

# Effects of amphetamines on dopamine neurotransmitter systems



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The link between a drug's effect on an individual's dopamine neurotransmitter system and potential for it to lead to a cycle of addiction and relapse has been well documented by many researchers. This paper will first discuss the function of the dopamine neurotransmitter system and how it is affected by Amphetamine, the chosen drug for this report. The second section of this paper will on the withdrawal and relapse that addicted users face as a result of the processes and systems detailed in section one.

### Section One: Dopamine Neurotransmitter and Amphetamine

The term neurotransmitter is used to describe chemicals that are released into a neuron's synaptic cleft and bind to receptor sites, allowing for signals to be relayed between neurons (Purves et al., 2001). There are two forms of neurotransmitter; excitatory, which create a positive internal charge, and inhibitory, which create a negative internal charge. A more positive charge increases the likelihood of an action potential (signal that travels through the neuron). Dopamine is one such neurotransmitter and from early studies (Olds and Milner, 1954) has been linked to playing a role in the brain's reward system. It is transported through the brain along the mesolimbic pathway from the Ventral tegmental area in the midbrain, to the nucleus accumbens in the forebrain (Rubenstein and Rakic, 2013).

Amphetamine, derived from the Ephedra plant, is classed as a stimulant. It rose in popularity in the 1920s due a civil war in China resulting in a lack of ephedrine. In the 1930s amphetamine was released to the public in the form of an inhaler for asthma and was given to troops throughout World War II, the Korean War and the Vietnam War as a means to increase their

attentiveness, although this became less common as its performance enhancing effects were merely in the minds of the users. It was also noted that amphetamine caused an enhancement in the mood of a user, and by the 1960s, there was an epidemic of amphetamine abuse.

Amphetamine is categorised as a dopamine agonist. This means that it fits with the dopamine receptor perfectly, resulting in the channel being either blocked or opened. In the case of amphetamine, it allows for dopamine agents to be released from a neuron's presynaptic terminals while also reversing the direction of the dopamine reuptake transporter, resulting in reuptake being prevented (McQueen, 2010). In a study conducted by Carvalho et al. (2012), it was noted that this prevention of dopamine reuptake caused a dopamine concentration increase in the synaptic cleft. Such an increase permits a continual stimulation along the mesolimbic pathway. The effects of amphetamine on the dopamine neurotransmitter system cause a user to experience a variety of sensations, most notably euphoria and increased libido (Sweis and Biller, 2017). Such positive experiences combined with other potential risk factors, such as an individual's family and friends, can lead to abuse and addiction of amphetamine.

## Section Two: Addiction, Withdrawal and Relapse

As discussed in the previous section, the release of dopamine into the mesolimbic pathway provides individuals with a pleasurable feeling. The addictive potential for such a dopamine release was seen in a study performed by Lyness et al. (1981) found that when rats were given access to

a lever that would cause a release of dopamine, they developed a self-administration response. Such behaviour suggests that the drugs, were rewarding. A further study conducted by Roy Wise (1996) recorded data that suggested an increase in dopamine activity will cause dopamine seeking behaviour to increase. From this it is easy to link dopamine release with drug addiction, suggesting that drugs that primarily act on dopamine receptors have a higher chance for addiction.

When an individual is taking drugs at a rate where it can be considered a chronic issue, their body will brain's receptors will autonomously become desensitised and will down regulate. This occurs naturally in order to optimise the drug's level of binding. Such a scenario will mean that a user will gain a tolerance to the drug and have to take a larger dose for a similar effect. This means that when an individual undertakes abstinence from a drug, it will result in the individual experiencing the opposite effects of the drug. In the case of amphetamine, since it activates neurons on the mesolimbic pathway, withdrawal will result in these having less activity. This will cause in a user to experience anxiety, loss of motivation and depression. A study performed Ackerman and White (1992) on rats that had been treated with either cocaine or saline showed that the number of dopamine cells that were firing after 10 to 14 days of withdrawal was 49% lower in the rats that were experiencing cocaine withdrawal. Such an outcome can also be assumed as a result of amphetamine withdrawal. Self-detoxification is considered the primary method for drug users to abstain from chronic use.

In a study performed by Cantwell and McBride (1998), chronic amphetamine users abstaining from the substance reported a variety of withdrawal

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symptoms in the first few weeks from abstinence. The most common of these included aches and pains, depression, irritability, and a lowered social functioning. As a result of such symptoms, the likelihood of relapse was very high, with most users relapsing within four weeks of abstinence (Arcuri et al., 2004). The reasons for relapse varied between persistent withdrawal symptoms, depression and peer pressure. It was also noted that users who relapsed did not cite amphetamine craving as a reason. The severity of an individual's withdrawal symptoms was found to be directly associated with the level of that user's dependence on the drug, as well as users who are older (Shoptaw et al., 2009).

In conclusion, it is evident that due to the effect amphetamine has on the dopamine neurotransmitter system, an individual is likely to fall into a cycle of addiction, withdrawal and relapse. This is can be directly correlated to the extent of a user's previous amphetamine usage. As a result of stimulation to the mesolimbic pathway providing reward seeking behaviour to a user, the administration of amphetamine by recreational users is a dangerous action that can lead to a life of dependence due to the neurological factors involved.

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