The Brain's Response to Drugs

An Power Point "Magazine"

Marijuana

Hi, my name is C/Sgt Cadet. Welcome to my magazine series exploring the brain's response to drugs.

Marijuana

In this issue, we'll investigate the fascinating facts about marijuana. Some of this information was only recently discovered by leading scientists.

Marijuana

You may have heard it called pot, weed, grass, ganja or skunk, but marijuana by any other name is still a drug that affects the brain.

Marijuana

Did you know marijuana can cause some people to lose focus on events around them? It makes others more aware of their physical sensations, and it has still more effects on other people.

Marijuana

All these different changes are caused by chemicals that affect the brain. More than 400 chemicals are in the average marijuana plant. When smoked, heat produces even more of them!

Where does Marijuana come from?

Marijuana is the dried leaves and flowers of the hemp plant (Cannabis sativa).

Where does Marijuana come from?

Like all plants it's sensitive to the environment where it grows. Different weather and soil conditions can change the amounts of the chemicals inside the plant.

Where does Marijuana come from?

That means marijuana grown in a place like Hawaii might be chemically stronger than marijuana from Mexico or vice-versa.

Where does Marijuana come from?

How does marijuana affect nerve cells in the brain? Marijuana causes some parts of the brain - such as those governing emotions, memory and judgement -to lose balance and controoooooooooooooooooollllllll.

Marijuana affects your senses

When someone uses marijuana, these chemicals travel through the bloodstream and quickly attach to special places on the brain's nerve cells.

Marijuana affects your senses

These places are called receptors, because they receive information from other nerve cells and from chemicals. When a receptor receives information, it causes changes in the nerve cell.

Marijuana affects your senses

The chemical in marijuana that has a big impact on the brain is called THC tetrahydrocannabinol. (Whew! Try saying that 10 times fast.)

Marijuana affects your senses

Scientists recently discovered that some areas of the brain have a lot of THC receptors, while others have very few or none. These clues are helping researchers figure out exactly how THC works in the brain.

What do you know about…

1. Rapid Heartbeat -- up to how many beats per minute? Is it 100, 130 or 160?
2. Dilated blood vessels -- can be seen in what part of the body? Is it the face, the eyes, the feet?
3. A feeling of panic -- accompanied by what kind of sensations? Is it sweating, dry mouth, breathing difficulties or all of these?
4. Daily cough and more frequent chest colds very much like who? Is it tobacco smokers, construction workers or the elderly?

The Answers

1. **Marijuana can speed the heart rate up to 160 beats per minute.**
2. **Dilated blood vessels make the whites of the eyes turn red.**
3. **Panic feelings may be accompanied by sweating, dry mouth and trouble breathing.**
4. **Tobacco smokers.**

The hippocampus

- One region of the brain that contains a lot of THC receptors is the hippocampus, which processes memory.
- When THC attaches to receptors in the hippocampus, it weakens short-term memory.

The hippocampus

- The hippocampus also communicates with other brain regions that process new information into long-term memory. (That's how you can remember today's math lesson or a new friend's phone number.)
- In the brain, under the influence of marijuana, new information may never register - and may be lost from memory.

The hippocampus

- Maybe you've heard that in some people, marijuana can cause uncontrollable laughter one minute and paranoia the next. That's because THC also influences emotions, probably by acting on a region of the brain called the limbic system.
- And don't forget this: THC can make something as simple as driving a car really dangerous.

Useful effects of THC

- Some of THC's effects are useful in the world of medicine -- like preventing nausea and blocking pain.
- The trick is for scientists to get these results without the harmful effects.
- Researchers recently found out the brain makes a chemical -- anandamide -- that attaches to the same receptors as THC.
- This discovery may lead to the development of medications that are chemically similar to THC but less harmful, and they may be used for treating nausea and pain.

OPIATES

- If you've ever seen "The Wizard of Oz," then you've seen the poppy plant -- the source of a type of drug called opiates.
- When Dorothy lies down in a field of poppies, she falls into a deep sleep.No wonder the Latin name of this plant -- Papaver somniferum -- means "the poppy that makes you sleepy."

OPIATES

- Opiates are made from opium, a white liquid in the poppy plant. They're also referred to as narcotics.
- Maybe you've heard of drugs called heroin, morphine or codeine. These are examples of opiates.Opiates can produce a quick, intense feeling of pleasure followed by a sense of well-being and a calm drowsiness. But they can also become an addiction.
- If someone uses opiates again and again, his or her brain is likely to become dependent on them.

Addiction to opiates

- What happens to make a person and his or her brain become addicted to an opiate?
- Long term opiate use changes the way nerve cells in the brain work. These cells grow so used to having the opiate around that they actually need it to work normally.

Addiction to opiates

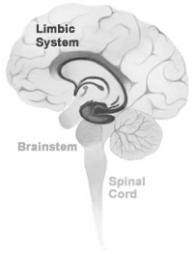
- If opiates are taken away from dependent nerve cells, many cells become overactive. Eventually, these cells will work normally again, but in the meantime, they cause a wide range of symptoms in the brain and body. These are known as withdrawal symptoms.
- Have you ever had the flu? You probably experienced symptoms such as aching, fever, sweating, shaking or chills. These are similar to withdrawal symptoms, but withdrawal symptoms are much worse. Yuck!

The brain responds to opiates

- Within the limbic system, brainstem and spinal cord, there are places on certain nerve cells that recognize opiates.
- When stimulated by opiates, these sites -- called opiate receptors -- trigger responses in the brain and body.
- Scientists have identified three types of opiate receptors: delta, mu and kappa (named after letters in the Greek alphabet).
- Each of these receptors is involved in different brain functions. For example, mu is responsible for the pain-relieving effects of the drug morphine.

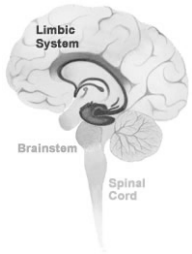
The brain and opiates

- The limbic system controls emotions. Opiates change the limbic system to produce increased feelings of pleasure, relaxation and contentment. (**red**)



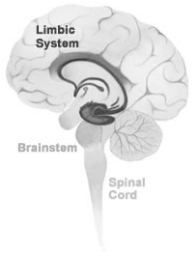
The brain and opiates

- The brainstem controls things your body does automatically, like breathing or coughing. Opiates can act on the brainstem to stop coughing or slow breathing. (**blue**)



The brain and opiates

- The spinal cord transmits pain signals from the body. By acting here, opiates block pain messages and allow people to bear even serious injuries. (**yellow**)



Cloning Receptors

- After years of experiments, scientists have discovered how to copy ("clone") the genes that control the production of opiate receptors.

Cloning Receptors

- Now it will be easier for researchers to make opiate receptors and study how opiates affect nerve cells.This discovery may lead to other exciting developments, such as better treatments for opiate addiction.

Opiates Stop Pain

- Did you know that some opiates can have important medical uses?
- They're powerful pain killers, and doctors sometimes prescribe them to control severe diarrhea. If you look on a cough medicine label, you might find that codeine is one of the ingredients.
- When used properly for medical purposes, opiates don't produce an intense feeling of pleasure, and patients have very little chance of becoming addicted.

Inhalants

- Maybe you haven't heard of inhalants, but you probably come across them pretty often.
- Hair spray, gasoline, spray paint -- they are all inhalants, and so are lots of other everyday products.
- Many inhalants have a strong smell. That's why they're called inhalants: Some people inhale the vapors on purpose.
- Why would anyone do this? Because the chemicals in these vapors can change the way the brain works, and those changes can make people feel very happy for a short time.But inhalants can also do harm.

Inhalants Enter the Body

- Inhalant vapors often contain more than one chemical.
- Some leave the body quickly, but others are absorbed by fatty tissues in the brain and nervous system. They can stay there for a long time.

Inhalants Enter the Body

- One of these fatty tissues is myelin -- a protective cover that surrounds many of the body's nerve cells (neurons). Nerve cells in your brain and spinal cord are sort of like "Command Central" for your body.
- They send and receive messages that control just about everything you think and do.

Inhalants Enter the Body

- If you picture nerve cells as your body's electrical wiring, then think of myelin as the rubber insulation that protects an electrical cord.One problem with inhalant use over the long term is that the chemicals can break down myelin. And if myelin breaks down, nerve cells may not be able to transmit messages.

Sudden Sniffing Death

- One reason scientists are so interested in inhalants is that these chemicals affect the body in lots of ways.
- While some effects are due to changes in the brain, others are direct actions on other parts of the body, such as the circulatory system.

Sudden Sniffing Death

- Did you know that some inhalants directly increase the size of blood vessels, allowing more blood to flow through? And some inhalants can make the heart beat faster.
- This can be a serious problem, especially if someone inhales butane gas.Butane, found in cigarette lighters and refills, makes the heart extra sensitive to a chemical that carries messages from the nervous system to the heart.

Sudden Sniffing Death

- This chemical, noradrenalin, tells the heart to beat faster when you're in a stressful situation -- like if something suddenly scares you.If the heart becomes too sensitive to noradrenalin, a normal jolt of it may cause the heart to temporarily lose its rhythm and stop pumping blood through the body. Some inhalant users die this way.
- Inhalants can also cause death by suffocation. This occurs when the inhaled fumes take the place of oxygen in the lungs and the brain. This is known as Sudden Sniffing Death.

Brain Damage

- Damage from long term use of inhalants can slow or stop nerve cell activity in some parts of the brain.
- This might happen in the frontal cortex, the part of the brain that solves complex problems and plans ahead.

Brain Damage

- Or if inhalants get into the brain's cerebellum, which controls movement and coordination, they can make someone move slowly or clumsily.
- Studies show that neurons in a part of the brain called the hippocampus can also be damaged by inhalants. The damage occurs because the cells don't get enough oxygen.

Brain Damage

- Since the hippocampus helps control memory, someone who repeatedly uses inhalants may lose the ability to learn new things, may not recognize familiar things, or may have a hard time keeping track of simple conversations.

Hallucinogens

- Hallucinogens cause people to experience - you guessed it - hallucinations, imagined experiences that seem real.
- The word "hallucinate" comes from Latin words meaning, "to wander in the mind."No wonder some people refer to hallucinating as tripping.

Hallucinogens

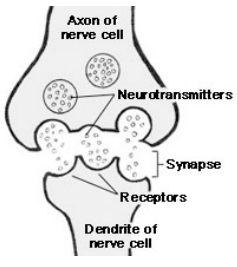
- The "trips" caused by hallucinogens can last for hours. Parts of these trips can feel really good, and other parts can feel really terrible.
- Hallucinogens powerfully affect the brain, distorting the way our five senses work and changing our impressions of time and space.
- People who use these drugs a lot may have a hard time concentrating, communicating, or telling the difference between reality and illusion.

Hallucinogens

- Some hallucinogens can be found in plants. Mescaline comes from a cactus called peyote. And certain mushrooms, also known as magic mushrooms, are hallucinogens.
- But many hallucinogens are chemicals that don't occur in nature. Some examples are:
  - LSD, also called acid
  - MDA, an amphetamine
  - MDMA, an amphetamine, called ecstasy
  - PCP (phencyclidine), often called angel dust.

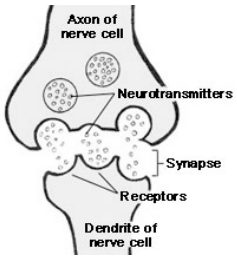
Hallucinogens and the Brain

- Your brain controls all of your perceptions -- the way you see, hear, smell, taste, and feel.
- How does your brain communicate with the rest of your body? Chemical messengers transmit information from nerve cell to nerve cell in the body and the brain.



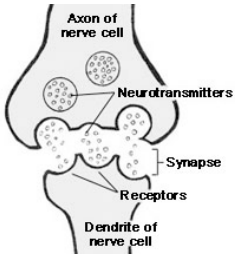
Hallucinogens and the Brain

- Messages are constantly being sent back and forth with amazing speed.Your nerve cells are called neurons, and their chemical messengers are called neurotransmitters.



Hallucinogens and the Brain

- When neurotransmitters attach to special places on nerve cells (called receptors), they cause changes in the nerve cells.
- This communication system can be disrupted by chemicals like hallucinogens, and the results are changes in the way you sense the world around you.



Changes in mood, learning, and memory

- MDMA and MDA cause neurons to release a neurotransmitter called serotonin.
- Serotonin is important to many types of nerve cells, including cells that receive sensory information and cells that control sleeping and emotions.

Changes in mood, learning, and memory

- The released serotonin can over activate serotonin receptors.
- In animals, MDMA and MDA have been shown to damage and destroy nerve fibers of neurons that contain serotonin. This can be a big problem, because serotonin neurons have a role in so many things, such as mood, sleep, and control of heart rate.

Changes in mood, learning, and memory

- Scientists have recently found that the damaged serotonin neurons can regrow their fibers, but the fibers don't grow back normally.
- The fibers may regrow into brain areas where they don't normally grow, but not into other brain areas where they should be located. The new growth patterns may cause changes in mood, learning, or memory.

PCP and the Brain

- PCP prevents the actions normally caused when a neurotransmitter, called glutamate, attaches to its receptor in the brain.
- It also disrupts the actions of other neurotransmitters.
- This drug's effects are very unpredictable. For example, it may make some people hallucinate and become aggressive, while others may become drowsy and passive. It is also addictive.

LSD's effects

- SD causes its effects mainly by activating one type of receptor for serotonin.
- Because serotonin has a role in many important functions, LSD use can have many effects.

LSD's effects

- These may include sleeplessness, trembling, and raised heart rate, and blood pressure. LSD users may feel several emotions at once (including extreme terror), and their senses may seem to get crossed -- giving the feeling of hearing colors and seeing sounds.

LSD's effects

- Even a tiny speck of LSD can trigger these effects. And LSD has an unusual "echo." Many users have flashbacks -- sudden repetitions of their LSD experiences -- days or months after they stop using the drug.

Anabolic Steroids

- Anabolic steroids are artificial versions of a hormone that's in all of us -- testosterone. (That's right, testosterone is in girls as well as guys.)
- Testosterone not only brings out male sexual traits, it also causes muscles to grow.

Anabolic Steroids

- Some people take anabolic steroid pills or injections to try to build muscle faster. ("Anabolic" means growing or building.)
- But these steroids also have other effects.
- They can cause changes in the brain and body that increase risks for illness and they may affect moods.

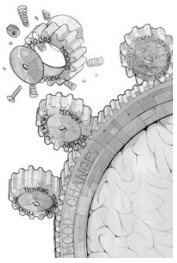
Do steroids make you strong?

- You may have heard that some athletes use anabolic steroids to gain size and strength.
- Maybe you've even seen an anabolic steroid user develop bigger muscles over time.But while anabolic steroids can make some people look stronger on the outside, they may create weaknesses on the inside.

Do steroids make you strong?

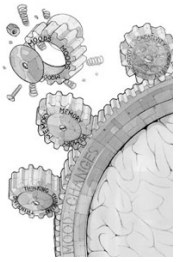
- For example, anabolic steroids can weaken the immune system -- the body's defense against germs and diseases.
- They can also lead to liver damage or cancer, even in young people. They can also permanently stop bones from growing in teenagers. This means that a teenage steroid user may not grow to be his or her full adult height and will be shorter for life.

Brain triggers



- Parts of the brain that influence your moods and are involved in learning and memory are called the limbic system.
- Anabolic steroids act in the limbic system. In animals, they have been shown to impair learning and memory. They can also lead to changes in mood, such as feelings of depression or irritability.

Brain triggers



- Anabolic steroid users may act mean to people they're normally nice to, like friends and family.Anabolic steroids in the brain may trigger really aggressive behavior.
- Some outbursts can be so severe they have become known in the media as "road rages."

Severe Effects…

- Your body's testosterone production is controlled by a group of nerve cells at the base of the brain, called the hypothalamus.
- The hypothalamus also does a lot of other things. It helps control appetite, blood pressure, moods, and reproductive ability.
- Anabolic steroids can change the messages the hypothalamus sends to the body.
- This can disrupt normal hormone function.In guys, anabolic steroids can interfere with the normal production of testosterone.

Severe Effects…

- They can also act directly on the testes and cause them to shrink.
- This can result in a lower sperm count and reproductive ability.
- They can also cause an irreversible loss of scalp hair.
- In girls, anabolic steroids can cause a loss of the monthly period by acting on both the hypothalamus and reproductive organs.
- They can also cause loss of scalp hair, growth of body and facial hair and deepening of the voice. These changes are also irreversible.

STIMULANTS

- Have you eaten any chocolate or drunk any soda lately? If you have, there's a good chance you gave your body a dose of a stimulant -- caffeine, which is also in coffee.
- Eating or drinking a large amount of caffeine can make you feel jittery, nervous, or energetic.

STIMULANTS

- That is because caffeine -- like any stimulant -- changes the way your brain works.
- But caffeine is just a mild example of a stimulant.
- Many other stimulant drugs are much stronger -- and some are illegal and very dangerous. Others require a doctor's prescription.

Examples of stimulants

- Cocaine: Made from the leaf of the coca plant, this drug often comes in the form of a white powder that some people inhale through their nose.
- Crack: A form of cocaine that can be smoked.

Examples of stimulants

- Amphetamines: Often called "speed," these pills are sometimes prescribed by doctors for medical problems.
- Methamphetamine: A powerful form of amphetamine that comes in clear crystals (called "ice") or powder (called "crank") that is smoked or injected.

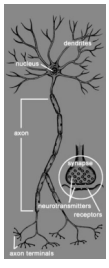
Stimulants and the Brain

- Cocaine and amphetamines change the way the brain works by changing the way nerve cells communicate.
- Nerve cells, called neurons, send messages to each other by releasing special chemicals called neurotransmitters.
- Neurotransmitters are able to work by attaching to key sites on neurons called receptors.
- One of the neurotransmitters affected by cocaine is called dopamine.

Stimulants and the Brain

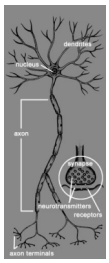
- Dopamine is released by neurons in the limbic system -- the part of the brain that controls feelings of pleasure.
- Normally, once dopamine has attached to a nerve cell's receptor and caused a change in the cell, it's pumped back to the neuron that released it.
- But cocaine blocks the pump, called the dopamine transporter. Dopamine then builds up in the gap (synapse) between neurons.
- The result: dopamine keeps affecting a nerve cell after it should have stopped. That's why someone who uses cocaine feels an extra sense of pleasure for a short time.

Cocaine and the Brain



- Although cocaine may make someone feel pleasure for a while, later it can damage the ability to feel pleasure.
- Research suggests that long-term cocaine use may reduce the amount of dopamine or the number of dopamine receptors in the brain.

Cocaine and the Brain



- When this happens, nerve cells must have cocaine to communicate properly.
- Without the drug, the brain can't send enough dopamine into the receptors to create a feeling of pleasure.
- If a long-term user of cocaine or crack stops taking the drug, the person feels an extremely strong craving for it, because without it he or she can't feel nearly as much pleasure.

Cocaine and the Brain

- Cocaine causes the body's blood vessels to become narrow, constricting the flow of blood.
- This is a problem. It forces the heart to work harder to pump blood through the body. (If you've ever tried squeezing into a tight pair of pants, then you know how hard it is for the heart to pump blood through narrowed blood vessels.)

Cocaine and the Brain

- When the heart works harder, it beats faster. It may work so hard that it temporarily loses its natural rhythm.
- This is called fibrillation, and it can be very dangerous because it stops the flow of blood through the body.Many of cocaine's effects on the heart are actually caused by cocaine's impact on the brain -- the body's control center.