This is Your Brain on Vortex: The Neuroscience and Art of Alcohol

Jeff Leake, MFA, Neuroscience, WSU Vancouver, PSU
Bill Griesar, Ph.D., Neuroscience, WSU Vancouver, PSU
John Harkness, Ph.D., Neuroscience, WSU Vancouver
nwnoggin.org
Beer beer beer beer beer... 😊
Alcohol is popular and easy to get

- Neolithic jugs (~10,000 BC!)
  - Henan Province, China
- Not always legal, but then...
  - Islam: Heroin, hashish
  - “Mormon tea” (ephedra)
- Fermentation
  - Natural process
But it’s not always as good as Vortex 😛

Or Buoy Beer, Astoria Brewing, Hondos, Rogue…
Alcohol Use, by Age

Binge, and Heavy Alcohol Use by Age (2013)

Substance Abuse and Mental Health Services Administration National Survey on Drug Use and Health, 2013
Alcohol* reduces risk of death

Especially from coronary heart disease, stroke... (Corrao, 2000)

* “Moderate” drinking only...

Women: 1 “drink”/day
Men: 2 “drinks”/day

Higher risk of mortality

Lower risk of mortality


The relationship of daily alcohol consumption to the relative risk of all-cause mortality in men and women.
What is a “drink?”

From the National Institute on Alcohol Abuse & Alcoholism

The amount of liquid in your glass, can, or bottle does not always reveal how much alcohol is actually in your drink…
Alcohol reaches the brain

- Absorbed primarily in the small intestine...
- Breakdown in stomach
  - By alcohol dehydrogenase
  - Cheese, snacks, meals 😊
- “First pass” through liver; more alcohol breakdown
  - Alcohol dehydrogenase
  - Also: Cytochrome P450
Breakdown in Stomach and Liver

Alcohol

Alcohol dehydrogenase

Acetaldehyde

Toxic: flushing, nausea, rapid heart rate, sweating, dizziness, confusion

Cytochrome P450

Non-toxic compounds

ALDH

Acetic acid

Non-toxic compounds
Your brain: made of cells

- Neurons
- Neurons carry electrical messages
- Neurons connect chemically across synapses
- Neurotransmitters
Alcohol has a very long relationship with art

While overindulgence was generally acknowledged, many cultures celebrated alcohol as something that could spur creativity.

Wang Xizhi after the gathering at the Orchid Pavilion

A woman who overindulged, tomb of Neferhotep at Luxor, New Kingdom, Dynasty 19
Art often reflects cultural views, this is particularly true of our complex relationship with alcohol

Charles Pickering created this series of photographs at the request of a temperance group in New South Wales which (not so coincidentally) coincided with a drunkard punishment bill.

Charles Pickering “The Five Stages Of Inebriation” 1886
Charles Pickering “The Five Stages Of Inebriation” 1886
Charles Pickering “The Five Stages Of Inebriation” 1886
Charles Pickering “The Five Stages Of Inebriation” 1886
Charles Pickering “The Five Stages Of Inebriation” 1886
All cells have membranes

Outside cells, including neurons

Phospholipids
- Charged “heads”
- Uncharged “tails”

Forms two layers...

Many drugs are charged and can’t get through...

But alcohol is special...

“Protein machines”

Inside cells
Alcohol Drug Actions

- **Nonspecific Actions:**
  - Membrane-disordering actions
- **Specific Actions:**
  - Activates GABA-A receptors
  - Blocks glutamate NMDA receptors
Alcohol at GABA-A calms brain

“GABA” is the primary inhibitory neurotransmitter in the brain

Reduced anxiety
Reduced incidence of seizures
Other “agonists”: Barbiturates, benzodiazepines, neurosteroids

Frontal lobes
Decision making
Considering consequences
Motor planning/activity

But with chronic use...
Alcohol impairs memory

If you remember something long term, your networks of neurons have changed...

Alcohol prevents these changes from occurring...

Alcohol impairs memory
How? Glutamate NMDA receptors

Glutamate is the primary excitatory neurotransmitter in the brain.

Normal stimulation at glutamate synapses: no NMDA response

At regular levels of synaptic activity, the NMDA receptor is blocked by Mg$^{+2}$, and no Ca$^{+2}$ gets in...
At high levels of activity...

Mg$^{+2}$ ion is ejected, and NMDA opens.

Ca$^{+2}$ ions rush in:
Leads to changes in gene expression, proteins; changes in neural networks that reflect memory...

Changes... genes, proteins

2nd messengers
Alcohol blocks NMDA receptors

Prevents activity-dependent changes in network connections

- **Blackouts**: worse in adolescents
  - e.g., The neurocognitive effects of alcohol on adolescents and college students, Zeigler et al (2005)
Acute alcohol provokes dopamine (DA) release.

Chronic alcohol reduces VTA activity; less DA release, withdrawal.
Acute alcohol releases opioids

Acute alcohol releases endorphin, enkephalin from the pituitary gland...

Reduces pain, promotes more dopamine release.

Chronic alcohol reduces opioid/DA release
Hogarth delighted in satirizing the faults of English society.

These images in part reflect the cultural view of moderation, but also are meant as a social comment on the politics and laws regulating distilling spirits.
Jan Steen had a conflicted view of alcohol consumption, enjoying the communal aspects of social drinking within his own home...

Jan Steen “The Artist's Family”
c. 1665 Oil on canvas, 134 x 163
Mauritshuis, The Hague

And alternately created moralizing images decrying the scourge of excessive drinking.

The Effects of Intemperance
1663-65 Oil on wood, 76 x 106 cm
National Gallery, London
Degas preferred to depict his drinkers from the viewpoint of an outside observer, disconnected from the world around them.

Edgar Degas “Absinthe Drinkers” 1876
Oil on canvas, 92 x 68 cm
Musée d'Orsay, Paris
Past Month Illicit Drug Use among Persons Aged 12 or Older: 2013

- Illicit Drugs: 24.6 million
- Marijuana: 19.8 million
- Psychotherapeutics: 6.5 million
- Cocaine: 1.5 million
- Hallucinogens: 1.3 million
- Inhalants: 0.5 million
- Heroin: 0.3 million

The most popular "illicit" drug

http://www.samhsa.gov/data/sites/default/files/NSDUHresultsPDFWHTML2013/Web/NSDUHresults2013.htm
Past Month Illicit Drug Use

Youths Aged 12 to 17: 2002-2013

Substance Abuse and Mental Health Services Administration
National Survey on Drug Use and Health, 2013
Past Month Alcohol Use

Current Alcohol Use, ages 12 to 20: 2002-2013
Substance Abuse and Mental Health Services Administration
National Survey on Drug Use and Health, 2013