Methamphetamine

BACKGROUND

Methamphetamine is an addictive drug that belongs to a class of drugs known as stimulants. This class also includes cocaine, caffeine, and other drugs. Methamphetamine is made illegally with relatively inexpensive over-the-counter ingredients. Many of the ingredients that are used to produce methamphetamine, such as drain cleaner, battery acid, and antifreeze, are extremely dangerous. The rapid proliferation of "basement" laboratories for the production of methamphetamine has led to a widespread problem in many communities in the U.S.

Methamphetamine has many effects in the brain and body. Short-term effects can include increased wakefulness, increased physical activity, decreased appetite, increased respiration, hyperthermia, irritability, tremors, convulsions, and aggressiveness. Hyperthermia and convulsions can result in death. Single doses of methamphetamine have also been shown to cause damage to nerve terminals in studies with animals. Long-term effects can include addiction, stroke, violent behavior, anxiety, confusion, paranoia, auditory hallucinations, mood disturbances, and delusions. Long-term use can also cause damage to dopamine neurons that persists long after the drug has been discontinued.

MECHANISM OF ACTION

Methamphetamine acts on the pleasure circuit in the brain by altering the levels of certain neurotransmitters present in the synapse. Chemically, methamphetamine is closely related to amphetamine, but its effects on the central nervous system are greater than those of amphetamine. Methamphetamine is also chemically similar to dopamine and another neurotransmitter, norepinephrine. It produces its effects by causing dopamine and norepinephrine to be released into the synapse in several areas of the brain, including the nucleus accumbens, prefrontal cortex, and the striatum, a brain area involved in movement. Specifically, methamphetamine enters nerve terminals by passing directly through nerve cell membranes. It is also carried into the nerve terminals by transporter molecules that normally carry dopamine or norepinephrine from the synapse back into the nerve terminal. Once in the nerve terminal, methamphetamine enters dopamine and norepinephrine containing vesicles and causes the release of these neurotransmitters. Enzymes in the cell normally chew up excess dopamine and norepinephrine, however methamphetamine blocks this breakdown. The excess neurotransmitters are then carried by transporter molecules out of the neuron and into the synapse. Once in the synapse, the high concentration of dopamine causes feelings of pleasure and euphoria. The excess norepinephrine may be responsible for the alertness and anti-fatigue effects of methamphetamine.

Methamphetamine can also affect the brain in other ways. For example it can cause cerebral edema, brain hemorrhage, paranoia, and hallucinations. Some of the effects of methamphetamine on the brain may be long-lasting and even permanent. Recent research in humans has shown that even three years after chronic methamphetamine users have discontinued use of the drug there is still a reduction in their ability to transport dopamine back into neurons. This clearly demonstrates that there is a long-lasting impairment in

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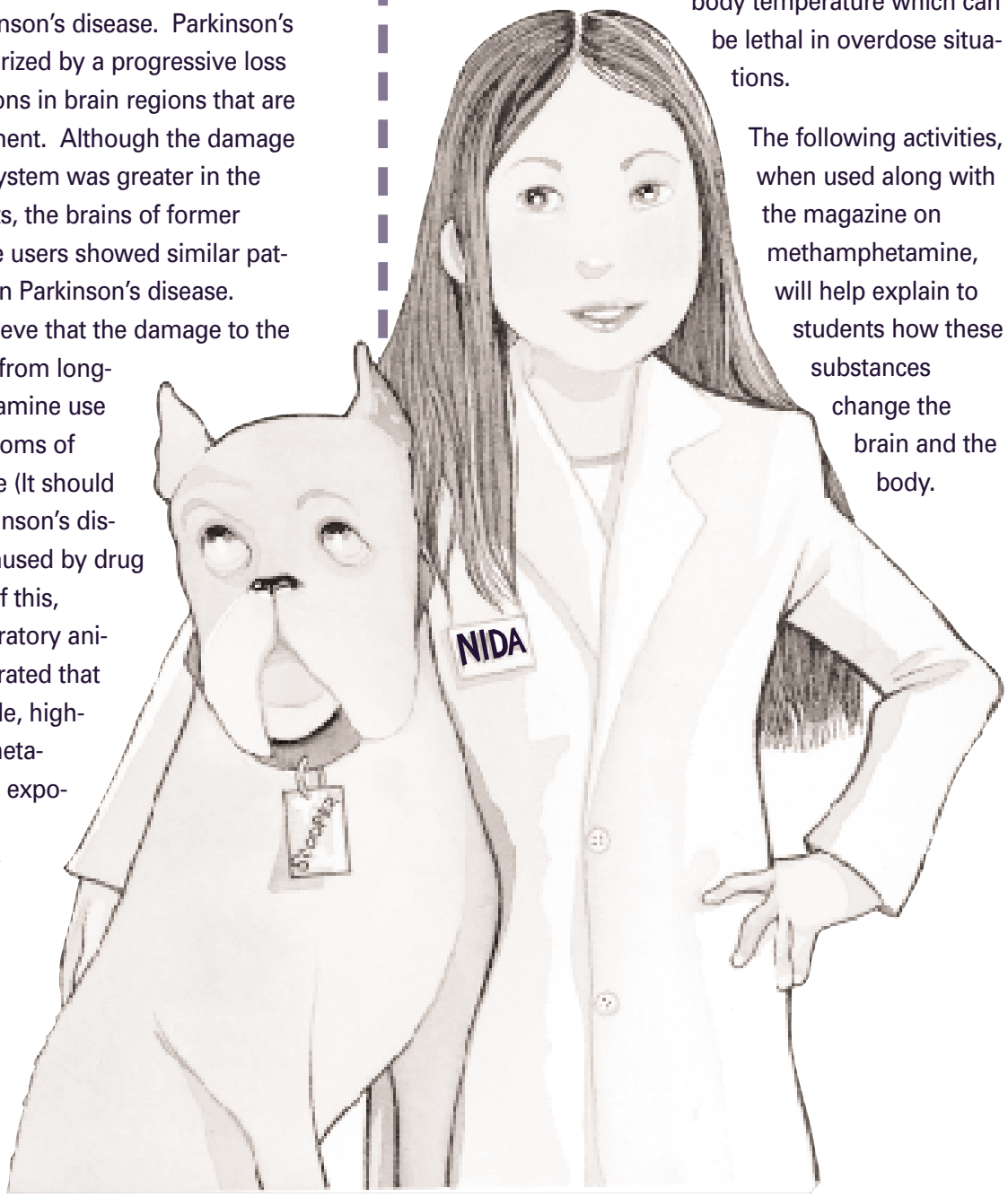
dopamine function as a result of drug use. This is highly significant because dopamine has a major role in many brain functions, including experiences of pleasure, mood, and movement. In these same studies, researchers compared the damage to the dopamine system of methamphetamine users to that seen in patients with Parkinson's disease. Parkinson's disease is characterized by a progressive loss of dopamine neurons in brain regions that are involved in movement. Although the damage to the dopamine system was greater in the Parkinson's patients, the brains of former methamphetamine users showed similar patterns to that seen in Parkinson's disease. Scientists now believe that the damage to the dopamine system from long-term methamphetamine use may lead to symptoms of Parkinson's disease (It should be noted that Parkinson's disease itself is not caused by drug use.). In support of this, research with laboratory animals has demonstrated that exposure to a single, high-dose of methamphetamine or prolonged exposure at low doses destroys up to fifty percent of the dopamine-producing neurons in certain parts of the brain.

Methamphetamine also has widespread effects on other parts of the body. It can cause high blood pressure, arrhythmias, chest pain, shortness of breath, nausea, vomiting, and diarrhea. It can also increase body temperature which can be lethal in overdose situations.

The following activities, when used along with the magazine on methamphetamine, will help explain to students how these substances change the brain and the body.



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OBJECTIVES

- **The student will become more familiar with the neuroscience concepts and terminology associated with the effects of methamphetamine on the brain and body.**

METHAMPHETAMINE ACTIVITY ONE

The students will complete the methamphetamine Word Find. The teacher will then review the words and have the students discuss how the terms relate to methamphetamine abuse. A copy of the Word Find and Word Find Solution is included in the guide.

OBJECTIVES

- **The student will become familiar with how methamphetamine changes brain functioning and the potential long-term implications of these changes.**

METHAMPHETAMINE ACTIVITY TWO

Review the effects of methamphetamine on the brain, paying particular attention to its effects on the neurotransmitter dopamine. Have students break into small groups. Ask each group to write and perform a play that demonstrates how methamphetamine changes the normal functioning of neurons that contain dopamine. Discuss with students how these changes can result in long-term impairment of dopamine function and the implications of this impairment (e.g. inability to feel pleasure, symptoms of Parkinson's Disease).

OBJECTIVES

- **Students will learn more about how methamphetamine and other drugs change the way the brain works.**

METHAMPHETAMINE ACTIVITY THREE

Review with students the function of various brain areas (e.g. amygdala, hippocampus, cerebellum, etc.). Have students break into small groups and assign each group one brain area. Ask the students to discuss how methamphetamine or other drugs might affect their brain area. Then have students discuss the function of this brain area and how changing it through drug use might change how a person feels, acts, remembers, learns, etc. Have each group present a summary of their discussions to the entire class. For extra credit, have students discuss and present how brain imaging techniques (such as PET or Positron Emission Tomography) help researchers to examine how drugs act in the brains of living humans subjects.

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WORD SEARCH

M	N	R	O	E	T	T	N	A	L	U	M	I	T	S
F	E	O	L	A	Q	P	N	Z	L	N	O	N	T	N
E	U	T	G	N	S	O	F	T	E	I	O	J	U	O
P	R	P	H	I	X	R	O	U	M	N	Y	E	G	I
W	O	E	L	A	J	E	R	E	I	O	K	C	A	T
Q	T	C	T	R	M	O	S	N	H	T	R	T	W	A
U	R	E	A	B	N	P	O	I	D	O	A	E	S	N
P	A	R	V	A	A	A	H	O	I	R	S	D	M	I
M	N	Y	Z	N	L	R	P	E	D	E	E	P	S	C
F	S	O	Y	E	O	A	L	A	T	S	Y	R	C	U
E	M	S	B	U	M	N	I	R	K	A	V	T	I	L
T	I	L	T	I	I	O	N	T	L	P	M	U	U	L
G	T	G	N	R	T	I	C	E	A	G	G	I	S	A
B	T	E	P	O	O	A	S	I	H	V	U	B	N	H
J	E	F	E	N	P	K	W	H	C	X	R	Q	B	E
C	R	A	S	H	N	I	E	T	I	R	D	N	E	D

Methamphetamine
Crystal
Speed
Paranoia
Dopamine
Synapse
Stimulant
Brain
Neurotransmitter
Axon
Receptor
Crash
Hallucinations
Serotonin
PET
Neuron
Stroke
Dendrite
Drug
Ice
Chalk
Injected

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WORD SEARCH

M	N	R	O	E	T	T	N	A	L	U	M	I	T	S
F	E	O	L	A	Q	P	N	Z	L	N	O	N	T	N
E	U	T	G	N	S	O	F	T	E	I	O	J	U	O
P	R	P	H	I	X	R	O	U	M	N	Y	E	G	I
W	O	E	L	A	J	E	R	E	I	O	K	C	A	T
Q	T	C	T	R	M	O	S	N	H	T	R	T	W	A
U	R	E	A	B	N	P	O	I	D	O	A	E	S	N
P	A	R	V	A	A	A	H	O	I	R	S	D	M	I
M	N	Y	Z	N	L	R	P	E	D	E	E	P	S	C
F	S	O	Y	E	O	A	L	A	T	S	Y	R	C	U
E	M	S	B	U	M	N	I	R	K	A	V	T	I	L
T	I	L	T	I	I	O	N	T	L	P	M	U	U	L
G	T	G	N	R	T	I	C	E	A	G	G	I	S	A
B	T	E	P	O	O	A	S	I	H	V	U	B	N	H
J	E	F	E	N	P	K	W	H	C	X	R	Q	B	E
C	R	A	S	H	N	I	E	T	I	R	D	N	E	D

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