Chapter 11

Caffeine

The Coffee Song

The Muppets
Caffeine

- The most widely used psychoactive drug
- Can cause dependence and interfere with functioning
- Belongs to a class of chemicals known as xanthines

Three plants containing xanthines have been used by humans for thousands of years:

1. Coffee — from the Middle East
2. Tea — first grown in China
3. Cacao — from the Americas

- All three played important cultural and economic roles

1. Coffee

a. History
   i. Coffee originated in Ethiopia
      • Legend of its discovery by an Ethiopian goat herder, Kaldi, who noticed unusually boisterous activity in his goats after they consumed the berries
      • The practice then spread to Egypt and other Arabic countries by the 1400s, throughout the middle east by the 1500s and into Europe in the 1600s.
1. Coffee

a. History

ii. Coffeehouses spread:

a location to relax, learn the news of the day, seal bargains, and listen and learn from literary and political figures

- England 1674: "The Women's Petition Against Coffee" argued against the use of coffee on the grounds that it made men impotent
- London Coffee Houses of 1765

Coffeehouses: then and now

1. Coffee: History

a. History

iii. Coffee consumption in the United States

- Use increased following taxation of tea and the American Revolution
- Use also increased during and after Prohibition
- Per capita U.S. coffee consumption
  - Peaked in 1946
  - Declined as soft drink consumption increased
  - Current = about 25 gallons of coffee per year

1. Coffee: History

a. History

iv. Preparation

- Originally: people chewed on coffee beans or put raw beans in hot water
- Roasting improves the flavor, aroma, and color of the drink made from the beans
- Coffeehouses and individuals originally roasted and ground their own beans
- 1790: Commercial roasting
- 1900: Vacuum packing for long-term storage of ground coffee
1. Coffee

b. Growing and Trade
   i. About half of American coffee comes from Latin America, the rest from Vietnam, Indonesia, and Thailand
   • Over $5 billion was imported to the US in 2008

   ii. Variations in coffee characteristics
   • Different varieties of the coffee shrubs
     • *Coffea arabica* - milder flavor, takes longer to develop after planting and requires a near tropical climate to grow.
     • *Coffea robusta* - stronger and more bitter flavor and a higher caffeine content, used in less expensive blends and to make instant coffee.

1. Coffee

c. Varieties
   i. Many varieties of preparation
      • Black
      • Espresso
      • Cappuccino
      • Latte
      • Turkish
      • Half-caf
      • Iced
      • Flavored
     • and many more

1. Coffee

a. Varieties
   ii. Decaffeinated coffee
      • Soaking unroasted beans in an organic solvent removes the caffeine (alternative Swiss water process not widely used—removes more of the coffee’s flavor)
      • Caffeine removed from coffee is used in the manufacture of soft drinks
1. Coffee

c. The caffeine content of coffee depends on how it is prepared:

<table>
<thead>
<tr>
<th>Type</th>
<th>Average caffeine content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewed, drip (5 oz)</td>
<td>115 mg</td>
</tr>
<tr>
<td>Brewed, percolator (5 oz)</td>
<td>80</td>
</tr>
<tr>
<td>Instant (5 oz)</td>
<td>65</td>
</tr>
<tr>
<td>Decaffeinated, brewed (5 oz)</td>
<td>3</td>
</tr>
<tr>
<td>Decaffeinated, instant (5 oz)</td>
<td>2</td>
</tr>
</tbody>
</table>

2. Tea

a. History

i. Tea is second only to water as the most widely consumed beverage in the world.

ii. Tea (Camellia sinensis) originated in China

- Legend of its creation by Daruma, the founder of Zen Buddhism, who cut off his eyelids to remain awake while meditating; a new plant grew from the spot where his eyelids touched the earth, with leaves that made a brew that would keep a person awake.

iii. AD 350: Chinese manuscript describes many medicinal uses

AD 780: Nonmedical cultivation and use of tea; Lu Yu, Chinese tea master of the 8th c.
2. Tea

a. History

iv. 1610: Dutch delivered tea to Europe
- English East India Company
  - Concentrated on importing spices, so the first tea was taken to England by the Dutch
  - As demand grew, the company expanded its imports from China
  - Became the world's first multinational corporation.
- Most tea sold in coffeehouses
- In Britain, major marketing campaigns promoted the switch from coffee to tea
  - After the American Revolution, to be a tea drinker was to be loyal to the Crown (a traitor!)

2. Tea

v. 1770s: Tea and the American Revolution
- American colonists were big tea drinkers
- Anger over a tax on tea that they had not helped formulate
  - "Taxation without representation"
- Legal tea sales dropped due to a boycott
- Illegal smuggling of tea increased

v. cont. Tea and the American Revolution
- A special arrangement was made for the English East India Company, giving them a monopoly and angering American merchants

The result was "The Boston Tea Party" of 1773
2. Tea

b. Consumption and Production

i. Annual per capita tea consumption
   • 4.5 pounds in the United Kingdom
   • .5 (1/2) pound in the United States

ii. Tea starts its life on a four- to five-foot bush high in the mountains of China, Sri Lanka, India or Indonesia.

iii. Bushes are regularly pruned to aid in harvesting new growth
   • Tea leaves are picked by hand, about every 6 to 10 days
   • Preparation: tea leaves are
     ▪ Dried
     ▪ Rolled to crush the cells in the leaves
     ▪ Placed in a cool, damp place for fermentation (oxidation)

c. Varieties
   ▪ Black tea is fully oxidized leaves
   ▪ Green tea is slightly oxidized leaves
   ▪ White tea is nonoxidized leaves
2. Tea: Varieties

c. Varieties
- **Iced tea** (orig. 1904, Louisiana Purchase Exposition, St. Louis) accounts for 75 percent of all tea consumed in U.S.
- **Flavored teas** are mixtures of tea and mint, spices, or other flavors (ex. Earl Grey, Jasmine)
- **Herbal teas** contain a mix of plant leaves and flowers but no actual tea

2. Tea

d. Active Ingredients
- **Xanthines** block inhibitory receptors for adenosine, thereby having a stimulant effect
- **Caffeine**
  - Pound for pound, tea has more caffeine than coffee **BUT**
  - 1 pound of tea leaves = 200 cups of tea
  - 1 pound of coffee = 50 to 60 cups of coffee
  - Tea has about 40 to 60 mg of caffeine per cup depending on the type and strength of the brew
- **Theophylline**
  - Tea contains a very small amount of theophylline
  - In high doses, theophylline is used as an asthma medication

3. Chocolate

a. History
- **Chocolate originated in Mesoamerica**
  - **Legend**: Cacao tree was a gift to humans from paradise from the Aztec god **Quetzalcoatl**
  - Linnaeus named the cacao tree **Theobroma**, meaning “food of the gods”
  - Aztecs cultivated cacao widely, and the cacao bean was an important part of their economy and culture
3. Chocolate

a. History

ii. “Xocolatl”—from the Mayan words xoc (“warm”) and latl (“beverage”)
It was a thick, bitter liquid flavored with vanilla

iii. Cortés introduced chocolate into Europe
- Chocolate drinking spread slowly
- Chocolate was often sold alongside coffee and tea in established coffeehouses

b. Processing

i. Prior to 1828, the traditional Aztec process was still used
- Cacao pods were dried in the sun, then roasted to remove the husk
- Kernels were ground to obtain a thick liquid (baking chocolate)

ii. 1828: Dutch patent issued for a process that removes about two-thirds of the fat (cocoa butter) and produces a powder
- A mixture of cocoa butter, sugar, and chocolate powder can be formed into slabs or bars

iii. 1876: Milk chocolate
Introduced by the Swiss
3. Chocolate

c. Xanthines

- **Theobromine** (lit. “Food of the Gods”)
  - Chocolate contains the unique xanthine theobromine
  - It acts in a parallel fashion to caffeine, but it is much less potent in its CNS effects.

- **Caffeine**
  - An average cup of cocoa contains about 4 mg of caffeine

4. Caffeine and Culture

a. The cultural effects of caffeine have been far-reaching

i. Propped-up legends (Lu Yu)

ii. Prompted revolutions (American Revolution, eg.)

iii. Practices of slavery (Burkina Faso)

iv. These abuses have created a strong movement toward Fair Trade

5. Other Sources of Caffeine

a. Soft Drinks: Coca-Cola

- Developed as a nerve tonic in the late 1800s; ingredients included:
  - Caramel
  - Fruit flavoring
  - Phosphoric acid
  - Caffeine
  - A secret mixture called Merchandise No. 5

- Named for two flavoring agents: coca leaves and cola (kola) nuts

- Up until 1906, the beverage did contain a small amount of cocaine
5. Other Sources of Caffeine

b. Other soft drinks
- All types of soft drinks are popular
- U.S. per capita soft drink consumption is about 50 gallons per year

c. Energy drinks
d. Over-the-counter medications ("no-doz", "vivarin")

5. Caffeine Content

<table>
<thead>
<tr>
<th>Item</th>
<th>Caffeine Content (mg)</th>
<th>Serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewed coffee</td>
<td>40-180</td>
<td>5 oz</td>
</tr>
<tr>
<td>Instant coffee</td>
<td>30-120</td>
<td>5 oz</td>
</tr>
<tr>
<td>Decaffeinated coffee</td>
<td>1-5</td>
<td>5 oz</td>
</tr>
<tr>
<td>Tea</td>
<td>20-110</td>
<td>5 oz</td>
</tr>
<tr>
<td>Cocoa</td>
<td>5-20</td>
<td>5 oz</td>
</tr>
<tr>
<td>Diet Coke</td>
<td>47</td>
<td>12 oz</td>
</tr>
<tr>
<td>Pepsi One</td>
<td>54</td>
<td>12 oz</td>
</tr>
<tr>
<td>Mountain Dew</td>
<td>54</td>
<td>12 oz</td>
</tr>
<tr>
<td>Jolt</td>
<td>72</td>
<td>12 oz</td>
</tr>
<tr>
<td>Red Bull</td>
<td>80</td>
<td>8.3 oz</td>
</tr>
<tr>
<td>Milk chocolate bar</td>
<td>1-15</td>
<td>1 oz</td>
</tr>
<tr>
<td>Dark chocolate bar</td>
<td>5-35</td>
<td>1 oz</td>
</tr>
<tr>
<td>Vivarin stimulant</td>
<td>200</td>
<td>1 dose</td>
</tr>
</tbody>
</table>

6. Caffeine Pharmacology

a. Three key xanthines
- Caffeine
- Theophylline
- Theobromine

b. Time course
- Rapid absorption if taken orally
- Peak levels reached in 30 minutes
- Half-life is about 3 hours

c. Dependence
- Reinforcing properties
- Withdrawal symptoms include headache and fatigue
6. Caffeine Pharmacology

d. Mechanism of action
• Xanthines block inhibitory receptors for adenosine, thereby having a stimulant effect

e. Physiological effects
• Stimulates the CNS and skeletal muscles
• Causes sleep disturbances
• Elevates mood
• Constricts blood vessels in the brain
  • May explain the ability of caffeine to reduce migraine headaches

7. Benefits and Drawbacks

a. Potential Benefits
i. Stimulation
  • Caffeine partially offsets the effects of fatigue on both mental and physical tasks, but it may not improve performance in well-rested individuals
  • High caffeine consumption among college students is associated with lower academic performance

ii. Headache treatment

iii. Hyperactivity treatment

iv. Sobering up? No.
  • Caffeine does not lower blood alcohol concentration and will not help a person sober up

b. Causes for Concerns
i. There is no clear evidence that moderate caffeine consumption is dangerous

ii. Cancer: Caffeine is not a risk factor in human cancer

iii. Reproductive effects:
  • High consumption of caffeine reduces a woman’s chances of becoming pregnant and slows the growth of the fetus
  • Research is mixed on whether caffeine increases the risk of miscarriage

iv. Heart disease: High intake of caffeine may increase the risk of heart attack, particularly in people with other risk factors
v. **Caffeinism** (excessive use of caffeine)

- **Toxicity is relatively low**
  - It would require about 100 cups of coffee to receive a fatal dose from oral caffeine

- Unpleasant symptoms do occur:
  - Nervousness
  - Irritability
  - Tremors
  - Muscle twitching
  - Insomnia
  - Flushed appearance
  - Elevated temperature
  - Palpitations
  - Heart arrhythmias
  - Gastrointestinal disturbances