In this TED-Ed lesson, Sara Garofalo explains how some drugs can alter the communication between cells in the brain.

TED-Ed Lesson TRANSCRIPT

Most people will take a pill, receive an injection, or otherwise take some kind of medicine during their lives, but most of us don't know anything about how these substances actually work.

How can various compounds impact the way we physically feel, think, and even behave?

For the most part, this depends on how a drug alters the communication between cells in the brain. There are a number of different ways that can happen.

But before it gets into the brain, any drug must first reach the bloodstream on a journey that can take anywhere from seconds to hours, depending on factors like how it's administered.

The slowest method is to take a drug orally because it must be absorbed by our digestive system before it takes effect. Inhaling a drug gets it into the bloodstream faster. And injecting a drug intravenously works quickly too because it pumps the chemicals directly into the blood.

Once there, the drug quickly reaches the gates of its destination, the brain. The entrance to this organ is guarded by the blood-brain barrier, which separates blood from the nervous system to keep potentially dangerous substances out.

So all drugs must have a specific chemical composition which gives them the key to unlock this barrier and pass through.

Once inside, drugs start to interfere with the brain's normal functioning by targeting its web of neurons and synapses. Neurons are brain cells that have a nucleus, dendrites, and an axon.

Synapses are structures placed along the dendrites or the axon which allow the exchange of electrochemical signals between neurons. Those signals take the form of chemicals called **neurotransmitters**.

Each neurotransmitter plays different roles in regulating our behaviors, emotions, and cognition. But they all work in one of two ways.

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They can either inhibit the receiving neuron, limiting its activity, or excite it, creating a new electrochemical signal that spreads throughout the network. Any leftover neurotransmitter usually gets degraded or reabsorbed into the transmitting neuron.

A drug's effectiveness stems from its ability to manipulate these synaptic transmissions at different phases of the process. That results in an increase or a decrease in the amount of neurotransmitters being spread.

For instance, common antidepressants, like SSRIs, stop the reabsorption of serotonin, a neurotransmitter that modulates our moods. This effectively pushes more of it into the neural network.

Meanwhile, painkillers, like morphine, raise levels of serotonin and noradrenaline, which regulate energy, arousal, alertness, and pleasure. Those same neurotransmitters also affect endorphin receptors, reducing pain perception. And tranquilizers works by increasing the production of GABA to inhibit neural activity putting the person in a relaxed or sedated state.

WHAT ABOUT ILLEGAL OR ELICIT DRUGS?

These have powerful impacts on the brain that we're still trying to understand. Crystal meth, an amphetamine, induces a long-lasting release of dopamine, a neurotransmitter linked with the perception of reward and pleasure. It also activates noradrenaline receptors, which increases the heart rate, dilates pupils, and triggers the body's fight or flight response.

Cocaine blocks the reuptake of dopamine and serotonin, pushing more into the network where they boost energy, create feelings of euphoria, and suppress appetites.

And hallucinogenic drugs have some of the most puzzling effects. Substances like LSD, mescaline, and DMT all block the release of serotonin, which regulates mood and impulsivity.

They also have an impact on the neural circuits involved in perception, learning, and behavioral regulation, which may explain why these drugs have such powerful impacts.

Even if some of these effects sound exciting, there are reasons why some of these drugs are highly controlled and often illegal. Drugs have the power to alter the brain's chemistry, and repeated use can permanently rewire the neural networks that support our ability to think, make decisions, learn, and remember things.

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There's a lot we still don't know about drugs and their effects, both the good and the bad. But those we do know about are the ones we've studied closely, and turned into effective medicines.

As our knowledge grows about drugs and the brain, the possibilities will also increase for treating the many medical problems that puzzle researchers today.

Resources for Further Reading:

Bugs, Drugs and Guts: Pratik Shah at TEDxBeaconStreet (Full Transcript)

The Biology of Gender, from DNA to the Brain: Karissa Sanbonmatsu (Transcript)

Disconnected Brains: How Isolation Fuels Opioid Addiction: Rachel Wurzman (Transcript)

Hacking Your Brain for Happiness: James Doty (Full Transcript)

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