

UNLEASHING YOUR INNER SUPERPOWERS: THE CONTROL CENTER OF YOUR BRAIN

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ELISE

AGE: 11



MERYEM

AGE: 14

EXECUTIVE FUNCTIONS

A group of skills that allow for controlling thoughts and actions, keeping things in mind, solving problems and planning.

Your brain possesses a group of superpowers called executive functions. These special abilities work together to help you reach your goals or complete challenging tasks. Executive functions are supported by the communication between various areas of the brain. Just like the rest of the body, the brain grows and develops from childhood to adulthood. This is what allows your executive functions to mature as you get older, and this can happen faster in some children and slower in others. Just as you can train the muscles in your body, training and using your brain's executive function superpowers can help them strengthen and grow!

YOUR BRAIN'S SUPERPOWERS

Did you know your brain can do many things at the same time? The communication between various areas of the brain supports an incredible group of superpowers, called **executive functions**. These

special powers help you to control your thoughts and actions, keep multiple things in mind, solve problems, and plan ahead. Multiple executive functions work together to help you reach your goals or complete challenging tasks [1].

Humans are not born with these superpowers, but they can form and develop in all of us as we get older. Some people find it harder than others to develop their executive functions, and some people may need help to get these superpowers to reach their maximum potential. In this article, we will explain what executive functions are, how the brain supports these functions, how they develop across childhood, and what you can do to train them.

WHAT ARE EXECUTIVE FUNCTIONS?

Executive functions are made up of several important skills that each help you perform everyday activities and tasks. For example, the executive function called *inhibition* helps you to stop before you act. For example, it helps you stop blurting out an answer before it is your turn to speak. *Working memory* lets you keep more than one thing in mind at a time, which helps you to do complex tasks because you can think about several steps simultaneously. This is useful when you are playing a board game, for example, and must remember the rules of the game as well as what to do on your next turn. *Mental flexibility* lets you switch between tasks, which helps you to learn complex new things or solve problems. Mental flexibility also allows you to adapt flexibly to changing environments—when things do not go as planned, it helps you find another way to reach your goal. Finally, *planning* allows you to choose the necessary actions to reach your goal and decide on the right order of those actions.

Life without your executive functions would be challenging. For example, you would have little control over your actions and simply do whatever came into your head—like eating way too many cupcakes and making yourself feel sick. You would struggle to pay attention, so you could end up losing your belongings or toys often. You would not be able to plan ahead, so you would arrive at school without your completed homework or lunchbox. You would also not realize that you could do things better, and therefore you would keep making the same mistakes over and over. You would get easily distracted, which could stop you completing tasks or from practicing any task or skill long enough to become good at it. It is clear that poor executive functions would make life difficult—and that no one would choose to have these problems!

PREFRONTAL CORTEX

The area at the very front of the brain, right behind the forehead. It plays a major role in executive functions.

CONNECTIVITY

Coordinated brain activity in separate areas of the brain, which means that these areas work together.

Figure 1

Overview of the key areas of the brain. **(A)** Executive functions mainly rely on the communication (connectivity) between the prefrontal cortex and the parietal cortex (demonstrated by the white arrows). **(B)** At the cellular level, information is transferred between brain areas by processes that happen at the junctions between neurons, known as synapses (© Elysia MacDonald, 2023).

HOW DOES THE BRAIN SUPPORT EXECUTIVE FUNCTIONS?

At the front of the brain, there is an area that is mostly used for executive functions [2]. Scientists call this part of the brain the **prefrontal cortex** (Figure 1). The prefrontal cortex is often thought of as the brain area that organizes and manages other parts of the brain. Like most actions and functions the brain performs, executive functions do not rely on just one part of the brain, but instead involve many brain areas. Brain areas communicate with each other to support complex processes like executive functions. For example, some aspects of executive functions rely on the connections between the prefrontal cortex and the parietal cortex, a part of the brain just beneath the back of the head. Another important brain region is the cingulate cortex (particularly the front part), which monitors the environment and can increase attention through its connections with the prefrontal cortex. Research has shown that the more these brain areas communicate, that is, the greater the **connectivity**, the better the executive functions are.

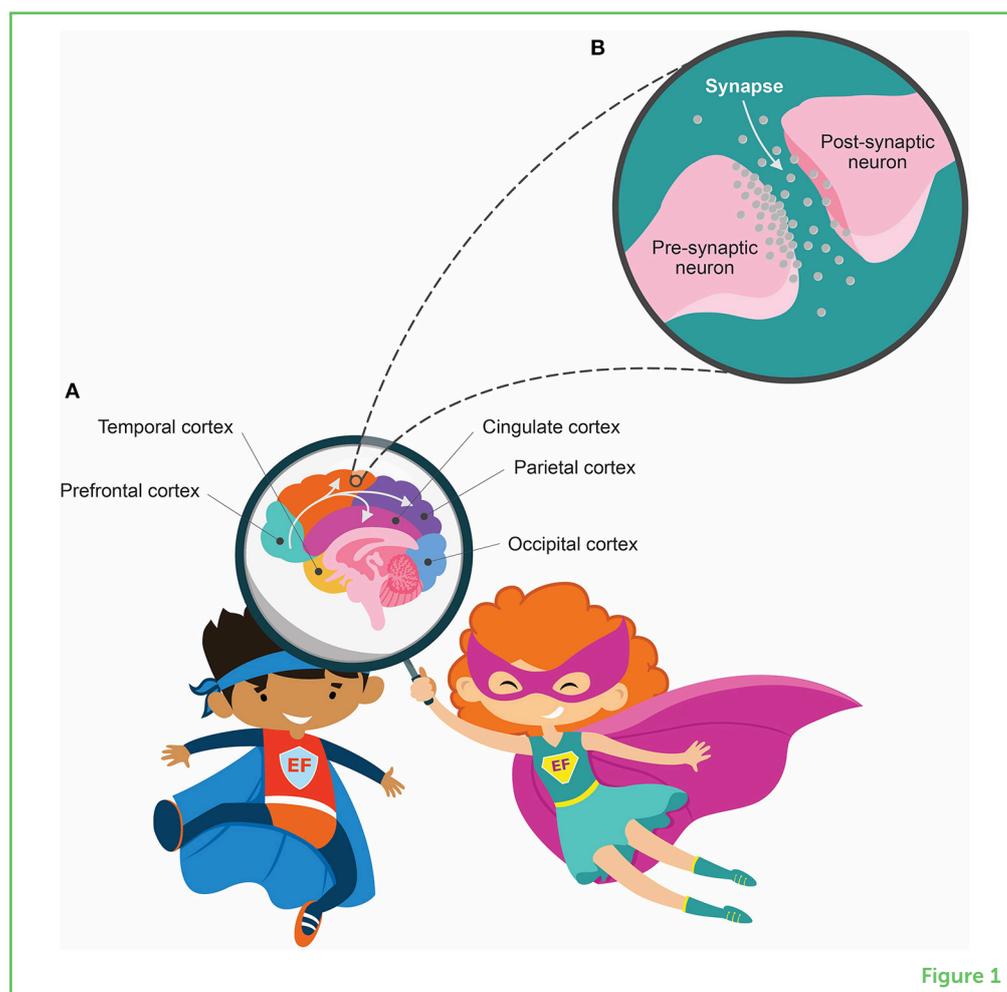


Figure 1

NEURONS

Brain cells that enable the transfer of information throughout the brain and to and from parts of the body.

SYNAPSE

A small space between two neurons that helps the transfer of information.

EXECUTIVE FUNCTIONS DEVELOP THROUGHOUT CHILDHOOD

Just like the rest of the body, the brain continues to grow as people get older. In fact, the prefrontal cortex is one of the last brain areas to fully develop and it continues to grow and change until adulthood. As the brain continues to mature and grow, more connections are made and strengthened. These connections occur when brain cells, known as **neurons**, make new junctions between each other, which are called **synapses**. As more synapses are made, the size of brain regions like the prefrontal cortex increases. After a period when many synapses are made and all important connections are in place, any synapses that are not needed anymore are eliminated. This is called pruning because it is similar to cutting away all the excess branches of a tree, so that the most important branches can grow better.

As the prefrontal cortex develops during infancy and childhood, executive functions also develop. As people get older, executive functions build and grow, enabling people to do increasingly complex activities. Have you ever wondered why a young child cannot wait their turn, or why babies cry and scream when they do not get their way? This is because the ability to control actions and emotions and inhibit inappropriate ones only begins to develop during the preschool years (3–5 years). This ability continues to mature during middle childhood (6–10 years), only reaching adult levels in early adolescence (11–14 years) [3]. **Figure 2** shows how executive function skills develop and grow at various ages and speeds.

Figure 2

Executive functions develop as people age and different aspects of executive function develop at different rates. For example, you can see that, around the age of ten, the ability to plan (*planning*, orange line) is still developing, while the ability to inhibit inappropriate actions (*inhibition*, pink line) is almost fully developed and similar to that seen in adults. Inhibition is the earliest executive function to emerge around the age of one, and is followed by working memory, mental flexibility and planning [Figure adapted from Anderson [5]].

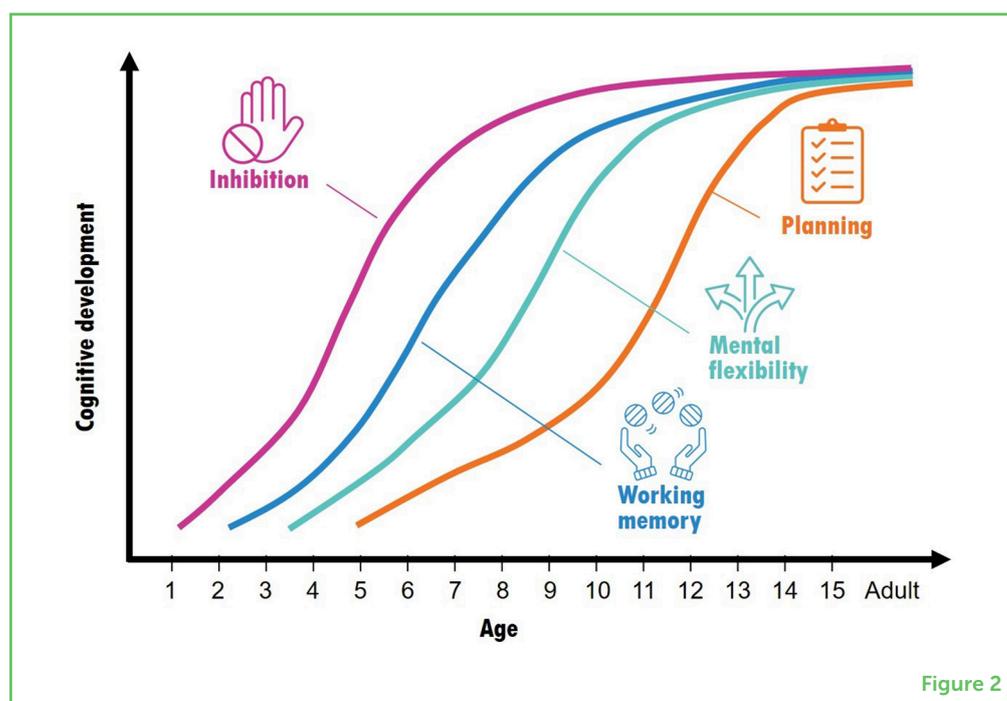


Figure 2

YOU CAN TRAIN YOUR EXECUTIVE FUNCTIONS!

While some people find it easy to use their executive functions in their day-to-day activities, others find it challenging to grow and build these skills. It is important to know that while not everyone has the same executive functions (and most of us have particular ones that are stronger than the others), the good news is that these skills can be trained and improved. You can think of the brain as a muscle that gets bigger and stronger the more it is used—and just like a muscle, regularly using your executive functions can make them better (Figure 3) [4]!

Figure 3

The brain can be trained like a muscle! Using your executive functions regularly by doing things like stopping to think before you act, being mindful, talking through your thoughts and actions, and trying new activities or challenges, can make them stronger (© Elysia MacDonald, 2023).

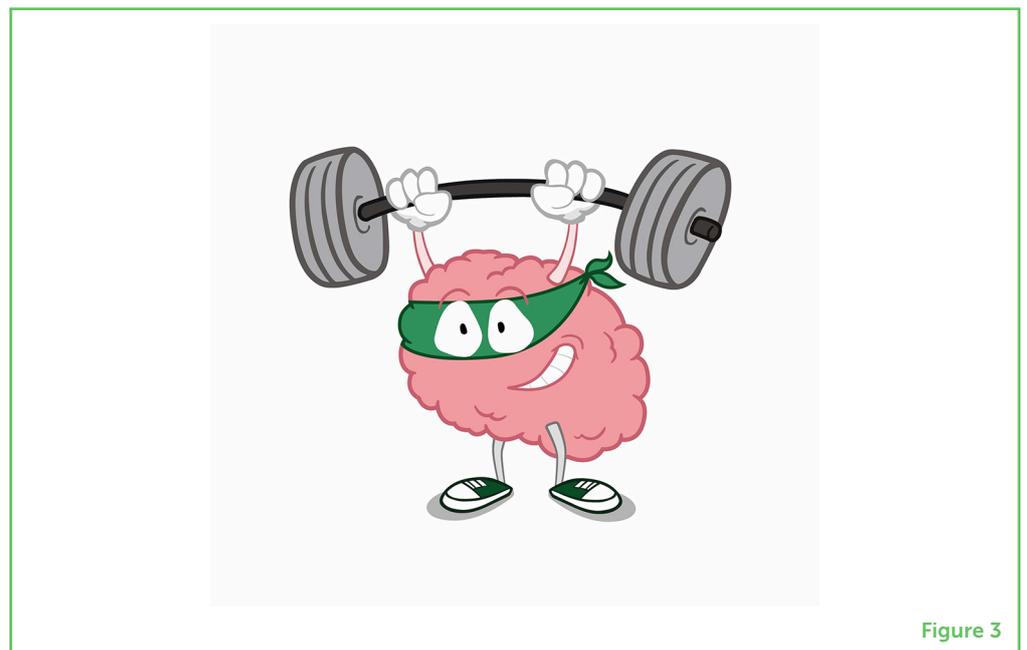


Figure 3

Here are some simple ways you could help to train and strengthen your executive functions. First, *stop and think*. Sometimes, you may make choices that you do not even realize, like eating a lot of chips when you are not really hungry. When you stop to think about whether you really want to eat those chips, it helps you to control your actions.

Another way to train your executive functions is to *slow down and be present*. Practicing awareness and **mindfulness** helps to strengthen your ability to hold your attention on one thing and quickly refocus when your attention wanders. It helps to try to focus on the simple things around you, and to change your focus from one thing to another. For example, you could close your eyes and listen to the birds chirping outside, and then change your attention to focus on the sound of your breathing.

Self-talk is another way to train executive functions. Having a chat with yourself in which you talk aloud about what you are feeling or doing can help with your mental flexibility. As you talk about a problem or task, you start to reflect on your thoughts and actions. This might

MINDFULNESS

The act of slowing down and noticing what is happening right now with one's thoughts, feelings and surroundings.

help you to rethink your goals and come up with a new plan or find new solutions.

You can also *challenge yourself* by trying out a new hobby, learning a new instrument or skill, or attempting a new route to a familiar place. This might be difficult at first but try to persevere and not lose courage. Every time you try something new and persist at it, your executive functions are likely to be involved.

Finally, *engage in mental exercises or activities*. There are many activities or exercises that help to train your inhibition, working memory, mental flexibility, or planning skills. For example, board games, puzzles, crosswords, or even some computer games, can help you to rely on and challenge your executive functions to navigate new problems and find solutions.

SUMMARY

Executive functions are a vital group of skills that enable you to achieve many aspects of your day-to-day life. A network of brain areas support these functions, such as the prefrontal, parietal and cingulate cortices. These brain areas grow as you age and the connections between them help to develop various execution functions. While executive functions are not something people are born with, there are many ways to learn these skills and strengthen them, such as practicing stopping to think before you act, being mindful and trying new activities. So, what are your superpowers helping you to achieve today?

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REFERENCES

1. Miyake, A., and Friedman, N. P. 2012. The nature and organization of individual differences in executive functions: four general conclusions. *Curr. Dir. Psychol. Sci.* 21:8–14. doi: 10.1177/0963721411429458
2. Rubia, K., Smith, A. B., Brammer, M. J., and Taylor, E. 2003. Right inferior prefrontal cortex mediates response inhibition while mesial prefrontal cortex is responsible for error detection. *NeuroImage.* 20:351–8. doi: 10.1016/S1053-8119(03)00275-1
3. Diamond, A. 2013. Executive functions. *Annu. Rev. Psychol.* 64:135–68. doi: 10.1146/annurev-psych-113011-143750
4. Diamond, A., and Lee, K. 2011. Interventions shown to aid executive function development in children 4 to 12 years old. *Science.* 333:959–64. doi: 10.1126/science.1204529

5. Anderson, P. 2002. Assessment and development of executive function (EF) during childhood. *Child Neuropsychol.* 8:71–82. doi: 10.1076/chin.8.2.71.8724

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YOUNG REVIEWERS

ELISE, AGE: 11

Hi, my name is Elise. I enjoy drawing and playing video games. I am learning to play the piano and speak French and Italian for fun. I love Fridays!



MERYEM, AGE: 14

Meryem is a 14 years old, who loves reading and writing. Meryem has a pet cat and wants a pet snake.



AUTHORS

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I am a researcher at the University Hospital of Child and Adolescent Psychiatry and Psychotherapy at the University of Bern. My goal is to better understand the interplay between emotion regulation, executive functions and brain development. Particularly, my aim is to find out how these processes work differently in children who have difficulties with mental health. In my free time, I like



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I am an academic at the Turner Institute for Brain and Mental Health and the Murdoch Children's Research Institute in Melbourne, Australia. My research is mainly in the areas of early birth, child development and neuroscience. Specifically, I am interested in understanding what influences brain skills and development in childhood, and developing treatments to help children at risk of learning or developmental difficulties. I am also a mum to two beautiful children, and enjoy cooking, the great outdoors, and a (hot) cup of coffee while listening to a good podcast!