

# How Drug Abuse Affects the Brain and What We Can Do About It

**Brain Awareness Week**

**March 17, 2022**

**Dr. Matthew Eckard**

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**SUNY Empire State College**



# Understanding Drug Addiction as a Biological Process

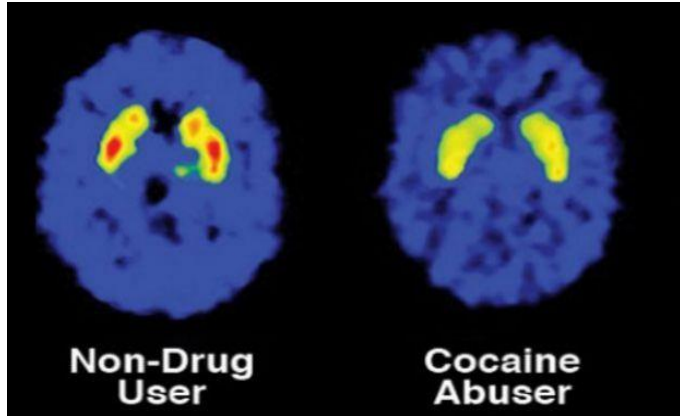
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# Neurological



# Medical



# Social



**DRUG  
ADDICTION**

# Economic



# Estimated Cost to Society of Substance Abuse and Addiction

**Alcohol:** \$249 billion/year

**Tobacco:** \$300 billion/year

**Prescription Opioids:** \$78.5 billion/year

**Illegal Drugs:** \$193 billion/year

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**Total:** \$820.5 billion/year

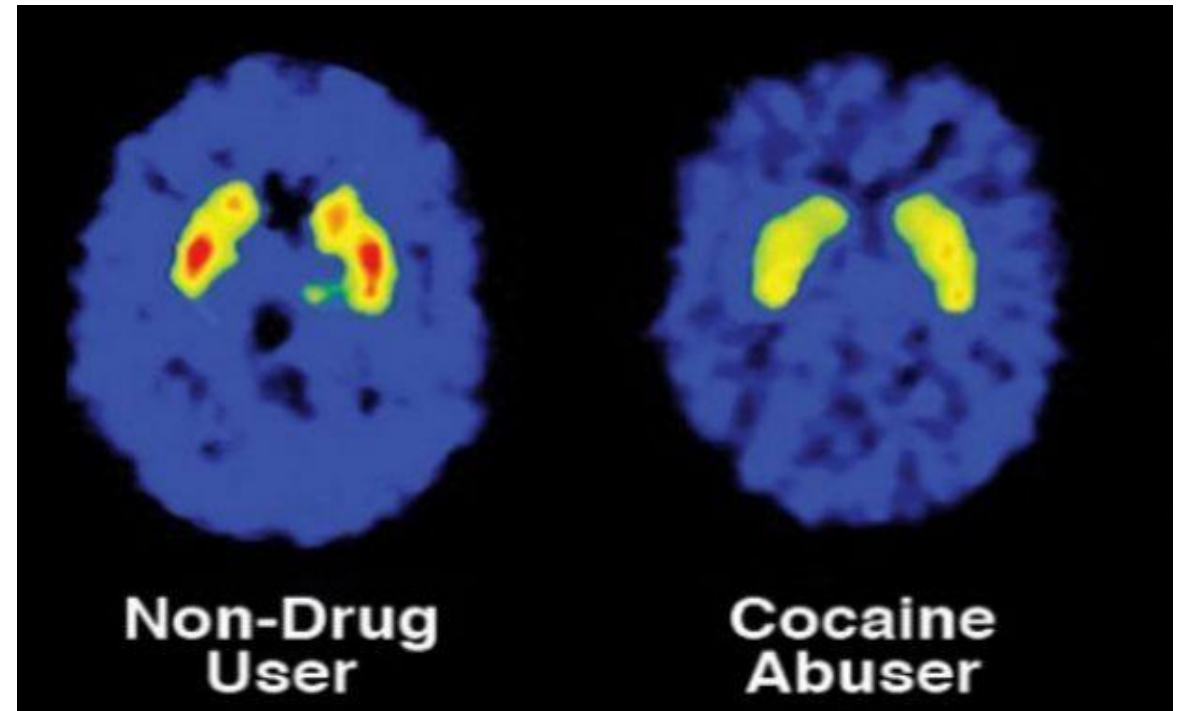


# What is Drug Addiction?

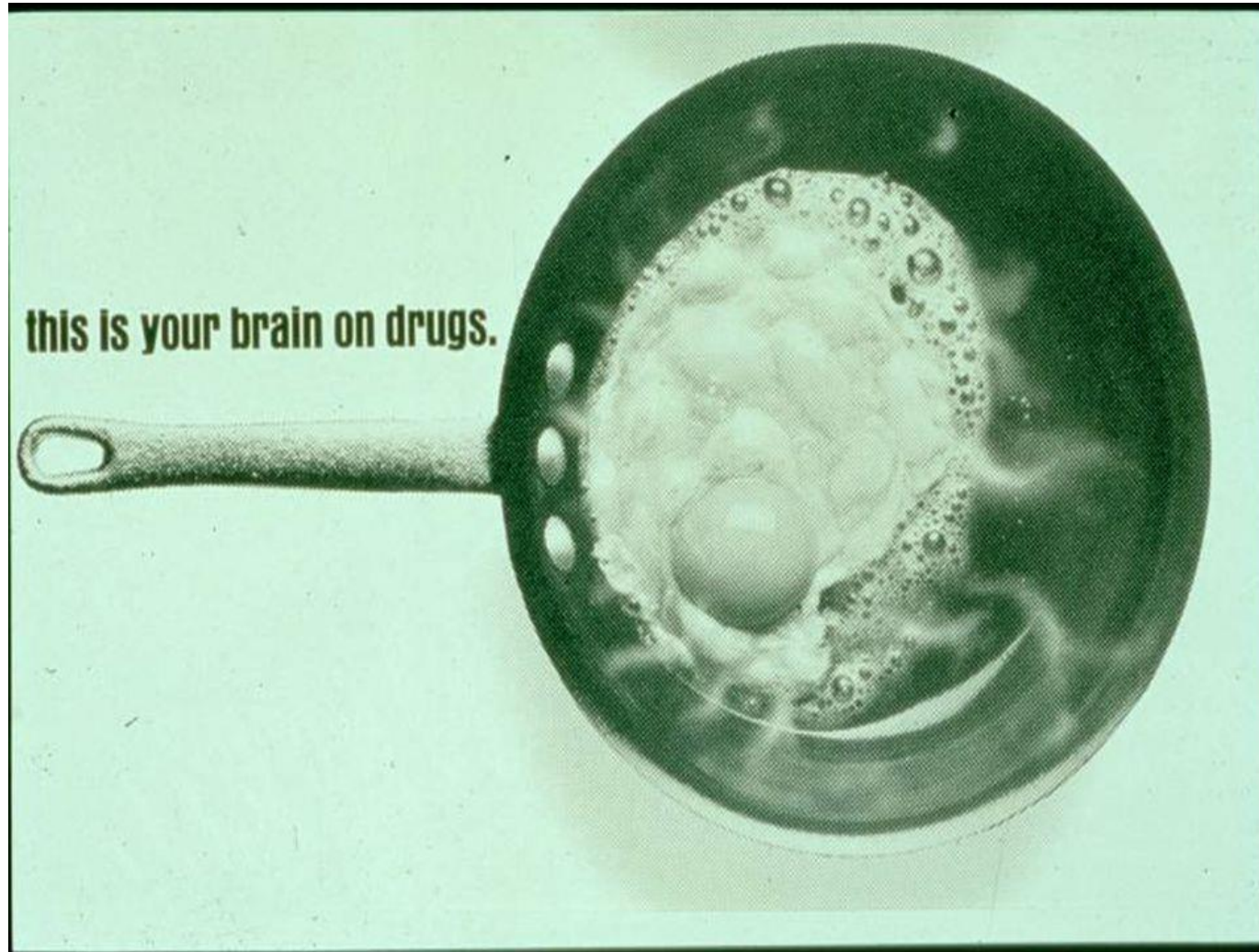
## A Brain Disease

### Characterized by:

- Compulsive drug-seeking behavior
- Continued use of drugs despite negative consequences
- Persistent changes in brain structure and function

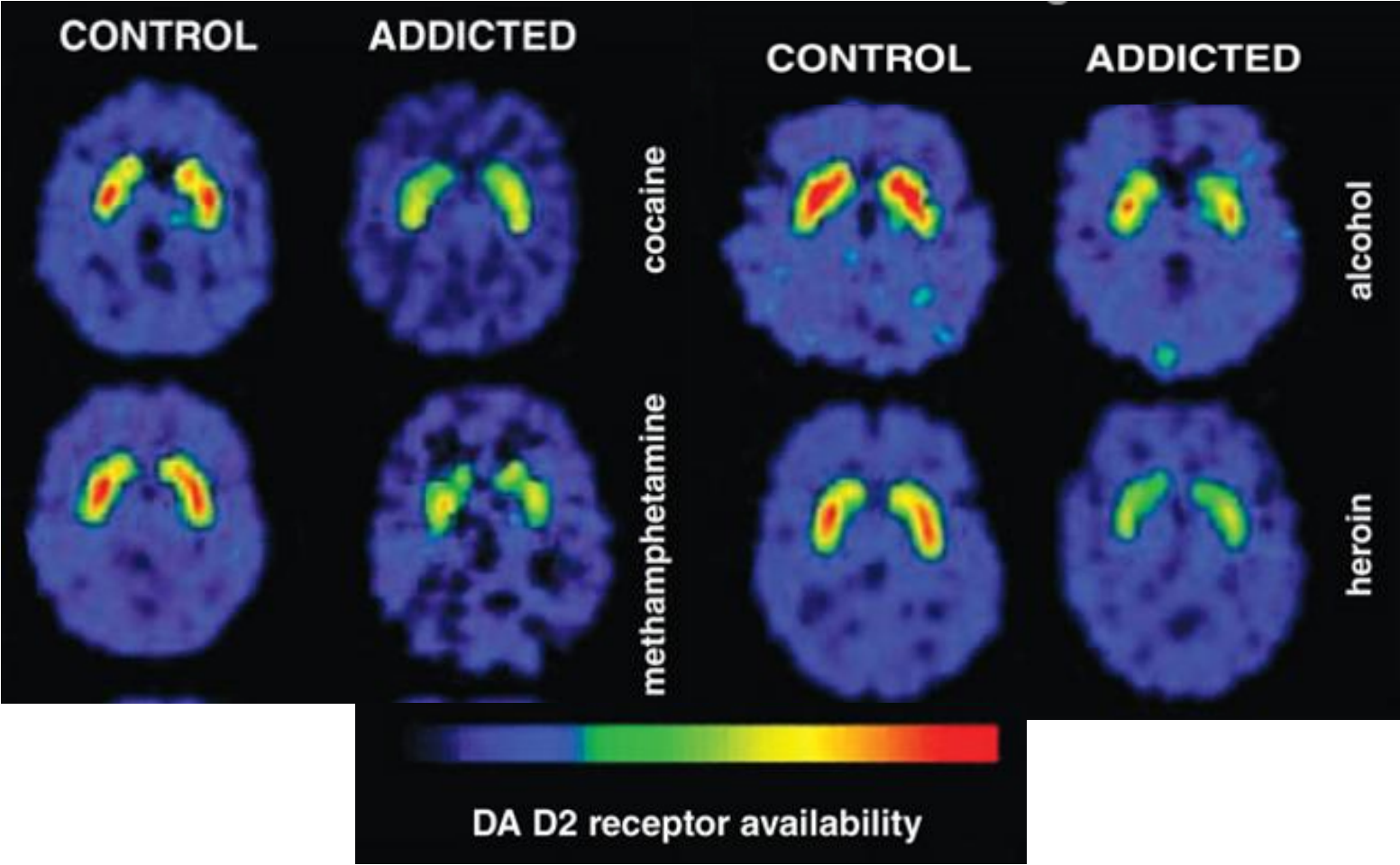


# The old perspective

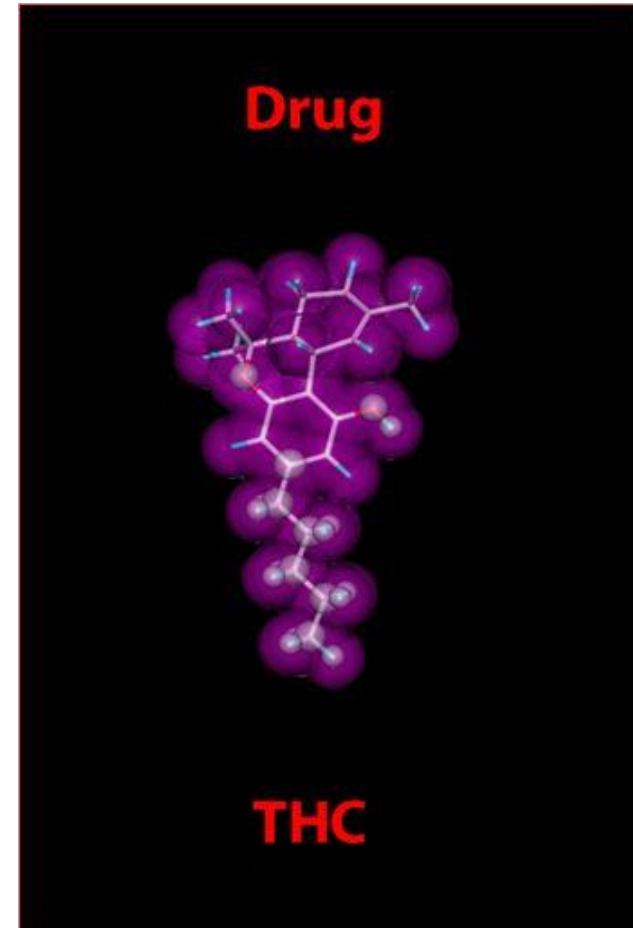
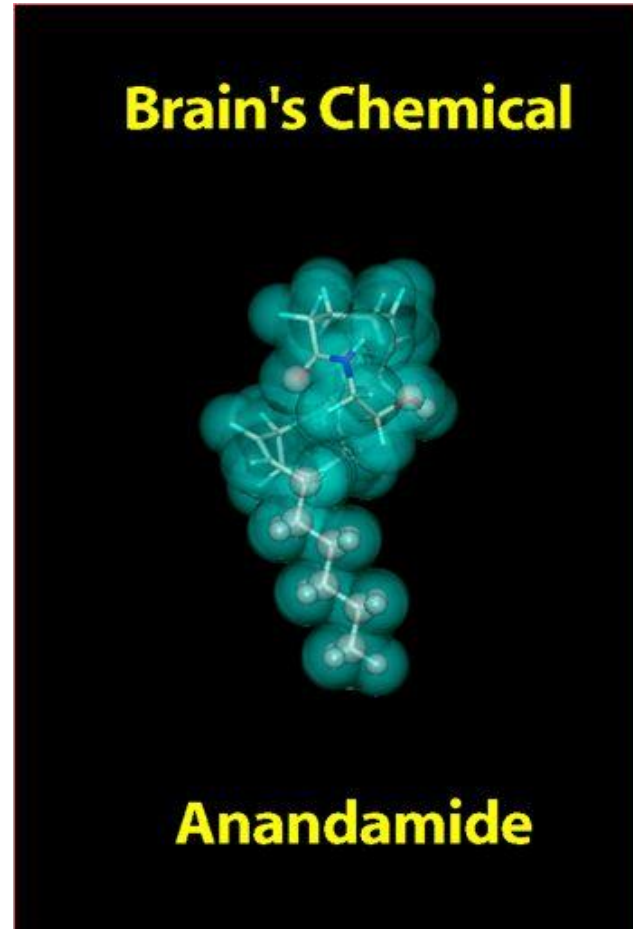




# The new perspective



# Drugs act as chemical “imposters” in the brain





# Why Do People Use Drugs?

## To Feel Good

Euphoric sensation  
Pleasure  
Social experience



**“Light” Side**

## To Feel Normal

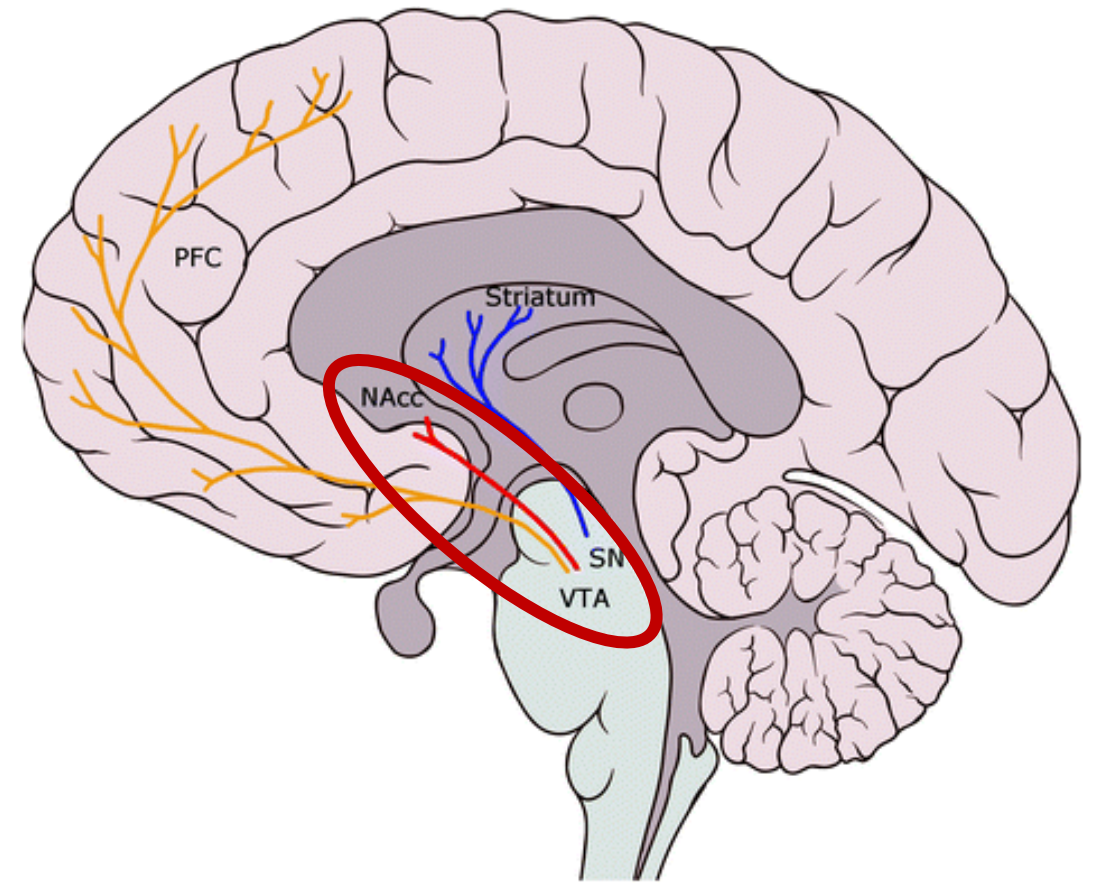
Reduce anxiety  
Reduce feelings of hopelessness  
Lift out of depression

**“Dark” Side**



# Brain reward system

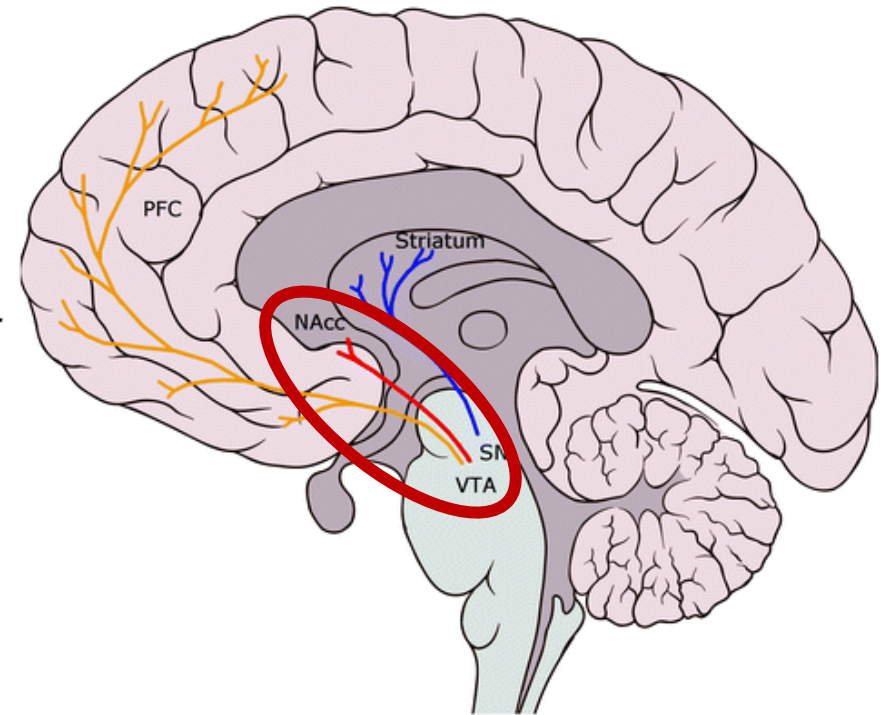
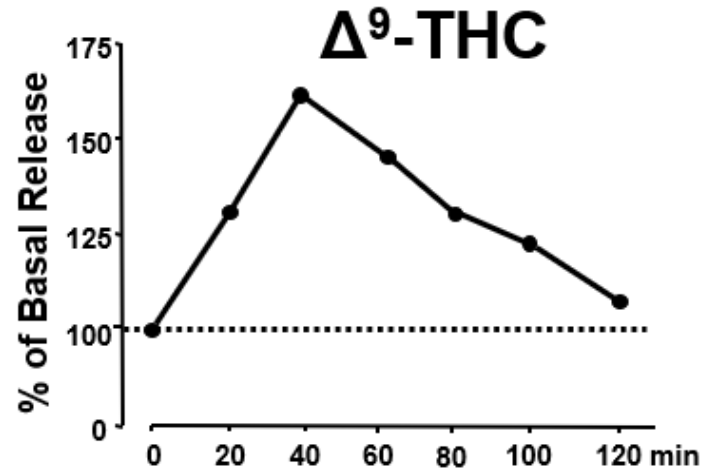
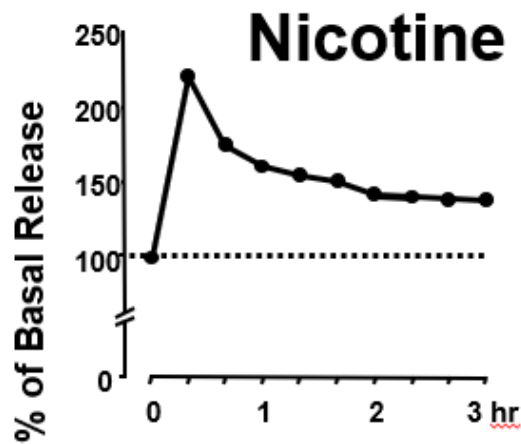
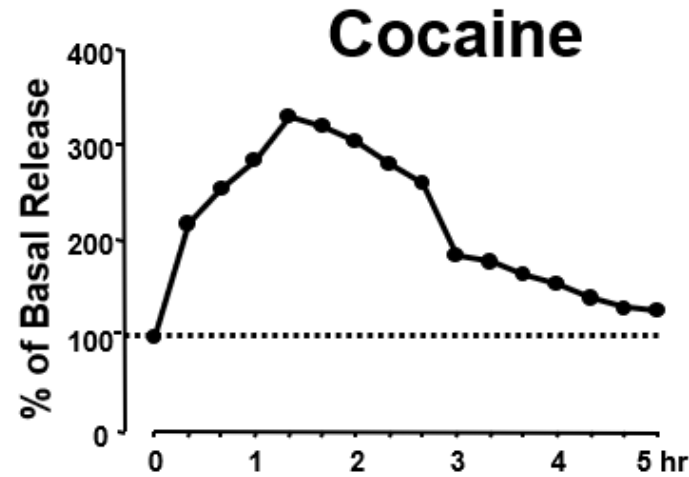
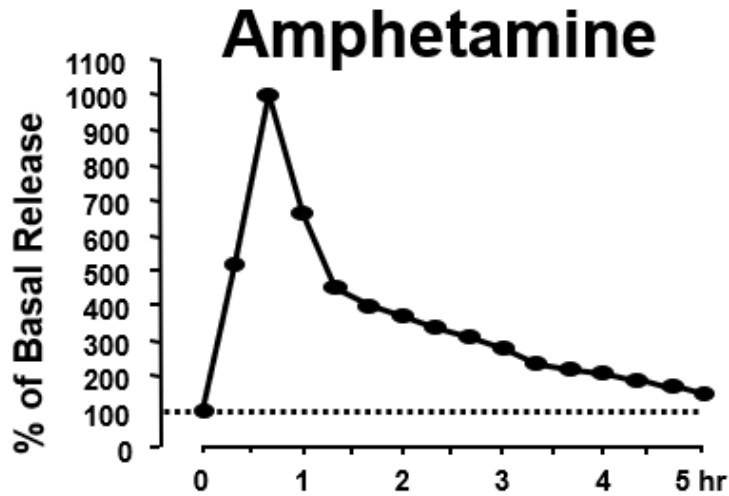
- Dopamine pathways mediate reward in the brain
- Mesolimbic pathway
  - Basal ganglia
  - VTA -> Nucleus Accumbens
- Drugs, food, sex, etc. increase dopamine in mesolimbic pathway



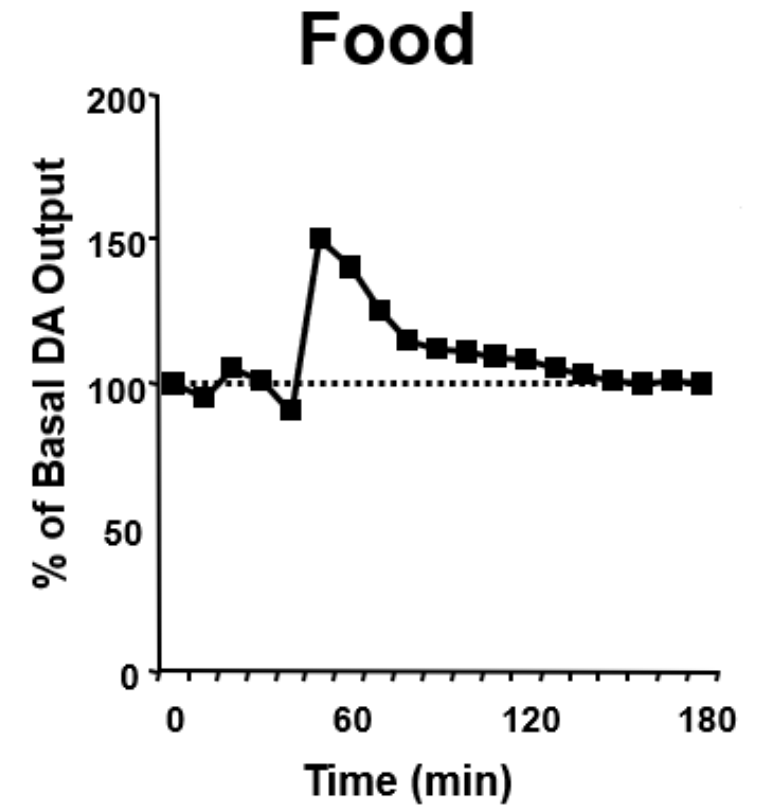
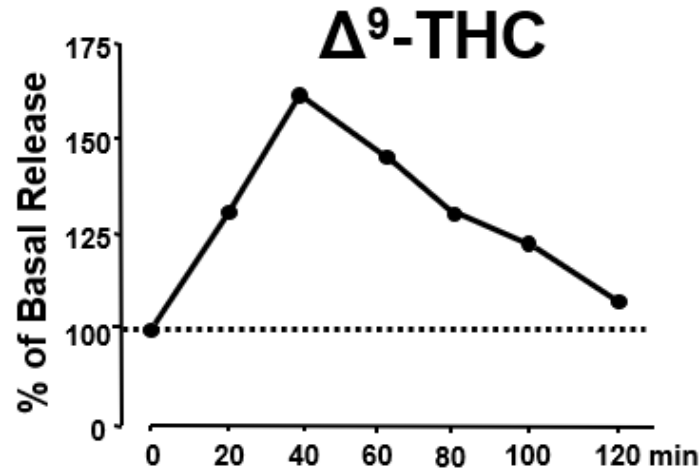
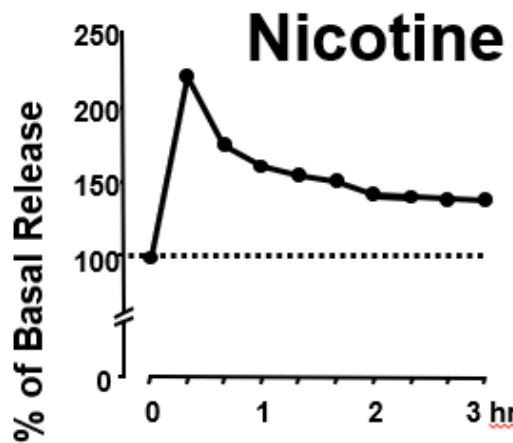
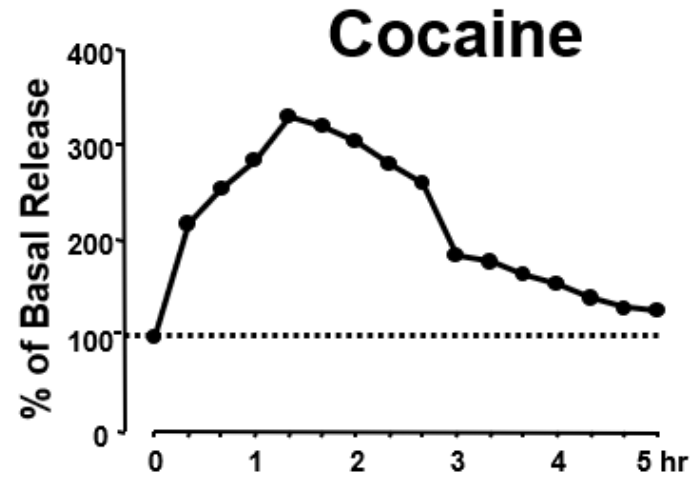
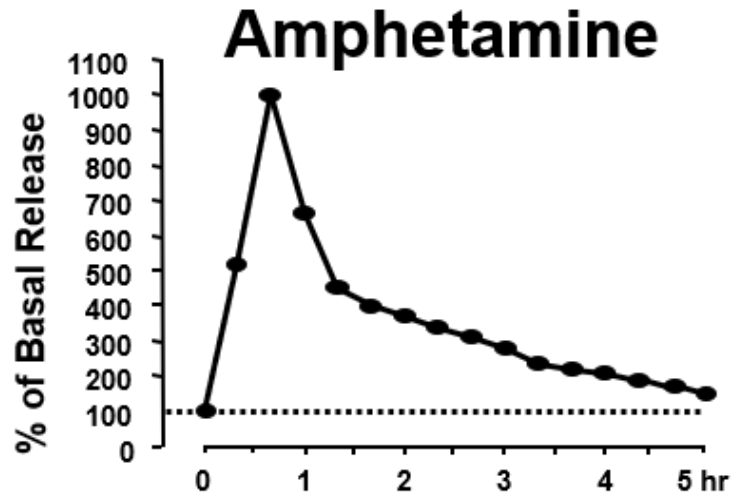
VTA = ventral tegmental area  
NAcc = nucleus accumbens



# Drugs increase dopamine release from the VTA

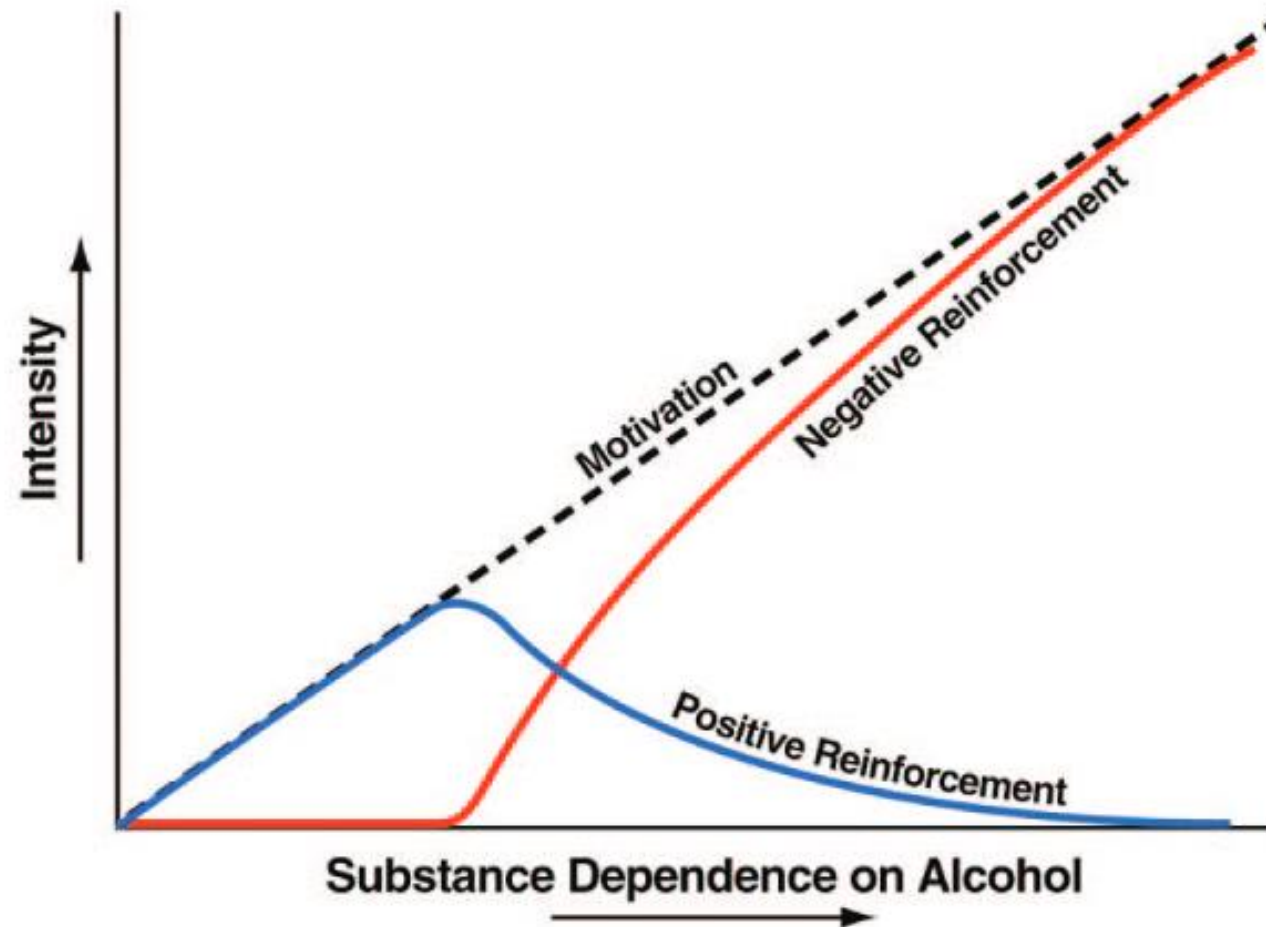


# Drugs increase dopamine release from the VTA



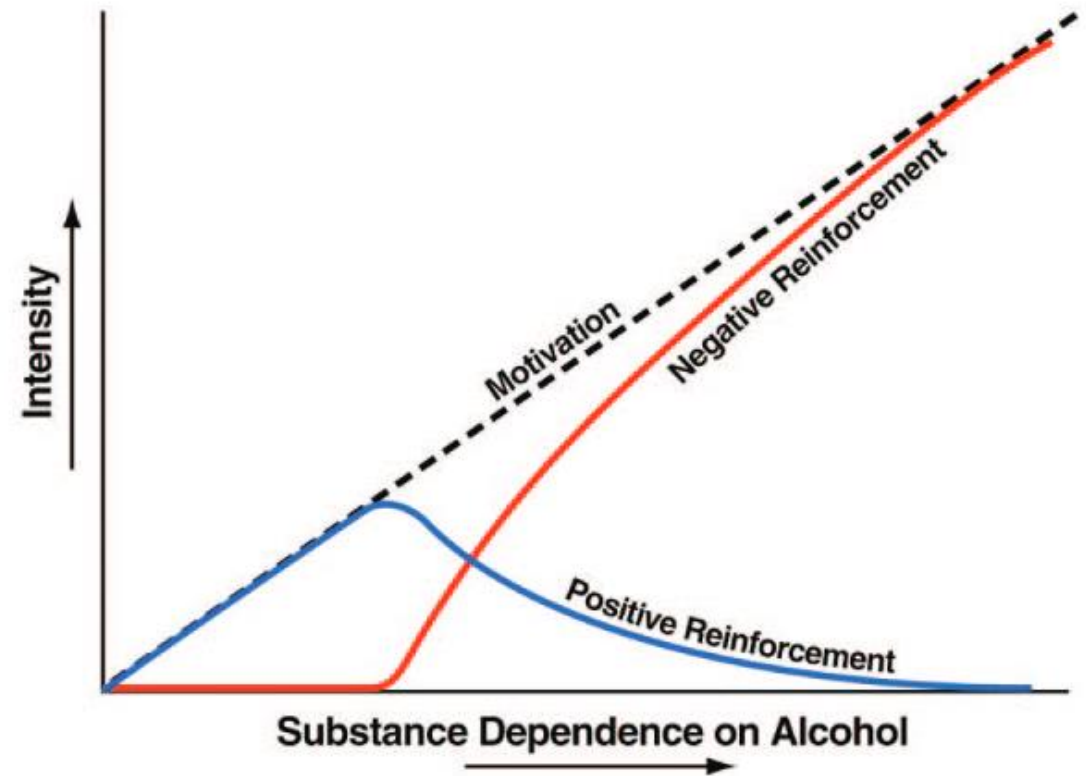


# Motivation in drug addiction



# Motivation in drug addiction

- **Positive reinforcement**
  - Adding something “pleasant” that increases behavior frequency
- **Negative reinforcement**
  - Removing something “unpleasant” that increases behavior frequency
- Motivation shifts from positive to negative reinforcement





# The Addiction Cycle

## Binge Intoxication

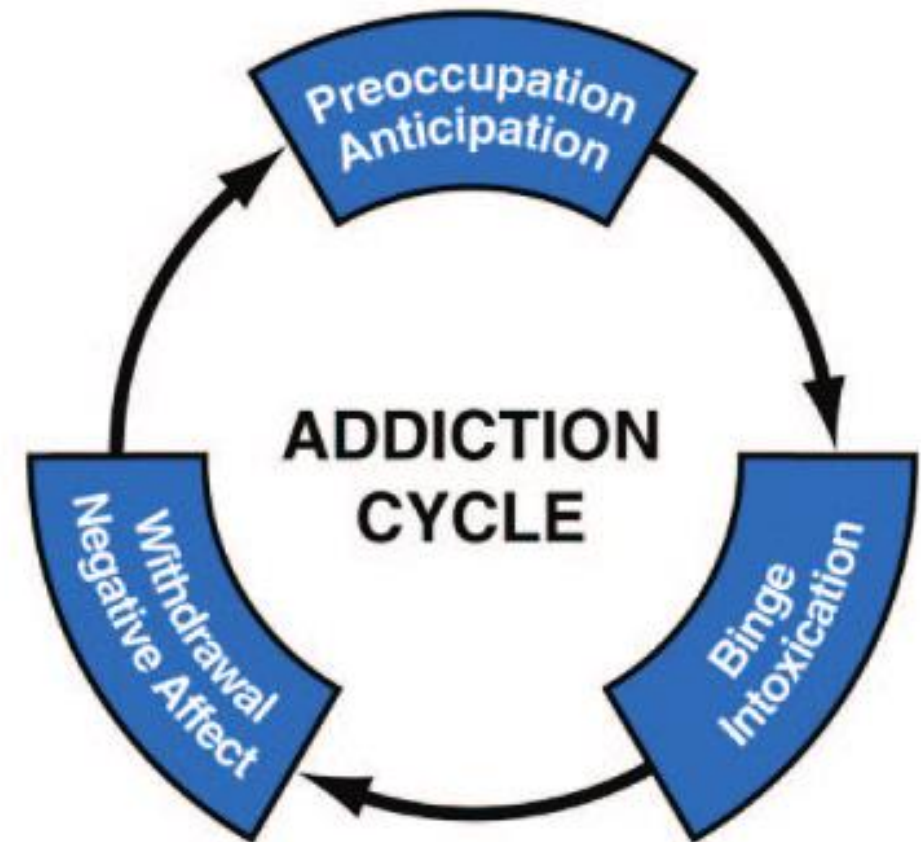
Patterns of heavy use

## Withdrawal / Negative Affect

Dysphoria and stress arise when drug is not present

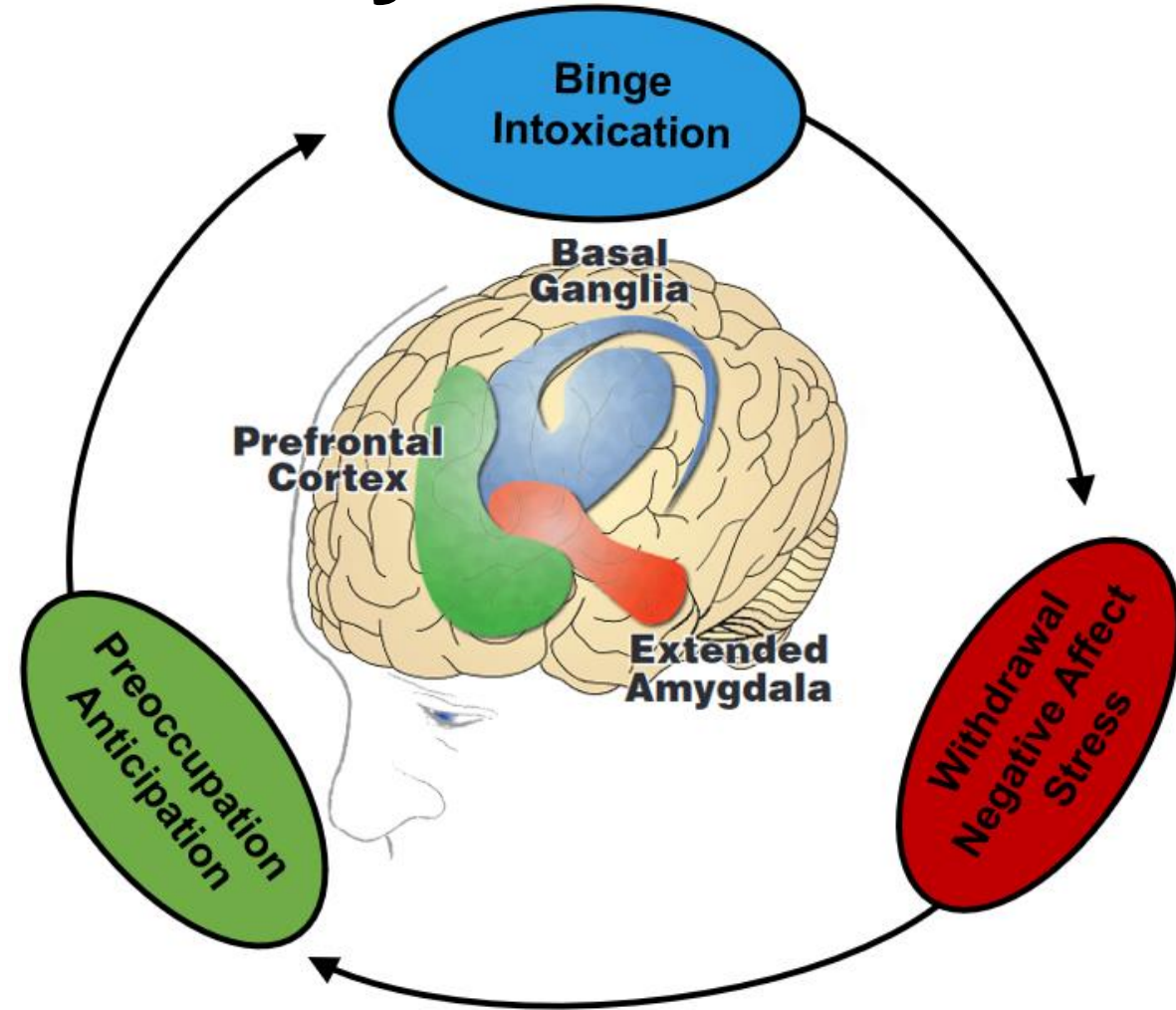
## Preoccupation / Anticipation

Directing all attention toward getting more drug



# Neural Basis of Addiction Cycle

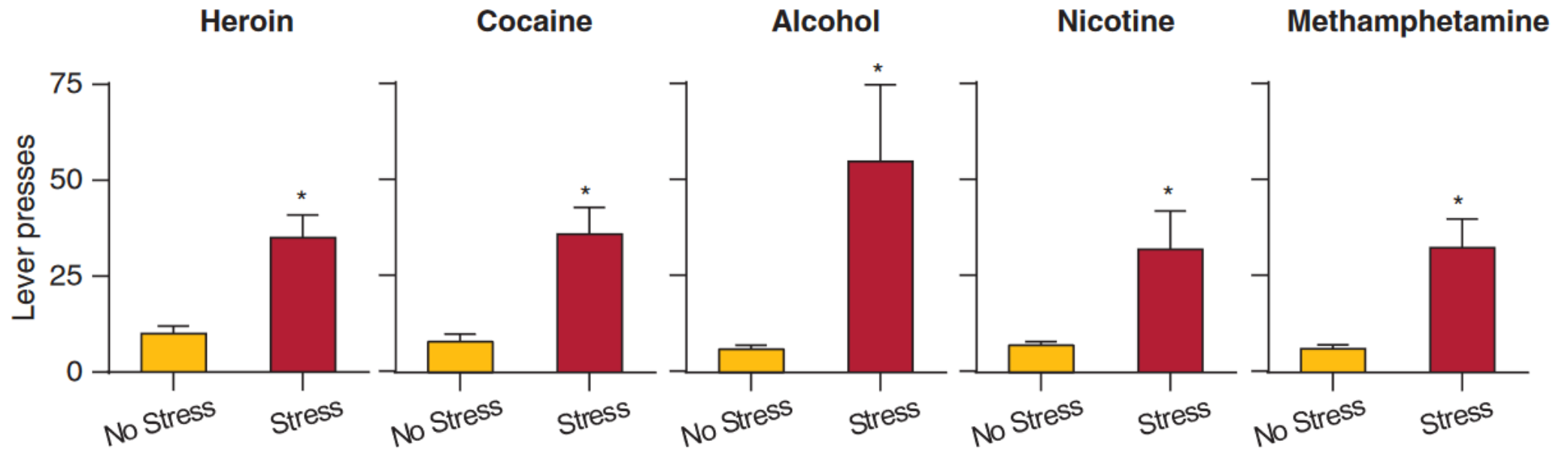
- Different neural circuits underlie different cycle stages
- **Basal Ganglia** – contains dopamine reward/motivation centers
- **Prefrontal Cortex** – decision-making & planning
- **Extended Amygdala** – amplifies stress and negative mood state



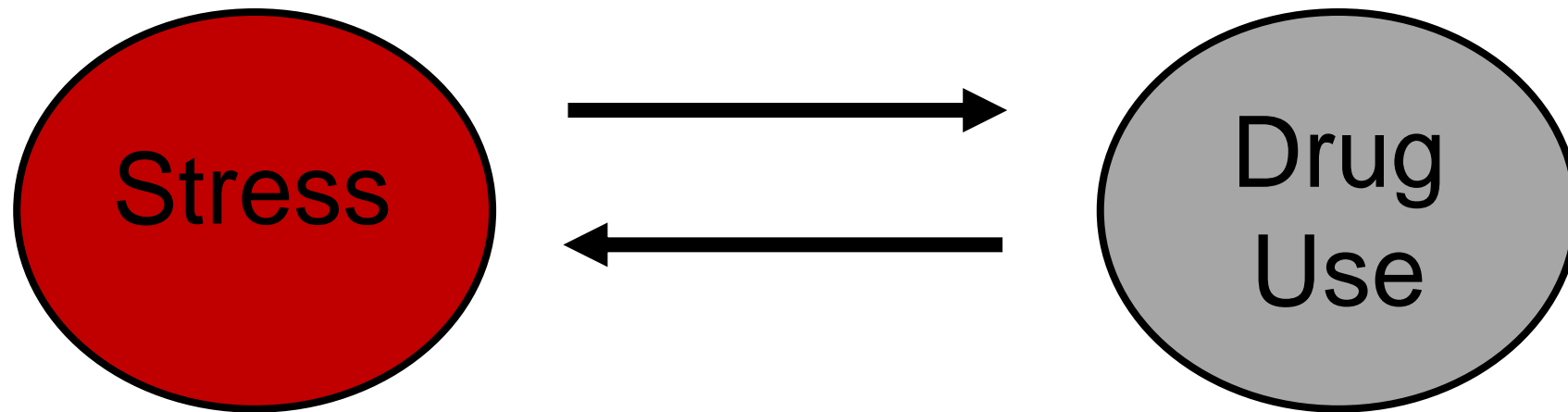


# Effects of Stress on Drug Use

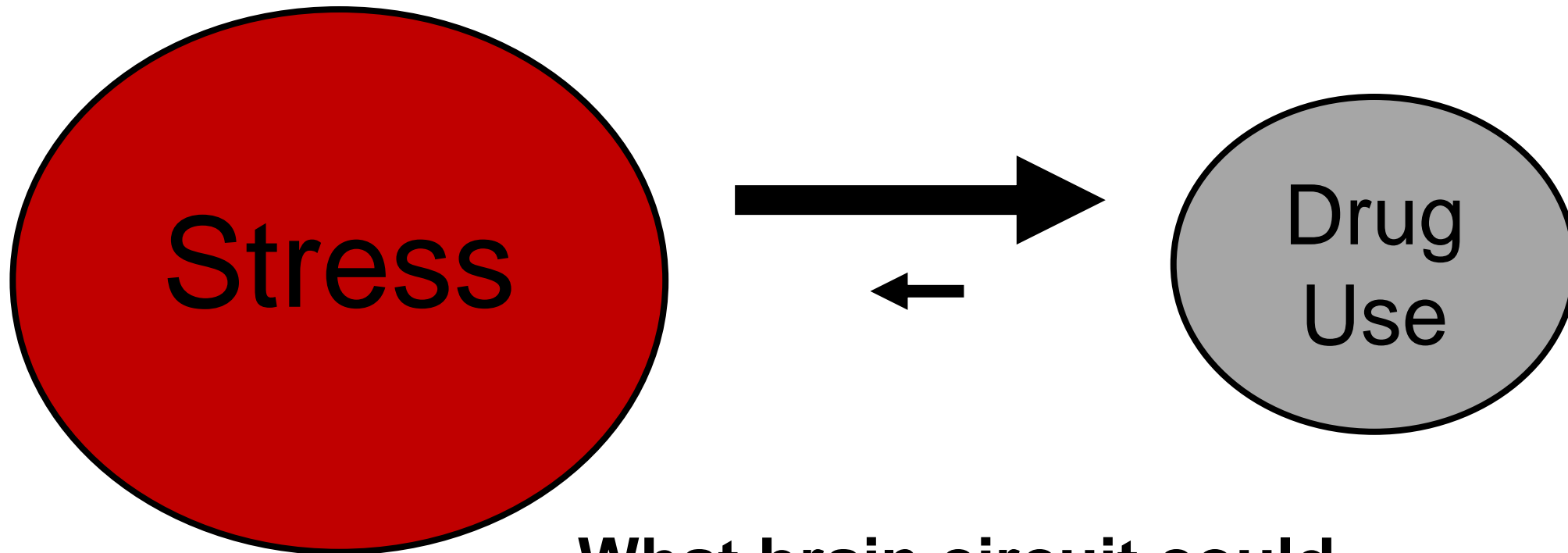
- Stressed animals will seek drugs much more intensely than non-stressed animals



# Dynamic interplay between stress and drug use



# Dynamic interplay between stress and drug use



**What brain circuit could cause this shift?**

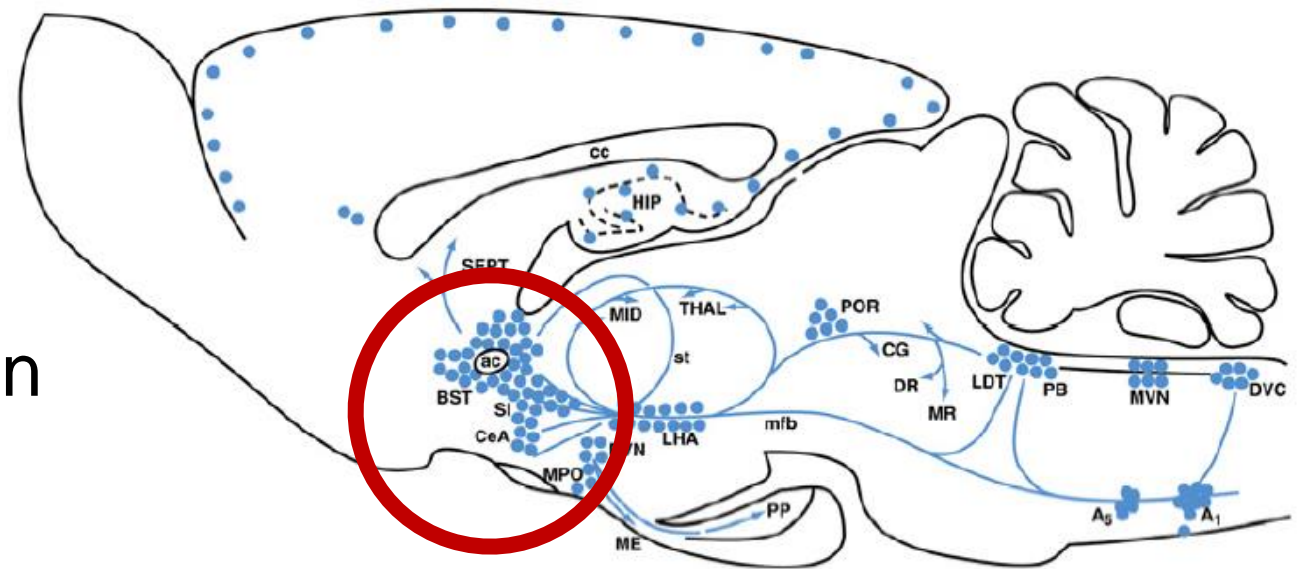




# Amygdala, CRF, and stress

- Amygdala has highest levels of stress hormones in the brain
  - CRF
- BST allows amygdala to communicate with rest of brain
- Prolonged stress & drug use **INCREASE** stress hormones in the amygdala

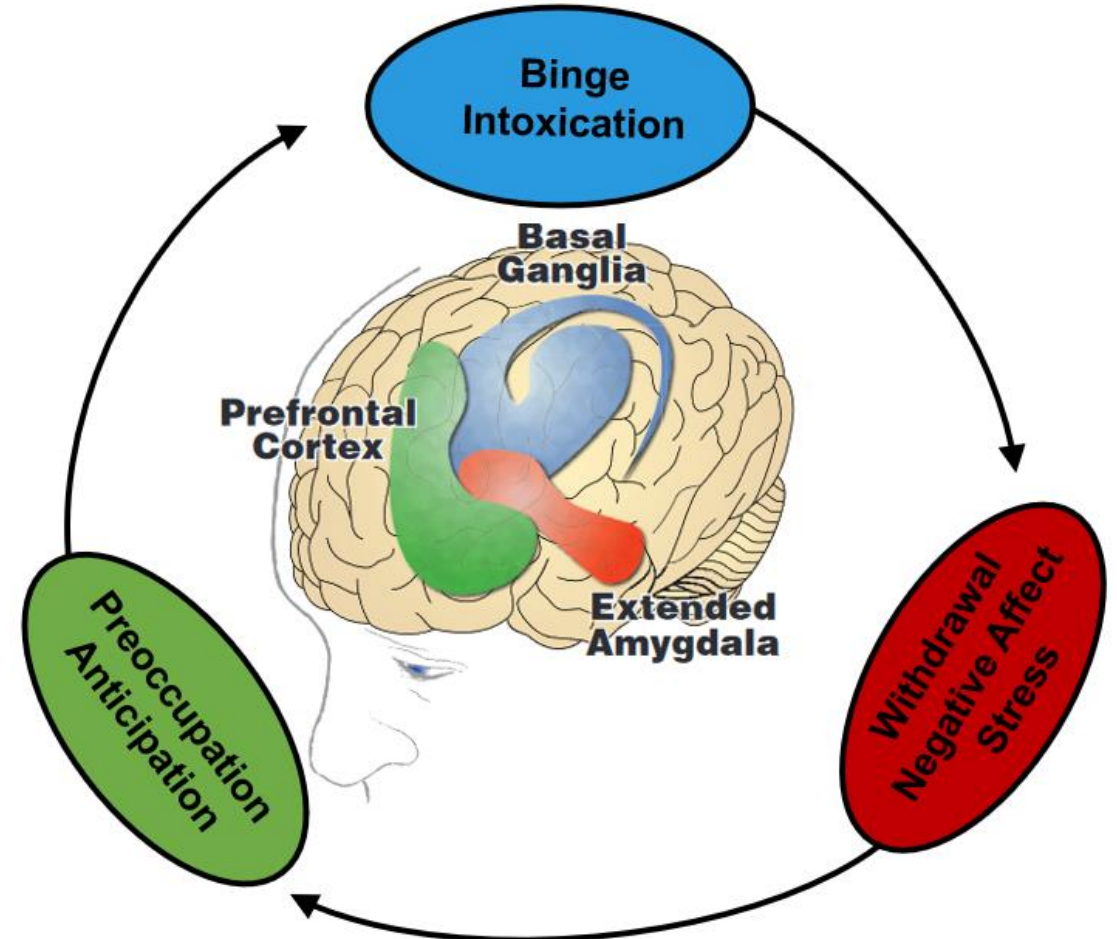
## Corticotropin-Releasing Factor



**CeA – Central Nucleus of Amygdala**  
**BST – Bed Nucleus of Stria Terminalis**

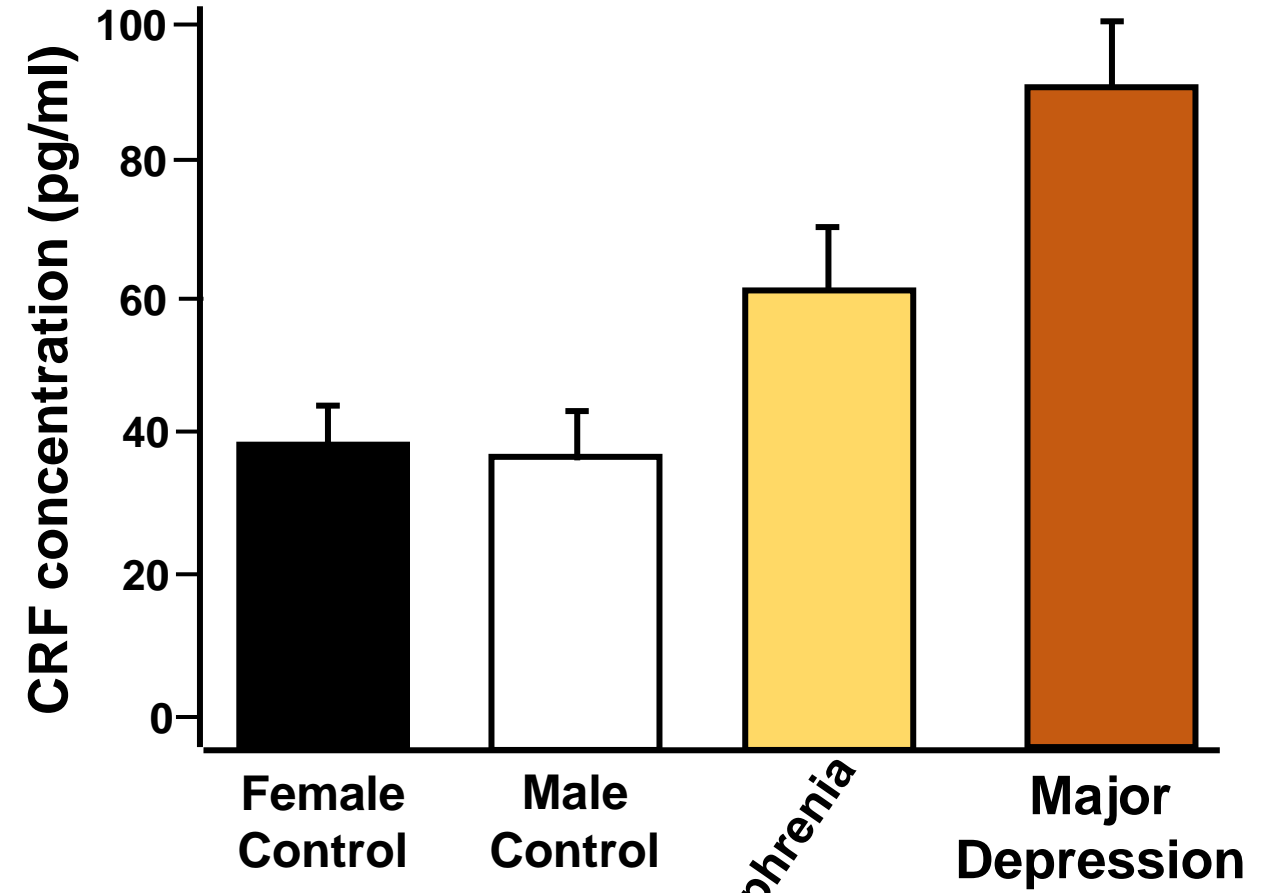
# Amygdala's role in drug withdrawal

<u>Drug</u>	<u>Amygdala stress (CRF) levels</u>
Cocaine	↑
Opioids	↑↑
Alcohol	↑↑↑
Nicotine	↑↑↑↑
$\Delta^9$ -THC	↑↑↑↑↑



# CRF and mental illness

- Increased CRF observed in schizophrenia and depression
- 2-fold higher in depression relative to control levels
- CRF also increased in people who attempt suicide



# Amygdala CRF and alcohol seeking

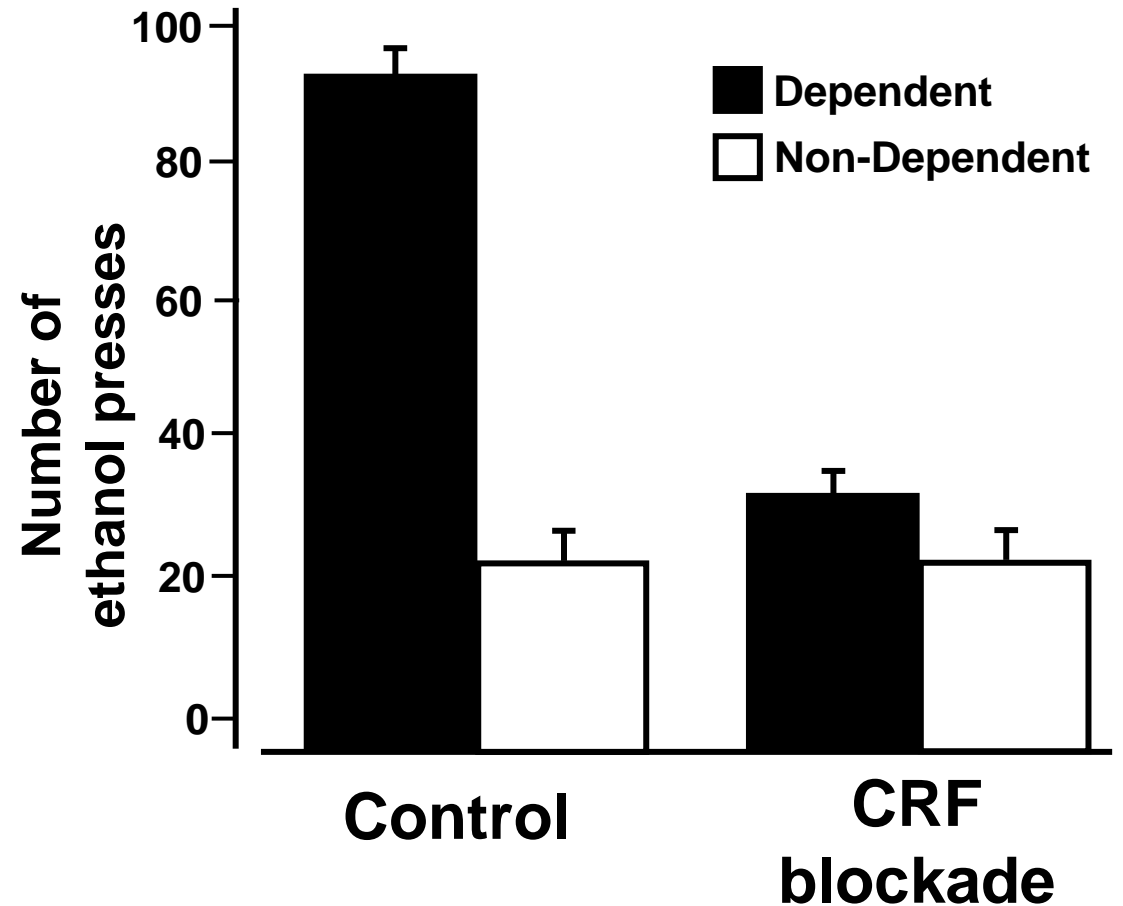


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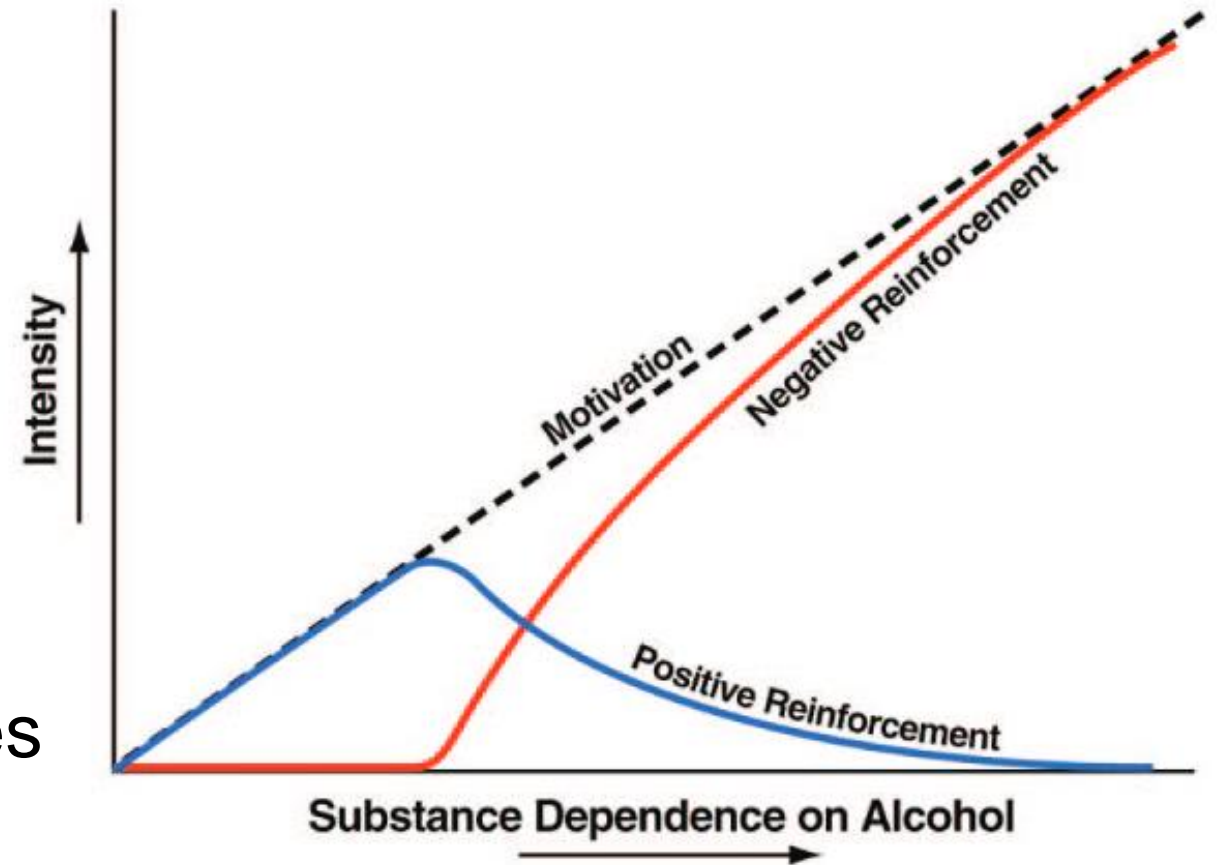
30-minute sessions of alcohol access

“Earn as much alcohol as you can in 30 minutes”

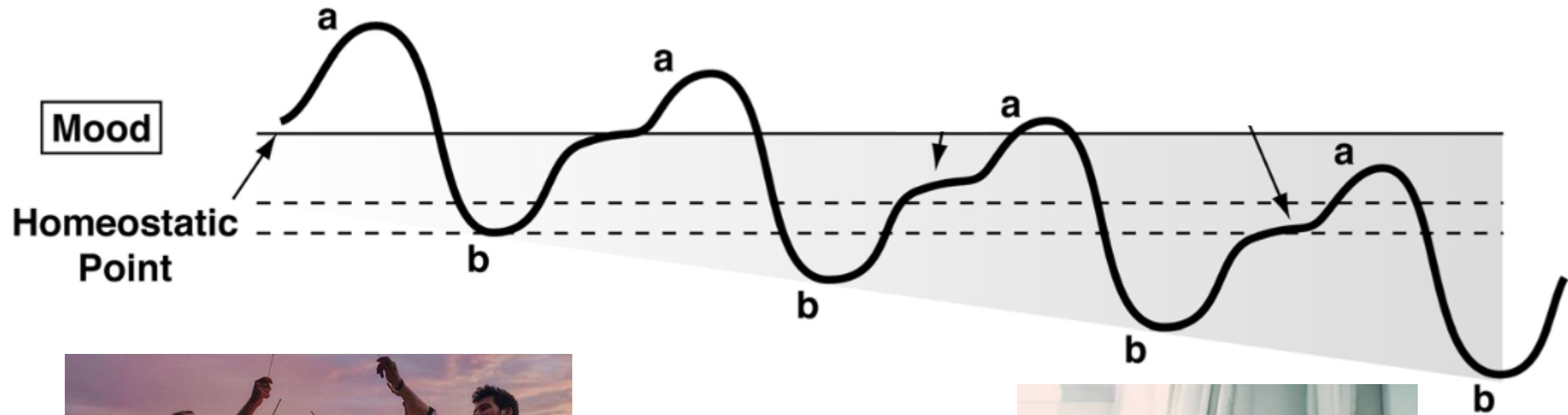


# Drug addiction isn't just about pleasure

- Drug use may start as a rewarding process
- Quickly shifts to using drugs to manage negative mood symptoms
- Contributes to high relapse rates across drugs (50%)



# Addiction is maintained through negative adaptations

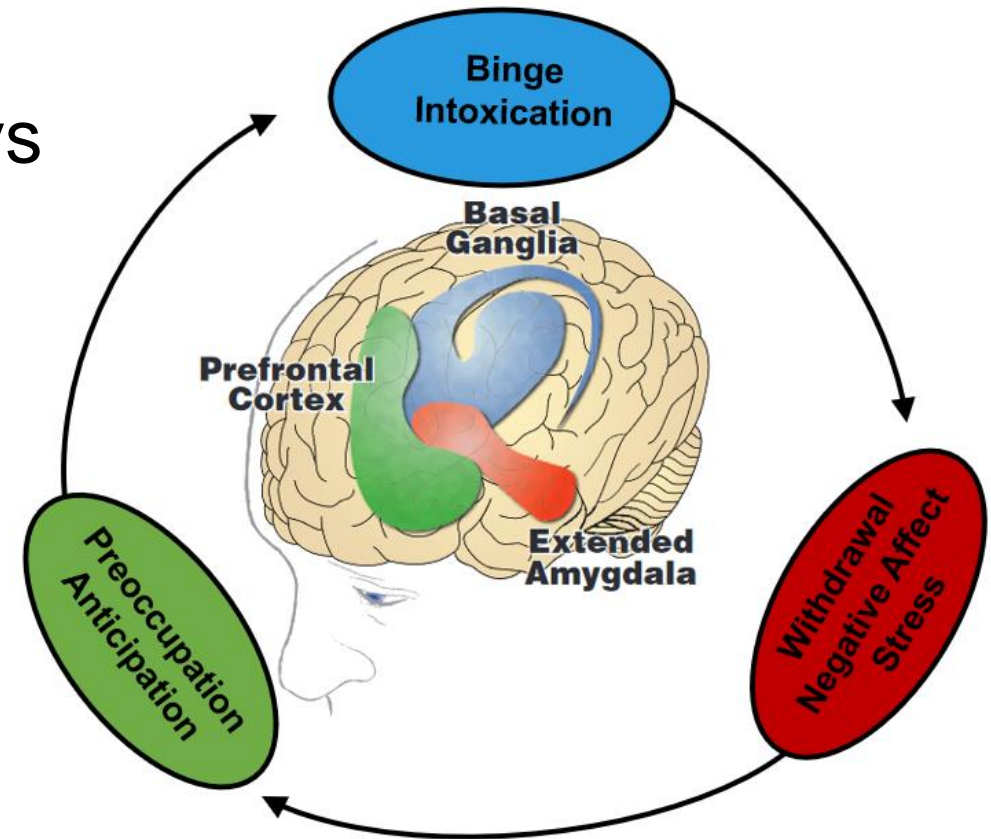


Koob (2013) *Frontiers in Psychiatry*

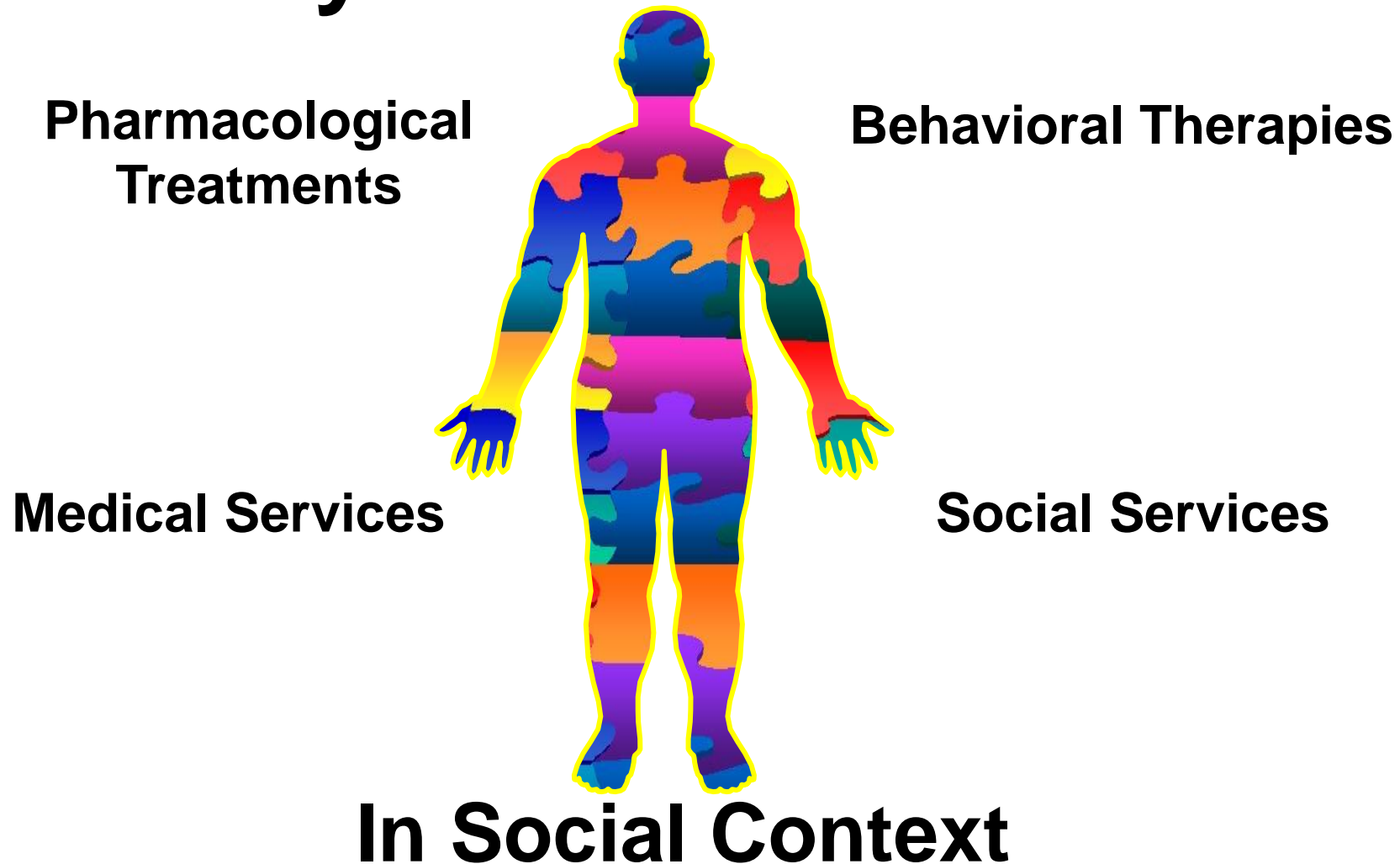


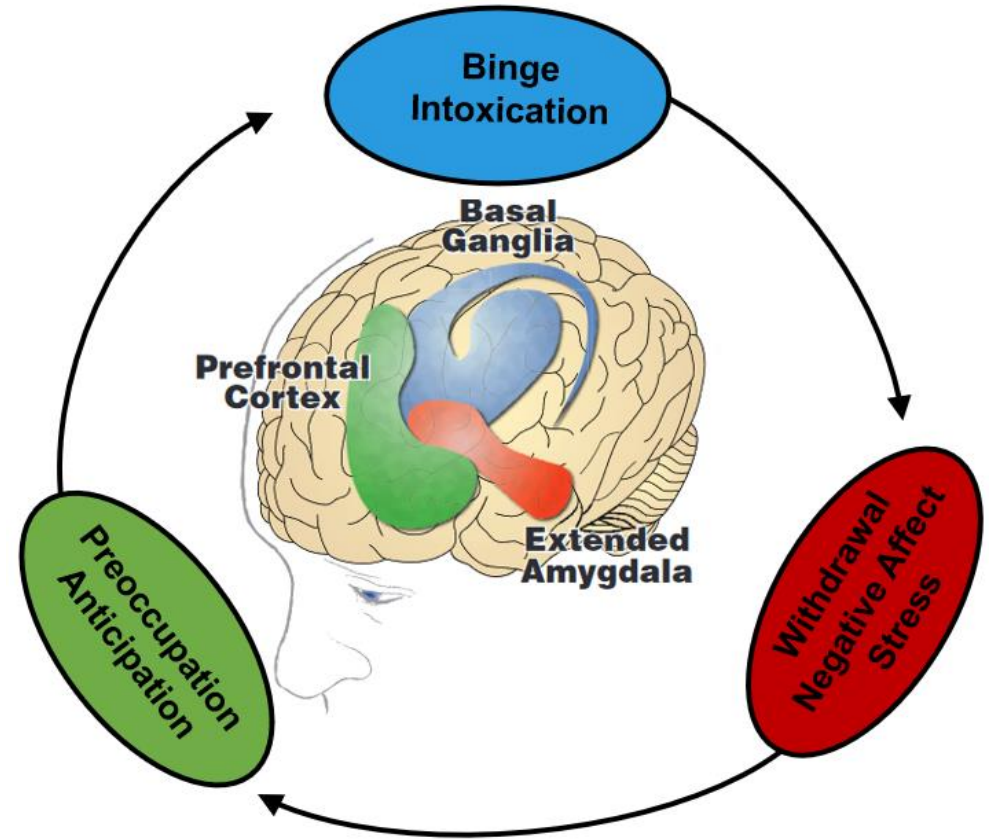
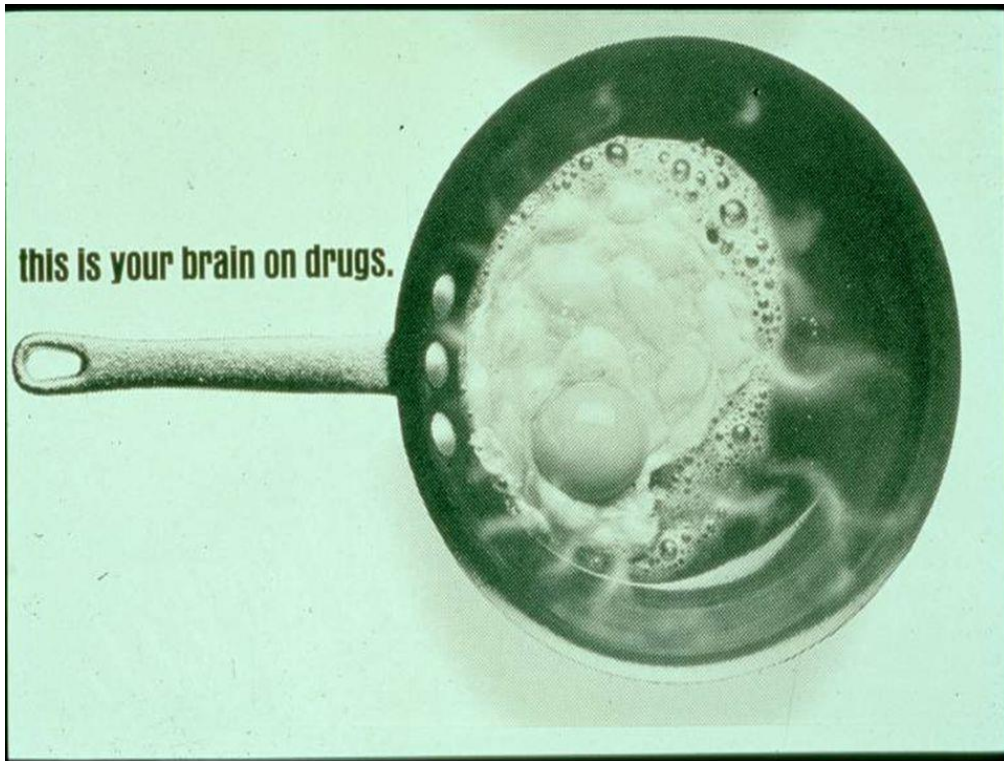
# Addiction is a brain disease

- The brain changes in very specific ways
- Drug use modifies and amplifies the brain's stress systems
- Other changes include:
  - Metabolic activity in the brain
  - Receptor availability
  - Gene expression
  - Responsiveness to environmental cues



# Addiction treatment must go beyond the chemistry





**Understanding addiction science can help reduce social stigma and increase treatment access and treatment success**



# Thank You for Joining Us This Week!

Our team will compile answers for any questions not addressed during the session. Find those answers on our Brain Awareness webpage in the following days:

<https://www.esc.edu/brain-awareness-week/>

For questions about the Brain Awareness Week at SUNY Empire, email [brainawareness@esc.edu](mailto:brainawareness@esc.edu).

