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Merryl Hammond Ph.D. & Rob Collins Illustrated by Marian Snow

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Hi! I'm Sam's teddy bear. This is him in the photo. I'm going to tell you a story about one of our days together.



Hey, Sam; sun's up! Time for you to wake up, too. It's a school day today.



Sam is my very bestest friend in the whole world. I love him so much! I always take good care of him.



Every morning, I help him brush his teeth...



I help him get dressed...



... and I help him eat his breakfast.



I wish I were a bit older, so I could walk Sam to school.



Quite often, Sam comes home in a bad mood after his long day at school. Sometimes he has a huge tantrum. I don't mind getting all wet and slobbery when he cries.



I understand that Sam's brain boo-boo causes a lot of problems for him. See, his brain was hurt before he was even born. I'll tell you the story...







It was many weeks laten that Sam's mom realized she was going to have a baby. Sadly the alcohol had already hurt the tiny, growing brain of little Sam-to-be. So you see, Sam's brain got a big boo-boo before he was even born.





Aften a baby is born, the brain keeps on growing for a few years. What does a child need to build a healthy brain? A loving home. Care and attention from kind adults. To feel secure. Games, puzzles, stories and songs. And healthy food.



Sam's mom told me that the more we all love and care for Sam, the better his hurt brain will grow from now on. So, I give him lots of kisses...



I help him with his homework...



I play games with him...



I build things with him...



I read stories to him...



... and of course, I watch over him at night.



I know that Sam's brain is hurt and works differently. But I also know that every single day we can all help him build his brain a bit stronger.

Sam's Bear: Guide for Parents & Teachers

Brain development; what affects it in the early years; and what we can do to promote it

Did you know: The unborn baby's brain and spinal cord already starts to develop **3 weeks after conception**. By the 17th week of pregnancy, the unborn baby already has **1 billion** brain cells. The brain continues to develop throughout pregnancy, and even after birth. (The brain is the only organ in the body that is **not completely formed** at birth.)

Here we explain how the brain is formed and grows – both before and after birth. From this information, we hope that you will have new appreciation and respect for this amazing organ, and that you will be inspired to help protect and nurture the developing brains of all the children in your life.

1. Appreciating the brain: brain cells (neurons) & connections (synapses)

Did you know that the brain consists of millions of **brain cells** (neurons)? And did you know that everything we see, hear, feel, taste and smell, and all our movements, thoughts, memories, and feelings are the result of messages that pass from one brain cell to another?

There is a tiny gap where each brain cell connects with its neighbour, called a **synapse**. For a message to make its way across this gap, it needs certain chemicals, called **neurotransmitters**. Trillions of **connections** (synapses) between brain cells form the "wiring" of the brain (like telephone wires or cables). Synapses and the neurotransmitters that pass across the gaps to their neighbour cells form the "chemical connections" in the brain. Taken together, brain cells and their connections make up what scientists call the "**architecture** (structure) **and function** (working) of the brain." The number, organization and strength of these connections influence every aspect of **brain functioning**, such as being able to recognize sounds, letters and numbers, controlling emotions, and maintaining relationships. For our brain to **work well**, we need both solid "brain architecture" and good "chemical connections". Neither one is enough on its own.

Brain cells develop very fast before birth. After birth, brain development consists mainly of wiring and rewiring the connections between existing brain cells. (New brain cells are mainly added in the parts of the brain that store memories.)

Children whose connections are not formed properly can face big challenges throughout life. Causes include prenatal exposure to alcohol and other drugs, industrial chemicals, heavy metals, injuries, any kind of abuse, some infections, poor diet or severe stress.

Imagine: Just imagine what your life would be like with damaged brain cells. What sensations (touch, warmth, cold, softness, etc.) would you miss? What movements and physical abilities (e.g. sports, walking, dancing, etc.) would you miss? And so on for thoughts, memories, and feelings. See how dependent we all are on our brain cells? See why it is so important to protect them, right from the time they first start to form in the mother's womb?

2. What do different parts of the brain do?

There are **3 parts** in the brain: the brain stem, cerebellum and cerebrum. Any or all of these parts of the brain may be damaged – before birth or after birth.



Parts of the brain

a. The brain stem

The brain stem is formed first, and controls essential, basic body functions including breathing, heart beat, temperature control, thirst, hunger, and sleep.

Imagine what life would be like if you were born with damage to your brain stem. Actually, you probably wouldn't even be alive...

b. The cerebellum

The **cerebellum** (at the base of the brain, just above the back of the neck) controls the regulation and coordination of movement, posture, and balance.

Imagine what life would be like if you were born with a damaged cerebellum. How might you walk, skip, run, dance, sit, play basketball, etc. if you had damage to this part of your brain?

c. Cerebrum

The **cerebrum or "cerebral cortex"** is the largest part of the brain and is the decision-making centre. It continues to develop until we are in our mid-20s. It consists of 4 separate lobes, each responsible for different functions. The **frontal lobe** determines personality, emotions, judgment, impulse control, language, etc.). The **parietal lobe** helps us understand what we see and feel, and processes information about the environment around us,

like distance and the position of objects. The **temporal lobe** controls hearing and the ability to recognize words, and affects memory. Finally, the **occipital lobe** is the visual centre of the brain.

Imagine what life would be like if you were born with a damaged cerebrum. Just look back at the functions of each lobe, and imagine: what if my frontal, parietal, temporal or occipital lobe were damaged? How would my life be different?

3. What can damage the brain before birth?

Note that in all cases below, the damage may be to the unborn baby's developing and multiplying brain cells (the "brain architecture" mentioned before), and/or to the brain chemicals (mostly neurotransmitters). Damage to either the structure (brain cells) or the functioning (flow of information between brain cells) of the brain can be devastating. Damage to both is even worse.

a. Brain damage from alcohol

The unborn baby is most susceptible to substances such as alcohol, nicotine, street drugs, and medications during the **first trimester** (months 1–3 of the pregnancy). This is a serious problem because – like Sam's mother – many women don't even realize that they're pregnant until several weeks or even months into the pregnancy.

Alcohol that a pregnant woman drinks directly affects the unborn baby. Approximately one third of all babies born to alcohol-abusing mothers will develop Fetal Alcohol Spectrum Disorder (FASD), causing central nervous system problems including Attention Deficit Disorder, lower scores on intelligence tests, and developmental delays. There is a severe risk of the baby being born with a small brain (see below). These children may also have growth problems; joint, limb, and heart malformations; a risk of low birth weight; and facial abnormalities. There is no cure for this syndrome; the damage is irreversible.



Normal brain of a baby at 6 weeks (left) and brain of a baby the same age with Fetal Alcohol Syndrome (FAS) (right)

Photo used with permission of Dr. Clarren

b. Brain damage from nicotine and street drugs

Nicotine (in tobacco and cigarettes) slows the growth of brain cells and interferes with neurotransmitters in the brain. Children exposed to nicotine before birth can have developmental delays, poor learning, and behavioural problems.

Cannabis (in marijuana) is able to cross the placental (afterbirth) barrier. Children born to mothers who have used cannabis in pregnancy tend to have poor verbal skills, problems processing information, memory difficulties, behavioural problems, and be smaller.

Cocaine use in pregnancy can disrupt the placement of brain cells in the cortex, the formation of connections, and brain chemistry. These children may have a small head.

Note: These are just examples of some drugs that can harm an unborn baby. Even some prescription medicines taken by a pregnant woman can cause brain damage. Please check with your health care worker before you take any medicines or other drugs while pregnant. Your baby's whole future may depend on it.

c. Brain damage caused by the mother's environment and stress

The kind of **social and physical** environment a mother experiences during pregnancy also affects development of the unborn baby's brain and nervous system. For example, a stimulating, varied environment causes chemical changes in the mother that affect the development of the baby's retina (part of the eye) and cerebellum (the part of the brain that controls movement, posture and balance, as we saw above). On the other hand, studies show that high levels of stress during pregnancy can actually be "**toxic stress**". If a mother is exposed to violence, abuse, severe poverty, and other stresses, this can damage the unborn baby's brain development and functioning.

d. What other factors affect brain development before birth?

There are still other factors that can harm an unborn baby's developing brain. If the mother has a poor **diet** (not enough protein, calories, vitamins and minerals), her baby may be born with brain damage. Brain problems may result from a baby having a **genetic disorder** (e.g. Down's Syndrome), **infectious disease** (e.g. toxoplasmosis or the complications of rubella), or **metabolic disorder** (e.g. phenylketonuria). Other **toxic substances** – apart from alcohol and other drugs discussed above – include industrial chemicals, environmental pollutants, heavy metals (including mercury, iron and lead), and pesticides. Please ask your health care worker for more details.

4. How does the brain develop from birth to age 6?a. "Use it or lose it"

After birth, new connections are formed while others are pruned away to ensure efficiency. This is called the **"use it or lose it" principle**. (Only those connections and pathways that are often used will be kept or **"hard-wired**".) Between birth and eight months, the connections are formed more quickly. There may be **1,000 trillion connections** in the brain by 8 months. After one year, pruning occurs more quickly. By age 10, a child has nearly **500 trillion connections**, which is the same as the average adult. Pruning occurs until about 12 years but the brain maintains flexibility for future learning.

Early **experiences**, both positive and negative, have a dramatic effect on this formation of connections. It is from early infancy to early childhood that these connections and pathways are made permanent. As we mature during these early years, the brain **physically changes** due to outside experiences.

The first big "growth spurt" in the brain occurs from birth until about age 6. (Another big spurt occurs in the teenage years.) The first three years see the fastest growth. At this time, the brain is most **flexible** (or "plastic"), able to adapt to changing stimuli, and prepared to learn.

Just like exercising muscles, we strengthen our brains by exploring, learning, and thinking about what we're doing. If we don't **"exercise" our brain**, connections will be pruned back.

b. How does stimulation affect brain development?

Touch, talking, and things an infant sees, hears, tastes and smells all build connections in the brain. If there are no **new experiences** (e.g. if a child is neglected or left with little or no stimulation, etc.), connections are not formed and the brain remains small. The connections that are used most often are the strongest, so it's important for a child to get the right experiences during the early years.

Think: What did Sam's family do to belp bim build connections in bis brain?

Children raised in **deprived environments** experience fewer sounds, colors, pictures, sights and interactions. Their

brains may be 20–30% smaller than those of children who grow up in stimulating environments with meaningful relationships.

So, the basic message is: provide children with the experiences and the positive, safe environments they need.

Whether a child goes to preschool or not, parents need to arrange for a variety of stimulating people and environments for the child to interact with. **Exposures** (e.g. to songs, music, storybooks, toys, friends) and **challenges** (e,g, puzzles, games, quizzes, etc.) will all help the brain form new connections, and maintain or strengthen existing ones. (Note that repetition [e.g. re-reading the same storybook many times, or doing the same puzzle again and again] strengthens existing brain connections.)

c. How does psychological trauma affect brain development?

Studies have found that severe **childhood trauma** (such as being emotionally, physically or sexually abused, or witnessing domestic violence) can directly affect the way the brain functions.

Traumatized children show physical symptoms of fear (e.g. high heart rates, high levels of stress hormones in their blood, problems sleeping) more quickly, more often, and for longer periods of time than other children. Even after the threat has been removed, they have trouble returning to a natural, calm state, almost as if their brains are "stuck" in their reaction to the shocking experiences. Many of these children later develop emotional, behavioral and learning problems.

d. What else can affect brain development in the early years?

As we saw in the section about brain development before birth, brain development in the child's early years may also be affected by a **genetic disorder** (e.g. Down's Syndrome), **infectious disease** (e.g. complications of measles, encephalitis, meningitis), or **metabolic disorder** (e.g. phenylketonuria). As well, birth injuries, car accidents, falls, shaken baby syndrome and sports injuries etc. can all cause **physical injury** to the brain of a baby or child.

e. Ten Things Every Baby & Child Needs for Healthy Brain Development

Before you read the list below, think for yourself: what does a baby or child need for healthy brain development? Then compare your list with the one below.

- Interaction with responsive and sensitive caregivers
- Loving touch, and experience using all their senses: taste, smell, sight, hearing
- A stable relationship with a parent or primary caregiver
- Safe, healthy environment
- Self-esteem
- **Quality care** (good food, personal hygiene, enough sleep, a stable routine, lots of attention, patience and understanding, etc.)
- Communication
- Play: time and space to explore and play
- Music (including singing, humming, clapping, drumming, etc.)
- Reading

Did you think of other needs we could add to this list? (Love? Story-telling?). How many of these needs do you think were being well met in Sam's case?

How many of your child's needs are being well met? Which one or two of these points might need more attention to help your child develop an even better brain? How could you try to meet those needs in future, starting right here, right now? Who could you ask for help with this challenge?

5. Summary & conclusion

- An unborn baby only goes through one pregnancy. We cannot go back and undo damage done during the very important early months of development in the womb.
- The kind of **environment** that a child is exposed to early on (both before birth and after) either positively or negatively affects the **architecture and function** of the brain.
- The unborn baby develops very quickly in the **early weeks after conception**, but this is a time when many parents – as we saw in the case of Sam's parents – might not even realize that they are pregnant.
- Therefore, all sexually active people of childbearing age have to assume that pregnancy is a real risk at any time, and they should **take care of themselves** by eating healthy, exercising, and avoiding stress and toxins.
- After birth, the quality and quantity of a child's interactions with parents, other caregivers and their environments result in connections that determine how well the brain will be built over time.
- All children, whether they have brain damage or not, need to be raised in **loving**, **nurturing environments** with lots of **stimulating experiences** to help develop their brains.
- Environmental factors that can make a difference to a child include: exposure to extreme stress, toxins (including alcohol and other drugs), diet, stability, relationships, and interaction with responsive caregivers.
- A child's **capacity to learn** (e.g. process and retain information, recognize patterns, listen and understand in the classroom, etc.) is strongly influenced by the connections made in the brain in the first few years of life.
- Brain architecture is **very adaptive** in the early years. What this means is that the brain is very receptive and shapes – or "builds" – itself depending on the stimuli it receives.

- Brain architecture **remains adaptive** throughout life. Just as people who have strokes can recover and learn to do many things they used to do, children who suffer early brain damage can grow and develop new skills. (This ability to adapt is called "brain plasticity".)
- All children, regardless of what kind of damage if any – their brains may have suffered before birth, deserve the best possible chance to develop to their full potential.

Did you think of other key points that should be in this summary?

May the story of Sam and Bear inspire families everywhere to persevere with the very challenging task of raising the next generation with all the love, understanding and patience that requires.

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