Special Topic: Drugs and the Mind

Lecture Presentation
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Special Topic: Drugs and the Mind

OUTLINE:

- Psychoactive Drugs and Communication between Neurons
- Drug Dependence
- Alcohol
- Marijuana
- Stimulants
- Hallucinogens
- Opiates
Psychoactive Drugs and Communication between Neurons

- A psychoactive drug alters one’s mood or emotional state
- Can cross the blood-brain barrier
- Alters communication between neurons by affecting the actions of neurotransmitters
Psychoactive Drugs and Communication between Neurons

- Ways in which psychoactive drugs alter communication between neurons
  - Stimulate release of neurotransmitter
  - Inhibit release of neurotransmitter
  - Prolongs effects of the neurotransmitter
Psychoactive Drugs and Communication between Neurons

Psychoactive Drugs and the Brain

A drug that alters one’s mood or emotional state is often described as a psychoactive drug. In this tutorial, we will examine some of the ways that mind-altering drugs produce their effects by altering the communication between nerve cells in the brain.

Press "PLAY" to begin Animation.
Figure 8a.1 *Psychoactive drugs alter a person’s mental state by affecting communication between neurons.*

(a) The natural sequence of events: molecules of neurotransmitter released by one neuron diffuse across a gap and fit into receptors on the membrane of a receiving neuron, causing a response.

(b) A psychoactive drug may increase the number of neurotransmitter molecules released, increasing the response of the receiving neuron.

(c) A psychoactive drug may decrease the number of neurotransmitter molecules released, decreasing the response of the receiving neuron.

(d) A psychoactive drug may fit into the receptors for a neurotransmitter, causing a similar response by the receiving neuron.

(e) A psychoactive drug may fit into the receptors for a neurotransmitter and prevent the neurotransmitter from entering the receptor, blocking the natural response by the receiving neuron.
Drug Dependence

- Occurs when someone can no longer function normally without the drug, the drug is needed for physical or psychological well-being

- Certain drugs stimulate the “pleasure centers” in the limbic system and encourage continued use
Drug Dependence

- Tolerance
  - Occurs when higher and higher doses of a drug are needed to generate a response
  - Develops because the body steps up production of enzymes that break down the drug

- Cross-tolerance
  - Occurs when tolerance to one drug results in a lessened response to another, usually similar, drug
Alcohol

- Alcoholism is America’s number one drug problem.
- The effects of alcohol on a person’s behavior depend on the blood alcohol level.
  - Grams of alcohol per 100 ml of blood
  - 1 g alcohol/100 ml blood = blood alcohol level of 1%
- The blood alcohol level is affected by:
  - How much alcohol is consumed
  - How quickly it is consumed
  - The rates of absorption, distribution, and metabolism of the consumed alcohol
Alcohol

- The amount of ethanol per ounce of alcoholic beverage varies widely
  - Some distilled spirits are 100 proof (50% alcohol)
  - The differences in the alcohol content are reflected in the standard amounts in which they are served as drinks
Figure 8a.2 *Caloric content by serving size of different drinks.*

<table>
<thead>
<tr>
<th>Type of drink</th>
<th>Serving size</th>
<th>Caloric content</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 oz Mixer Fruit juice</td>
<td>1 glass</td>
<td>35–105 calories</td>
</tr>
<tr>
<td>8 oz Mixer Carbonated beverage</td>
<td>1 glass</td>
<td>~70–120 calories</td>
</tr>
<tr>
<td>1.5 oz Distilled spirits</td>
<td>1 jigger</td>
<td>~100 calories</td>
</tr>
<tr>
<td>(80 proof gin, whiskey, vodka, scotch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 oz Wine (12% alcohol)</td>
<td>1 glass</td>
<td>110–200 calories</td>
</tr>
<tr>
<td>12 oz Most beer</td>
<td>1 bottle or can</td>
<td>140–150 calories</td>
</tr>
</tbody>
</table>
Absorption and Distribution

- The intoxicating effects of alcohol begin when it is absorbed from the digestive system into the blood and reaches the brain
- 20% of alcohol is absorbed at the stomach
  - The effects of alcohol are felt in about 15 minutes
  - Food in the stomach slows alcohol absorption
- The remaining alcohol is absorbed through the intestines
- Alcohol is then distributed to all body tissues
Absorption and Distribution

- As a rule, the higher the concentration of alcohol, the faster the rate of absorption.
- Overall body size affects one’s blood alcohol level and degree of intoxication.
**Figure 8a.3** Alcohol consumption can impair driving.

<table>
<thead>
<tr>
<th>Weight (in pounds)</th>
<th>Number of standard drinks over a 2-hour interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>120</td>
<td>1</td>
</tr>
<tr>
<td>140</td>
<td>1</td>
</tr>
<tr>
<td>160</td>
<td>1</td>
</tr>
<tr>
<td>180</td>
<td>1</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
</tr>
<tr>
<td>220</td>
<td>1</td>
</tr>
<tr>
<td>240</td>
<td>1</td>
</tr>
</tbody>
</table>

- Driving may be impaired Blood alcohol level (BAC) to .05%
- Driving is risky and may be illegal BAC .05%–.07%
- Driving is dangerous and illegal BAC .08% or higher
Rate of Elimination

- Liver converts alcohol to carbon dioxide and water
- Rate of metabolism is about one-third of an ounce of pure ethanol per hour
- If intake is faster than metabolism, then a person becomes more intoxicated as more alcohol is consumed and continues to circulate in the blood
- Alcohol has a negative effect on nearly every organ in the body
Health-Related Effects

- Nervous system
  - Alcohol is a depressant and slows neurons’ activity
  - Areas of the brain are affected in sequence
    - Higher cortical ("thinking") centers
    - Balance and coordination centers
    - Regions responsible for consciousness
  - Excessive amounts of alcohol can cause unconsciousness, coma, and death from respiratory failure
Health-Related Effects

- Liver
  - Excessive alcohol consumption damages the liver, which performs many vital functions
    - Causes the buildup of fat, which reduces blood flow through the liver
    - Causes inflammation of the liver (alcoholic hepatitis)
    - Causes the buildup of fibrous scar tissue in the liver (cirrhosis)
    - Can result in death
Health-Related Effects

- Cancer
  - A person who drinks heavily is at least twice as likely to develop cancer of the mouth, tongue, or esophagus as compared to a nondrinker
  - People who smoke and drink are especially at risk of developing cancer
Health-Related Effects

- Heart and blood vessels
  - In moderation, alcohol can be good
    - Reduces stress
    - Raises HDL in the blood
    - Reduces the likelihood of clots formation
  - In excess, alcohol is bad
    - Weakens the heart muscle
    - Promotes deposition of fat in blood vessels
Health-Related Effects
Health-Related Effects

- Fetal alcohol syndrome (FAS)
  - Patterns of growth abnormalities and birth defects common among children of women who drink alcohol during pregnancy
    - Mental retardation
    - Growth deficiency
    - Characteristic facial features
Marijuana (Cannabis sativa)

- Most widely used illegal drug in the United States today
  - Principal psychoactive ingredient in the leaves, flowers, and stems is delta-9-TetraHydroCannabinol (THC)
    - Binds to receptors in brain regions involved in thinking, memory, and motor control
    - One neurotransmitter that normally binds to the receptors is anandamide
    - May regulate mood, memory, pain, appetite, and movement
Figure 8a.4 A rat’s brain areas with marijuana receptors.

Marijuana receptors are most highly concentrated in regions involved in thinking and memory and in motor control areas.
Health-Related Effects of Long-Term Use

- Effects of long-term use of marijuana:
  - Respiratory system
    - Experiences the most harmful effects
    - Caused by residual material in the smoke; not caused by THC
      - Tar contains cancer-causing chemicals
      - Carbon monoxide prevents red blood cells from carrying oxygen
      - Air passages become inflamed and breathing capacity is reduced
Health-Related Effects of Long-Term Use

- Circulatory system
  - Causes an increase in heart rate and blood pressure

- Reproductive systems
  - THC is structurally similar to estrogen
  - Male: THC reduces levels of testosterone and sperm production
  - Female: effects of THC are unclear
Stimulants

- Drugs that excite the Central Nervous System (CNS)
- Examples of stimulants:
  - Cocaine
  - Amphetamines
  - Nicotine
Cocaine

- Extracted from leaves of the coca plant
- Methods of taking
  - Inhalation into nasal cavity (snorting)
  - Smoking (freebase and crack)
- Interferes with the reuptake of dopamine
  - Causes a rush of intense pleasure, a sense of self-confidence and power
- Increases the effects of norepinephrine
  - Prepares the body systems for emergency
Cocaine

- The high is very short-lived and is followed by depression, anxiety, and exhaustion

- Cardiovascular system
  - Constricts arteries, possibly causing heart attack or stroke
  - Increases blood pressure
Cocaine

- **Respiratory system**
  - Once the high is over, respiratory centers in the brain are depressed, and breathing can stop
  - Snorting damages the nose
  - Smoking damages the lungs and airways
Amphetamines

- Synthetically produced stimulants that closely resemble dopamine and norepinephrine
- Example: methamphetamine ("crystal meth")
- Effects
  - Cause user to feel exhilarated and confident
  - Suppress appetite and need for sleep
  - Last longer than those produced by cocaine
  - Amphetamines cross the placenta and can affect the developing fetus (premature birth, low-birth-weight baby)
- Tolerance to amphetamines develops along with both physical and psychological dependence
Nicotine

- Psychoactive ingredient in tobacco products
- Highly addictive
- Activates acetylcholine receptors
  - In the Peripheral Nervous System (PNS), increases heart rate and blood pressure
  - In the CNS, facilitates the release of dopamine and serotonin, which creates pleasurable feelings of relaxation
Nicotine

- Increases heart rate
- Constricts blood vessels
- Increases blood pressure
- Increases stickiness of platelets
  - Increases the likelihood of abnormal clots forming
  - Can cause heart attack or stroke
Hallucinogens

- Act by augmenting the action of serotonin, norepinephrine, or acetylcholine
- Effects of hallucinogenic drugs
  - Alter sensory perception
  - Produce unusual changes in thought and emotions
- Examples:
  - Mescaline and psilocybin (natural)
  - LSD and MDMA, ecstasy (synthetic)
Hallucinogens

- Physiological reactions typically are not especially harmful

- Real dangers result from distortions of reality that may lead to dangerous behavior
  - “Bad trips” include paranoia and depression
  - Users of ecstasy may dance all night and suffer from dehydration and heat stroke

- Ecstasy pills may contain additional drugs, with a variety of health effects
Opiates

- Natural or synthetic drugs that are medically important but have high potential for abuse
  - Reduce pain and anxiety
  - Produce a sense of euphoria
Opiates

- **Examples**
  - Morphine and codeine (from the opium poppy)
  - Heroin (synthetic derivative of morphine)
- **Mode of action**: opiates bind to the receptors of the body’s natural opiates
  - Endorphins, enkephalins, and dynomorphins function in the perception of pain and fear
Opiates

- Slow the breathing rate
  - Overdose may cause coma or death
- If injected, inflame the veins and promote the spread of pathogens that cause diseases such as AIDS, hepatitis, and syphilis
Figure 8a.5 The effects of certain drugs on the brain.

LSD and “ecstasy” (MDMA) act in brain regions where neurons communicate using serotonin.

Heroin acts in brain regions where neurons communicate using endorphins.

Cocaine and amphetamine act in brain regions where neurons communicate using dopamine and norepinephrine.
You Should Now Be Able To:

- Understand how psychoactive drugs affect communication between neurons and describe drug dependence
- Know how alcohol is distributed in the body and how to determine blood alcohol level
- Know the long-term effects on the human organs caused by the intake of:
  - Alcohol
  - Marijuana
  - Stimulants such as amphetamine and nicotine
  - Hallucinogens (Mescaline, LSD, MDMA, ecstasy)
  - Opiates