

Introduction

“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...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” (Porter, 2015). Scientists know that very little of a baby’s brain is “wired” at birth. The environment in which children develop helps mold growing brains, forming the tools infants will use for the rest of their lives. Research has provided a deeper understanding of how the brain grows, how it is changed by experience, and what parents and caregivers can do to help children develop the tools they will need to succeed in life. A child’s environment between birth and three years of age plays a tremendous role in the success of that child as an adolescent and as an adult.

Brain Formation

“If little else, the brain is an educational toy”
~ Tom Robbins (*BrainyQuote*, 2015)

At birth, babies can only perform basic functions necessary for survival. During the first three years their brains will grow and change; helping them learn to walk, talk, and interact with others. Their brains will continue to grow and change throughout their lives. However, brain growth will never again be as rapid as it is during the first three years.

Brain development begins long before a baby is born and continues at varying rates throughout life. By 3 ½ weeks after conception a baby has already begun to form what will become the brain and spinal column. By the fifth month of pregnancy, over 100 billion brain cells, known as neurons, have been formed (Zero to Three, 2014a). As birth nears, the growth of neurons slows down and connections start to form between them. By forming connections between cells, the brain is preparing the fetus for its entry into the world, as the connections will allow the cells to communicate and work together to form any thought, feeling, or action.

At birth, infants have more brain cells than an adult, yet their brains weigh only 25% of an adult brain. The vast growth in brain size and weight is a result of the formation and coating of new synapses. Synapses allow different cells in the brain to communicate with one another. Shortly after birth, a baby’s brain speeds up the production of connections between brain cells, forming more connections than it needs (Zero to Three, 2014a). This sensitive period of brain plasticity, or “the brain’s ability to change in response to repeated stimulation,” plays a key role in the child’s development (Child Welfare Information Gateway, 2015b).

Experience determines which connections will grow strong, and which will be allowed to die off, or be “pruned.” Each time a certain action takes place, or a certain emotion is elicited, the same neurons are used simultaneously. The cells that are frequently stimulated at the same

time will grow strong connections and become more sensitive and efficient. However, the brain will also prune unused synapses throughout early childhood and even early adolescence, after which point the number of connections will remain fairly constant through adulthood (Zero to Three, 2014a).

Young children who feel love and comfort will easily be able to feel these emotions as an adult. Groups of neurons and synapses that are used relatively little throughout infancy will remain slow and clumsy, throughout life. Thus, if a child does not experience love and comfort between birth and three years of age, it will be difficult for them to experience these feelings as an adult because the part of the brain needed to produce these emotions will be weak and unresponsive. This can cause serious repercussions for the child, as without feeling these emotions they can grow up to become a poorly controlled adult.

The fact that the brain is still growing and adapting throughout childhood offers both dangers and opportunities. The impressionable mind of a young child can be more dramatically harmed by stress and trauma than the mind of an adult. However, the young brain also possesses the ability to overcome challenges the adult brain cannot cope with. It is important to realize that a baby's brain is not a miniature version of an adult's brain. A child's experiences in the first three years will actually shape his or her brain. Between birth and three years of age, while the brain is still "wiring" itself, it will find a way to produce and strengthen the parts of the brain that the environment creates a need for.

Growth of a newborn's brain depends on care, genetics, and nutrition. A child raised in a loving and comfortable environment will grow to have a brain well suited to feeling loved and comfortable. Those children who are abused or neglected are likely to develop brains that are eager to sense fear and feel stress, conditions that will hinder their ability to function in society.

<http://www.help4teachers.com/gardening.htm>

Describes the process by which the brain prunes unused cells to make room for more connections between the cells it is keeping.

<http://www.nea.org/home/31627.htm>

This website gives a list of resources that provide information and research on cognition and brain development.

Prenatal Care

A parent's responsibility to his or her child begins before the child is born. Prenatal care is the care a woman receives during pregnancy, and helps to ensure that the mother and baby are ready for birth, identifies problems before they become serious, and teaches mothers how to make healthy choices for their unborn children.

Almost 4 million women give birth every year in the US, with nearly one third of them expecting some sort of pregnancy complication (Kids Health, 2015). It is important that a woman start seeing a doctor for prenatal care as soon as possible. Ideally, a woman should start prenatal care before she becomes pregnant. However, it is not uncommon for prenatal care to start after conception. During the first 2 trimesters, most women see their doctor once a month. By the last trimester, women usually see their doctor every other week. Doctors use tests and measurements to track progress and watch for complications (Medline Plus, 2014).

An important part of prenatal health is nutrition. Expectant mothers should raise their folic acid intake to at least 400 micrograms a day, through diet and/or supplements. It is recommended that mothers begin this process one month prior to and during the first 3 months of pregnancy (Medline Plus, 2014).

Not only do unborn children obtain nourishment from their mothers, but they also receive the harmful substances that their mothers consume. Many complications can arise from lack of prenatal care, insufficient nutrition, or risky behavior during pregnancy. Pregnant women must also avoid smoking and using drugs, and should not take any

medication without consulting their doctor. There are often severe consequences for any of these actions.

Doctors say that during pregnancy no amount of alcohol is safe. Women who consume alcohol while they are pregnant put their children at risk for fetal alcohol syndrome (FAS) and low birth weight. The effects of FAS include mental retardation, behavioral problems, trouble remembering and/or learning, and problems with the central nervous system (Centers for Disease Control and Prevention [CDC], 2015).

Mothers who smoke during pregnancy put their children at risk by being more likely to have a premature delivery, increasing chances of the child having sudden infant death syndrome (SIDS), and doubling the likelihood of the child having Low Birth Weight (LBW) (March of Dimes, 2015). LBW is associated with higher infant mortality, brain damage, and higher rates of illness. By not smoking, eating right, and gaining an appropriate amount of weight during pregnancy women can lower their risk of having a LBW child (Cheong, 2015).

<http://www.womenshealth.gov/publications/our-publications/fact-sheet/prenatal-care.html>

Describes prenatal care and why it is important. Also explains how women should take care of themselves during pregnancy.

http://www.marchofdimes.com/pnhec/159_513.asp

Explains the benefits of prenatal care and the risks that are associated with pregnancy.

A Parent's Influence

Infants are completely dependent upon their caregivers. They have no control over their environment or their experiences. Parents have the responsibility to ensure their child's safety and well-being in order to prepare them for life. Through actions and choices, parents shape their child's environment. The choices parents make have significant and lasting effects upon the child. Understanding brain development will help parents make the right choices for their children, as parents influence whether their child will go to school prepared to learn or start school lagging behind other children.

Children who benefit from early childhood development programs are more likely to finish high school and pursue post-secondary education or training, less likely to receive public assistance, and less likely to commit a crime (The World Bank, 2011).

Parents have the duty to provide an environment that will encourage physical health for the child: Injury, infection, malnutrition, or exposures to toxins are all physical dangers that can negatively impact a child's central nervous system and development (World Health Organization, 2008, p. 2). It is the parents' responsibility to protect their children from hazards and make sure their child's physical needs are met.

Through hard work and dedication, parents can help their infants grow into successful students and productive adults. Parents have the incredible opportunity to shape the future of their child. By providing children with a safe and healthy environment, parents give their children limitless possibilities for future success and happiness.

<http://www.zerotothree.org>

A wide range of information for both parents and educators is provided. Visitors can track child development stage by stage as well as read a general overview of how a baby's brain grows. The website has various articles pertaining to most aspects of a baby's life.

<http://www.usa.gov/Topics/Parents-Young.shtml>

This website explains the important role parents play in their young child's life. It also has links to other websites offering resources and advice to parents of young children.

Nature and Nurture

People have long wondered whether genetics or experience determines who a child will become. Brain research suggests that both are important and dependent on one another. "The developing brain's ongoing adaptations are the result of both genetics and experience" (Child Welfare Information Gateway, 2015b). Though nature provides the framework, the repetition or lack of experiences create, strengthen or

discard synapses in the brain. The “use it or lose it rule” refers to the brain reinforcing consistently activated connections and disposing of the unused synapses. “All children need stimulation and nurturance for healthy development. If these are lacking—if a child's caretakers are indifferent or hostile—the child's brain development may be impaired. Because the brain adapts to its environment, it will adapt to a negative environment just as readily as it will adapt to a positive one” (Child Welfare Information Gateway, 2015b). Depriving a child of certain stimulation may result in an over-pruning of neuronal connections. Though the child may be able to gain back some experience related synapses in the future, it will be much more difficult than reinforcing them as a child. It is clear that a child's environment plays a crucial role in further developing, enhancing or diminishing their genetic ability.

Before birth, a baby's world is largely controlled by genetics. The baby's growing body consists of neural circuits, where cells are genetically programmed to go where they need to go. Cells are rapidly produced and sent to their appropriate locations. One of the most impressive instances of genetic programming occurs in neurons. In order to form synapses, neurons must form both the sending and receiving portions of connections (see Diagram 1).

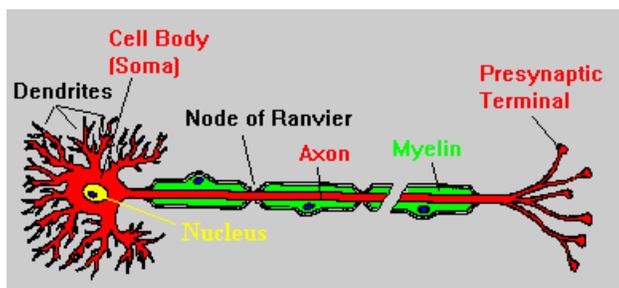


Diagram 1
(Chudler, 2013)

The dendrites, or receivers, pick up chemical signals across the synapse carrying the impulse to the axon. But to complete the wiring, the axons, or transmitters, must stimulate the release of neurotransmitters to inhibit the dendrite (Gable, S and Hunting, M, 2015). While genetics seem to be leading the influence

during gestation, the environment still plays a key role. Without proper nutrition, the fetus will not have the nutrients it needs to develop properly. Drug and alcohol abuse, smoking, and infection can also negatively impact the growing fetus, reducing a child's chances of developing normally (Zero to Three, 2014a).

Early experiences are crucial in shaping the cultivation and pruning of neural synapses that account for so much of brain growth (Zero to Three, 2014a). Once the connections are made between the dendrites and axons, the environment will make them more efficient by strengthening those which will be kept and eliminating the ones that the brain does not need. Each neuron can begin firing with one another as soon as the connection between the two neurons is complete. A child's experiences will determine the amount the neurons are fired, which in turn will determine the shape and path of the connections leaving it.

<http://extension.missouri.edu/p/GH6115>

This website offers information about the interaction between nature and nurture, and offers advice for parents and caregivers.

Vision

Babies are not born with the same visual capabilities as adults. Vision is a basic function, and thus the part of the brain necessary for processing visual input is one of the first to develop. As visual input is processed and new synapses are formed in the brain, vision improves, eventually creating the ability to focus on the object of a baby's choice and follow that object across the field of vision.

At birth, infants at best see out of the corner of their eyes and can only focus on objects 9-12 inches from their face (Zero to Three, 2014b). With time, babies gain the ability to see out of the center of their eyes. At eight months of age, a baby's vision is similar to an adult's, allowing him or her to track objects, scan, focus at different depths, and distinguish between colors (Baby Center, 2015).

Visual input is particularly important early in life, as the brain is learning how to interpret

data provided by the eyes. With normal vision the brain will grow stronger synapses, allowing the infant's vision to improve rapidly. It is important to seek medical attention as soon as possible if an infant seems to have trouble seeing. Without the correct input from the eyes, the parts of the brain needed to interpret visual stimulus will not develop, and the neurons crucial to interpreting visual input may be pruned. The sooner the problem is corrected the greater the chance the brain can develop the ability to process input from the eyes normally.

<http://www.babycenter.com.au/a6508/developmental-milestones-sight>

Provides a timeline of when babies learn to see, and what parents can do at each stage. It also provides information about common problems with vision and what can be done about them.

<http://www.allaboutvision.com/parents/infants.htm> and <http://www.childrevisions.com/links.htm>

These websites are devoted entirely to vision at various stages in life. The first site explains how vision develops in infants and when infants should have their vision checked, while the second provides vision links and resources.

Language Development

The young mind has an amazing capacity for learning language. At birth, infants have the ability to learn any language. They pay attention to sounds from any language they hear. By the time they are six months old, infants pay more attention to the sounds of their own language, and like adults, cannot distinguish between slight differences of sound in other languages due to brain development. As the brain processes the same sounds over and over again, the connections for these sounds grow stronger and more efficient. The parts of the brain that process sounds the child rarely, if ever, hears grow weak and die off (Multilingual Children's Association, 2004).

Infants are more responsive to "baby talk," the higher pitched, more melodic sound most adults use when they address infants. Infants will begin making noise and trying to mimic this

melody long before they are actually able to talk.

Parents should encourage these noises with smiles, and respond by asking the infant questions. This encourages babies to explore language and communicate with those around them.

Using baby sign language has been shown to have numerous benefits for both parents and the child. Teaching the child to communicate with hand signs before they can talk reduces frustration for both the parents and the child. Signing also builds trust between babies and their caregivers, boosts babies' self-confidence, helps parents to be more observant, and promotes positive emotional development. Babies that use sign language tend to have more advanced language skills than those who do not; in one study, 36 month old signers were talking like 47 month olds (Baby Signs, n.d.).

As with vision, it is important that any problems with a child's hearing be addressed as soon as possible. In order for the neurons to process sound and form synapses, a child must be able to hear correctly.

http://www.speech-language-therapy.com/index.php?option=com_content&view=article&id=35:admin&catid=2:uncategorised&Itemid=17

Explains what babies and toddlers enjoy that assists their language development.

http://baby.lovetoknow.com/wiki/Toddler_Language_Development

Offers general timelines of language development and include tips for helping babies learn to talk.

<http://www.nidcd.nih.gov/health/voice/pages/speechandlanguage.aspx#6>

Contains a checklist to help parents gauge their child's hearing and language abilities.

Consequences of Neglect and Abuse

Children who are abused or neglected in their early years often suffer damage that stays with them their entire lives. The implications of the maltreatment of infants are far reaching and surpass the implications of the same treatment later in life, because the brain is still growing

and producing connections. Abuse and neglect during this time will change the way the brain develops and the way it reacts to various situations.

Infants who experience extreme lack of stimulation will have smaller brains; their brains can even look different than other children (Child Welfare Information Gateway, 2015a). Researchers at Baylor College of Medicine found that children who rarely played and were seldom touched or spoken to had brains 20% to 30% smaller than other children their age (Porter, 2015).

Emotional and social consequences exist as well. According to the Child Welfare Information Gateway (2015a), “prolonged, severe, or unpredictable stress—including abuse and neglect—during a child’s early years is problematic...the brain’s development can literally be altered by this type of toxic stress, resulting in negative impacts on the child’s physical, cognitive, emotional, and social growth.” Abused or neglected children will frequently use the fear activated parts of their brains in response to threats in the environment. Children who are exposed to traumatic experiences may suffer from the effects long after the event has happened. If a child is continuously exposed to a threatening and negative world the brain may be “hyperalert” in sensing danger. The brain may focus too much on strengthening and developing strategies for survival, and in turn other areas of growth may not develop as fully. When adults, children who were abused will be quicker to start or engage in confrontational behavior because their brain has been trained to process threats quickly.

When mothers do their best to stay healthy during pregnancy, and parents avoid abuse and neglect, they can lower a child’s risk of developing disorders such as Attention Deficit Hyperactivity Disorder, depression, and social conduct disorders (USDHHS, 1999). Social conduct disorders are generally characterized by acting out, not following directions, and not getting along well with peers. Children of depressed

parents are more likely to suffer from mental disorders because depressed parents are often either overcritical of their children or apathetic and lack the energy to be sufficiently involved in the lives of their children. Their children grow up in an environment that makes healthy development difficult. Parents’ attitudes have a substantial effect on their children; infants even respond to their parents’ moods.

The rules enforced in the house also contribute to the child’s well-being in the long run. According to the surgeon general’s report, “a difficult child’s chances of developing mental health problems are much reduced if he or she grows up in a family in which there are clear rules” and consistent enforcement of these rules (USDHHS, 1999, p. 130). By establishing clear rules and enforcing them consistently, parents teach their children to follow rules and behave appropriately. Without these skills a child cannot learn and function properly in school.

<http://teacher.scholastic.com/professional/bruceperry/>

Dr. Bruce Perry, an expert in neglect and early childhood development, explains how abuse can hinder brain development.

https://www.childwelfare.gov/pubpdfs/long_term_consequences.pdf

Describes the physical, emotional, cognitive and social consequences of abuse by age group.

Benefits of Spending Time with Your Child

What parents do in the first three years helps shape their child’s entire life. The time parents spend reading and interacting with their children pays off in both the short and long term. Children who experience a safe and stimulating environment are generally more intelligent, have better social skills, and possess the ability to adapt to new or challenging situations with a lower stress level than children who did not experience the same nurturing environment. There are numerous benefits to improved parenting, some include:

- Intimate contact between parent and infant benefit both parties. Touching, holding,

comforting, rocking talking and singing to a baby provides stimulation for their growing brain.

- Forming secure and trusting relationships with babies will help them throughout life. Babies who feel safe in their relationships are more likely to feel safe creating new relationships.
- A child provided with love, nurture and encouragement will learn to reciprocate these actions and feelings towards others.
- Helping children develop properly helps all of society. Children of parents who attended parenting classes and implemented the training at home have been shown to be more successful in academics and get in less trouble.

(Zero to Three, 2012c)

Children raised in a healthy environment where they spend time interacting with their parents are more likely to become productive, socially responsible adults. Children that have been neglected or abused may have more difficulty performing tasks which require a higher-level of thinking or emotional cognition. Children who suffer maltreatment may also engage in impulsive and high-risk behavior that can lead to societal problems such as violence, crime and prison. Guidance and encouragement coupled with the modeling of appropriate behaviors on the part of the parents will give the children the opportunity to develop the skills necessary to become healthy, productive members of society (Child Welfare Information Gateway, 2015a).

<http://www.rif.org/> and

<http://www.ed.gov/parents/read/resources/edpicks.jhtml>

Describe the benefits of reading to children and offer tips for parents on reading and selecting books.

<http://www.zerotothree.org>

This website (listed earlier) explains benefits of varying practices at different stages of development and is an excellent resource for parents and educators.

Some Ideas for Parents and Caregivers

Babies' needs vary depending on their age and stage of development. The caregiver needs to adapt to each stage with the child; however, there are some concepts that consistently apply from birth to three, and even after. It is a parent's responsibility to be aware of their child's needs and do their best to meet them. Some ideas for parents to help their children develop strong, healthy brains include:

- Attend parenting classes to learn more about child development and parenting skills. Parents will interact with other parents and be able to share the joys and frustrations of raising a child.
- Allow babies as much room to explore as safety permits. Babies need a chance to practice things like crawling and walking in order to master these tasks and build the parts of their brain involved in coordination. By giving babies safe things to touch and explore, parents help him or her to become a more coordinated adult.
- Interact with the child. The relationships children form in the first few years will be the basis for their relationships for the rest of their lives. It is important to engage children often and form a secure and trusting relationship with them.
 - Pay attention to what the child likes and repeat these activities often. Children learn by repetition and are comforted by routines.
 - Babies need love and attention. Young minds benefit from stimulation such as gentle touch, play, and human interaction.
- Have consistent rules, expectations, and interactions with the child. Outbursts and overreactions that send inconsistent messages to the child should be avoided. Consistent and repetitive interactions positively impact a child's development.
- Talk to children and respond to the sounds they make as they try to imitate speech. Helping babies learn to communicate will benefit them for the rest of their life;

children who do not communicate well are at risk for slower learning and needing special help when they start school.

- Foster children's multi-sensory learning with experiences that expose children to sights, sounds and smells to simulate a growing mind. Parks, zoos, restaurants and other outings contribute to the child's development.
- Contact a physician or health care professional if the child is not developing normally. The sooner problems are addressed the better chance the child has of catching up with other children his or her age.
- Be aware that children feel parents' stress and that, when under severe stress, interactions with the child may have adverse impact. Parents should seek help if emotions are affecting the relationship with their child.
- Toddlers often have fits of emotion they cannot control. It is important to help the child manage them. The more children use the reasoning abilities of their brains the quicker they will be to evaluate situations before acting and they will become more controlled adults.
- Play is important to healthy brain development. Play allows children to creatively use their imagination while developing dexterity, physical, cognitive, and emotional strength. Providing stimulation does not have to be complicated or expensive—simple games such as Simon Says and Red-Light, Green-Light help children acquire self-control.
(Ginsburg, 2007; Zero to Three, 2014b)
- Ensure that the basic needs of the child are met by having proper nutrition, well-baby checkups, additional medical attention

when needed, and a safe environment. Assistance may be required to meet basic needs and parents of young children are encouraged to actively seek available resources to ensure that the basic needs of their families and children are met.

- Advocate for the child. Whenever parents are unable to be with their child, they are not able to directly control the quality the child's environment. Ensure that the caretaker of the child understands the importance of the early years and will provide the child with a safe and nurturing environment. Even when parents are not around, the first years of life will affect the child for the rest of his or her life.
 - Children who have attended quality childcare programs when they were 3-4 years old scored better in math, languages and social skills in elementary school than those children who attended poor quality child care programs.
 - Children who participate in programs aimed at development and school readiness before kindergarten are more likely to graduate from high school.

(World Bank, 2011)

<http://www.babycenter.com>

This interactive website allows parents to input their own information and track the needs and development of their baby, starting before birth and continuing on through infancy and the toddler stage.

<http://www.childcareaware.org/>

Available in both Spanish and English, helps parents find safe childcare centers and evaluate and compare childcare providers. It also offers various other tips on child safety.

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