." The second is, "It takes a while for a baby to see or hear". Both of these myths have been blasted out of the water by scientists today.**

**Infants are learning almost from the time of conception. Much work has been done to study how and what an infant learns while still in utero. This is a fascinating field. Dr. Brazelton has demonstrated how it is possible to capture a baby's attention at birth and engage the child in interaction. The real key to interaction is in matching the adult's behavior to the needs of the child.**

**Interactions with people and objects are as necessary to the baby as protein, fat and vitamins. All are vital nutrients for the growing and developing brain. Different experiences will cause the brain to develop in different ways due to its plasticity.**

## **#2 Touch**

**Touch is critical to development! Of all the sensory experiences, touch is how the infant first knows he is loved. It is the source of comfort. Holding is reassuring in the face of strangeness. For an older child, touching a "lovey" gives security in new situations.**

**Touch literally sends signals to the brain telling it to grow (make connections).**

**There is much research about infant massage. In preemies, massage causes faster growth, calmer babies and better development. Babies who are massaged daily develop movement earlier, sleep more soundly and have less colic. Without this touch nurturing at an early age, infants can NEVER develop. Think about it! While in utero, babies actually are "massaged" much of the time as a result of the**

**mother's physical mobility and movements. Infants need this experience to grow. For both the brain and the body, touch is a critical nutrient, as critical as vitamins. Touch lets the child know that "Yes, I am a wanted organism and it is worth survival."**

### **#3 Stable relationship**

**Dr. Spitz did studies in the 1940's and found that infants need a loving, trusting adult to act as the interpreter of life experiences, otherwise they have no meaning. He compared infancy to being in a foreign land where no one can understand you or speak your language. This stable relationship is a necessity for survival.**

**Recent studies have been done at the University of Minnesota by Dr. Megan Gunnar about the production of a stress hormone called CORTISOL. If levels of cortisol get too high, the heart rate, digestive system and ability to think are affected. Since the amount of cortisol in the body can be measured in the saliva, many tests have been conducted with children (it is noninvasive) to determine who produces cortisol and when. It was found that the presence of a loving caregiver during a time of stress (shots at the doctor's office) reduced the production of cortisol. The child may still cry, but the smaller amount of cortisol indicated that the body was not reacting as strongly to the stress.**

**In other words, a loving, consistent relationship can offset even the most stressful situation. Without it, growth can be stunted both mentally and physically. Every time a child learns something new, the brain works seven times harder than normal. This in itself is a stressful event.**

**According to Gunnar, the brain is the major target of cortisol. Frequent and prolonged exposure to elevated cortisol may affect the development of brain areas involved in memory, negative emotions, and attention regulation. Early experiences affect later emotional, behavioral and hormonal stress reactivity. Secure emotional relationships with sensitive and responsive caregivers may protect**

**the developing brain and thereby reduce later stress reactivity. This is accomplished by reducing or preventing elevations in cortisol in reaction to threatening and mildly painful events. The early secure relationship acts as a prevention for difficulties in handling stress later in childhood. Children with a history of secure care come to expect their worlds to be controllable and predictable. These expectations may provide further stress inoculation. A sense of control and predictability are key factors in modulating cortisol responses to potentially threatening and painful events.**

**Gunnar's research on neural plasticity has demonstrated that experience shapes the developing brain. High cortisol levels in preschool children coincide with poor "effort control" and self-regulatory competencies.**

**At birth, the human adrenocortical system is highly responsive to stimulation. Simply undressing, weighing and measuring the newborn will elicit significant elevations in cortisol. From birth to three months this elevation of cortisol from stress reduces. There is another reduction between three and twelve months. By the second year, there is no increase in cortisol level during the routine health exam with inoculations for an average child. (Gunnar, 1998).**

**Infants in secure attachment relationships show more evidence of maternal buffering of the adrenocortical system than do so insecurely attached infants. Securely attached infants will still cry under stress but not produce as much cortisol. Sensitive, responsive and secure caregiving plays an important role in buffering or blocking elevations in cortisol for infants and young children. Professionals have maintained for years the necessity of creating safe, secure and supportive environments in daycares. Now there is a set of physiological processes that lead to the same conclusion.**

#### **#4 Safe, healthy environment**

**We are all familiar with this topic (there are other pages on this website describing this). One element that does directly affect the**



**brain is the effect of lead. Exposure to even small amounts is dangerous. This is called "the silent epidemic" because the symptoms do not appear until ages six, seven and eight years. Some symptoms of lead poisoning are learning difficulties and even delinquency. There is a blood test for lead poisoning, and, if caught early enough, this condition is treatable.**

**A high fat diet facilitates the absorption of lead, so it is important to provide healthy meals for all children in our care.**

## **#5 Self esteem**

**The root of all emotional feeling is in the brain stem. It takes nearly one and a half years for a child to learn how to control her feelings. How well she does this depends solely on the parents.**

**Dr. Brazelton has said that he can recognize by eight months which kids expect themselves to succeed and which do not. Children mirror what is around them - like sponges, they absorb. If a child is in a violent environment, he needs a calm, nurturing and predictable caregiver. A mother only has to be "good enough", not perfect.**

## **#6 Communication**

**A child's ability to communicate begins at birth. By six months of age (Sometimes much younger) a child can duplicate the sounds he hears. Language is a complex skill which contains many nuances. Researchers believe that the reason some children have problems with language is because their brains cannot process sounds fast enough to make the necessary neural connections.**

**One can exercise the brain. The plasticity of the brain is what makes it possible to learn language in the first place. All the circuits are in place. They just need to be connected. The more words the infant hears, the more connections are made. Children need to interact with people to learn a language. They learn words by hearing them repeatedly. It is critical to engage them in conversation. (LaMorelle, 2001)**

## **#7 Play**

**Play is essential to a child's development. Everything is learned through play. The first ability to symbolize their experiences is through play. They duplicate the world around them. We, as teachers, learn about children by watching and listening to their play. Play is linked to mental development. It is the experience, NOT the toy, that aids growth in the brain. Observation is the best way for parents to learn about their children.**

**It has been found that children who do best on tests are those whose parents play with them. So, parents, put yourself in the picture of your child playing - be part of it!**

## **#8 Music**

**Children have an affinity for music from birth. They need to be involved in music, not just listen to it. Parents and children should make music together. For the adult, it is such a soul-moving experience to observe an infant as she is influenced by and becomes part of the music and rhythms she hears. Infancy is not too early for a child to experience music as a form of recreation, enjoyably integrating the sounds and vibrations into her bodily movements.**

**The benefits of music are:**

- It brings many learning elements together.**
- Physical coordination**
- Timing**
- Engages memory, imagination and language**
- Builds self-confidence**
- Stirs a response between parents and child that helps build the connection between them.**

**Montessori, Maria. The Absorbent Mind. Oxford, England: Clio Press, 1994.**



Based on lectures given by Montessori at Ahmedabad, this book covers the early development of language, motor skills, social adjustments and work habits. Physical and psychological growth is discussed. The idea of the mind absorbing information during the first three years of life is of enormous importance coinciding with the new information about brain development.

**Montessori, Maria. The Discovery of the Child. India: Kalakshetra Publications, 1966.**



This book is broader in scope than Montessori's other books. She describes how the Montessori Method covers the entire development of the human being, from infancy to adulthood. This method has been used on all five continents by many cultures, religious groups, and all social classes. This translation by Mary A. Johnstone is a little different than the usual translation by M. Joseph Costelloe. It is more true to Montessori's style of speaking and is almost musical in quality.

**Montessori, Maria. The Secret of Childhood. New York: Ballantine Books, 1966.**



This translation by M. Joseph Costelloe covers the application of the Montessori Method to all children. There is good coverage of infancy with emphasis on the "spiritual embryonic stage" as well as the absorbent mind. Even those educators not using this method w