How Drugs Work & The Relationship Between Drugs and The Brain

Public Health 147: Drug Abuse & Prevention
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Introduction: Drugs

- A drug is defined as any substance that can alter the homeostasis of the body.

- Individuals consuming these substances can be described as using, misusing, or abusing drugs or any other substances.

- Drugs are licit and illicit

- Drugs can be injected, smoked, inhaled, drunken, or consumed in the form of a pill.
An estimated 22.5 million Americans over the age of 12 used illicit drugs one month in 2011.

9% of deaths in the 15-29 age group are alcohol related.

At least 15.3 million persons have drug use disorders.
Why do people use drugs?

- People take drugs because they want to change something about their lives.
  - To fit in
  - To escape or relax
  - To relieve boredom
  - To seem grown up
  - To rebel
  - To experiment

- They think drugs are a solution. But eventually, the drugs become the problem.
Drug addiction involves a biological process which results in adaptations of drug exposure.

This exposure induces a change in the function of individual brain neurons and further changes the function of the neural circuits in which those neurons operate.

This eventually leads to complex behaviors such as tolerance, sensitization, dependence, and cravings that characterize the drug addicted state.

Drug tolerance occurs when the effect of a drug decreases over the course of repeated consumptions of the drug.
Relationship Between Drugs & The Brain

- **Alcohol**: effects two distinct gated channels, enhances GABA and inhibits Glutamate. Agonist for GABA, serotonin, dopamine, and endorphin. Antagonist for glutamate. Learning is a result of the glutamate receptor, that is why you forget many things after heavily drinking.

- **Nicotine**: smoking gets nicotine to your brain in seven seconds. Stimulates the release of many chemical messengers such as acetylcholine, norepinephrine, epinephrine, serotonin, dopamine, beta-endorphin.

- **Cannabis**: impinges on the CNS by attaching to brain's neurons and interfering with normal communication. For example, impedes memory due to communication not happening between neurons.
Relationship Between Drugs and The Brain

- **Opioids**: act by attaching to specific proteins called opioid receptors, which are found in the brain, spinal cord. When these drugs attach to their receptors, they reduce the perception of pain.

- **Hallucinogens**: Mimic neurotransmitters: causing temporary brain toxicity that results in altered perceptions, hallucinations, strong emotions, impairment and dissociation.

- **Stimulants**: act on monoamines, which include norepinephrine and dopamine. Stimulants enhance the effects of these chemical in the brain.
How Drugs Are Absorbed In The Brain

- Drugs interfere with the way nerve cells normally send, receive, and process information.

- Some drugs can activate neurons because their chemical structures mimic neurotransmitters, leading to abnormal messages being transmitted through the neural network.

- Other drugs can cause nerve cells to release large amounts of neurotransmitters or prevent the normal cycling of brain chemicals, producing a greatly amplified message.
Your Brain on Drugs

http://www.youtube.com/watch?v=oeF6rFN9org

1. Marijuana (THC)
   - Hippocampus has lots of THC receptors
   - Limbic system is affected

2. Cocaine (build up of dopamine)
   - Parts of the brain that involve memory and learning

3. Amphetamines (methamphetamine)
   - Dopamine and norepinephrine
   - Brain swelling and hemorrhage

4. Inhalants (NOx, Nitrites)
   - Break down myelin in frontal cortex
   - The cerebellum and the hippocampus
Common Side Effects of Drugs on the Brain

- Different drugs elicit different side effects due to abnormal activity on the brain.
- **CNS depressants**: reduce CNS activity and diminish the brain's level of awareness.
- **Narcotics (opioids)**: cause drowsiness, euphoria, and mental clouding
- **Stimulants**, such as amphetamines: agitation, anxiety, and panic.
- **Ecstasy**: releases serotonin and dopamine
- **Hallucinogens**: alter sensory processing in brain, causing perceptual disturbances, changes in thought processing, and depersonalization
- **Marijuana**: THC causes user to feel euphoric/"high" by releasing dopamine
Main long term effect: **ADDICTION**

Drugs increase the release of dopamine from neurons in the brain, which is the rush that drug users enjoy for a short time.

Development of cravings; the amygdala in the brain is activated when a craving is stimulated.

Tolerance to the specific drug is created and increased as long as the person keeps administering the drug to themselves; brain becomes resistant (long term effect).

THC in marijuana affects the neurons in the brain and alters a person's behavior for the time THC is in the brain (short term).
Short Term & Long Term Effects of Drugs on the Brain

- MDMA (Ecstasy) causes the brain to reduce the amount of serotonin released and transported after a few weeks from using the drug; scientists are still doing research to see how MDMA increases the risk of long term problems with learning and memory.

- MDMA studies have also reported that MDMA can kill neurons.

- Cocaine (stimulant) over time can affect the neurons in the brain responsible for metabolizing glucose and cause them to decrease their activity in the long run. Drug addiction is a brain disease!

- ***Each person responds differently to drugs, no matter what kind of drug! This has to be taken into consideration when doing research***
Based on what we've learned about how drugs affect the brain, we strongly agree with the Biological Theories regarding drug abuse and addiction.

- Drugs target the Central Nervous System
- Addiction is based on genes, brain dysfunction, and biochemical patterns
- Under the influence of drugs, your brain functions abnormally, releasing pleasurable neurotransmitters such as dopamine or serotonin - leading to cravings for the drug when your brain cannot naturally produce such high levels of these neurotransmitters.
The way our brains and bodies react to these drugs makes addiction almost inevitable.

Because addiction is so hard to treat after it occurs, prevention is the key.

- Teens and young adults are especially vulnerable. Thus, drug prevention efforts and education must target them specifically.
How do drugs work in the brain to produce pleasure?
Drugs of abuse target the brain’s reward system with dopamine which rewards our natural behaviors.

- **Dopamine** functions as a neurotransmitter in parts of the brain that regulate movement, motivation, emotion, cognition, and feelings of pleasure.

- Over stimulation produces the euphoric effect sought by people who abuse drugs which teaches them to repeat the behavior.
Q & A

How does stimulation of the brain’s pleasure circuit teach us to keep taking drugs?
Q&A

• The brain functions to ensure that we repeat “life-sustaining” activities.

• Activities are associated with **pleasure or reward**.

• Whenever this reward is activated, the brain notes that something important is happening that needs to be remembered.

• The brain teaches us to do it again and again without thinking about it → leads to **drug abuse**.
REFERENCES

- http://www.indiana.edu/~engrs/rbook/drug.html
- www.drugabuse.gov/publications/science-addiction/drugs-brain