Brain Reward Pathway and Addiction

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Part 1: Is Floratryp Addictive?

Medical Report

Ray is feeling horrible. He is very depressed and nervous. He has a headache and nausea, and he is having trouble sleeping. Ray has experienced some of these symptoms in the past, but they disappear when he uses "Floratryp," a mixture of over-the-counter and herbal medications.

Ray doesn't think his symptoms are caused by Floratryp addiction. "Lots of people use Floratryp. It's not illegal. It's not addictive. What's wrong with feeling good?" He likes using Floratryp because it makes him feel happy and confident. "I only take it when I'm feeling low or stressed out. A little Floratryp and I feel great."

He has been using Floratryp for about a year. Over the past few months Ray's use of Floratryp has increased from once a day to five or more times each day. Ray has not been able to use Floratryp for the past few days because he ran out of money. He was recently fired from his part-time job because he skipped work a lot – especially after late nights of doing Floratryp with friends.

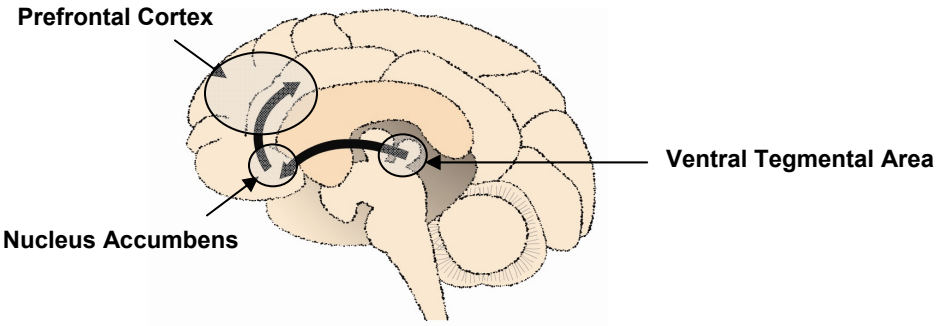
"Drug addiction is defined as "uncontrollable, compulsive drug seeking and use, even in the face of negative health and social consequences."
Scientists from the National Institute on Drug Abuse

1. Based on the information in the Medical Report, do you think that Floratryp is **addictive** even though it is not illegal? Support your answer by listing <u>three</u> pieces of evidence from the Medical Report.
   - _____
   - _____
   - _____

Part 2: The Brain Reward Pathway

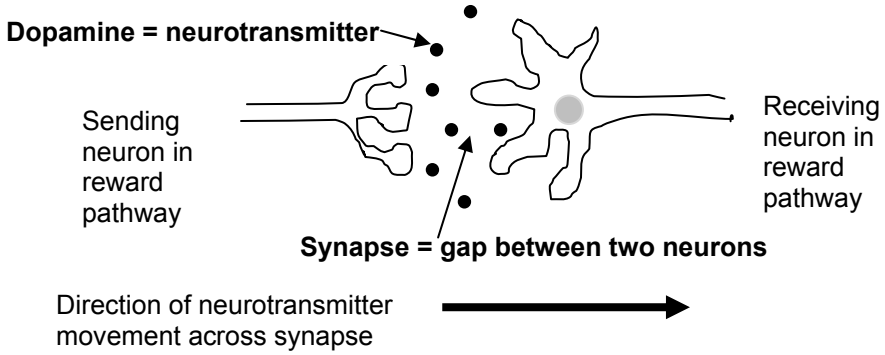
The **reward pathway** is a group of neurons (nerve cells) that conduct impulses (electrical signals) to specific brain regions that produce a sensation of pleasure. The arrows on diagrams below show the parts of the human brain involved in the **reward pathway**.

Parts of the Brain Involved in the Human Reward Pathway



The reward pathway causes animals to associate certain behaviors with a sensation of pleasure. When an animal carries out certain behaviors, such as eating or sexual activity, electrical signals travel through neurons in the reward pathway and cause a sensation of pleasure. This pleasure sensation is a reward that causes the animal to learn to repeat these behaviors again and again. Researchers theorize that this is how behaviors necessary to survival, like reproduction and eating, are learned. Research has also shown that drugs of abuse, such as cocaine, affect the brain reward region and can lead to addiction.

Scientists have identified dopamine as the neurotransmitter (chemical signal molecule) that carries information from one neuron to another in the brain reward pathway.



Base your answers to questions 1 through 6 on the information in the box on page 2.

1. What is the function of the reward pathway of the brain?

   _____

   _____

2. List two behaviors which cause impulses (electrical signals) to travel through the reward pathway in the brain.

   - _____
   - _____

3. What causes animals to repeat behaviors that stimulate the brain reward region?

   _____

   _____

4. Addictive drugs have been shown to increase the activity in the brain reward pathway. What neurotransmitter (chemical signal) may be increased in the brain reward region during drug use?

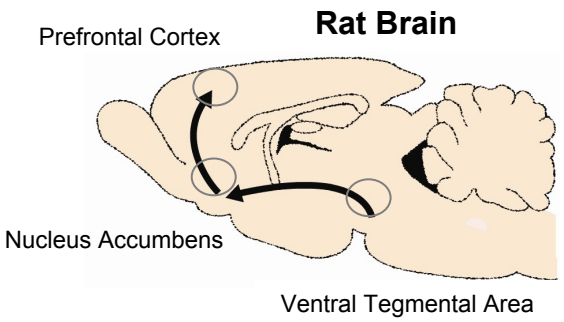
   _____

5. Do you think that shopping, smoking, and gambling may activate the reward pathway and lead to addiction for some people? Explain your answer.

   _____

   _____

6. The parts of the rat brain involved in the reward pathway are shown in the diagram on the right. Some scientists who study the effects of addictive drugs on the brain use rats, instead of humans, in their experiments. What are <u>two</u> advantages of using rats instead of humans when conducting research on the effects of drugs on the brain?



   - _____
   - _____

Part 3: How does Floratryp affect dopamine levels in the brain reward region?

A scientist wants to determine if Floratryp is an addictive drug. If a drug is addictive, it will increase the dopamine levels in the brain reward region to levels that are higher than typical for normal rewarding substances. To determine if Floratryp is addictive, scientists can do animal experiments to determine how Floratryp affects dopamine levels in the brain reward region.

In this activity, you will conduct tests to compare the levels of dopamine in samples of brain fluid collected from the reward regions of three rats. Rat A was injected with sugar (a normal rewarding substance). Rat B was injected with cocaine (a known addictive drug). Rat C was injected with Floratryp that scientists think might be addictive.

Rat A
Sugar
Normal rewarding substance

Rat B
Cocaine
Known Addictive Drug

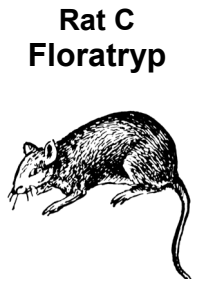
Rat C
Floratryp

The brain fluid samples were collected from the reward regions of the rat brains at three times: 0 minutes (immediately before the substance was given to the rat), 30 minutes after the substance was given to the rat, and 60 minutes after the substance was given to the rat.

The scientist has already tested the dopamine levels for brain fluid samples from Rats **A** and **B**. The data from the scientist's research is provided in Data Table 1.

Data Table 1: Concentration of Dopamine in Rat Brain Fluid Samples

Substance Given to Rat	Time after being given substance (minutes)	Concentration of dopamine in rat brain (picograms/mL)
Rat A - Sugar (a normal rewarding substance)	0 min.	10
	30 min.	100
	60 min.	10
Rat B - Cocaine (a known addictive drug)	0 min.	10
	30 min.	400
	60 min.	100
Rat C - Floratryp	0 min.	
	30 min.	
	60 min.	

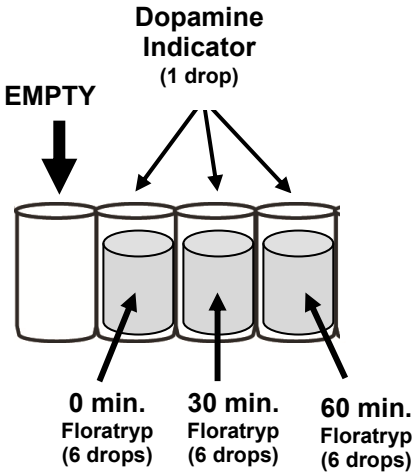


1. You will test the dopamine levels in the brain fluid samples from Rat C (the rat exposed to Floratryp).

2. Obtain a 4 Test Cup Strip from your kit. Leave the small cup on the left empty. Do not add anything to the left well (as shown on the diagram).

3. Add 1 drop of "Dopamine Indicator" to each of the small cups on the Dopamine Test Cup Strip.

4. Obtain three tubes of brain fluid samples (labeled 0 min. Floratryp, 30 min. Floratryp, and 60 min. Floratryp) from your lab kit. These tubes contain brain fluid samples collected at different time points in the experiment after the rat was injected with Floratryp.



5. Add 6 drops of the brain fluid sample (0 min. Floratryp, 30 min. Floratryp, and 60 min. Floratryp) to the appropriate cups on the Dopamine Test Strip.

6. Compare the color of the brain fluid samples with the "Color Chart for Dopamine Concentration" that is included in your lab kit. *It is easier to see the colors of the brain fluid samples in the test cups if you hold the cup strip up to the light.*

7. Record the estimated dopamine concentration in **Data Table 1: Concentration of Dopamine in Rat Brain Fluid Samples** on page 4.

Base your answers to the following questions on the information in **Data Table 1: Concentration of Dopamine in Rat Brain Fluid Samples** on page 4.

8. What happens to the level of dopamine in the brain when a rat is given sugar (a normal rewarding substance)?

_____

_____

9. Compare the levels of dopamine in the rat given Floratryp with the levels of dopamine in the rat given sugar.

_____

_____

10. Compare the levels of dopamine in the rat given Floratryp with the levels of dopamine in the rat given cocaine.

_____

_____

11. Based on the results of this experiment, do you think that Floratryp is addictive? Explain why or why not.

_____

_____

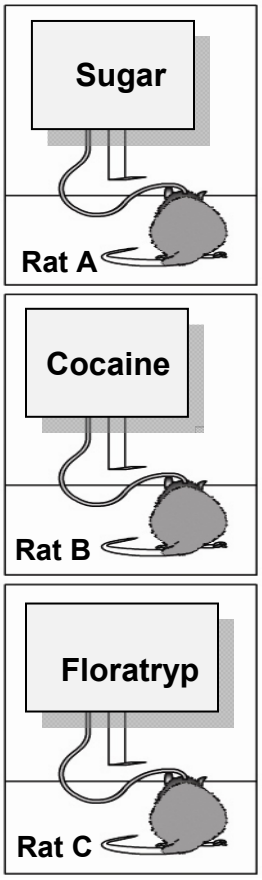
Part 4: Does Floratryp cause repetitive drug-seeking behavior?

To be considered addictive, a drug must activate the reward center and produce the repetitive drug-seeking behavior associated with addictive drugs. To determine if Floratryp is addictive, scientists can do experiments to see whether it results in repetitive drug-seeking behavior.

In this activity you will analyze data collected by a scientist who investigated drug-seeking behavior in rats.

For this experiment, rats were placed in individual cages with a lever they could press that delivered a rewarding substance.

- When Rat A pressed a sugar lever, it received an injection of sugar solution.
- When Rat B pressed a cocaine lever, it received an injection of cocaine.
- When Rat C pressed a Floratryp lever, it received an injection of Floratryp.



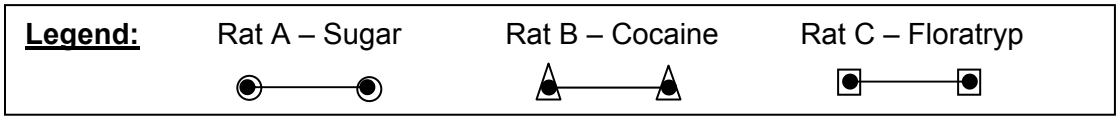
Each day (for 6 days), the rats were placed in the appropriate cages and scientists observed and recorded the number of times the rats pressed the levers in 5 minutes.

The results of the experiment are presented in Data Table 3 on the next page.

Data Table 3: Effect of Sugar, Cocaine, and Floratryp on Rat Lever Pressing Behavior

		Total number of lever presses during 5 minute observation					
	Lever	**Day 1**	**Day 2**	**Day 5**	**Day 10**	**Day 15**	**Day 20**
Rat A	**Sugar** (a natural reward)	4	3	4	5	7	8
Rat B	**Cocaine** (an addictive drug)	3	7	12	29	52	77
Rat C	**Floratryp**	4	8	10	27	49	73

1. Summarize the data from the experiment by plotting the total number of times that the each of the rats pressed the levers versus days.
   - Label the vertical axis and the horizontal axis.
   - Mark an appropriate scale on both of the axes. Use equal intervals.
   - Plot the data using the legend provided.



Effect of Sugar, Cocaine, and Floratryp on Rat Lever Pressing Behavior

Independent variable (or manipulated variable) is the variable (factor) you change in the experiment. The independent variable is chosen before you conduct the experiment. It is usually associated with the "If" part of the hypothesis.

Dependent variable (or responding variable) is the variable that may change as a result of the independent variable. The dependent variable is the data that is observed and measured in an experiment. It is usually associated with the "then" part of the hypothesis.

2. What is the **independent variable** in this experiment?

_____

3. What is the **dependent variable** in this experiment?

_____

4. Rat A and Rat B were **controls** in this experiment. They provided a basis of comparison.

   - Which rat provided a control (basis of comparison) to show the difference between a rat's reaction to a normal rewarding stimulus and Floratryp? _____
   - Which rat provided a control (basis of comparison) to show the difference between a rat's reaction to an addictive drug and Floratryp? _____

5. Why does the number of lever presses for sugar increase?

_____

_____

6. Compare the number of lever presses for Floratryp with the number of lever presses for sugar.

_____

7. Compare the number of lever presses for Floratryp with the number of lever presses for cocaine.

_____

8. Does the data from the rat lever pressing support the hypothesis that Floratryp is addictive? Explain why or why not.

9. State one way that the scientist's experiment could be improved to make it more reliable.

10. Based on the information and data from this lab activity, discuss the pieces of evidence you would provide to lawmakers who are considering classifying Floratryp as an illegal drug.