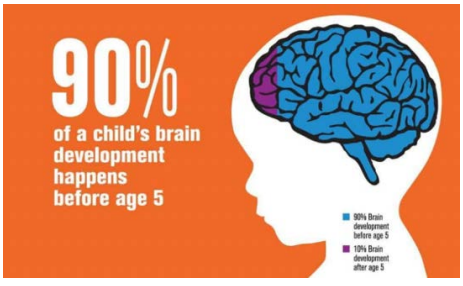
Early Brain Development

Brain development theory is a rapidly growing area of research within the field of Early Childhood Development (ECD). We know more now about the developing brain then ever before as a result of advances in science, technology and the growing passions of ECD researchers. Not only do we know how a brain grows and develops, but we also know when different areas of the brain are more sensitive to growing and even how best to support these different “sensitive” or critical periods. This article aims to simplify the mystery behind early brain development, highlight when these sensitive periods blossom and provide an understanding of how best to support a developing brain.

So How Does the Brain Develop?

Just like the developing body, an infant’s brain begins developing at conception. Brain cells rapidly multiple to form the tissue of the brain, spinal cord and nervous system. As the cells of the brain grow they bind together and fold into one another forming a tube that will become the structure of the brain. This growth of cells and folding process is completed around eight weeks after conception and creates a foundation for the physical brain. By around seven weeks after conception the first neurons are beginning to form. More information about neurons can be found below.

These neurons continue to multiply at a rapid rate and travel to different areas of the brain where they turn into specialized neurons. Once all the specialized neurons have formed they begin to communicate with one another. While your little one is still growing in the womb this communication creates the first stages of learning. These early learning experiences include simple reflexes, movement, and activation of their senses. By the time the infant is born they have the ability to distinguish their own language from other languages, recognize familiar voices, especially their biological mother’s voice and perform simple movements like bringing their hands to their mouth. At the end of the first year an infants brain typically doubles in size. By the time a child reaches kindergarten, or five years of age, their brain is 90% developed and wired. This fact helps to highlight why early experiences are so important for the life long health and development of adulthood.



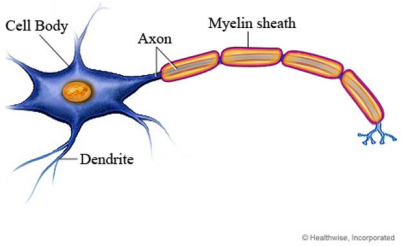
Another important thing that happens to an infant’s developing brain during pregnancy and throughout their infancy is myelination. This process is the growth of fatty tissue that surrounds the arms of a

neuron. This coating, or myelin as it is called, helps to protect the arms of the neuron and can help speed up the communication that travels between different neurons. The production of myelin can be negatively affected while in the womb and after birth by very poor nutrition. This helps support our understanding of why pregnant women, breast feeding women, infants and toddlers need high calorie diets full of healthy fats.

But what is a Neuron and synapse?

A neuron can be thought of as a communication centre. Neurons are the cells of the brain that read and decode messages. At birth, an infants brain has all of the neurons that they will have for the rest of their life. Research tell us this is around 100 Billion neurons. That's a lot!

Every neuron has branches or "wires." The physical structure of a neuron can be compared to the beams of the sun or the many legs of an Octopus. These wires are called axons or dendrites. These are responsible for sending and receiving information between neurons like telephone wires connecting and communicating with each other. Axons are responsible for delivering communication and dendrites are responsible for picking up communication. However, the axon from one neuron is not physically connected to the wires or dendrites of another neuron. Instead there is a tiny microscopic gap between each arm. These gaps are called synapse. In other words, when two neurons communicate together the axon from one neuron sends a signal through the synapse (the space between neurons) and dendrites pick up the incoming signal. When two neurons are able to communicate with each other they are said to have what is called a synaptic connection. The most up to date research and brain imaging says that 1 million synaptic connections are formed every second for the first 1000 days of life. That is trillions of synaptic connections! In fact, by the time a child reaches two to three years of age they have twice as many synaptic connections then a full grown adult.

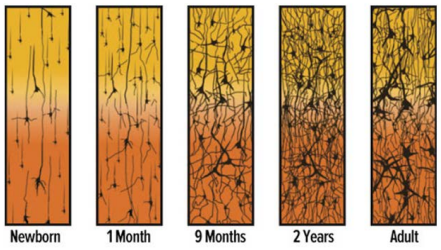


But what happens to all those synaptic connections?

Over early childhood and adolescence, the brain begins to prune or lose synaptic connects it no longer uses. This is in an effort to become more efficient and to strengthen other synaptic connections. The old saying of "use it or lose it" has never been more true then when looking at synaptic connections. During the rapid growth period of the first three years of brain development everything an infant hears, sees, feels, tastes, and experiences forms millions of connects but not all of these connections are needed. In order to support learning harder skills and more complicated tasks, some synaptic connections strengthen with repeated use while others fade away. This allows for stronger skills to piggy back on earlier experiences and grow stronger, faster, and more

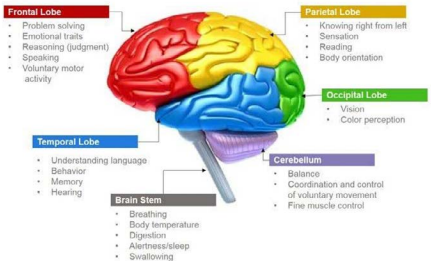
specialized synaptic connections.

What do sensitive periods of development mean to a growing brain?

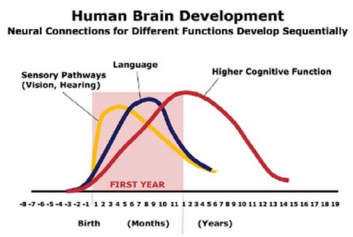


Before we dive into what sensitive periods are we need to understand a little bit more about how the brain actually works. So we know that neurons communicate with each other and send messages to one another through synaptic connections but where do those messages end up? The brain can be divided into different areas, much like different rooms in a house. Each area or room has a special set of skills they control and are responsible to monitor. For example, in your home each room serves a function. Kitchens are for food, bedrooms are for sleeping, and we all know what bathrooms are for. In the human brain motor skills, language skills, thinking skills, emotions, and many other abilities are found in different areas (or rooms) of the brain. However, even though there are specialized regions or lobes, even the most basic skills require coordination and communication between the different regions. This communication happens between neurons and synaptic connections.

So now that we know that different areas of the brain are responsible for different skills we can talk about what sensitive periods are and when they happen. We know from science that different flowers bloom at different times of the year, and that different areas of the brain bloom at different times too. The first areas of the brain to bloom are the areas related to motor movements, language development and sensory learning. At birth an infant can only focus their eyes on objects about 8 – 12 inches away but the area of the brain responsible for sight quickly starts firing neurons to build stronger synaptic connections resulting in better vision. Similarly, the area responsible for language started developing while in the womb and quickly strengthens its neural connection in the first years of life. This growth can be seen by the explosion of language development early in life. For example, a child who is 18 months of age typically has about twenty words but by two years' toddlers have around 150 words. These sensitive periods are important for development. Similar to how a flower can turn into a more complex thing (like an apple), early synaptic connections are needed to build more complex skills later in development.



One of the areas of the brain which blooms a little later in development is related to skills called executive functioning skills. This area of the brain is active from birth but accelerates its growth between 3-5 years of age. Executive functioning skills include impulse control, emotional regulation and flexibility along with other mature skills. This helps to explain why little ones have very little to no control of these skills while under the age of five. Practicing these skills early in life is vital to a successful future. Interestingly, the area responsible for these complex

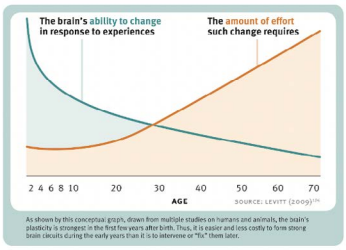


skills also bloom in early adolescence into adulthood and is fully developed by around 25 years of age. However, research also tells us that if the foundation built in the first five years of life is weak or underdeveloped the more complex skills are extremely difficult to learn without the right foundation. You can image these skills like building blocks. If you try and build a tower with missing blocks along the way your task is a lot more difficult. Not impossible but more effort, planning, and dedication is needed.

Even with all the science behind sensitive periods and their importance it is important to know that a brain, whether it is 16 or 96, is still able to learn new skills and grow synaptic connections. This is known as brain plasticity. The younger the brain is the more plasticity it has. This means it is easier to learn new skills and for synaptic connections to occur more regularly. As the brain matures the plasticity levels decrease, however they never disappear.

What can negatively affect early brain development?

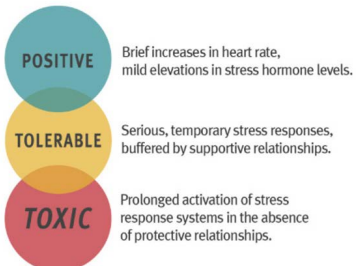
There are many different factors that can affect the developing brain and if it reaches its full potential. Research tells us that genetics have a role but a developing child's environment and early experiences plays a larger role.



When children experience maltreatment, neglect, poor nutrition, trauma or abuse it could negatively impact early brain development which may have lasting effects on future development. These types of experiences are called adverse childhood experiences. Experiencing these really difficult circumstances may cause an infant or child to experience toxic stress. To understand toxic stress, we need to talk about the different types or levels of stress. Not all stress is bad.

Research tells us that there are three main levels or types of stress. These include positive stress, tolerable stress and toxic stress. Positive stress are brief experiences of stress infants and children go through while learning from their environment with support from their parent or caregiver. For example, a child getting frustrated while learning how to use a new toy or practicing rolling over for the first time might cause positive stress if they are guided and supported by an adult. Tolerable stress is when an infant or child experiences serious stress for a moderate period of time while receiving support from their parent or caregiver. An example of tolerable stress might be when a child resists sitting in a care seat and is showing signs of distress like crying, tightening their bodies, and getting flushed. This experience is considered tolerable if the infant or child is supported and soothed by their adults. Toxic stress is repeated and prolonged periods of distress in the absence of a

supportive and responsive parent or adult.



Positive and tolerable stress can support an infants brain development and their ability to learn resiliency. This is because infants and children learn how to manage their emotions when they are supported and 'rescued' from a difficult situation. When a child is soothed by a caring adult in response to a stressor, their body returns back to a level of calm. Anytime anyone young or old experiences stress, danger, or is frightened a particular part of the brain is activated and sets off a chain reaction throughout the body. Often referred to as the fight, flight, or freeze response. This is a survival response. A hormone called cortisol is released as a signal for the brain to turn your senses to full forces, turn off your ability to listen and your ability to think wisely. This hormone also has the potential to cause damage to the tissue of the brain with frequent and prolonged exposure.

Another reason toxic stress is harmful while positive stress is healthy is because when infants and children are supported in calming down the neural pathways linked to recovering from stress are strengthened.

When the brain is repeatedly exposed to the fight, flight or freeze response for expended periods of time those neural pathways and synaptic connections become stronger then the calming pathways. This mean every exposure to any form of stress is stronger, lasts longer and the child's ability to recover or calm down takes more effort. These adverse childhood experiences mean that the brain is exposed to the negative effects of the harmful cortisol hormone more often and for longer periods.

How can we encourage positive brain development?

There are many things you can do to help promote healthy brain development in infants and children. One of the most important and impactful things you can do is to be a responsive caregiver and develop a secure attachment with the child. For more information on building a secure attachment, please see attached article. Being a responsive caregiver means supporting your little one when they are in distress and meeting their needs as much as possible. This may not always be easy, especially with very young infants. With infants you may not know right away what their immediate distress is (hungry, tired, over stimulated) and that is okay! What you can do is stay calm and keep trying different things until they are calm and relaxed. This will help to strengthen the important synaptic connections that are vital for the executive functioning skills we talked about earlier. Responsive caregiving also means watching for cue or hints your little one might be sharing with you. If your child is getting frustrated, step in and support them with a little help, encourage them to keep trying and help them learn that mistakes are okay and a great way to learn! This will promote persistence and resiliency.

Along with responsive care and supporting the development of a secure attachment, providing opportunities to explore, play and learn is developmentally beneficial. Research tells us that following a child's lead during play provides the best opportunities for learning and brain development. When children show an interest in a toy or something else in their environment (which is safe for them to interact with) a caregiver or caring adult should encourage the interaction by sharing interest as well. Playing with children can often seem challenging and many adults feel silly or awkward playing with their children. This is understandable and one way to move past this feeling is to simply copy exactly what your child is doing. For example, if your infant is banging a toy on the floor, pick up a toy yourself and bang away. Similarly, if your three your old is watching ants walking across the playground, get down with your child and talk about the ants together.

Ensuring your little one is getting enough sleep, proper nutrition and access to medical care will also support healthy brain development.

Disclaimer: The information contained in this article are the opinions of the author based on their own interpretation of the resources and research reviewed in the creation of this article.

References:

- https://www.cdc.gov/ncbddd/childdevelopment/early-brain-development.html
- https://www.youtube.com/watch?v=hMyDFYSkZSU
- https://www.pregnancybirthbaby.org.au/how-your-babys-brain-develops
- http://www.urbanchildinstitute.org/why-0-3/baby-and-brain
- https://www.caringforkids.cps.ca/handouts/your_babys_brain
- https://www.zerotothree.org/espanol/brain-development
- https://www.earlyyearscount.earlychildhood.qld.gov.au/age-spaces/timeline-brain-development-birth/#:~:text=During%20this%20time%2C%20prenatal%20sensory,are%20exposed%20to%20each%20day.
- https://www.firstthingsfirst.org/early-childhood-matters/brain-development/
- https://www.zerotothree.org/resources/529-baby-brain-map
- https://www.whattoexpect.com/pregnancy/fetal-development/fetal-brain-nervous-system/
- https://www.psychologicalscience.org/journals/cd/12_1/kolb.cfm
- http://scitechconnect.elsevier.com/what-is-brain-plasticity-why-so-important/