

Is there a link between ADHD and dopamine?

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Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder that affects children and often persists into adulthood. Research suggests that there is a link between dopamine levels and the development of this condition.

According to the [Centers for Disease Control and Prevention \(CDC\)](#), 6.1 million children living in the United States in 2016 had received a diagnosis of [ADHD](#). The symptoms of ADHD can vary from person to person, but they typically include difficulties with concentrating, paying attention, and controlling impulses.

It is not clear what causes ADHD, but scientists believe that genetics, certain environmental factors, and brain changes may play a role in its development. Researchers have also investigated the role of neurotransmitters, such as dopamine.

In this article, we discuss the link between dopamine and ADHD. We also cover other effects of low dopamine levels and treatment options for ADHD.

What is the link?

Genetics and family history may be a risk factor for ADHD.

Multiple factors are likely to contribute to ADHD. According to the [National Institute of Mental Health](#), risk factors for ADHD may include:

- genetics and family history of ADHD
- low birth weight
- premature delivery
- alcohol, tobacco, or drug use during pregnancy
- exposure to toxins, such as lead, during pregnancy or early childhood
- brain injury

Scientists have also been studying the role of dopamine in the development of ADHD. Dopamine is a type of neurotransmitter that has several important functions in the brain and body. There is an association between dopamine levels and several psychiatric and neurological disorders, including [Parkinson's disease](#).

Dopamine levels can affect a person's mood, attention, motivation, and movement. Dopamine also regulates the brain's reward system, with its levels increasing in the brain when a person experiences something pleasurable, such as eating food or having sex.

Experts initially believed that ADHD occurs as a result of low levels of dopamine, but they have since realized that the relationship is a little more complicated.

According to the [Gulf Bend Center](#), people with ADHD may have a higher concentration of dopamine transporters in the brain. These transporters remove dopamine from brain cells. When there are more transporters in one area of the brain, they do this too quickly, which means that dopamine has less time to exert its effects.

Reduced levels of the neurotransmitters [serotonin](#) and norepinephrine may also contribute to the development of ADHD.

What does the research say?

Scientists have been studying the link between dopamine transporters and ADHD symptoms. However, other research suggests that structural changes in the brain may also play a role in ADHD.

According to the [DNA Learning Center](#), a small study in 16 children and adolescents with ADHD found that medications that increase the availability of dopamine in the brain lead to the inhibition of the motor cortex, the brain region that controls voluntary movement. This effect was more significant in children with a genetic variation called *DAT1*, which is a gene that usually increases the activity of dopamine transporters.

These results suggest that genetic factors that affect dopamine transporters may play a role in the development of ADHD.

The [DNA Learning Center](#) also report on another study that compared the [MRI](#) brain scans of children with and without ADHD. The researchers found that the children with ADHD had a thinner cortex in the areas of the brain responsible for attention control.

The researchers behind a small [2013 study](#) found that methylphenidate (Ritalin) increased dopamine levels in the brain and improved attention in adults both with and without ADHD.

They also observed that both groups of participants had an equivalent availability of dopamine receptors in the brain. They concluded that their results suggest that dopamine dysregulation is unlikely to be the leading cause of ADHD in adults.

In a [study from 2015](#), researchers identified an association between genetic changes in the *DAT1* gene and mood instability in healthy adults. Mood instability tends to be a persistent symptom in people with ADHD.

Other effects of low dopamine

Dopamine has a powerful effect on the brain and plays a role in other [mental health](#) disorders. We discuss some of these below.

Drug use

According to the [National Institute on Drug Abuse](#), when a person experiences pleasure, this activates the reward circuitry in the brain and causes the release of dopamine. This process reinforces the association between the activity that the person was doing and pleasure, which encourages them to repeat the activity in the future and can lead to a habit forming.

Recreational drugs, such as cocaine or amphetamine, can cause a feeling of intense euphoria that produces a large surge of dopamine in the brain. This burst of dopamine can lead to a person favoring drugs over more healthful activities and personal goals.

Over time, continued drug use can result in the brain producing less dopamine or fewer dopamine receptors. As a result, the person needs to keep using drugs to maintain a normal level of reward, which worsens the problem and creates a cycle that can be difficult to break. The person may also need to take increasing amounts of the drug to get the same high.

Parkinson's disease

Parkinson's disease is a chronic neurodegenerative disorder that primarily occurs due to the loss of neurons in the substantia nigra, which is the area of the brain that produces dopamine. The reduction of dopamine in the brain can affect a person's coordination and body movement.

The symptoms of Parkinson's tend to develop gradually and can vary from person to person. However, the main symptoms include:

- tremor, or shaking, in the hands, arms, legs, and head
- stiffness in the muscles, particularly in the arms
- slower movement
- balance and coordination difficulties, which can increase the risk of falls

Doctors do not fully understand what causes the loss of dopamine-producing neurons in people with Parkinson's, but they believe that it may involve a combination of genetic mutations and environmental factors, such as exposure to specific toxins.

The treatment for Parkinson's disease includes therapies that increase the levels of dopamine in the brain and medications that can help improve motor symptoms.

Depression

[Depression](#), or major depressive disorder, is a mood disorder that can severely affect how a person feels and thinks. The symptoms of depression can vary greatly among individuals, but people with this condition will often feel sad and hopeless and lose interest in activities that they previously enjoyed.

[Research](#) suggests that the disruption of the dopaminergic system may play a role in the development of depression.

Schizophrenia

Scientific studies have also linked dopamine to the underlying pathology of [schizophrenia](#). Schizophrenia is a chronic mental health disorder that can cause a range of severe psychological symptoms.

According to a [2014 review](#), the reduced activation of a type of dopamine receptor may cause the "negative" symptoms of schizophrenia, which include speech changes, loss of pleasure, and poor motivation. Conversely, experts believe that "positive" symptoms, such as hallucinations and delusions, are the result of an increased release of dopamine.

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ADHD treatment

Experts recommend behavior therapy as the first line of treatment for young children.

The treatment of ADHD often involves a combination of therapies.

The [American Academy of Pediatrics \(AAP\)](#) recommend teacher- or parent-administered behavior therapy as the first line of treatment for children aged 4–5 years. For children over the age of 6 years, the AAP suggest that doctors prescribe a combination of behavior therapy and medication.

Medication options for ADHD include both stimulant and nonstimulant drugs that can help improve a person's symptoms and enhance functioning.

Stimulants, which contain forms of amphetamine and methylphenidate, help with focus and attention. Experts also believe that these medications increase levels of dopamine in the brain.

The [Food and Drug Administration \(FDA\)](#) have also approved three nonstimulant medications for treating the symptoms of ADHD: atomoxetine (Strattera), guanfacine (Intuniv), and clonidine (Kapvay). Doctors typically prescribe these drugs for people who have problems when taking stimulants.

Summary

ADHD is a neurodevelopmental disorder that can cause attention difficulties, impulsivity, and hyperactivity. Research suggests that imbalances of neurotransmitters, such as dopamine, and structural changes in the brain may play a role in the development of this condition.

Dopamine levels also seem to be a factor in several other neurological and mental health disorders, including Parkinson's disease, substance use disorder, depression, and schizophrenia.

- [ADHD / ADD](#)
- [Neurology / Neuroscience](#)
- [Pediatrics / Children's Health](#)
- [Psychology / Psychiatry](#)