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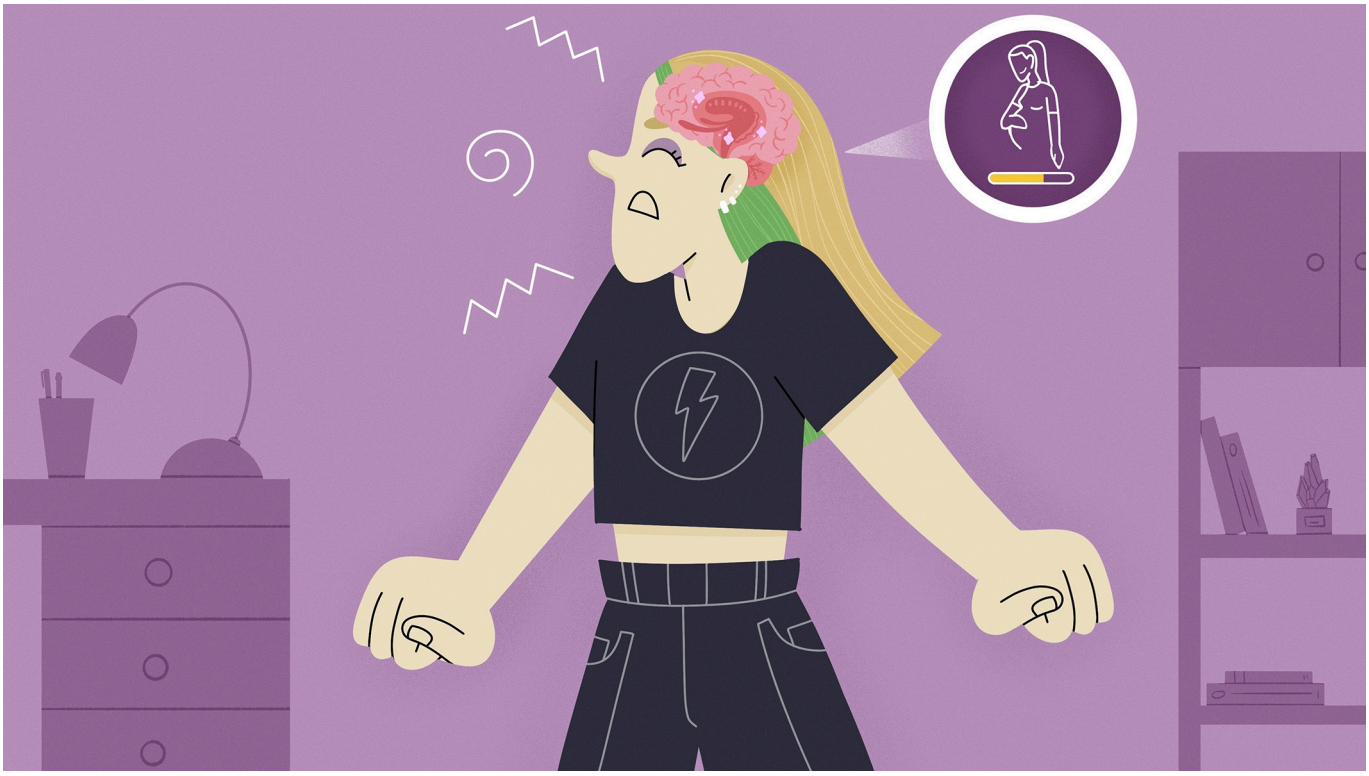

BEING BORN EARLY CAN AFFECT THE WAY WE CONTROL OUR EMOTIONS

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YOUNG REVIEWERS:

GRETTA
AGE: 14

LARISSA
AGE: 14

Every year, 13 million babies are born before the usual 9 months of pregnancy. To understand what happens to these babies' brains when they grow up, we used powerful brain scans to take detailed photos of the brain, and we compared the brains of children born early to those born at 9 months. We also studied the development of these children. We found that a part of the brain important for feelings and emotions, develops slightly differently in babies born early. These differences could explain why children born early may have more difficulty controlling their emotions. Brain differences could also explain why children born at 9 months may be less likely to develop anxiety and depression in later life. In this article, we will discuss the study findings, the impacts they might have, and how we can use this information to improve mental health in vulnerable children.

BRAIN DEVELOPMENT DURING PREGNANCY

Pregnancy is a time of change. As the mother's womb grows, the baby develops. The final 3 months of pregnancy, known as the third trimester, are a really important time for brain development—but sometimes babies are born early.

The third trimester is especially important for the development of the **limbic system**. If you have ever seen the movie *Inside Out*, the limbic system is like the brain's control center for emotions. The limbic system is made up of five main parts: the amygdala, hypothalamus, basal ganglia, thalamus and hippocampus, which each help us control and understand our emotions. Figure 1 shows where these areas are and what they do. Without the limbic system, it would be impossible to stop crying or yelling and we might have no idea why we even started. During the third trimester of pregnancy, every part of the limbic system is developing to help the baby handle their emotions once they are born. By the end of the third trimester, babies have as many neurons as adults (about 100 billion), even though their brains are only about a quarter of the size! Neurons are brain cells that help the parts of the brain talk to each other.

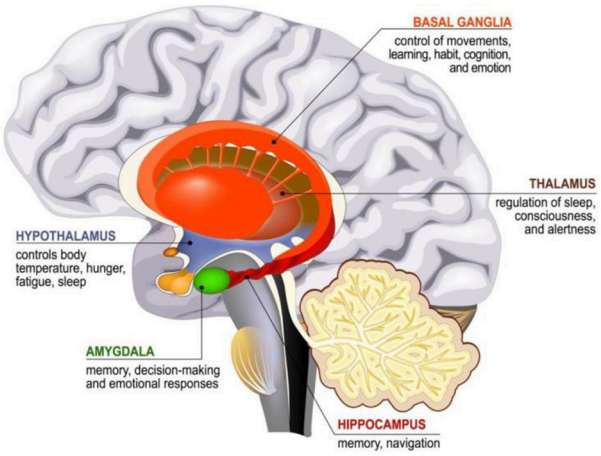

Figure 1

But what happens when this process is interrupted? Being born early can impact people in lots of ways, with long-term consequences lasting into adulthood. For example, our research found children born very **preterm** (after just 33 weeks, or 8 months of pregnancy) had a harder time controlling their emotions than children born at the usual 9 months, or at **term** [1]. This means very preterm children might find it harder to control their tears when they feel sad or their voices when they feel angry. Scientists also think this problem of regulating

LIMBIC SYSTEM

The brain's emotional control center.

Figure 1

The limbic system: the amygdala helps us feel and respond to emotions like fear and happiness. The hippocampus is important for making and storing memories. The hypothalamus regulates body functions, like hunger and sleep. The thalamus acts like a traffic director, sending information to different brain areas. Lastly, the basal ganglia help with movement and habits. Together, these parts work to keep our feelings and actions balanced, helping us learn and experience the world around us! (Image developed by Designua and used under license from Shutterstock.com).

PRETERM

Babies born before 37 weeks of pregnancy. We use "very preterm" to mean babies born before 33 weeks of pregnancy.

TERM

The usual 9 months of pregnancy, meaning children born at term developed in the womb for about 40 weeks.

emotions could make very preterm children more likely to develop mood disorders, like depression or anxiety, when they grow up.

Not all preterm children have problems regulating their emotions, and we believe some of the differences we found in the limbic system could help us to understand why. In the rest of this article, we describe these differences and how we could use them to spot children at risk of emotional and mental health problems and support them before serious issues develop.

CONNECTIONS BETWEEN THE AMYGDALA AND OTHER BRAIN AREAS

The amygdala is an important part of the limbic system that helps us handle our emotions, stores scary memories, and, even though it is only about the size of a peanut, it acts like a really loud alarm [2]. This means that when we are stressed or scared, the amygdala connects to lots of other brain areas so we can act fast and think later. For example, when we are trying to run away from a big dog or move out of the way of a fast car, the amygdala helps get us to safety quickly. But if we keep feeling stressed and the amygdala stays very active, it can change the brain in ways that are not good for us.

Scientists have found that the way parts of the brain communicate with one another when we are relaxing is linked to how well we control our emotions. In technical terms, the study of how the brain functions during rest is called **resting state functional connectivity**. Imagine your brain is like a team of friends sharing ideas to help each other out. For example, when watching a scary movie, if your amygdala is communicating well with other parts of your brain you might feel scared, but you will know it is just a movie and be able to calm down. Constant communication between different brain areas helps you enjoy the movie without getting too frightened! Being born early is a really stressful experience on babies' bodies. If this stress affects the function of the amygdala, this could be why very preterm children may have more difficulty controlling their emotions than children born at term.

RESTING STATE FUNCTIONAL CONNECTIVITY

How different parts of the brain communicate and work together when a person is at rest.

To study this, we used a special kind of brain scan called functional magnetic resonance imaging (fMRI) to look at the brains of 129 very preterm babies [3]. When these babies turned 5 years old, we asked them lots of questions and played games with them to see how they handled their emotions as they interacted with others. By using brain scans, questions, and games, we hoped to find out how their brains were connected to their social and emotional development —like putting pieces together to complete a puzzle!

We found a link between how well children could control their emotions and how their amygdalae communicated with other parts

of their brains when they were babies. This is interesting because, as we mentioned earlier, problems regulating emotions could be linked to mental health issues like anxiety and depression as kids grow up. We could use these findings to spot babies at risk of developing mental health difficulties early and provide them with support so these problems do not develop!

WHITE MATTER AND EMOTIONAL DEVELOPMENT

WHITE MATTER

Part of the brain made up of long wire-like connections that help different brain areas talk.

Imagine the brain as a big city, and **white matter** is like its roads, connecting all the parts of the city, allowing people and cars to travel quickly between them. The better the roads, the faster everything moves, helping the brain send signals to think, learn, and move smoothly.

White matter makes up almost half of the brain and it spreads out in many directions (Figure 2). Some of these roads, or white matter pathways, are bigger than others. One of the most important roads for emotion regulation (amongst other functions) is called the uncinate fasciculus. It is shaped like a hook and helps us control our emotions by connecting the limbic system to part of the brain that helps us remember and experience emotions and make decisions, called the frontal lobe. This pathway helps people bring together their emotions and thoughts so they can make choices that feel right.

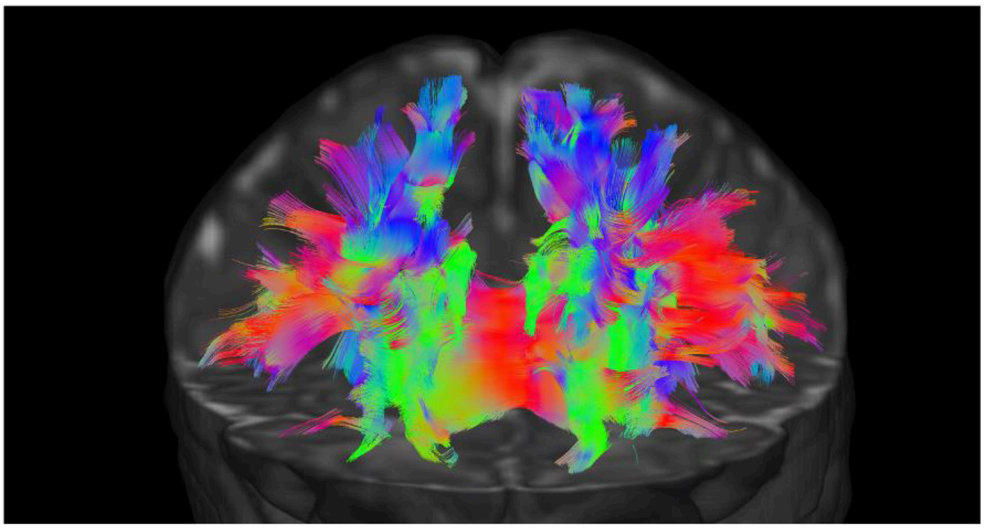

Figure 2

Tractography is a method to create pictures of the brain's pathways. This is an image of an infant's brain that shows us how parts of the brain are connected. The colors show the various directions: red shows connections from left to right, green shows connections from top to bottom, blue shows connections from the back of the head to the front of the head. These images help scientists understand how the brain is organized. [Image courtesy of Dafnis Batalle].

Could differences in the uncinate fasciculus and other white matter pathways explain why very preterm babies might sometimes find it difficult to regulate their emotions? To study this, we asked 151 very preterm children aged 4 years about how they managed their feelings. We also took special brain scans soon after birth to look closely at their white matter [4]. When we looked at the children's answers and brain

scans together, we found that a more developed uncinate fasciculus just after birth was linked to better control of emotions in childhood. This link could help us identify babies who are more likely to have difficulties regulating their emotions, so they can receive the right support as they grow up.

TRAINING OUR BRAINS: MINDFULNESS AND MEDITATION

MINDFULNESS

Paying close attention to what you are thinking and feeling right now, without worrying about the past or future.

MEDITATION

A quiet time when you sit still and focus on your breathing or a thought to help calm your mind and feel peaceful.

Our brains are very flexible and adaptable, meaning that even when things like preterm birth get in the way of our development, the brain can react and change to maximize its performance in these new conditions. Just like a football team can adjust its game plan to win, our brains can adjust to overcome challenges and do great things!

Brain flexibility also means that we can change our brains through training. We can practice **mindfulness** and **meditation** to control our emotions better. Mindfulness and meditation involve breathing, relaxing our bodies, and being still. Researchers found that mindfulness and meditation can help people become more patient and tolerant of others [5]. This can make it easier to stay calm when someone says something silly or mean, instead of getting upset right away. It is a lot easier to control how we feel when we are calmer.

Encouraging anyone who struggles to control their emotions to practice brain training in this way could help prevent mental health problems from happening or lessen any problems a person is already experiencing.

KEY TAKEAWAYS

Our brains are extremely flexible. When things happen to change their development, like being born early, our brains can adjust and change to be the best they can be! Scientists can learn a lot by studying differences in people's brains. After all, brain differences are what make each of us special. In this article, we described differences in the amygdala and uncinate fasciculus of some children born very preterm. These brain differences may be linked to later problems with controlling emotions, which could lead to mental health problems. However, another benefit of the brain's flexibility is that we can change it. So, by noticing differences in the brains of preterm babies, we may be able to spot babies at risk of mental health problems and support them before the problems happen. For example, mindfulness and meditation could improve kids' control over their emotions. Try it out yourself—a few slow, deep breaths can benefit anyone!

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

GRETTA, AGE: 14

I am a 14 year old from New Mexico in the U.S.A. I was excited to review this article because I love babies and want to volunteer as a baby cuddler in the hospital one day.

LARISSA, AGE: 14

Larissa goes to a Dutch high-school school and she follows mainly scientific subjects. Her favorite subjects are biology and chemistry, and when she grows up she would like to be a medical doctor. She also likes arts and crafts and to be creative.

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Professor Nosarti leads large studies that follow the development of children and adolescents over time. Professor Nosarti is interested in researching the long-term impacts of early life adversity, as well as methods to predict and prevent mental health problems. In her spare time, Professor Nosarti enjoys exploring London with her family, reading poetry and gardening.