The Neuroscience of Drugs and Their Modifying Effects on the Human Body

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BioS 10
Bioscience in the 21st Century
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Outline

I. Overview of Drugs and Neuroscience
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   II. Facts and Figures
   III. The Brain
   IV. The Neuron at Rest
   V. The Neuron Active

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   I. How it works
   II. Side effects

III. Amphetamines
   I. How it works
   II. Side effects

IV. Heroin and Opioids
   I. How It works
   II. Side effects
   III. In the News
What is a Drug?

• **Drug** --- A chemical substance that, when taken into the body, alters the structure or functioning of the body in some way
Four Categories of Drug-Taking Behaviors, Derived From The Combination of Goal and Legal Status

<table>
<thead>
<tr>
<th>Goal</th>
<th>Legal Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrumental Use</td>
<td></td>
</tr>
<tr>
<td>Taking Valium with a prescription to relieve anxiety</td>
<td>Taking amphetamines without a prescription to stay awake the night before a test</td>
</tr>
<tr>
<td>Taking No Doz to stay awake on a long trip</td>
<td>Taking morphine without a prescription to relieve pain</td>
</tr>
<tr>
<td>Recreational Use</td>
<td></td>
</tr>
<tr>
<td>Having an alcoholic drink to relax before dinner</td>
<td>Smoking marijuana to get high</td>
</tr>
<tr>
<td>Smoking a cigarette or a cigar for enjoyment</td>
<td>Taking LSD for the hallucinogenic effects</td>
</tr>
</tbody>
</table>
Illicit Drug Use Prevalence Rates

After Marijuana, Prescription and Over-the-Counter Medications account for most of the commonly abused drugs among high school seniors.

Source: https://www.drugabuse.gov
U.S. Deaths per Year From Tobacco, Alcohol, and Illicit Drug Use

More than four times as many Americans die from tobacco-related illnesses such as cardiovascular and respiratory diseases and cancer as die from alcohol-related and illicit drug-related problems combined.
The Anatomy of a Neuron
The Neuron: at Rest
The Neuron: when Active

1. Sodium channel opens, Na+ enters cell
2. K+ channels open, K+ begins to leave cell
3. Na+ channels become refractory, no more Na+ enters cell
4. K+ continues to leave cell, causes membrane potential to return to resting level
5. K+ channels close, Na+ channels reset
6. Extra K+ outside diffuses away

Threshold of excitation
Synaptic Transmission
## Drugs and the CNS

### TABLE 3.1

<table>
<thead>
<tr>
<th>DRUG</th>
<th>RESULT</th>
<th>MECHANISM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>amphetamines</strong></td>
<td>CNS stimulation</td>
<td>Mimicking of norepinephrine at its receptor sites</td>
</tr>
<tr>
<td>antianxiety drugs in general</td>
<td>Reduction in anxiety and stress</td>
<td>Stimulation of GABA receptors in the brain</td>
</tr>
<tr>
<td>antidepressant drugs, MAO-inhibitor type</td>
<td>Reduction in depressive symptoms</td>
<td>Inhibition of enzymes that metabolize norepinephrine and serotonin</td>
</tr>
<tr>
<td>antidepressant drugs, tricyclic type</td>
<td>Reduction in depressive symptoms</td>
<td>Slowing down of reuptake of norepinephrine and serotonin at their receptor sites</td>
</tr>
<tr>
<td>antipsychotic drugs, typical type</td>
<td>Reduction in schizophrenic symptoms</td>
<td>Dopamine blocked from entering receptor sites in the brain</td>
</tr>
<tr>
<td>caffeine</td>
<td>CNS stimulation</td>
<td>Adenosine (an inhibitory neurotransmitter) blocked from entering its receptor sites</td>
</tr>
<tr>
<td><strong>cocaine</strong></td>
<td>CNS stimulation and local anesthesia</td>
<td>Blocking the reuptake of norepinephrine and dopamine at their receptor sites</td>
</tr>
<tr>
<td>LSD</td>
<td>Visual hallucinations and disordered thinking</td>
<td>Stimulation of receptor sites sensitive to serotonin</td>
</tr>
<tr>
<td>morphine, heroin, and codeine</td>
<td>Pain relief and euphoria</td>
<td>Stimulation of endorphins at their receptors in the spinal cord and brain</td>
</tr>
</tbody>
</table>

The Major Stimulants: Cocaine
In the late 1800s in the United States, cocaine was an ingredient in over-the-counter medications.
The Major Stimulants: Cocaine

**Side Effects**
- Powerful burst of energy
- General sense of well-being
- Heart rate and respiration are increased
- Appetite is diminished
- Blood vessels constrict and blood pressure is increased
- Pupils are dilated
- Continuously stuffy or runny nose
- Hallucinations (cocaine psychosis)
The Major Stimulants: Amphetamines
The Major Stimulants: Amphetamines

- Euphoria
- Insomnia
- Increased heart rate
- Increased blood pressure
- Dilated pupils
- Parkinson's-like symptoms
- Tremors
- Convulsion
- Paranoia
- Hallucinations
- Strokes
- Cardiovascular collapse, death
The Opioids: Heroin
The Opioids: Heroin

Side Effects
• Intense euphoria
• Subsequent tranquil drowsiness
• Elevated body temperature

Withdrawal
• Increased blood pressure
• Tearing, runny nose
• Diarrhea
• Spontaneous ejaculations
• Restlessness
• Involuntary kicking movements
• Pain and irritability
• Depression and anxiety
Prescription Heroin and Opioid Epidemic Awareness Week (September 8-14th, 2019)
The Opioids: In the News and On the Rise

THE OPIOID EPIDEMIC BY THE NUMBERS

- **130+** People died every day from opioid-related drug overdoses (estimated)
- **11.4 m** People misused prescription opioids
- **47,600** People died from overdosing on opioids
- **2.1 million** People had an opioid use disorder
- **81,000** People used heroin for the first time
- **886,000** People used heroin
- **2 million** People misused prescription opioids for the first time
- **15,482** Deaths attributed to overdosing on heroin
- **28,466** Deaths attributed to overdosing on synthetic opioids other than methadone

**SOURCES**
2. NCHS Data Brief No. 293, December 2017

Updated January 2019. For more information, visit: http://www.hhs.gov/opioids/
Opioid Related Deaths

By Peter Mucha and Frank Kummer
Breaking News Desk

An accidental overdose of heroin caused the Aug.
5 death of Garrett Reid, son of Eagles head coach
Andy Reid. Northampton County Coroner Zachary
Lysek announced at an afternoon news
conference.

The cause of death will be listed as "acute opiate
(heroin) toxicity" and classified as "accidental,"
Lysek said.

The finding confirms what many, including the
coach himself, suspected, because of Garrett
Reid's history of drug abuse.

Some are likely to wonder, though, if the release
of the findings, about ten weeks after the death,
was delayed to coincide with the Eagles having a
bye week.

The body of Garrett Reid, 29, was found in a
Lehigh University dormitory room during Eagles
training camp. He was working for the club as a
strength and conditioning coach, and had been
Opioid Related Deaths

Overdose Deaths Involving Opioids, by Type of Opioid, United States, 2000-2016