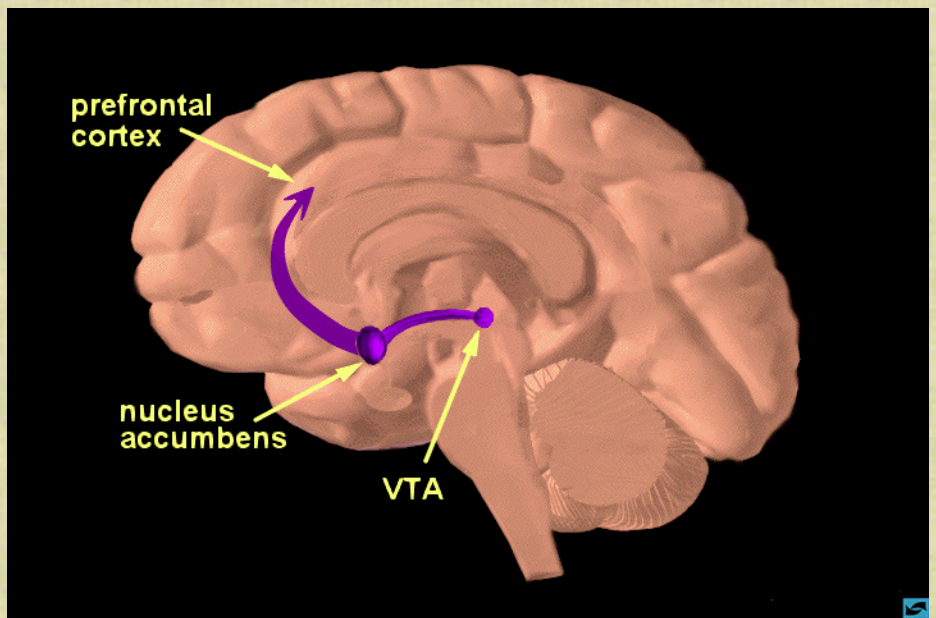


The Reward Pathway and Addiction

Humans, as well as other organisms engage in behaviors that are rewarding; the pleasurable feelings provide positive reinforcement so that the behavior is repeated. There are natural rewards such as food, water, sex, and nurturing, as well as artificial rewards such as drugs. Each of these naturally rewarded behaviors is required for the survival of the species, so the reward pathway is a crucial part of the brain, as well as a key in understanding addictions. Let's examine this pathway now.

The Reward Pathway

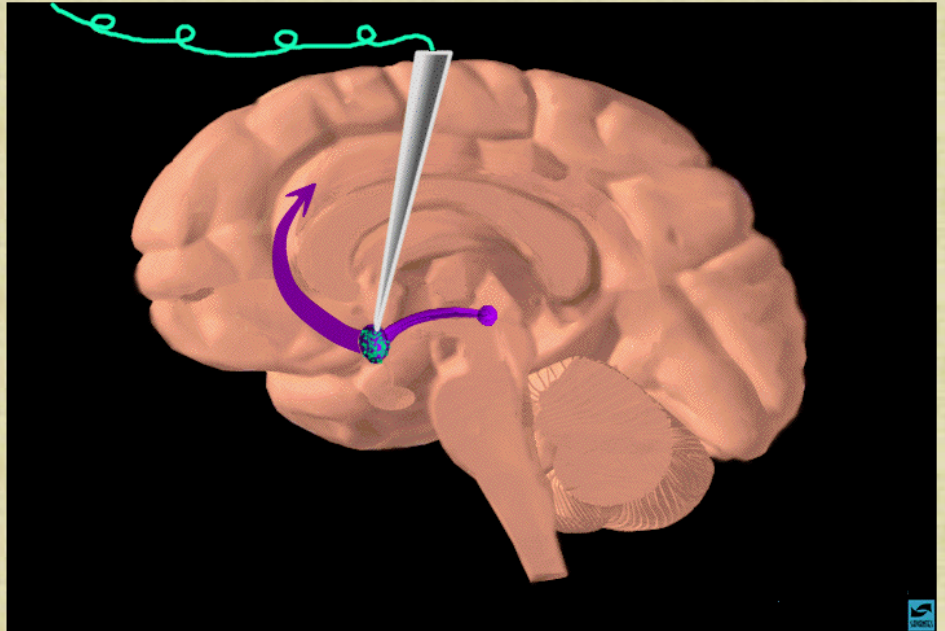
This is a view of the brain cut down the middle. An important part of the reward pathway is shown and the major structures are highlighted: the ventral tegmental area (VTA), the nucleus accumbens and the prefrontal cortex. The VTA is connected to both the nucleus accumbens and the prefrontal cortex via this pathway and it sends information to these structures via its neurons. The neurons of the VTA contain the neurotransmitter dopamine which is released in the nucleus accumbens and in the prefrontal cortex. This pathway is activated by a rewarding stimulus. [Note: the pathway shown here is not the only pathway activated by rewards, other



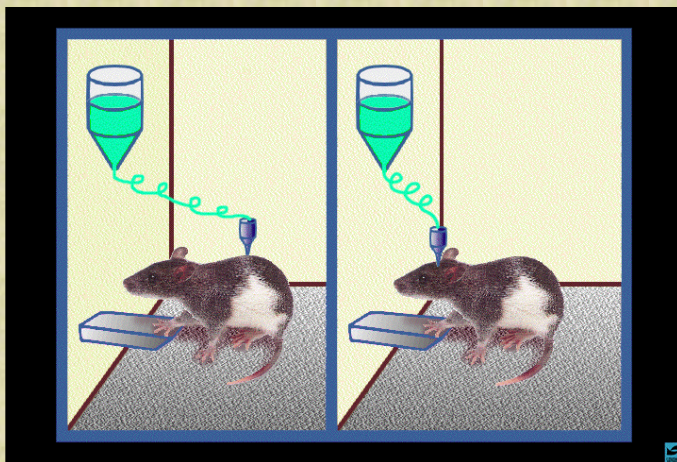
structures are involved too, but only this part of the pathway is shown here for clarity.]

The Discovery of the Reward Pathway

The discovery of the reward pathway was achieved with the help of animals such as rats. Rats were trained to press a lever for a tiny electrical jolt to certain parts of the brain. When an electrode is placed in the nucleus accumbens, the rat keeps pressing the lever to receive the small electrical stimulus because it feels pleasurable. This rewarding feeling is also called positive reinforcement. It has been shown that when an electrode is placed in an area around the nucleus accumbens, the rat will not press the lever for the electrical stimulus because stimulating neurons in a nearby area that does not connect with the nucleus accumbens does not activate the reward pathway. The importance of the neurotransmitter **dopamine** has been determined in these experiments because scientists can measure an increased release of dopamine in the reward pathway after the rat receives the reward. Also, if the dopamine release is prevented (either with a drug or by destroying the pathway), the rat won't press the bar for the electrical jolt. So with the help of the rats, scientists figured out the specific brain areas as well as the neurochemicals involved in the reward pathway.



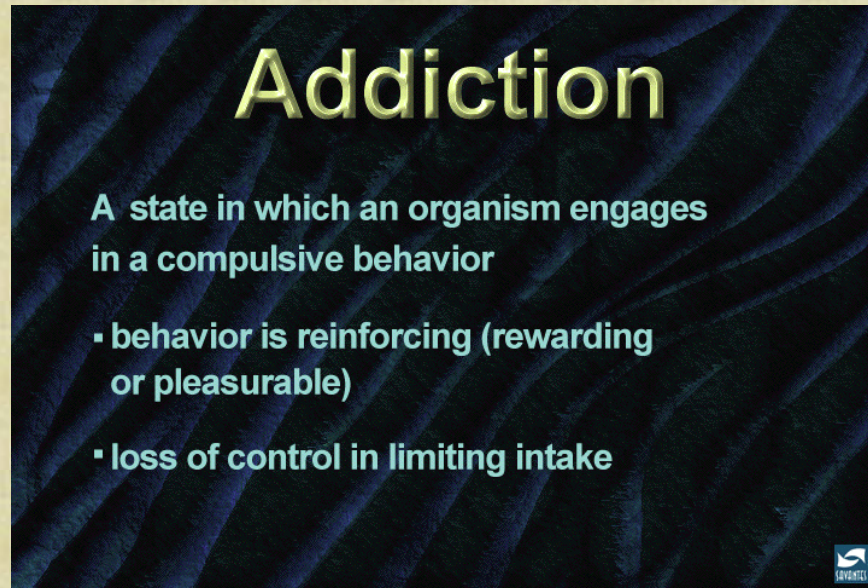
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This has also been demonstrated in experiments where rats had the opportunity to press a lever to self-administer cocaine injections. In the cartoon shown here, the rat on the left would NOT repeatedly press the lever to cause injection of the drug because the proper areas of the brain (nucleus accumbens, VTA, etc) would NOT be stimulated by the injection. On the other hand, stimulation of the nucleus accumbens in the brain of the rat on the right WOULD cause activation of the Reward Pathway, and thus the behavior would be repeated. (Note: this cartoon is an exaggeration, but it drives home the point that the reward pathway has very specific component areas in the brain as shown by various experiments on rats.)

Addiction Is...

Scientists know a lot more than just where the drug acts to produce rewarding effects - they also know how the drugs work, but before we go on to discuss the actions of heroin, marijuana, and cocaine, let's first define addiction:



Addiction is a state in which an organism engages in a compulsive behavior, even when faced with negative consequences. This behavior is reinforcing, or rewarding, as we have just discussed. A major feature of addiction is the loss of control in limiting intake of the addictive substance. The most recent research indicates that the reward pathway may be even more important in the craving associated with addiction, compared to the reward itself. Scientists have learned a great deal about the biochemical, cellular and molecular bases of addiction; it is clear that addiction is a disease of the brain.

With an understanding of the Reward Pathway, as well as a clear definition of exactly what an addiction is, you're now ready to take a look at some specific examples of the Neurobiology of Drug Addiction, so follow the Drug Actions link below!

[The Neurobiology of Drug Addiction \(Intro\)](#)

[The Reward Pathway and Addiction](#)

[The Actions of Cocaine, Opiates, and Marijuana](#)

Page last updated May 10th 1999 by [Rebecca Cammauf](#)