Chapter Two — The Biology Of The Brain

We have huge brains.

People have massive brains. Our brains have billions of cells and even more billons of connections between the cells that create the functionality for our brain and our thought processes.

The heads of babies are disproportionately much larger than the rest of babies bodies — and that size difference make a clear statement about us and about what defines us, supports us, and keeps us alive from generation to generation. We are not the biggest or fastest or fiercest beings on the planet. We are, however, the smartest. We think to survive — and the better we think, the better our chances of survival tend to be.

Our large brains give us the tool we use to think.

Even though our brains are disproportionately large compared to the rest of the body at birth, we obviously are not born with all of our brain functioning in place. Our brains go through a clearly defined process and time of learning to function and to create the infrastructure and the lifelong internal neuron connectivity linkages that end up making each of us who we are.[1]

Our brains are actually developing and learning even before we are born. Some fascinating studies of brain activity show that newborn infant brains react differently when a very small baby hears a language that is different than the language that the baby heard through the walls of the mother's womb prior to birth.[32]

The language building parts of our brains are particularly amazing and worth understanding as an example of how the process works. The language learning process for each of us begins very early in our lives and goes through very clear stages.

All babies can hear all sounds in all languages at birth. Our brains can discern every sound when our brains are first born.[15,33,34,35]

Then — in a pruning process — we actually lose the ability to hear many sounds if we don't actually hear those sounds in our own life in those first years.

Every baby can hear all sounds from all languages in the first year of life. All babies have full sets of those sound discernment connections at birth. All children can hear all sounds from every language in that first year of life.

The reality is that not all languages use all sounds. So many babies don't hear some sounds in those first years. When that happens, those connections in our brain that allow us to hear those sounds disappear — literally pruned out.

Many of the sound detection neuron connections in our brain that don't get used in that time frame simply melt away. We lose them if we don't use them. Those connections that let us hear every sound are literally "pruned" at and eliminated from our brain if they are not used. Neuroscientists call that process neuron connection pruning.

Japanese children who do not hear the "R" and "L" sounds that are used in our language, but that are not used in their language, actually can never hear those "R" and "L" sounds later in life because those neuron connections are permanently gone from their brains for life.[32]

"Use It Or Lose It" Is The Pattern

That basic "use it or lose it" process happens for multiple areas of our brain. We all start life with a massive brain capability with billions of neuron connections and then we each keep the neuron connections for life that are reinforced for each of us by being used in those first years of our lives when the pruning process in our brain is most extreme.

The first three years of our lives are the most important and highest impact years for the basic biological processes that build and structure our brains. Those are the years when our brains are shaped, formed, and even organized based on the exercise and the interactions that happen for each brain.

That pruning process is needed because it organizes the brain and creates more efficient brain functions. It creates pathways rather than just having a forest of connections and we use those pathways to think.

To build strong brains, we each need our brains to be stimulated and to be exercised during those key years. Babies and infants need the right stimulation in those key years so that the richest and most effective sets of neuron connections are retained in each baby brain and not pruned out of each baby brain.[34,35]

Those key years are when we need to stimulate and exercise every single baby brain if we want strong brains for life. The process is entirely biological. The biology of brain development actually has its peak levels in those first years of life.

Every input into our brain through our various senses in our first years of life actually exercises our brain. In practical and functional terms, what

that tells us is that we need to have the right set of interactions with each child in that key time frame to build each child's brain. Interaction is the key factor that builds brains.

Every interaction with a baby and infant in those key years has an impact on the growth and the development of each brain. External input for each baby and each infant in those key years causes neuron connections in the baby and infant brain to be used, strengthened, and retained.

Retention of those neuron connections in each brain tends to be for life. The infrastructure we each build in our brain in those key years serves us forever.

Brains With More Connections Are Stronger Brains

When it comes to neurons and neuron connections in our brains, more is better.[1]

Brains with more neuron connections are stronger brains. Neurons connections solidify their existence in our brains when each infant and each baby receives stimulus through what the baby sees and through what the baby hears. Those connections in each brain are heavily strengthened by repeated use.

Repetition is a very powerful factor for building brains. Repetition of input in key areas creates brain connections that last for life.

Those connections that build the infrastructure for our brain in those key years give each of us capabilities that extend through our entire lives.

The Best Connectivity Strengthening Time For Each Brain Is Relatively Brief

That neuron connectivity strengthening process in our brains happens at its most intense and most beneficial levels in the first three years of life — and then the ability of external input to strengthen that aspect of our brain drops off significantly.

We can still have a positive impact on those components of our brain after that time — but it is significantly harder and the input that we receive after those first years does not align as well with that initial very best and highest opportunity time for intense brain structuring.

After those first years, the brain for each of us moves from building its basic biological infrastructure to actually using its basic infrastructure to think and to learn. The brain then goes through key learning processes to learn self-regulation, logical and abstract thought, basic components of

memory, and other thinking skills. Those are all key areas of brain development.

Thinking And Learning Are Also Extremely Important

Thinking and learning are both extremely important processes for each of us. We all need to think and we all need to learn. Our lives are influenced heavily at multiple levels by what we learn and by what we think.

We are also heavily influenced by the thoughts and the facts that other people share with us in various teaching processes.

After the key neuron connections are made in our brain, we acquire information about the world around us that utilizes those neuron connections. Our subsequent learning processes and our information gathering experiences generally continue for each of us for our entire lives — and those information acquisition processes tend to function in the basic brain capacity that we each create in those first key years.

Learning for each of us can be much more difficult in later years — beginning at age four and five — if we have not built strong neuron connections in our brain in those first key years of biological development.

Studies show that children at 18 months who did not get the needed level of external input from adults in their world before that time can already have fallen behind in learning capabilities by that very early age.[2,3]

Some additional brain connectivity can also happen after those first years. Our brains don't become static or frozen. We can strengthen our neuron connectivity after those first years. The pace of brain strengthening slows, but it doesn't stop entirely. We should not give up on any children who did not get solid levels of brain exercise in those three key years because progress can be made with intensive support for each child.

That process is more difficult, but it can have a positive impact.

Adolescence Tends To Be Another Brain Capacity Opportunity

There is actually another major opportunity for new connections and for selective new brain growth that happens for each person at adolescence. Our brains tend to go through another set of structural and chemical changes at that point in our lives. That is another time when we can strengthen the capabilities of each child's brain.[36,37]

Those brain changes that happen at adolescence are nicely timed to deal with the physical fact and the functional reality that we each become able to make new babies at that time of our lives.

The limbic system part of the brain has a significant growth spurt during those adolescent years. All cultures tend to have a focus on specific learning processes for boys and girls at that point in our lives. It is not coincidental that there tend to be ceremonies and processes in many cultures that reflect the change from childhood to adulthood for each child at that point in our lives.

In the cultures where those "coming of age" ceremonies and celebrations happen, they tend to be aligned and roughly coincide with that second spurt of brain development and with adolescence.

Those particular years tend to be important periods of time for our intellectual life, our emotional life, and for our alignment with our cultures and our communities.

Those adolescent years are not, however, the primary years for foundational brain structuring and for neuron connectivity strengthening.

The first three years of our life are, clearly, the most important years by a large measure for the physical development and the physical structuring

of our brains. Those first few years are the key years that determine how our neurons connect and those are the years that determine which connectivity levels will be strengthened and retained in our brains for our use throughout our lives.

Neurons Help Us Think

Those neurons and their connections are very important to us.

The neuron cells of our brains do the work of helping us think. The connectivity links and basic paths between those neurons give us the tools and the physical infrastructure and context that we use to think and do the things that our brain directs our body to do.

Those neuron connections could not be much more important to us. Our brains are more effective when we have more connections in place. Scientists have shown us the impact of having ample arrays of connections in each brain and the consequences of having fewer connections in place.

When we have a rich and robust array of those connections, then our brains are stronger and our brains function at higher levels.[1]

Learning Does Not Start At Kindergarten

We used to think that learning started in children at kindergarten times or even later for each child. We were wrong. Very wrong. We now know

that learning actually starts at birth — even slightly before birth — and that extremely important learning that builds our brains runs at high levels through our first years of life.

We now know that building the learning capability for each child happens long before kindergarten and is most intense during those first years of brain development for each of us. We also now know that our neuron connectivity levels in each brain have actually begun to diminish significantly by our kindergarten years.

That piece of science has stunned many people. Relatively few peoples knew that "pruning" even existed as part of our brain biology and development.

Pruning is a powerful, necessary, but sometimes grim process. Neuroscientists can measure the impact of the pruning process on our brains.

The reality is — for all of us — that pruning happens. Unused connections get pruned. The connections in our brain that are pruned are lost forever. Our brain needs to go through that process to become more efficient and to create the connectivity pathways that help us think.

We do not prune or lose the brain connections that we functionally use. Connections in our brains that actually do get used by each of us in

those key time frames tend to be reinforced, strengthened, and functionally preserved in our brains instead of lost to us.

So doing the things that we can do to keep important connections from being pruned in very young children is the right thing to do if we want our children to have stronger and bigger brains.

We Are Physically Weak In Our Earliest Years

We are physically entirely helpless in our earliest years. We could not be much more helpless than we are as infants. Unlike baby deer, we can't spring to our baby feet almost immediately after birth and sprint into the forest if we need to flee. We don't flee well in those first years.

In fact, we can't flee at all. We barely learn to crawl in our earliest months and years. We are functionally inert. But we are mentally on fire. We have massive levels of intellect related neuron connectivity reinforcing activity going on in our baby brains.

Those times of almost complete physical inability and extreme weakness are actually the times when we each build our own mental strength infrastructure at its highest level and rate of growth.

Brains Before Brawn

We begin to build physical strength in those earliest years and we can each continue to maintain or even build our physical strength in various ways for our entire lives. But we build our basic mental infrastructure strength in our first months and years of life. The years of major physical weakness for each of us are key years for making our brain strong.

As we become better informed and as we acquire learning, knowledge, judgment, and wisdom in various ways, we use the brain structure that we built in those first years to guide the actions of our physical body. As we each build our brain capability, we build our physical ability in a parallel and appropriately timed process.

Our Bodies Are Weakest When Our Intellect Is Least Developed

Our physical bodies give us the tools we need physically to interact functionally with the world around us and to make what we learn in our basic learning processes the guidance that each of us uses to interact in various physical and mental ways with the world we live in us.

In those earliest years of our lives — when we have no learning and no judgment — we also have bodies that are weak enough to keep us out of

trouble. Our weak bodies and our inability to move quickly or well help make our bad or non-existent judgment in those early years less relevant.

That entire process and that set of linkages and alignments makes great logistical sense when we look at it as an entire process.

As we grow older, we go through significant times of learning — both about the world around us and about the people around us. All of that subsequent learning is done in the context of the brain infrastructure that we build and support in our first years of life.

We Need Direct Interactions With People To Build Each Baby's Brain

We need to understand the basic processes that can build strong brains in those first key years. Too many people do not know what those processes and opportunities are. That lack of knowledge about those opportunities is almost criminal — because that knowledge is basic, simple, easy to share, and because it is almost impossible to forget once we understand what that science is and once we each understand how relevant that science is to each of us.

We need everyone to understand the basic process so that we can do the things we need to do to help all children.

We can, in fact, help all children.

Interactions are the key. Babies need interactions with adults to build baby brains.

To build each baby's brain and to strengthen those neuron connections in those first years of life for each child, our infants and babies need direct and caring interactions with other people.

Interactions are golden. Interactions are the only sure process for exercising brains. Direct interactions with adults create the sparks that light up each baby's brain. When babies interact with adults through play and through adults talking to the child, then brain growth and brain strengthening happen for that baby.

Children With No Interactions Have Fewer Neuron Connections

Children who have no one interacting with them at that point do not have the basic neuron connection strengthening experiences that makes brains strong. The brains that do not have adults interacting with children in those times when neuron connections are happening end up with many fewer neuron connections in their brains. Those children fall behind other children — and that falling behind process can happen with painful speed.

The first year of life is extremely important for each child relative to the biology of each brain. The second and third years are major brain structuring years as well.

The process that builds connections in those key years is direct, consistent, and it is extremely important to each child's brain development.

Interactions with adults are key for each child.

We know that when you electronically scan a baby's brain, the parts of the brain that literally light up to show growth and active neuron linkages are the parts that light up when each baby is interacting with another person — not just with a pure external stimulus.[38]

Too Much Television Can Cause Reading Readiness To Deteriorate

That was important science to uncover. Interacting directly and personally with other people is the key factor for each child that triggers those connections. Some people thought that watching television might make people smarter. Brain scans and reading readiness tests both now show that isn't true. Babies who watch TV are often entertained by the TV, but their brains do not grow from TV watching. Brains build and retain

connections in babies only when the babies interact directly with other people.

We now know that babies need those direct, one-to-one interactions with real people to strengthen and retain the neuron linkages that make brains strong. We also know now that pure television viewing as a sole source of sensory input can even cause some very young brains to lose ground on their learning readiness levels.[39]

We Lose The Language Connections If We Don't Use Them

We have a much higher level of ability to both hear and learn other languages early in our lives and we tend to lose that ability as we age. Early neuron connections make it easy for most very young people to learn other languages. Those connections are much weaker in most people later in our lives.

People are not all identical and some people do continue to have great language learning proficiency later in life, but for most of us that language learning proficiency peaks at a very early age. A number of excellent research papers and books have focused on those issues.[40,41,42]

That is actually a very good argument for us speaking to young children in multiple languages when that possibility to speak in multiple

languages exists. Speaking is a major neuron connectivity trigger. Children need to be spoken to in order to strengthen neuron connections.

Speaking directly to a child is a wonderful, essential, and very basic neuron connectivity-building tool. A key point for us all to recognize and remember is that any language can achieve those goals.

The Language Does Not Need To Be English To Solidify Brain Connections

We have seen some settings and situations where bilingual mothers in this country have chosen to speak to their children only in English to help their children be better at learning English. Helping children in this country do well in English can be a good thing. However — it is also very true that approach can unintentionally be a bad thing for a child. It can be a bad thing if speaking only in English reduces the total time spent speaking to each child.

It can be bad for a child if that approach of speaking only English reduces the total verbal interactions with adults that are experienced by the child. It would be far better to speak extensively in both languages or just speak extensively in the language that isn't English. Children's brains need

many and frequent verbal interactions to grow — and any language that is spoken to the child does that job of triggering growth.

For brain growth it is more important for a child to be spoken to in any language than it is for the child to hear a specific language.

Hearing Multiple Languages Can Strengthen Language Related Brain Capacity

Hearing multiple languages can be very beneficial for children because basic language skills can improve in each language and because increased verbal interactions for the child with the mother or with other family members creates brain strength for each child regardless of the language used for the interactions. Brain capacity grows even more when multiple languages are heard.

Sadly, brain capacity shrinks in areas that extend beyond language skills when the total amount of direct verbal interaction with a child is reduced significantly in order to focus on only having direct spoken interactions happen in one language.

Hearing music in those early years of brain development also tends to have an impact on the neuron linkages in the brain. Simple background music seems to have less positive impact on children's neuron capabilities

then focused music and music that involves some level of interaction with the child.

Stronger connections and higher musical ability levels seem to be triggered by music that directly involves the child or music that involves the parent rather than music that is simply part of the background environment in a general and non-focused way.

We learn by doing. Our brains are set up to learn things by doing things. We learn to do conversations by conversing. We learn music by being musical. Our brains have great capacity for being strengthened and structured by what we actually do in those key years. We need to help children do the things in their lives that take advantage of that almost overwhelming plasticity and massive and time-linked connectivity opportunity for each child's brain.[43]

Toxic Stress Can Create Brain Related Problems

There is another key reason why we need to provide specific levels of support to each of our children in those first key years of life.

That other key reason is toxic stress.

What we did not understand well until fairly recently is that those key years are also the time when each child is at great risk for having toxic stress

chemicals build up in each brain in ways that damage each brain. The first chapter of this book pointed out that those first years are also the high-risk time for toxic stress syndrome for each child.

That toxic stress syndrome is another clearly biological reality that can have a lifetime negative impact on each child.[25,43]

The children who get little attention, who feel isolated, or who are treated with negative or even abusive interactions actually have different levels of brain structuring built by being in a stressful environment. The brain of a child facing those kinds of negative experiences generates neurochemicals that can do damage to thought processes and trigger very different sets of behaviors, reactions, and thought processes for each affected child.

The children who are either neglected or abused end up with different behavior patterns that include being more aggressive and easier to anger than a child who hasn't faced toxic stress.

Those toxic stress levels in a child's brain can be prevented and even offset by the child having direct daily interactions with a caring adult.

The children who feel that there is a safe and caring adult in their world build different brain chemicals than a child who doesn't have that sense of safety and security.

Studies have shown that having more than half an hour each day of safe time with a caring adult can actually defuse and serve as a buffer against those damaging neurochemicals.

When very young children are isolated, ignored, or feel threatened, stress chemicals build in each child's brain. Those chemicals, over time, change both brain functioning and behavior patterns. It creates toxic stress syndrome for children when those neurochemicals are present in the brain of a child for extended periods of time.

Children with toxic stress syndrome tend to experience personality changes. Those children are more likely to have issues with physical violence and those children are more likely to become pregnant. They are more likely to drop out of school.

The children who suffer from toxic stress are damaged — and we now know that damage does not need to happen. It can be prevented. We know how to prevent it.

Direct interactions with a caring adult also prevent toxic stress. Studies have proven that to be true.

We need to make very sure that each and every child receives direct interaction with a caring adult every day at a level that eliminates the negative brain chemical buildup that creates toxic stress syndrome.[44]

The fact that the same kinds of basic daily interaction with an adult that build strong brains can also prevent and defuse toxic stress makes creating needed parenting process simpler than it would be if we needed separate parenting strategies to achieve each goal.

It is a very good thing for our children that the time spent reading, talking, and singing to each child can also create that needed direct interaction buffer time to defuse those destructive neurochemicals for each child.

That time spent talking and reading to each child can directly help each child increase his or her vocabularies and that same process can build needed connections that enhance reading skills for a child at the same time that it buffers toxic stress for that child.

Children do better in life — feel less stress — and interact better with other children and other people if the children feel safe, protected and loved, and if the children have direct interactions with adults the children trust.

Children need to feel cared for in order for the toxic stress levels to be buffered and in order for the learning process to have its maximum impact. Brain development processes are strengthened when a child feels loved and protected.

85% Of The Children In The Juvenile Justice System Read Poorly

We need to help all of our children relative to each of each issues, risks, and opportunities.

Currently, we have record numbers of children in the juvenile justice system. The functional reality is that 85 percent of those children in the juvenile justice system today either read poorly or can't read at all.[11]

We could cut the number of children in the juvenile justice system and we could reduce the number of children who go to jail significantly — by half or more — by doing the right things to help each child build neurons in those first key years of life when neurons strengthen their connections and

by also doing the right things for each child to help the child avoid toxic stress syndrome in those same years.

Thirty Minutes A Day Strengthens Brains And Buffers Stress

Science tells us that only half an hour of intervention for each child each day with a trusted adult can be enough to create a buffer against toxic stress for most children.[44] Thirty minutes can build a buffer that reduces the level of those damaging neurochemicals to non-toxic levels.

We also know that reading to each child for a half-hour each day both builds neuron connectivity and improves the vocabularies of children.

The children who have higher vocabularies at age three and age five are much more likely to learn to read and much more likely to avoid being dropouts or going to jail. We now know that those simple and direct interactions by an adult with each child every day in those years of highest opportunity have the ability to change lives in very positive ways for each child.

Children Need Adults Who Interact With Them

The key to success for each child is to interact directly with each child. That biological process is the same for every child. Interactions are key for brain strengthening. Interactions with trusted and caring adults are

the essential child support tool that each child needs. Children need adults who interact with them and children need to feel safe in those interactions.

A wide variety of basic and achievable interactions can have a positive impact on the brain strength for each child. The interaction with each child can be talking, reading, singing, or playing in a wide variety of ways. Direct interactions with an adult are golden for brain development for each child and the lack of interactions can damage brain development in each child.

Those same interactions with an adult that build strong brains can also be golden for the emotional security of each child as well.

The interactions with each child should be daily and they should be frequent when possible. But even infrequent interactions can make a positive difference. Every positive interaction can reinforce and strengthen the neuron connections that become permanent parts of the children's brains.

So even infrequent, but positive, interactions with a child are far better than no interactions for a child.

Isolation Can Be Poisonous

Isolation is bad for brain growth and structuring.

Isolation has poisonous impact on children. Children who are isolated end up with severe emotional limitations and their brains even show up on scans as being significantly smaller brains.[45,46] We need to eliminate isolation and we need to encourage and create regular and positive interactions if we want to build the best futures for each of our children.

The science is now much more clearly understood. The biology is well known. The time frames are also much more clearly understood. We now understand those aspects of biological brain development better than they have ever been understood.

The opportunities that are created by those processes for each child are extremely clear. The negative impact on children of not reinforcing and not retaining the right level and set of neuron connections in those early years is also painfully clear.

We need to address those negative impacts and we need to take advantage of those opportunities in ways that work for the well being of each child.

That is the next chapter of this book.

We understand the biology. Now we need to understand how to get the full benefit of the opportunities that the biology creates for each child.

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32
15,33,34,
35
32
34,35
1
2,3
36,37
1
38
39
40,41,42
43
25,43
44
11
44
45,46