

Introduction

“Scientists have found that a baby’s experiences . . . actually change the physiological development of his or her brain—the quality and quantity of the electrical wiring between cells. And the better they’re wired the better life will likely be” (Public Broadcasting Service (PBS), 1997). 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. Research shows that 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

“Experience is the sculptor of the human brain”
~Helen Neville, University of Oregon (Public Broadcasting Service (PBS), 2001)

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, the 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, 2009). As birth nears, the growth of these new brain cells slows down and connections start forming between them. Forming connections allows the cells to communicate and work together. Many cells must work together to form any thought, feeling, or action. By forming connections between cells, the brain is preparing the fetus for its entry into the world.

At birth, infants have more brain cells than an adult, yet their brains weigh only 25% of an adult brain. What infant brains do not have are the number of connections between cells, connections known as synapses. Synapses allow different cells in the brain to communicate with one another. The vast growth in brain size and weight is a result of the formation of new synapses, and the coating of these synapses. Shortly after birth, a baby’s brain speeds up the production of connections between brain cells, forming more connections than it could ever use. This is when experience plays a key role. Experience determines which of these 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, at which point the number of connections will remain fairly constant through adulthood (Hawley, 2000).

So how does the shape of an infant's brain and the connections between brain cells affect that child later in life? Young children who are constantly allowed to feel love and comfort will be able to feel these emotions easily as adults. On the other hand, those groups of neurons and synapses that are used relatively little will remain slow and clumsy throughout life. This means if a child does not experience comfort between birth and three years of age, it will be difficult for him or her to experience comfort as an adult because the part of the brain needed to produce these emotions will be weak and unresponsive. If a young child is not taught to control his or her emotions, he or she will likely grow up to be a poorly controlled adult (Davies, 2002). The fact that the brain is still growing and adapting offers both dangers and opportunities. The impressionable mind of a young child can be harmed more dramatically by stress and trauma than the mind of an adult. However, it 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 those parts of the brain 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>

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

<http://www.fcs.uga.edu/bbbgeorgia/aboutUs.php>

This website is sponsored by a group of organizations in Georgia dedicated to teaching parents about brain growth in babies.

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, it helps ensure 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.

In 2002, about 4 million women gave birth in the US, many of them experiencing some sort of pregnancy complication (Medline Plus, 2009). 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 (Medline Plus, 2009). Doctors will use tests and measurements to track progress and watch for complications.

An important part of prenatal health is nutrition. Expectant mothers should raise their caloric intake by 300 calories a day, making sure the food they eat is high in protein and other nutrients. Unborn children get the nutrients they need from the food their mothers consume (Medline Plus, 2009).

Not only do unborn children obtain nourishment from their mothers, they also receive the harmful substances their mothers consume. Many complications can arise from lack of prenatal care, insufficient nutrition, or risky behavior during pregnancy. Doctors say that during pregnancy no amount of alcohol is safe; pregnant women should not drink alcoholic beverages. Pregnant women must also avoid smoking or using drugs, and should not take any medication without consulting their doctor. There are often severe consequences for any of these actions.

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, reduced coordination, and malformed hearts and brains. Mothers who

smoke during or after pregnancy put their children at risk as well. Mothers who smoke during pregnancy are more likely to miscarry, to have a still born child or to have children with low birth weight. Babies exposed to cigarette smoke, whether from the mother or others around them, are more likely to experience respiratory problems, colds, and ear infections (Medline Plus, 2009). Low Birth Weight (LBW) is associated with higher infant mortality, learning delays, 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 (National Institutes of Health (NIH), 1999).

<http://www.4woman.gov/faq/prenatal.htm> This website tells women all about prenatal care, why it is important, and how to take care of themselves during pregnancy.

http://www.marchofdimes.com/pnhec/159_513.asp This is the March of Dimes website. It is an easy to use site that explains the benefits of prenatal care and the risks associated with pregnancy.

A Parent's Influence

Infants are completely dependent on their caregivers. They have no control over their environment or events they experience. Parents have the responsibility to ensure their child's safety and well-being in order to prepare them for life. Through their actions and choices, parents shape their child's environment. The choices parents make will have significant and lasting effects. 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, less likely to receive public assistance, and less likely to commit a crime (The World Bank, 2009). Understanding brain development will help parents make the right choices for their children.

Parents have the ability to provide an environment that will encourage physical health as well. "Injury, infection, poor nutrition, or exposure to toxins" are all physical dangers that

can negatively impact a child's development (U.S. Department of Health and Human Services (USDHHS), 1999). It is the parents' responsibility to protect their children from these 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 an 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> This is a comprehensive website offering a wide range of information for both parents and educators. Visitors can track child development stage by stage as well as get 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.babytalk.org/materials/essays.htm> 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. Is the person a child becomes already established by genetics at birth, or does a child's experiences determine what his or her life will be like? Brain research suggests that both are important and dependent on one another. Though nature provides the framework, "the brain operates on the 'use it or lose it' rule" (Hawley, 2000). "An 'over-pruning' of these (brain) connections can occur when a child is deprived of normally expected experiences in the early years. This leaves the child struggling to do what would have come more naturally otherwise" (Hawley, 2000). Whether or not the abilities genetics gives a child will be used to their full potential will be determined by a child's environment (Nash, 1997).

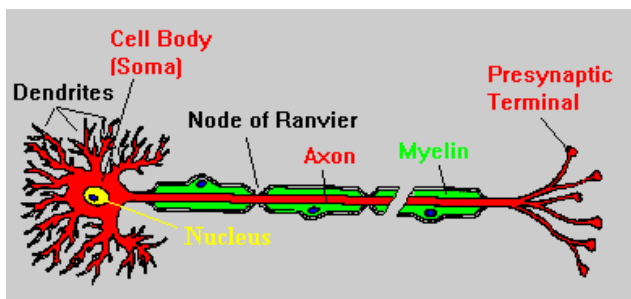


Diagram 1

Picture from

<http://faculty.washington.edu/chudler/cells.html>

Before birth, the baby's world is largely controlled by genetics. The baby's growing body consists of cells 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). The dendrites, or receivers, do not have far to go. But to complete the wiring, the axons, or transmitters, must weave their way through the other cells and connections, finding the dendrite meant just for it (Nash, 1997). 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 abuse, alcohol abuse, smoking, and infection can also negatively impact the growing fetus, reducing a child's chances of developing normally.

Once the connections are made between the dendrites and axons, the environment will make them more efficient, strengthening those which will be kept and eliminating those the brain does not need. Each neuron can begin firing with another as soon as the connection between the two is complete. The events a child experiences will determine the amount the neuron is fired, which in turn will determine the shape and path of the connections leaving it. It appears that, "early experiences are crucial in shaping the cultivation and pruning of neural synapses" that account for so much of brain growth (Zero to Three, 2009).

<http://extension.missouri.edu/explore/hesguide/humanrel/gh6115.htm>

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

http://www.childcareaware.org/en/resources/rethinking_the_brain.php

This website explains how nature and nurture work together and what things can be helpful or harmful to a child's developing brain.

Vision

Babies are not born with the ability to see the same way adults do. 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 see out of the corner of their eyes and focus on objects 10-12 inches from their face. Because vision is a basic function, the part of the brain necessary for processing visual input is one of the first to develop. As time goes on, babies gain the ability to see out of the center of their eyes. Around three months of age, they will have control over their eye movement, allowing them to focus on objects of their choice. Around 3-4 months, a baby's vision is "similar to an adult's," allowing him or her to track objects, scan, and focus at different depths (Zero to Three, 2009).

Visual input is particularly important early in life. 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.

One unfortunate and sad example is of an Italian boy with vision defects, for which doctors could find no physical cause. Despite the fact that his eyes were okay, he could not see normally. Eventually, researchers learned that as an infant,

the boy's eye had been covered as a result of an external injury. This cover limited the formation of synapse that could process information the eye takes in (Davies, 2002). Despite his eyes' ability to see things, his brain could not interpret what it was being shown.

<http://www.covd.org/Home/AboutVisionLearning/LearningtoSee/tabid/115/Default.aspx>

This website provides a timeline for 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.childrensvision.com/links.htm>

These websites are devoted entirely to vision at various stages in life. One page explains how vision develops in infants and when infants should have their vision checked, while the other 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 eleven 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 (PBS, 2001). This specialization is 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.

Research shows that 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.

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.weetalk.net/page.cfm?id=4>

This website provides an average timeline for a child's speech development and advice on when to seek professional help.

http://baby.lovetoknow.com/wiki/Infant_Language_Development and

<http://www.scholastic.com/littlescholastic/>

These website provide general timelines of language development and include tips for helping your baby learn to talk.

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. This is 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.

On a basic level, infants deprived of stimulation will have smaller brains; their brains can even look different than other children (Davies, 2002). Researchers at Baylor College of Medicine found that children who rarely played and were rarely touched had brains 20% to 30% smaller than normal for their age (Nash, 1997).

Emotional and social consequences exist as well. Dr. Bruce Perry, of Child Trauma Academy, points out that children abused early in life will be particularly tuned to danger. Children who are exposed often to stressful situations can experience side effects which include, slower than average physical growth, slower brain cell growth, and possibly delayed sexual maturity (Davies, 2002). Abused and neglected children use the fear activated parts of their brains frequently. If this occurs while the brain is developing, the part of the brain that responds to fear will become quick to act in any situation. While the body's natural responses to

danger (elevated heart rate, focus on threat related cues, and hypervigilance) are beneficial in dangerous situations, they are harmful in everyday life (Perry and Marcellus, 1997). 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. Studies show that children of depressed parents are more likely to suffer from mental disorders. This is 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 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 which are consistently enforced" (USDHHS, 1999). By establishing clear rules for their children 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/bruce_perry/abuse_neglect.htm This page on the Scholastic website summarizes the work of Doctor Bruce Perry, an expert in neglect and early childhood development.

<http://www.news.wisc.edu/wire/i033199/brain.html> This website contains an article that

explains how children deal with danger and stress in their environment.

Benefits of Spending Time with Your Child

The time parents spend reading and interacting with their children pays off in both the short and long term. As experts conduct more research about the benefits of good parenting in the early years, it becomes obvious that what parents do in the first three years helps shape their child's entire life. Studies have shown that 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. Here are some of the benefits to improved parenting in the early years.

- ❖ Intimate contact between mother and infant benefit both parties. Intimate contact and playful interaction activate the opiate system by raising endorphins for both. Babies are happier and have lower levels of stress when they experience close contact and interaction with their mothers (Davies, 2002).
- ❖ Forming secure and trusting relationships with babies will help them throughout life. Babies who feel safe in their relationships at one year are more likely to feel safe creating new relationships later in life, particularly in school (Davies, 2002).
- ❖ Helping children develop properly helps all of society. Children of parents who attended parenting classes and implemented the ideas at home have been shown to be more successful in academics and get in less trouble.

Children raised in a healthy environment where they spend time interacting with their parents are likely to become more productive, socially responsible adults. Children who are abused and neglected generally do not grow up to become productive members of society. Encouraging the safe and healthy development of young minds will eventually help reduce societal problems, such as school violence, high crime rates, and crowded jails (Peck, 2003).

<http://www.rif.org/parents/readingaloud/default.aspx> and <http://www.ed.gov/parents/read/resources/edpics.jhtml> These websites 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. A caregiver needs to adapt to these stages, changing with the child; but there are some concepts that apply from birth to three, and even beyond. It is a parent's responsibility to be aware of their child's needs and do their best to meet them. Here are some ideas for parents to help their children develop strong, healthy brains:

- ❖ Attend parenting classes to learn more about your child's development and how to become an even better parent. At parenting classes you will meet other parents and be able to share your joys and frustrations in raising your child.
- ❖ Allow your baby 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 your baby safe things to touch and explore you are helping him or her become a more coordinated adult.
- ❖ Interact with your 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 your child often and form a secure and trusting relationship with him or her (USDHHS, 1999).
- ❖ When interacting with children, pay attention to what they like and repeat these activities often. Children learn by repetition and are comforted by routines.
- ❖ Have consistent rules, expectations, and interactions with your child. Avoid outbursts and overreactions that send inconsistent messages to your child. Consistent and repetitive interactions positively impact your child's development.
- ❖ While spending time with children, talk to them and respond to the sounds they make as they try to imitate your 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.
- ❖ Babies need love and attention. Studies have shown that young minds can benefit from stimulation such as gentle touch, play, and human interaction. Helping your baby develop can be fun and rewarding for both of you.
- ❖ Foster your child's multi-sensory learning with experiences that expose your children to sights, sounds and smells to simulate a growing mind. Parks, zoos, restaurants and other places you go contribute to your child's development.
- ❖ Keep an eye on your baby's development and contact a physician or health care professional if you think your child is not developing normally. The sooner problems are addressed the better chance your child has of catching up with other children his or her age.
- ❖ Be aware that your child feels your stress and that, when under severe stress, your interactions with your child may have adverse impact. Seek help if your emotions are affecting the relationship between you and your child.
- ❖ Toddlers often have fits of emotion they cannot control. It is important to help your 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.
- ❖ Providing stimulation for your child does not have to be complicated or expensive. The Children's Institute for Learning and Development outlines the benefits of play to

a young child and describes play as “essential to brain development”. One example given is, “the rocking motion associated with swinging or being carried develops the cerebellum and vestibular brain systems associated with balance and the inner ear” (International Play Equipment Manufacturers Association (IPEMA), 2001). Even simple games such as patty-cake and peek-a-boo help program the brain and improve abilities in things ranging from art to math (IPEMA, 2001).

- ❖ Make sure the basic needs of your child are met. He or she should have 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.
- ❖ Be an advocate for your child. Whenever you are unable to be with your child you will not be able to directly control the quality of his or her environment. Make sure that the people you leave your children with understand the importance of the early years, and will provide your children with a safe and nurturing environment. Even when you are not around, these first years will affect your 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.

<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/> This website, available in Spanish and English, helps parents find safe childcare centers and evaluate and compare childcare providers. It also offers various other tips on child safety.

<http://www.nga.org/portal/site/nga/menuitem.9123e83a1f6786440ddcbeeb501010a0/?vgnextoid=4d095aa265b32010VgnVCM1000001a01010aRCRD&vgnnextchannel=4b18f074f0d9ff00VgnVCM1000001a01010aRCRD> This issue brief briefly covers why brain development is important and provides suggestions for parents about how to care for their children.

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