

Substance Use and the Brain



Substance Class	What happens in the brain?	Short-term brain effects	Long-term brain effects
Stimulants e.g. amphetamines (including methamphetamine), caffeine, cocaine, methylphenidate, nicotine, pseudoephedrine	- Most stimulants dopamine (DA) and norepinephrine (NE) activity in the prefrontal cortex, affecting focus, decision-making, and self-control, and in the reward pathway, increasing motivation and cravings - Nicotine increases acetylcholine (ACh) and DA activity in the ventral tegmental area (VTA) and nucleus accumbens, strengthening reward and cravings - Methamphetamine causes extremely high DA activity, producing stronger and longer-lasting effects than many other stimulants	- Increased alertness, energy, and mood - Reduced need for sleep - Anxiety, restlessness, irritability, or impulsivity - At high doses: agitation, paranoia, or seizures - Methamphetamine-induced psychosis, which can cause paranoia, hallucinations, and delusions	- Changes in mood, memory, attention, self-control, and decision-making - Dependence, cravings, tolerance, substance use disorder, and withdrawal - Anxiety, sleep problems, stimulant-induced psychosis, seizures, stroke, or movement disorders - Methamphetamine can cause inflammation of brain blood vessels, causing stroke or vision loss, including blindness
Depressants e.g. alcohol, barbiturates, benzodiazepines, date rape drugs, opioids, sleeping medications (e.g. zopiclone)	- Increase GABA activity, slowing communication between brain cells and reducing brain activity - Affect the prefrontal cortex, making it harder to think clearly, make decisions, and control impulses - Affect the hippocampus and other memory-related areas, which can interfere with learning and memory - Opioids also affect brain regions involved in pain, breathing, emotions, and reward	- Relaxation and drowsiness - Slower thinking, reaction time, and coordination - Poor judgement and decision-making - Memory problems (e.g. blackouts with alcohol) - Opioids can slow breathing	- Problems with learning, memory, and attention - Increased impulsivity and difficulty concentrating - Negative effects on school, work, and relationships - Worsen mental illnesses, such as anxiety, depression, ADHD. - Risk of developing a substance use disorder,

Substances can affect youth differently because the brain is still developing. To find out more information on how substance use can affect brain development visit:

<https://decyde.ca/educational-materials/#mental-health>



Be aware: Self-treating risks

Using substances to cope with stress, emotions, or mental health symptoms is sometimes called **self-treating** or **self-medicating**. It may seem helpful in the short term, but it can delay support, hide mental health concerns, and make symptoms worse over time.

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Hallucinogens (Psychedelics) e.g. DMT, ketamine, LSD, MDMA, psilocybin (magic mushrooms)	- Alter serotonin signaling, changing mood, emotions, perception, and decision-making - Affect brain networks involved in thinking, self-awareness, and how we experience the world - Change activity in areas involved in vision and hearing, which can alter perception - MDMA also affects reward and self-control pathways, increasing DA and serotonin activity	- Changes in vision, hearing, and perception - Hallucinations may occur - Changes in mood, emotions and thinking - Effects vary depending on dose, environment, mental health, and medications	- Lasting changes in mood and perception in some people - Memory and thinking problems with repeated or heavy use - Increased risk of stroke, seizures, neurocognitive impairment, or movement disorders - May trigger or worsen psychosis or other mental illnesses in vulnerable individuals - Risk of developing a substance use disorder,
Cannabinoids e.g. cannabis (marijuana, weed)	Using THC: - Affects the prefrontal cortex, influencing attention, planning, decision-making, and impulse control - Alters activity in the hippocampus, affecting learning and memory - Affects the VTA and reward pathways, changing motivation, pleasure, and dopamine signaling - Changes communication between brain cells involved in memory, attention, emotions, and reward	Using THC may lead to: - Relaxation or euphoria - Altered perception of time and surroundings - Problems with attention and short-term memory - Slower reaction time - Anxiety, panic, or psychosis in some people	Using THC may lead to: - Problems with learning, memory, attention, planning, and problem-solving - Increased impulsivity and poorer decision-making - Negative effects on school or work performance - Increased risk of anxiety, depression, psychosis, and schizophrenia in vulnerable individuals. - Risk of developing a substance use disorder,

Did you know?

Cannabis contains more than 150 natural **cannabinoids**. The best known are **THC**, which causes the "high" and changes how the brain processes thoughts, emotions, and movement; and **CBD**, which doesn't cause a high and may influence the brain differently, including possible calming effects in some people. However, the effects of CBD on the brain are still being studied and are not as well understood as the effects of THC on the brain.



**SUBSTANCE
SNAPSHOT**

For more information on the specific effects of substances, refer to our Substance Snapshots:
<https://decyde.ca/substance-snapshots/>

References

- Salmanzadeh et al. (2020). Adolescent drug exposure: A review of evidence for the development of persistent changes in brain function. <https://www.sciencedirect.com/science/article/abs/pii/S0361923019308809?via%3Dihub>
- Lappin & Sara (2019) Psychostimulant use and the brain. <https://pubmed.ncbi.nlm.nih.gov/31321619/>
- Kwan et al. (2022). The neural basis of psychedelic action. <https://doi.org/10.1038/s41593-022-9177-4>
- Sood et al. (2021). Effects of Caffeine and Caffeinated Beverages in Children, Adolescents and Young Adults: Short Review. <https://doi.org/10.3390/ijerph182312389>
- Edinof et al. (2022). Methamphetamine Use: A Narrative Review of Adverse Effects and Related Toxicities. <https://doi.org/10.52965/991c-38161>
- Sideris et al. (2024). The Basic Science of Cannabinoids. Anesthesia and analgesia. <https://doi.org/10.1213/ANE.00000000000006472>