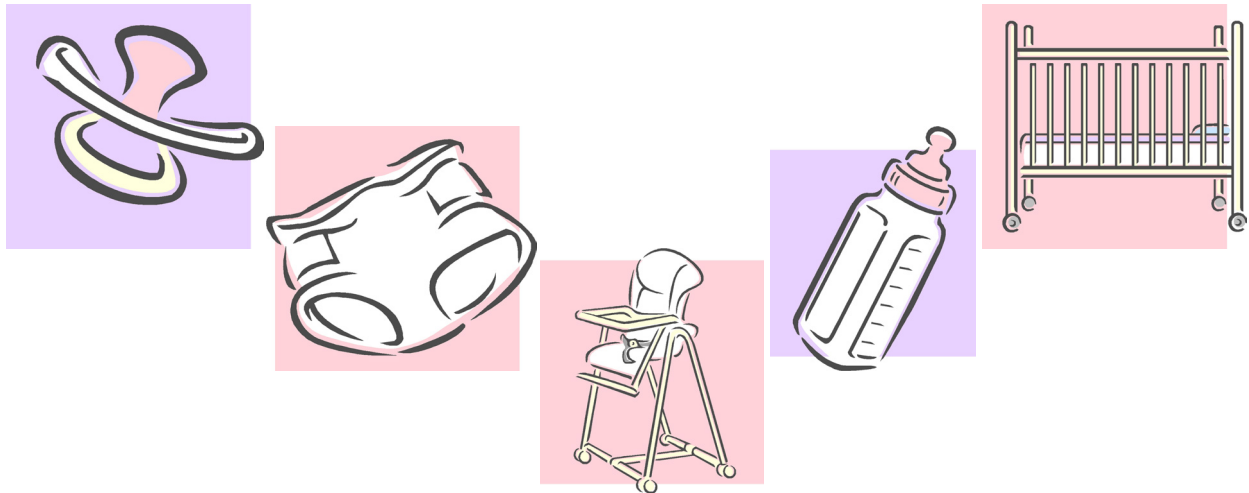


Infant Brain Development

Supporting Infants' Social & Emotional Growth



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This publication meets the requirements for 3 hours of
continuing education credit

~

3 hours of Social and Emotional Training

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UPON COMPLETION OF THIS COURSE, YOU WILL BE ABLE TO:

- 1) Describe how an infant's brain develops.
- 2) Describe how infants use their senses to gather information about their environment.
- 3) Explain how caregivers can support critical periods of brain growth in infants through responsive care.

INTRODUCTION

Did you know?

- The brain is the least developed organ at birth.
- At birth, the human brain has about 100-200 billion nerve cells.
- A baby's brain is changed, both positively and negatively, by what the baby experiences in their first 3 years of life.
- The timing of the experiences can be very important to proper brain development.
- The relationship between a child and his or her caregivers can influence social and emotional functioning.

All of the little steps that we think about when we hear the term “infant development” such as smiling, rolling over, crawling, walking and even talking are all examples of abilities that are a result of a rapidly growing brain. Infants change and grow so much that it is probably not surprising to learn that a baby's brain doubles in size from birth to age three! This early brain development is important because it is the “groundwork” for the child's future learning to be built on. If children do not develop properly when they are infants, it is much more difficult for them to succeed later in school and life.

For this reason, it is vital for us to foster early brain development in infants and young children to help them have the best future possible. In this course, we will be exploring how the infant brain develops, and how caregivers can support optimum brain development in infants by providing responsive care.

BRAIN DEVELOPMENT THEORIES

Historically, there have been two different views about how the human brain develops:

- 1) *The “nature” philosophy is the belief that an infant’s genes are responsible for how smart he or she will be and how well his or her brain will function.*
- 2) *The “nurture” philosophy is based on the idea that children are born a blank slate. The “nurturing” experiences they have when they are growing up will determine how their brains are formed.*

The reality is that babies’ brains are shaped by both nature and nurture!

A baby’s genes (nature) are responsible for the basic “wiring” of the brain and the sequence of neural development. This can be seen by the fact that all infants pass through the same developmental milestones at about the same age (reaching, rolling over, crawling, etc.) In fact it is easier to tell a child’s age by what they are doing than by their physical characteristics (how big they are, how much hair they have, etc.)

A baby’s environment (nurture) shapes the quality of brain development. Experiences help fine-tune the wiring that a child was born with. The outside world shapes the development of the

brain through the stimulation the child receives. A good example of this is that all babies are born with the ability to learn language. The language a child learns, and the accent that the child has are determined by the language spoken around them.

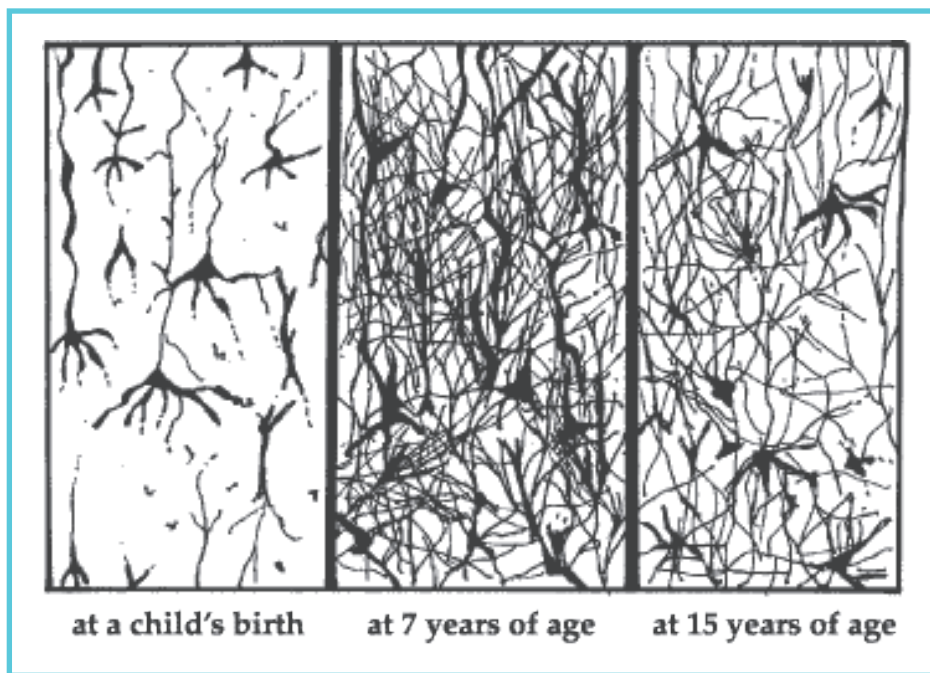
As a childcare provider, there is little that you can do about a baby's genes, but you can do a great deal about the type of environment you provide for the children in your care. By providing responsive care, you can have a great impact on the quality of childrens' brain development!

HOW THE BRAIN DEVELOPS

The human brain is considered the least developed organ at birth because while the 100-200 billion nerve cells (neurons) that are present in a baby's brain at birth is equal to the number of neurons found in adult's brain, most of them are not yet connected. Critical nerve cells in a baby's brain are connected at birth. For example, nerves that are needed for basic survival such as breathing and controlling the heartbeat are already connected at birth. However, much of the "wiring" of the brain takes place after birth. In an infant, the synapses connecting the neurons, and the myelin sheath that protects them have not yet fully formed. As the brain develops, the neurons build complex synaptic connections (kind of like scaffolding) that are necessary for future learning.



A baby's environment **before** birth can have an effect on the formation of these synaptic connections. If a developing fetus is exposed to malnutrition, infections, drugs or other toxins, the formation of their neurons can be negatively affected. For example, malnutrition while in the womb can lead to inadequate brain growth. These malformed neurons often cannot make the necessary connections to other neurons and do not allow for the scaffolding process to occur. This can lead to problems such as mental retardation and mental illness. So, ensuring healthy pregnancies can contribute greatly to fostering healthy brains in babies.



By the time a child is 3 years old, their brain has formed nearly 1,000 trillion connections. Beginning at about 11 years of age, a child's brain will get rid of extra unnecessary connections through a process called "pruning". This is necessary because brain cells form too many connections at first. Gradually, the connections that are being used become stronger, and the neurons not being used get weeded out. Only about one-half of the neurons generated during development will survive to adulthood. That is why the above illustration of the brain cell connections looks less dense at age 15.

There are also critical periods when changes occur in baby's brains. These are windows of time during which the brain needs certain experiences in order to develop fully. For an example, a monkey raised from birth to six months of age with one eyelid closed will lose some useful vision in that eye. This is because the neurons responsible for sight in that eye were not stimulated during the critical period of development. The neurons were then "pruned", so it would not be possible for the monkey to have excellent vision in that eye even if the eyelid were fixed later on. This is the reason why a baby born with an eye impairment such as crossed eyes need prompt correction of the problem so that their eyes receive normal visual input to develop healthy neural pathways. We will be exploring more about these critical periods of brain development later on in the course.

BRAIN DEVELOPMENT TERMS

Axons are the long, slender part of the neuron that conducts the nerve impulses away from the cell body and towards another neuron.

Dendrites extend out from the cell body like tree branches and receive messages from other neurons. This allows electrical signals to be passed rapidly from one neuron to another.

Myelin, a fatty substance made by cells that support nerve cells, wrap around the axon to form an insulating sheath. This myelin sheath insulates the axon and allows for more rapid transmission of the electrical signal from one neuron to another. Myelination of neurons occurs rapidly during infancy and it is one of the factors related to the development of certain physical skills such as crawling and walking. This rapid myelination is also the reason that children under the age of two need adequate amounts of fat in their diet (to supply the necessary building blocks for myelin production).

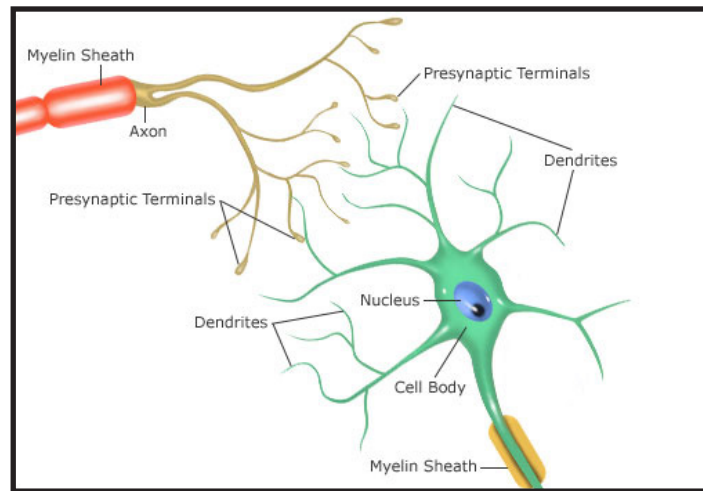


Image source: www.massgeneral.org

Neurons (nerve cells) are electrically excitable cells that make up the nervous system. Neurons transmit information through electrical and chemical signaling. Most neurons contain a cell body with dendrites and an axon. The cell body contains the nucleus where most of the cell's necessary molecules are manufactured.

Synapses are contact points that permit neurons to transmit and electrical or chemical signal to another cell's dendrites.

HOW INFANTS USE THEIR SENSES TO LEARN ABOUT THEIR ENVIRONMENT

Caregivers of infants can help ensure healthy brain development by providing an environment supporting the development of skills in all of the sensory areas (hearing, sight, taste, smell and touch). A rich sensory environment is essential for an infant's development and for the optimal development of the brain connections that we previously explored. Stimulation of the senses is crucial to help a baby's brain make the connections it needs. The senses truly are a child's first method of learning.

SIGHT:

Vision is the only sense that does not receive stimulation in the womb. It is therefore not surprising that vision is poorly developed at birth.

Newborns cannot see very clearly, in fact their world is quite blurry at first. Newborns see best at distances of about 8 - 12 inches, so it is understandable that we all instinctively hold an infant close to our face so that he or she may see us better. Infants especially prefer to look at faces and bold patterns. Research shows that complex shapes and high contrast targets (such as black and white patterns) best stimulate the interest of infants. To help infants develop their vision, be sure that infants have toys or pictures to look at which include bold patterns and designs. Babies' eyes are also drawn to new objects, so changing their environment is also beneficial.

The most important thing that caregivers can do to encourage normal sight development is to make sure that babies can see! Up to 5% of all infants will develop some kind of visual abnormality in the first few years of life. The earlier these problems are picked up, the better the outcome for the infant. Binocularity, or the ability to see using both eyes together, develops at about 3 ½ months of age. If a child has a problem that interferes with the ability to see, such as crossed eyes or cataracts, binocularity cannot develop properly. As we saw in the previous example with the monkey, the neurons that support binocularity will eventually become smaller or pruned away if they are not stimulated. If the "window of opportunity" closes before the baby gets his vision corrected, he or she may never be able to use both eyes together very well.

Keep in mind that from birth up to the first eight weeks of life, it is normal for a child's eyes to not always track together. This is usually not a concern unless the baby's eyes never align or the alignment doesn't improve after the first two months. If you observe or suspect a problem with an infant's eyes, inform the parent. Experts recommend that every child have an eye exam at about 6 months of age. InfantSEE, a public health program for infants, can help parents and caregivers find eye doctors who will give free exams to babies under the age of 12 months.

Their website at www.infantsee.org can provide more information.

SIGHT GAMES TO PLAY WITH BABY:



Babies love to look at faces. Try different facial expressions to entertain infants. Blink your eyes, stick out your tongue, make a variety of contortions with your mouth, or wiggle your eyebrows.



Show your baby several colorful toys and move them around so that she can follow with her eyes.



Blow bubbles outside so baby can watch them float.



Show baby large, colorful books with pictures. Talk about what you see in the pictures.



When you are at the grocery store, show him the foods that you are buying and talk about how they taste or look.



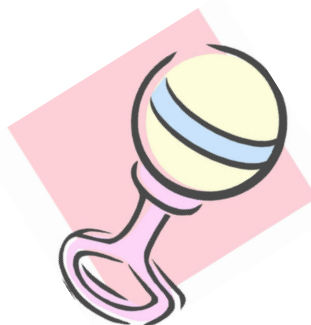
SOUND:

The ability to hear forms early in utero. By the time a baby is born, she has had about 12 weeks worth of hearing experience.

What has baby been listening to? His mother's heartbeat, the gurgles of her digestive system, and the external sounds of the mother's environment have filled the baby's ears before his birth. But, babies do not have perfect hearing at birth, newborn babies cannot hear quiet music and conversation very well. After birth, loud sounds might frighten an infant, while sounds that remind her of the womb, such as the clothes dryer or dishwasher may be soothing.

Like vision, hearing is a sense that is developed by experience and time. In order for a baby to develop optimum hearing ability, he or she must be exposed to a variety of sounds. Listening experiences shape the way a baby's brain becomes wired to process and understand different sounds. As we have seen with other senses, early exposure to music, speech, and other sounds can shape additional aspects of brain function. Providing a variety of hearing opportunities by talking, singing, playing music, and reading to a baby can help develop their emotional, language, and thinking abilities.

As with vision, the most important issue for caregivers to be aware of is, can baby hear? Most newborns have a hearing screening before they are discharged from the hospital, but any indications that an infant cannot hear should be investigated. As with vision, if the synapses associated with hearing are not stimulated early on by hearing sounds, the baby may lose some of his or her ability to hear. This can be especially devastating in the area of language development.



Protecting an infant's ears is another important part of a caregiver's role. Anything louder than 85 decibels can cause damage to hearing even during a relatively short exposure time. Some toys manufactured for children exceed this decibel level. Before giving a toy to a child, listen to it while holding it no more than about a foot from your head. If it makes you flinch, it is too loud! To limit the baby's exposure to damaging noise, you can also make a point of buying toys with volume controls or remove the batteries from noisy toys.

SOUND GAMES TO PLAY WITH BABY:



Sing songs to your baby such as “Twinkle, twinkle little star” or “The itsy, bitsy spider.”



Try singing songs or talking in different ways. Use a high voice, a whisper, a low voice, etc.



Crumple up noisy paper such as waxed paper or a brown paper bag. Talk about what you are doing.



Give infants toys that make crinkling noises or that play a song. Wind up a musical toy and put it out of the infant's sight (or shake a rattle out of the infant's sight). Ask him “where is the music?”



Tap two sticks together or clap your hands when singing your baby's favorite song.



Read to your baby! Recite poetry or nursery rhymes which have varying cadences and rhythms.



Play a variety of music for babies to listen to from classical to collections of children's songs.

TASTE:

The sense of taste is well developed at birth. This is because babies have already had many taste experiences in the womb.

Whatever is on mom's menu ends up in the amniotic fluid and the baby can taste it. Newborns naturally prefer sweet tastes, and their taste buds are especially attuned to appreciate mother's milk which will give them optimal nutrition. Like smell, taste is a big part of a newborn's world because it is one of their most highly developed senses. The sense of taste offers an important opportunity for new sensory experiences.

Infants form taste preferences based on flavors they experience in the womb and through drinking mother's milk. It has been shown that breastfed infants have a wider variety of taste experiences than formula-fed infants (who taste the same flavors with every bottle). Mother's milk can have different flavors depending on the mother's diet. Studies show that breastfed infants are more likely to accept new foods at their first feeding.

TASTE EXPERIENCES FOR BABY:



When an infant starts eating food, talk to her about the foods she is eating. Are they hot, cold, chewy, or crunchy? What color are they?



Continue to add new foods to an older infant's diet (once foods have been added one at a time to help identify any food allergies) to encourage the acceptance of a wide variety of foods.



Encourage breastfeeding for infants since it provides optimum nutrition and ultimately will enhance an infant's acceptance of new foods later on.

SMELL:

Newborns rely on their sense of smell more than they will at any other time of their life. An infant's keen sense of smell helps compensate for some of the less-developed senses at birth such as hearing and vision.

As with the other senses, infants need “smell experience” to develop a good sense of smell. How do we know this? In a study involving rats who were prohibited from smelling after birth (they had one nostril closed off), it was found that they developed fewer neurons that corresponded to smell. In another study, rats raised in a rich olfactory environment (in which there were many different odors to experience) had 20% more neurons form that corresponded to smell.

Newborns find smell very soothing. Babies can recognize their mother from other women by her smell. Their mother's odor is very familiar to babies because it contains some of the same odors the baby was used to smelling in the amniotic fluid.

SMELL EXPERIENCES FOR BABY:



Let baby smell items when you are cooking. She can smell the cocoa powder, spices, herbs and fruits and vegetables.



Head outside and smell the flowers, the dirt, and anything else that you find that looks interesting.



Have baby smell soap, his baby shampoo, etc.



Let baby smell scratch & sniff books.

TOUCH:

Touch is one of a baby's most advanced abilities at birth. As you might expect, a baby's early experiences touching and being held are very important for physical reasons such as enhancing the development of motor skills.

What you might not know is that touch is also very important for a baby's health and social /emotional growth. Babies deprived of touch do not undergo normal brain development. It is important for caregivers to hold and cuddle babies, especially when feeding them, to help them feel safe and secure.

Early touch experiences will determine the quality of brain development in the area that deals with tactile (touch) sensitivity. In other words, the bigger variety of touch experiences a baby has (touching and playing with toys with different textures, etc.) the more developed this area of the brain becomes.

As you may have observed, touch sensitivity develops in a head to toe sequence. Babies use their mouths to "touch" and learn about objects because that is the area that allows them to learn the most at first. Even at five years of age, touch sensitivity remains greater in the face than in the hands. Babies learn more about objects by mouthing them than if they were to feel them with their hands. It is important to understand this and allow babies to have the opportunity to mouth their toys.



TOUCH EXPERIENCES FOR BABY:



Play games like “This Little Piggy” with infants and touch their toes one by one as you recite the rhyme.



Massage baby’s legs while diapering her and tell her what you are doing.



Play “So big.” Ask “How big is baby?” Then answer “So big!” and gently help baby spread his arms as wide as he can.



Clap hands. As you sing a song, guide the infant’s hands or feet in a clapping motion.



Show baby hand games as you recite the rhymes that go with them. Pat-a-cake, Itsy-bitsy spider, and Little Bunny Foo-Foo are all fun for infants.



Always hold babies when you feed them.

If you are a caregiver, make sure that you do activities each day that focus on each of the five senses. This will have an impact on the child’s development in the three areas of learning (social/emotional, intellectual, and physical).

SUPPORTING CRITICAL PERIODS OF BRAIN GROWTH IN INFANTS THROUGH RESPONSIVE CARE

A) WHAT IS RESPONSIVE CARE?

Responsive care is caring for infants in a way that allows them to develop trust and to feel valued, loved, confident, competent and secure. Responsive care happens when the caregiver closely observes the child and tunes into what the child is trying to communicate. By identifying the child's needs, and responding to them, the caregiver forms an attachment with the child that is stable, enduring and secure. When babies form these secure attachments to their caregiver, and are in a safe and caring environment they are better able to learn and grow. Infants that do not have a secure attachment to their caregiver find it hard to be confident enough to venture out and learn. If these secure attachments are not formed during a baby's first year, it is difficult for the child to undergo normal brain development. Ensuring children receive responsive care is important because the type of care a child receives when they are an infant can affect a child's life even into adulthood. Unresponsive care inhibits optimal brain growth and negatively affects growth in the three areas of learning (social/emotional, intellectual and physical).

B) CHILDREN WHO RECEIVE RESPONSIVE CARE:

- Get along better with others in life.
- Are more engaged with the world around them.
- Are better prepared for school.
- Are better able to focus in the classroom and spend less time aimlessly wandering.
- Have higher levels of language development and play.
- Are more self confident.
- Have fewer behavior problems.
- Have the ability to relate to others better in life.
- Can solve problems better in life.

C) CHILDREN WHO RECEIVE UNRESPONSIVE CARE:

- Have less confidence.
- Exhibit oppositional behavior such as crying and clinging.
- See themselves as unworthy of positive attention from adults.
- Can't concentrate as well.
- Are more anxious.
- Have more emotional problems in life.
- Are quicker to respond with aggression.
- Have more health problems in life because they have chronically over-activated stress response systems.
- Have more difficulty getting along with others in life.
- Are more likely to be addicted later in life.

D) HOW TO PROVIDE RESPONSIVE CARE:

Get to know each infant -

What are his likes and dislikes? What schedule does she follow at home? What calms him down or comforts him when he is upset? Watch for the baby's verbal and non-verbal cues to see what he or she needs from you and respond appropriately.

Be affectionate and nurturing -

During the first 6-8 months of life, infants focus on developing a sense of security. By helping each child feel safe and secure, adults can help infants develop a strong sense of self. How children are treated molds the way they see themselves. Creating a nurturing, responsive and caring relationship is vital to a child's development of a positive sense of self. Responsive care results in children who see themselves as people who are likeable and listened to.

As infants approach 7 months of age, they become focused more on exploring and learning about their world. A secure relationship with their caregiver allows them to have the confidence to explore knowing that they have a safe "base" to return to.

Establish routines -

Establishing routines can help children feel secure. By providing structure, you can help children know what to expect throughout the day.

E) WHY RESPONSIVE CARE IS CRITICAL TO INFANTS' BRAIN DEVELOPMENT:

Infants differ from older children because they are instinctually motivated to learn the skills that they need to survive. A good example of this is the acquisition of language. Infants are genetically programmed to learn language. Infants do not need motivation from adults to help them master language skills. It is therefore important for caregivers to understand that their role in a baby's development is to facilitate a baby's learning.

Providing structured lessons for infants will not provide any benefit to their learning. Instead, caregivers of infants should allow the infant to take the lead. For example, talking to infants about the routines of the day and responding to their attempts at verbal communication is a much more effective strategy. Responsive care facilitates learning because the caregiver is following the infant's lead and providing care that will allow them to flourish.

It is also important to identify what responsive care is not. Responsive care does not mean that a caregiver is constantly “smothering” a child with attention. By watching for an infant’s cues and identifying and meeting each infant’s needs, a caregiver can help support critical periods of growth in their brain.



ARE YOU PROVIDING RESPONSIVE CARE?

The Missouri Infant/Toddler Responsive Caregiving Checklist is available online and is a great way to assess the care in your child care center or home and determine strategies for providing responsive care.

[https://www.openinitiative.org/content/pdfs/MoNotes/IT Checklist Notes.pdf](https://www.openinitiative.org/content/pdfs/MoNotes/IT%20Checklist%20Notes.pdf)



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