

CANNABIS AND THE LEARNING BRAIN

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YOUNG REVIEWER:



GREESHMA

AGE: 13

How does cannabis (marijuana) affect the developing brain, learning, and academic performance? Research tells us that the brain continues to develop through the teenage years into the mid-20s, and during this time the brain is especially sensitive to the effects of drugs like cannabis. This article will give an overview of the research on the short- and long-term effects of cannabis on thinking, learning, and academic success. We will also provide a window into brain imaging research, which allows researchers to see what is happening in the brain over time when youth use cannabis. We hope to leave you with more answers than questions, but will finish by highlighting some of the unanswered questions about the potential negative effects of cannabis use in youth.

INTRODUCTION

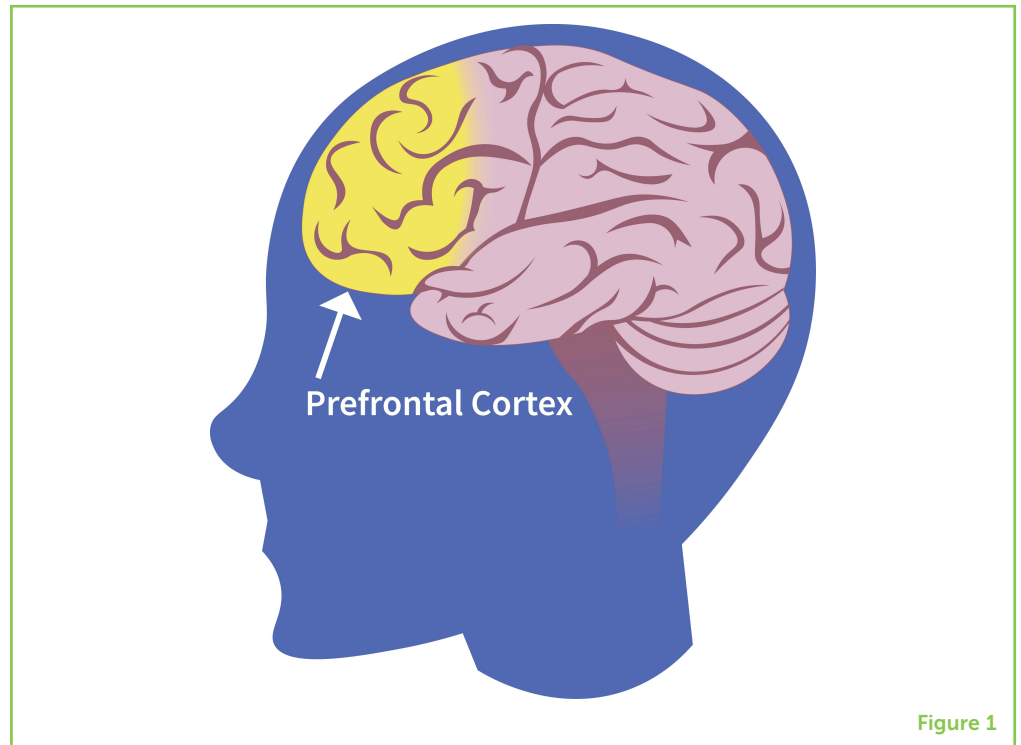
As a teenager, you are faced with an overwhelming number of choices and pressures. One choice you may face is whether or not to try cannabis or other drugs. You may hear different things about the risks of trying cannabis or using it regularly. Recent public debate, changes in the laws around cannabis, and its use as a treatment for some medical conditions have led some people to believe that cannabis is safe and without any risks to health or learning. This article is not here to tell you what to do, but to share the most up-to-date research about the effects of cannabis on the learning brain and to challenge some of the stereotypes and myths about cannabis use.

Cannabis is also known as marijuana, weed, or pot, and has psychoactive effects, meaning it can temporarily change brain function to alter mood, thinking, and behavior. After tobacco and alcohol, cannabis is the most commonly used drug in the world and is most often consumed by smoking, vaping, or in edible form. In North America, recent changes in the laws have legalized cannabis use for those over 18 or 19 in Canada, and over 21 in most U.S. states. People say that they use cannabis for a number of reasons, including for the “high” feeling that happens, to “experiment,” to help with socializing, or for medical purposes. Initially, it may seem like cannabis is helping—for example, by improving mood or making social situations a little easier—but with repeated use, cannabis tends to be related with making things worse. Cannabis can also have negative consequences on physical and mental health, especially when it is used while you are a teenager or young adult, used very often, or used in large amounts. Cannabis can also impair your judgment and ability to make decisions, and can lead some people to do risky things they might not do otherwise, like driving a car while high [1].

Advances in technology allow researchers to look closely at how the brain looks and works. Brain imaging techniques, like magnetic resonance imaging (MRI), have shown that adolescence through young adulthood is a time of dramatic change, especially in two major parts of the brain. The first part, called the endocannabinoid system, helps to develop and streamline the connections between different parts of the brain [2]. As you might be able to tell from the name, this system is affected by cannabis. The second part of the brain that changes a lot during this time, the prefrontal cortex, is the command center or “boss” of the brain, responsible for functions like making decisions, solving problems, and controlling our own behavior (Figure 1) [2]. Research tells us that the endocannabinoid system and the prefrontal cortex are still developing until we are in our mid-20s. Until this age, these parts of the brain are especially sensitive to the effects of chemicals like alcohol, cannabis, and other drugs [2].

Figure 1

The prefrontal cortex. The area of the brain colored yellow in this image is known as the prefrontal cortex. It is the command center of the brain and is responsible for things like making decisions, solving problems, and controlling our behavior (illustrated by Madelyn Vedelago).

**QUESTION 1: WHAT ARE THE SHORT-TERM EFFECTS OF CANNABIS ON THE BRAIN AND LEARNING? HOW DO RESEARCHERS KNOW THIS?**

The short-term effects of cannabis on the brain include a variety of negative consequences that can impact grades and success at school in teenagers (Figure 2). Researchers have found that adolescents who use cannabis did not do as well as their peers who were not using cannabis on tasks requiring attention, learning, memory, and reaction time [3]. This held true even if the cannabis users stopped using for 1 month before the experiment. Teenagers who start using cannabis at a younger age (under 15) perform even more poorly on these tasks than those who start using at an older age [2]. So, what is happening in the brain to cause this decreased performance?

As mentioned above, the endocannabinoid system in the brain is still developing throughout adolescence. While its role in the brain is not yet entirely understood, we know that the endocannabinoid system strengthens important connections and weakens unimportant ones in areas of the brain that are critical for learning and memory [2]. Using cannabis while this system is still developing may explain the problems with thinking, paying attention, and learning that are seen in teenagers who use cannabis [2].

Using MRI images, researchers found that a specific area of the prefrontal cortex was smaller in adolescents who use cannabis heavily compared with adolescents who do not use cannabis [4]. The cannabis-using group also tended to be more impulsive, that is,

Figure 2

The negative effects of using cannabis during adolescence. Since the brain is still developing while you are a teenager, certain skills necessary to succeed in school like thinking, memory, learning, and attention can be negatively impacted by using cannabis (illustrated by Madelyn Vedelago).

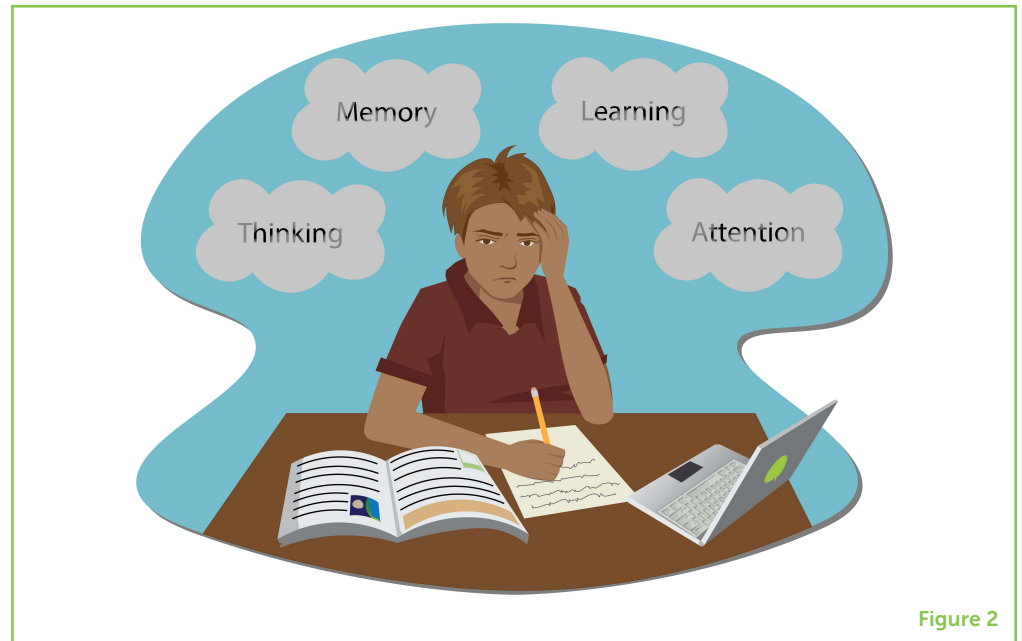


Figure 2

to do things without thinking [4]. In a memory task, cannabis users showed less activity in the prefrontal cortex compared with non-users [3]. Overall, it appears that cannabis use can interfere with both the size and the activity of the prefrontal cortex, which is very important to learning.

QUESTION 2: WHAT ARE THE LONG-TERM EFFECTS OF CANNABIS USE ON SCHOOL SUCCESS?

Research suggests that people who are heavy cannabis users in adolescence do not go as far in school, that is, they are less likely to achieve higher levels of education. A study that observed people from their teenage years into adulthood found that individuals who use cannabis as teenagers and continue to use throughout life tend to be in school for fewer years than those who did not use cannabis during the teen years [5]. Why might this be the case? More research is needed to be certain about how cannabis use impacts school success, but it is possible that the changes in the brain that occur when cannabis is used in the teenage years may explain this. Or, it could be due to the short-term negative effects of cannabis on memory, attention, and motivation, which could lead to lower grades in high school and reduced chances of getting into university or college.

QUESTION 3: CAN THE NEGATIVE EFFECTS OF CANNABIS ON LEARNING BE REVERSED?

The good news is that, because of the rapid changes and reorganization happening in the teenage brain, adolescents may be better able to bounce back from the effects of toxins like alcohol,

cannabis, and other drugs. For example, researchers have found that when cannabis users stopped using for 3 months, most of their problems with memory, learning, and attention returned to normal [3].

CONCLUSION

Overall, the research suggests that cannabis may have negative effects, particularly when use starts in the teen and young adult years. However, the research findings are also unclear in some studies and much remains unknown, because not enough good research has been done yet. Additionally, most of the research that has already been done focuses on links (or correlations) between cannabis use and differences in the brain. This means that we do not know yet whether cannabis is the cause of these differences, or if these differences existed before cannabis use started. While we still have a lot to learn about the effects of cannabis use, most doctors, researchers, and governments recommend not using it during adolescence.

If you are thinking about trying cannabis, it may be helpful to ask yourself a few questions:

- Why do I want to use cannabis? Am I trying to escape something or to cover up a problem?
- How would I know if cannabis is impacting my ability to learn or go to school? How would I recognize if cannabis use was becoming a problem for me?
- Who could I talk to or where could I find help if I or one of my friends started having problems with cannabis?

Considering these questions will help you to make the best decisions for you and your learning brain.

AUTHOR CONTRIBUTIONS

LV, JH, CM, KG, and MA contributed to the conception and design of the manuscript. LV wrote the first draft of the manuscript. All authors contributed to manuscript revision and read and approved the submitted version.

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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.

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YOUNG REVIEWER



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My name is Greeshma and I am 13 years old. Both of my parents are software engineers and my favorite subjects in school are mathematics and science. Outside of school, I love to play volleyball and participate in science clubs.

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I am a graduate student studying addictions and related mental health problems. I am interested in improving the lives of people struggling with these issues. When I am not in the laboratory, you can find me volunteering at the animal shelter, dancing, and cross-stitching! *vedelagl@mcmaster.ca



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I am a mental health nurse and a researcher. I am interested in trying to figure out how youth can be successful and happy while they are young and when they grow up. Much of my research focuses on if and how substances (mainly cannabis and alcohol) and mental health concerns co-occur. In my free time, I like to lift weights, play board games, and hike!



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I am a doctor (psychiatrist), educator, and researcher focused on mental health and substance use in college and university students. I like to read books, exercise, spend time outdoors, and hang out with my family and friends.



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I am an Associate Professor in the Department of Psychiatry and Behavioural Neurosciences at McMaster University. My research examines social disparities in children's mental health and access to effective mental health services and supports. In my free time, I enjoy spending time with family and friends and traveling back to Greece and Cyprus.



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I am an Assistant Professor of Psychiatry at McMaster University in Ontario, Canada. I am interested in understanding the brain basis of alcohol and drug use and how they relate to other mental health problems. We hope that our research will improve treatments for people who are struggling with addictions. I enjoy working with my students and colleagues on many exciting research studies using brain scans and other types of technology. In my spare time, I enjoy cooking, traveling, and spending time with my family.