Brain Development

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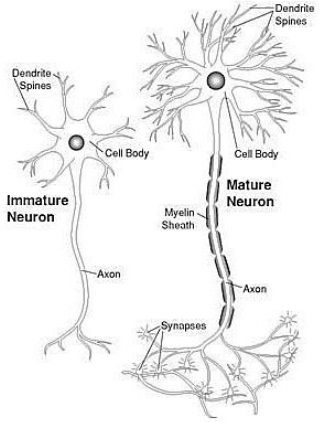
The Big Picture: Five Important Things to Remember

1. Babies build connections through day-to-day experiences, interacting with their world. The more times they repeat something, the stronger the connections.
2. As your child grows, myelination helps them process information more quickly. Good nutrition helps with the myelination process.
3. Children prune connections they don't use, so continue to practice and reinforce things you want them to master.
4. Children learn best when they are happy and feel safe.
5. There are sensitive periods when the brain is especially primed for learning certain skills, but don't worry that "if I don't do everything right when he's two, he'll *never* learn to…" There will always be more opportunities to learn.



The Details, starting with the basics:

First, some vocabulary: Neurons are brain cells that regulate thinking and regulate the work of the body.

Synapses are the connections between neurons that help them do that well.

When a baby is born, his brain is just ¼ the size of an adult's brain. But, he's got a huge number of neurons –as many an adult… that's as many as 100 billion neurons. In the nature vs. nurture debate, this is the nature… the raw material your child has to work with.

But, at birth, those neurons don't have many connections to other neurons. Connections are strongest in the brain stem, which is responsible for things like breathing, digesting, and eliminating. This ensures that at your birth, your baby had the reflexes necessary to keep her airway clear and to seek food. The connections are weaker in the parts of the brain responsible for balance, spatial understanding, hearing, language (the occipital, parietal and temporal lobes). The brain is especially immature in areas related to control of emotions (the limbic system), concrete thinking and decision-making (frontal lobe.)

A baby's job in the first 3 years is to build lots and lots of connections.

Building Connections: When cells communicate with each other, the axons send messages (electrical impulses), and the dendrites receive. The cells start to build connections: the synapses. Over time, there get to be more and more complex connections, branching like roots on a tree. Each neuron may have thousands of synapses. These connections help the brain process information more efficiently and take action more quickly.

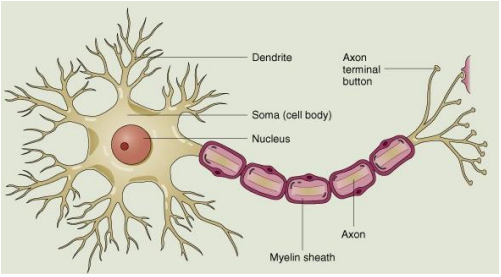
By the time a child reaches three years old, she has 500-1000 trillion synapses. To give you an idea of the numbers here, in one human brain, there are 100 billion neurons – that's how many trees there are in the Amazon rain forest. In that same brain, there are as many synapses as there are *leaves* on trees in the Amazon rain forest.

How do those connections build? Through experience. Through hands-on, in-person, multi-sensory experience where sight, sound, smell, taste, and touch are all activated.

A young baby is making connections all the time: up to 3 billion connections a second! Every sight, sound, smell, taste, and touch is being filed away for future reference. This is why children can be so over-stimulated at the end of a busy day. They need time to rest quietly and process all that new information.

In the nature vs. nurture debate, the experiences we expose our child to (our 'nurture') are essential in building the connections that will be important in their lives. What inspires learning:

1. Novelty – the first time your child encounters something, you'll see her looking attentive and puzzled, taking it in.
2. Repetition – the more times a child does something, the stronger the connection, till those connections become permanent and effortless. (I bet it's been a long time since you had to think about how to tie a shoe!)
3. Emotionally charged experiences – Strong emotions, either positive or negative, can build especially strong connections, even if the child only has that experience one time.



You don't need to buy special toys, tools, or DVD's that will build your child's brain and you don't need to shell out money for lots of specialty classes for your toddler to make sure they get the opportunity to develop. A trip to the grocery store, a bubble bath, singing songs during diaper changes, and playing with spoons on the kitchen floor are all great ways to build a young brain!

Myelination:

As the brain cells mature, they become surrounded by a myelin sheath. This is a dense, fatty substance that insulates the nerve fibers, and helps with clear, efficient transmission of nerve messages. Infants and toddlers don't have much myelin, and that's why they seem to process information so slowly at times.

Illustration source: http://disjointedthinking.jeffhughes.ca/2011/02/all-about-the-brain-part-1/

You may find that when things are quiet and calm, your child is able to make connections quickly, and he may "listen" well to you, following your requests quickly. A mellow child may easily be able to make choices in response to a question like "Would you like the blue shirt or the red shirt."

Under distress, a child is less able to process information. When a child is in a full scale tantrum, she is incapable of making a calm rational choice between two options. You will need to make choices for her.

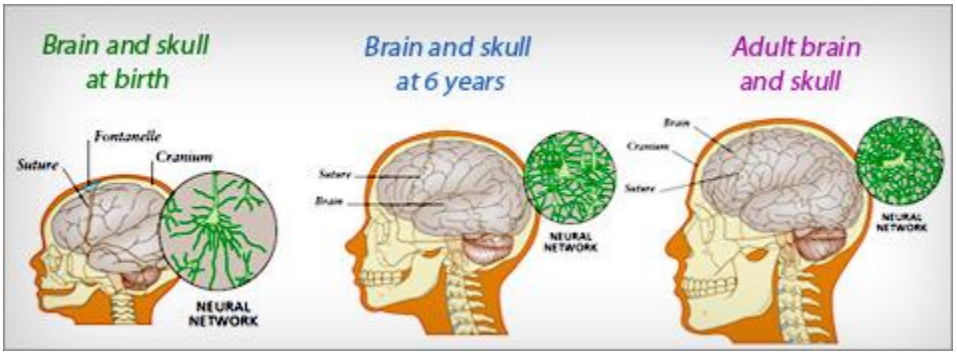
An excited child who is busy using his body is not in the space to listen to a lot of words… If you say to a toddler, "Don't throw that rock. Rocks aren't for throwing. I need you to give me the rock." Your child may just stare blankly at you. Or they may think back to the very first verb they heard you say – they figure that verb is the big clue about what they were supposed to do… hmmm…. What was that verb? Ah, throw! And they throw the rock.

What happens if instead you slow it down, look them in the eye, reach out and say "Give me the rock"? You'll watch them think, then process, then have the a-ha moment, and hand you the rock.

Myelination begins in the brain stem, then in areas dedicated to motor activity and the senses, and then into areas associated with thoughts, feelings, and decision-making. The myelination process continues through your child's teen years and into their early 20's.

Over time, when children have a safe environment where they are allowed lots of exploration, with consistent structure and limits, they will become better at regulating their emotions and inhibiting inappropriate behavior.

Nutrition for Brain Growth: Remember that the newborn's brain is 25% the size of an adult's brain? By age 5, it's 92% of adult size. That's a lot of brain growth!



When brains are building all those nerve connections, they need a LOT of energy… a toddler needs about 1000 – 1200 calories a day (e.g. a cup of fruit, a cup of veggies, two cups of milk, a couple ounces of protein foods, and 3 ounces of grains.) Especially important are healthy fats, as those myelin fibers and the cell walls in the brain are composed of fats. So, breast milk is fabulous, anything with omega 3's is helpful. We'll discuss lots of nutrition at some future class. The one other thing they really need is plenty of water to drink – the brain is 60% water!

Learn more at Brain-Boosting Foods for Kids: http://www.whattoexpect.com/toddler-nutrition/brain-food-for-kids.aspx

Illustration Source: http://doctorcare4u.com/images/brain-skull.jpg

Pruning

Children build huge numbers of connections. At their peak (around 4 – 8 years old) they may have twice as many synapses as an adult! But at that point, things have gotten kind of cluttered and tangled, and there are some connections they're really not using, so they start pruning those away to focus on the really essential connections.

The phrase "use it or lose it" is often used to describe this process. Children do a lot of pruning around age 10, so if there are things you want them to remember from their younger years, this is a great time to reinforce them.

Emotional Context of Learning

We learn from interaction with the objects in our world, but we especially learn within the context of relationships.

We learn best when we're happy. When we're feeling loved, and cared for, and safe, our system floods with oxytocin (the "love hormone") and our brains have a high level of "neuroplasticity" – we are open, flexible, and primed for learning. And we want to remember the things we're doing, and repeat them over and over, which reinforces that learning.

When we are stressed or frightened, our brain goes into survival mode – fight or flight – and we are less open to learning. We *can* learn when stressed… but much of what we learn at that time is how much we want to avoid having that experience again. Children typically don't want to return to a task that was unpleasant to learn.

Things to reflect on: What do you think this means for discipline? Is punishment a likely motivator for learning? What kinds of things would help to motivate your child to learn something?

If we learn best when we're happy, what does that tell us about what kind of environments are best for your child's learning? When you seek out activities and pre-schools, keep this in mind!

Lots of caring and touch helps with learning in general, but it especially builds pathways that help a child cope with stress. One study examined rats - mother rats typically lick their pups repeatedly throughout the first few hours of life. When the pups were deprived of that licking, they had a lifelong tendency to higher levels of cortisol, a stress hormone. As adults, those rat had lower intelligence and less ability to cope with stress.

Bathing our children in a sense of safety with predictable, loving responses help to create a better brain for learning throughout the rest of their lives.

Sensitive Periods / Windows of Opportunity

There are optimal times for children to learn skills – when certain portions of the brain are developing, or those cells are myelinating. There are a few things that have what's called "critical periods" where if the brain is not exposed to the right stimulus, it simply doesn't develop an ability, and once it's missed it, it's gone forever. An example of this: if kittens were temporarily blinded during the critical period for vision development, later when sight was restored, they couldn't use it – they were effectively blind.

Luckily, critical periods are *rare*. Most things have what's called "sensitive periods" – windows of opportunity where it's *easiest* to learn something. For example, if you want your child to be bi-lingual, the best time to learn a second language is between the ages of birth and 10. Now, obviously, you can learn a second language later in life – many of us started

one in 7th grade or 10th grade, right? Our brains are "plastic" and always capable of new learning. But providing opportunities during sensitive periods can make it easier.

At birth, the newborn's brain stem and spinal cord are mature. These handle all the reflexive behaviors of a baby: rooting for food, suckling, startling if they fear they're being dropped, and so on. At this point, babies really only have two "emotions": contentment and distress. At this age, they can't calm themselves – they can't self soothe, so they "borrow" emotional control from a caring adult who responds to them. The main learning for this age is Trust. Can they trust that their needs will be met?

If a child's needs are not met, they can get stuck in a survival mode and have a hard time developing higher functions. As your child gets older, if she is frightened, she may go back into this survival mode: the "fight, flight, or freeze" mode. This is where tantrums happen. Words won't reach a child who is so upset that they've regressed back to this.

Sensory cortex. Next to develop are the occipital lobe, which handles vision and balance, the parietal lobe that includes touch, and the temporal lobe which addresses hearing and language. Diverse experiences, including outdoor play, cuddling, and reading to your child help all of these to develop. The sensitive period for these is birth to grade school.

Limbic system. Then the limbic system develops – the "feeling" part of our brain. It's responsible for long term memories and more sophisticated emotions (beyond distress and contentment.) Our loving touch, soothing words, consistent responses, and a safe environment help it to develop. As it develops, around 8 months – 2 years your child will start to gain an ability to self-soothe. This self-regulation helps them manage their emotions.

The cortex manages concrete thinking, categorizing, associating. These skills build from pre-school to early adolescence.

Pre-frontal cortex is the executive function of the brain – thinking, planning, reflecting, reasoning, abstract thinking, judgment. It really develops in adolescence through age 22 – 25. So when my college age daughter makes decisions that seem foolish to me, perhaps it's just that her pre-frontal cortex is still developing.

Respect their capability. It's hard to learn something before the brain is ready for it. If there's something you and your child are struggling with, ask yourself whether your expectations are developmentally appropriate. You can research this, or you can observe other kids at toddler class – what do they all seem capable of?

For example, if you tell a toddler "don't throw that rock at your brother", they are not developmentally capable of coming up with a different plan for what to do instead – that's a pre-frontal cortex skill and won't come for years. Instead, you can re-direct them with a clear plan of what *to do*: "it's OK to throw the rock in the water. Let's go to the water."

Don't push your child to something she's not ready for. Respect your child's cues – her interest level and frustration level tell you whether or not she's ready for learning something.

Resources

There's lots of great resources on brain development, but here are some especially helpful ones:

Ten Things you Should Know About Early Brain Development: http://www.todaysparent.com/baby/baby-health/early-brain-development/

A slide show with lots of great details on brain development and how parents can aid it: http://www.slideshare.net/shibelle007/healthy-beginnings

The book, Brain Rules for Baby by John Medina. (It's also a great listen as an audiobook.)