



# Neurobiology of Addiction

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# Objectives

Understand

Understand addiction as an illness

Understand

Understand the biologic basis of addiction

Understand

Understand how current treatment trends work towards the above







What is Addiction?

Compulsive behavior  
despite harmful  
consequences















# Addiction

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A brain disease, not a moral failure





What is Addiction?

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Cravings

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Loss of Control

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Physiologic Dependence

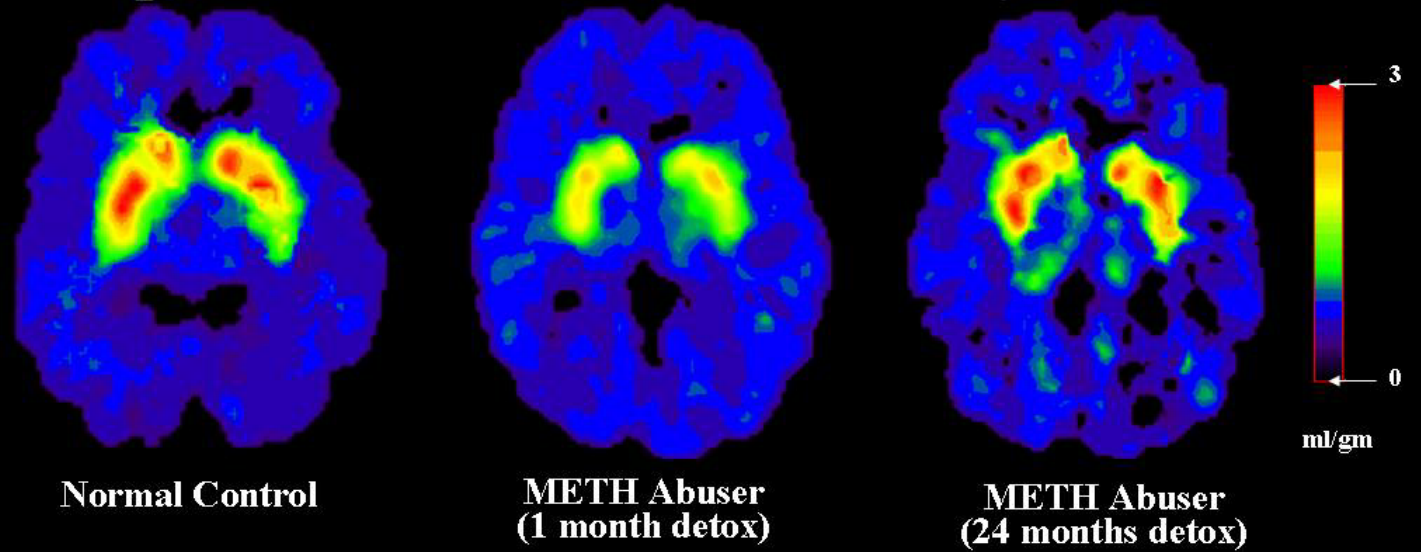


# Addiction is a Disease

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## 4. ADDICTION CAN BE TREATED

Partial Recovery of Brain Dopamine Transporters  
in Methamphetamine (METH)  
Abuser After Protracted Abstinence




Source: Volkow, ND et al., *Journal of Neuroscience* 21, 9414-9418, 2001.



# What Does it Take to be Addicted?

- Bad childhood?
- Traumatic event?
- Bad friends?

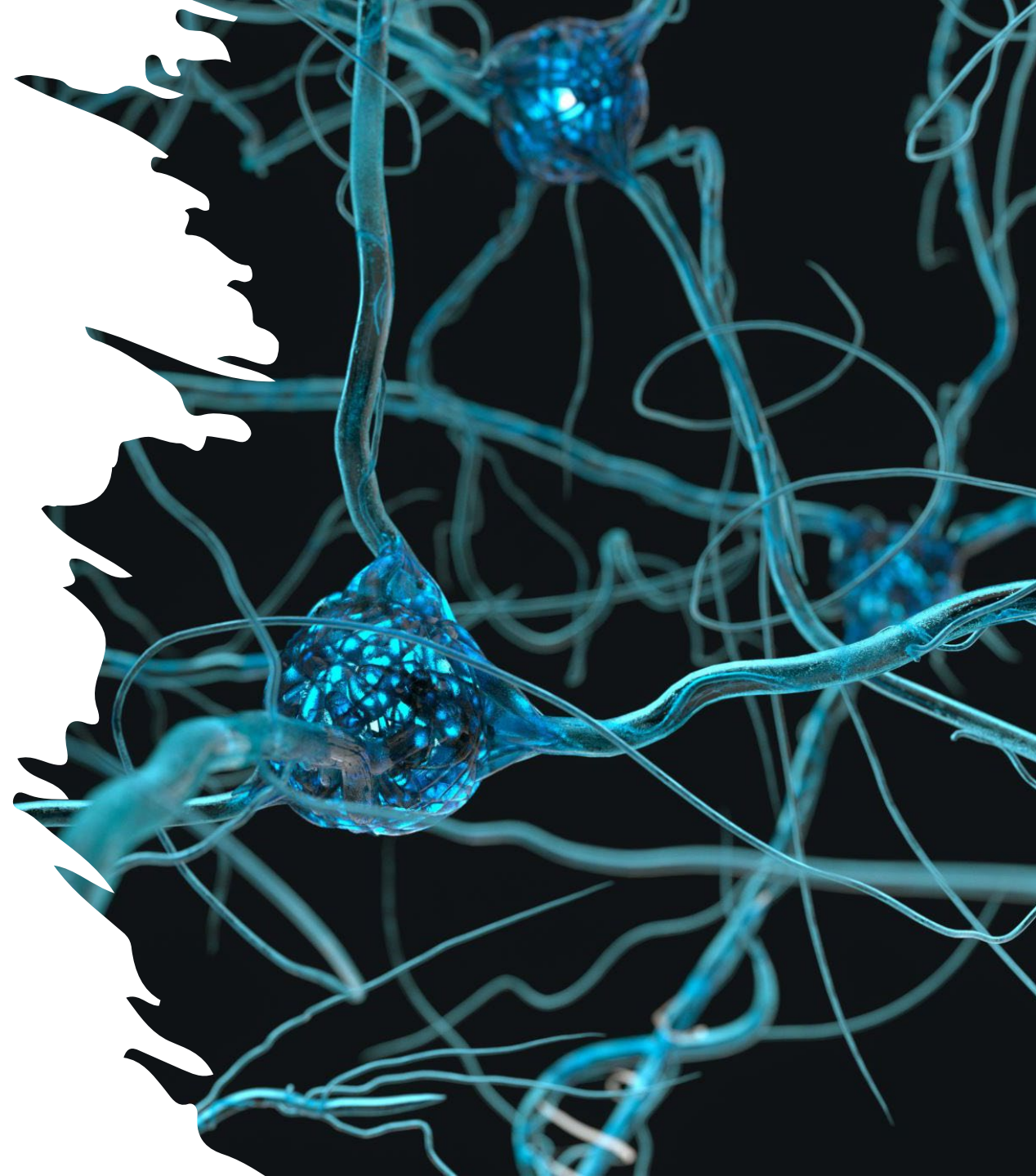
What Does  
it Take to be  
Addicted?



Exposure to addictive  
substance

# Brain's Response to Exposure

1. Activation of reward circuit
2. Change in receptor density
3. Alteration in neurotransmitter levels

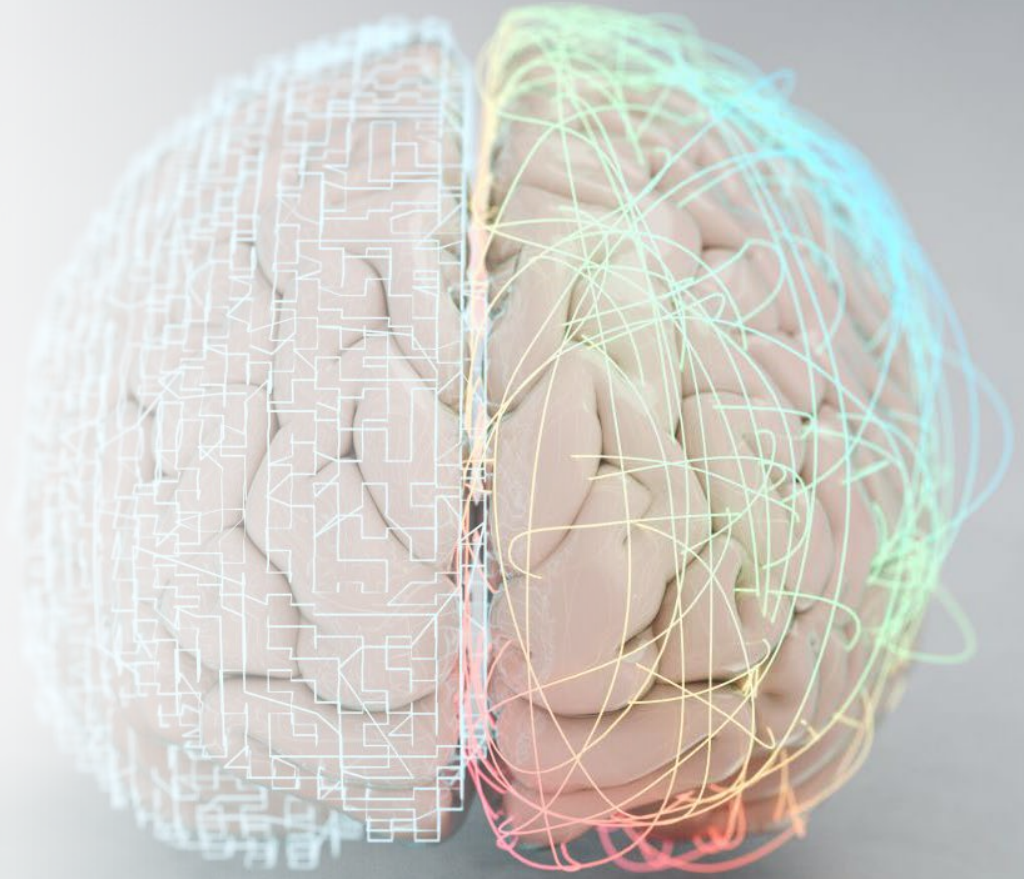


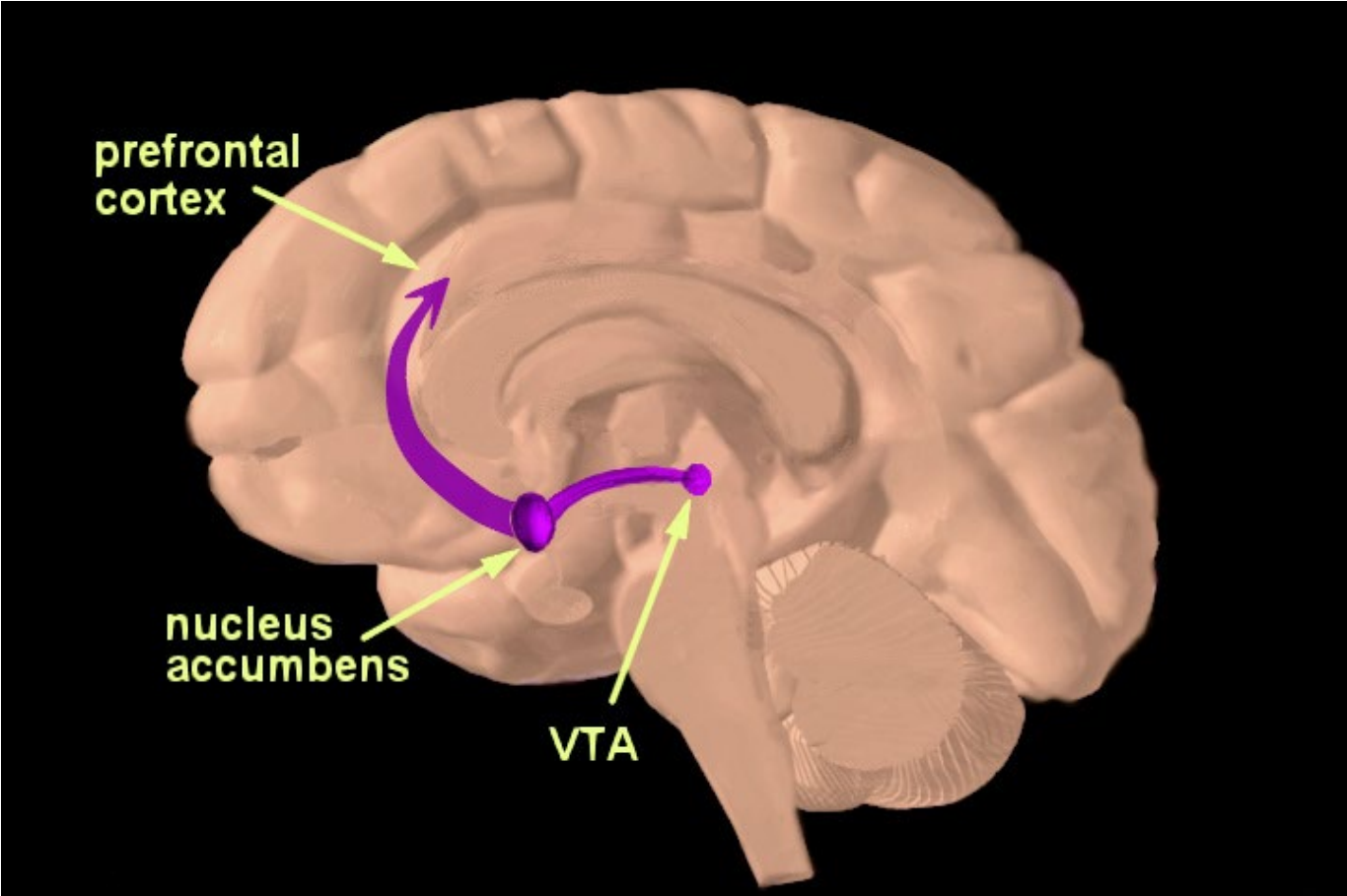


## Activation of Reward Circuit

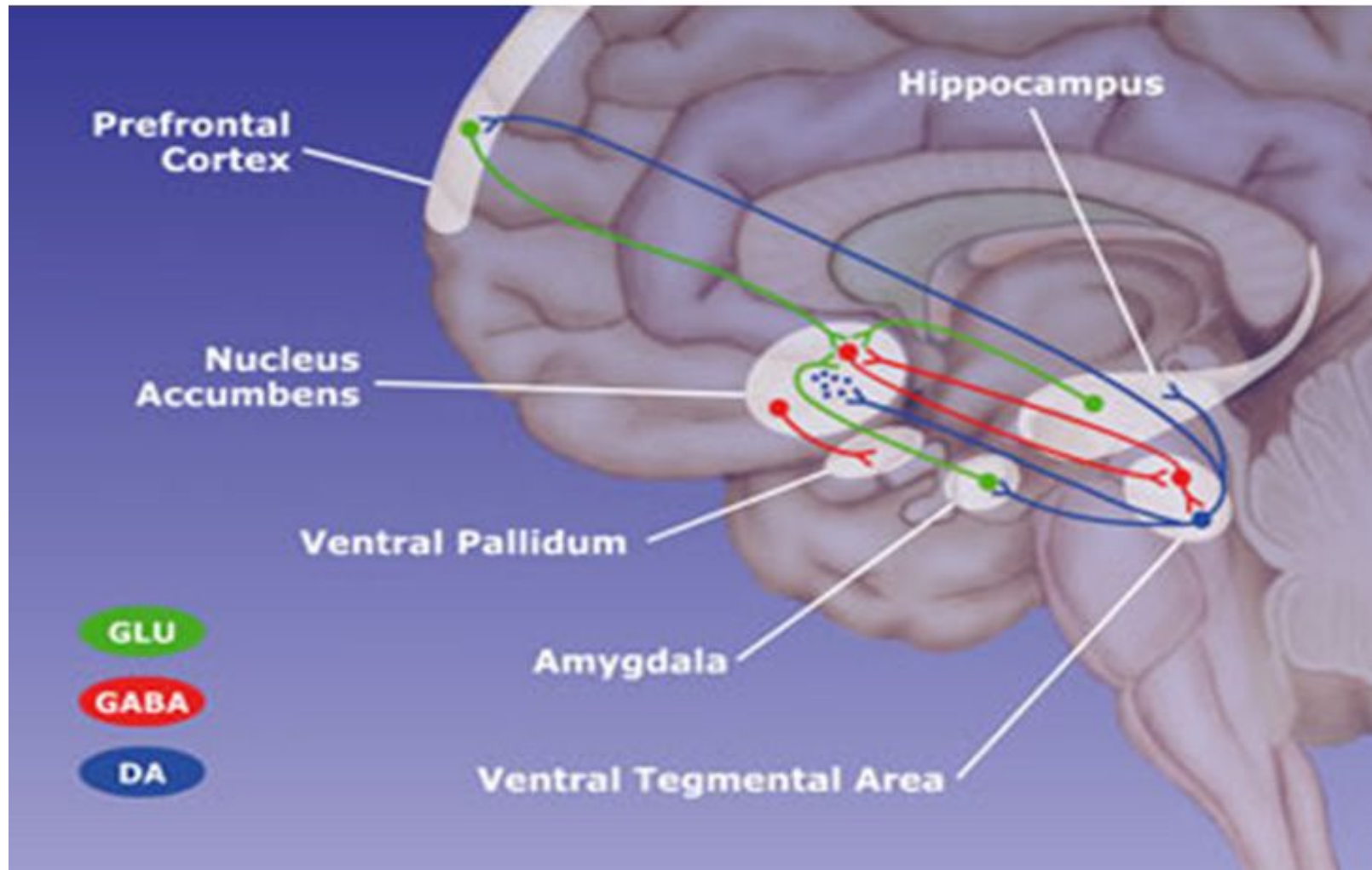
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- An area of the brain that is involved in a feedback loop of reinforcement:
  - Nucleus Accumbens
  - Ventral Tegmental Area





# The Reward Circuit



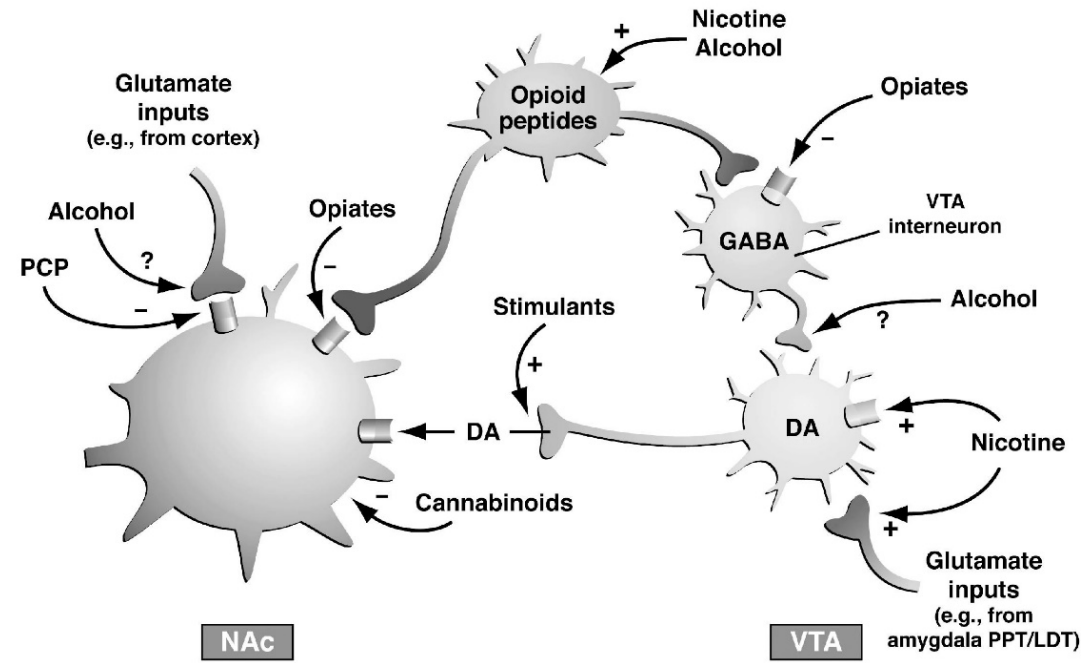


# Reward Circuit

- Tells the individual what to repeat in order to obtain reward
- Builds pathways and connections that remain



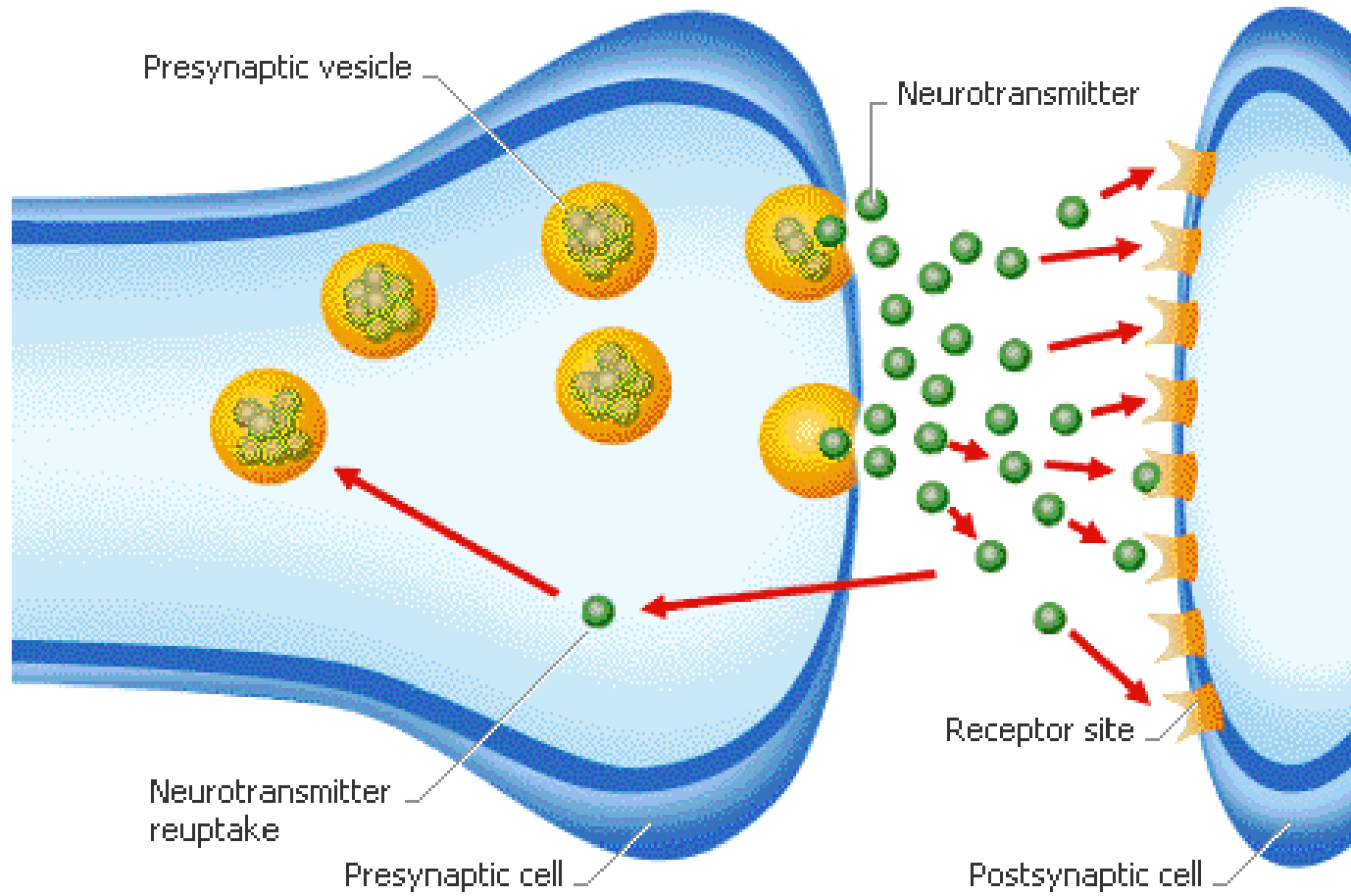
# Reward Circuit



# Change in Receptor Density

- When more of a substance is available, the body makes more receptors
- This requires more of the substance to feel the same effects





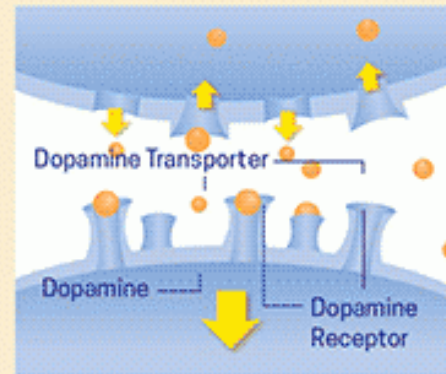
## Some drugs target the brain's pleasure center

Brain reward (dopamine pathways)



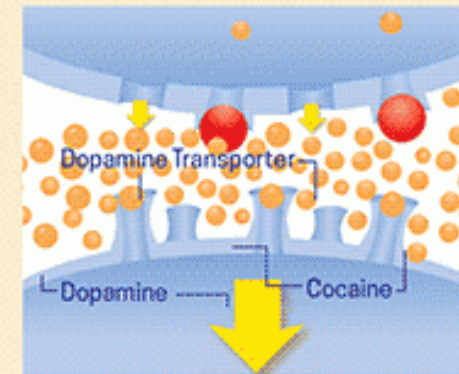
*These brain circuits are important for natural rewards such as food, music, and sex.*

How drugs can increase dopamine



**While eating food**

*Typically, dopamine increases in response to natural rewards such as food. When cocaine is taken, dopamine increases are exaggerated, and communication is denied.*



**While using cocaine**

Alteration in Neurotransmitter Level

Drugs

Food

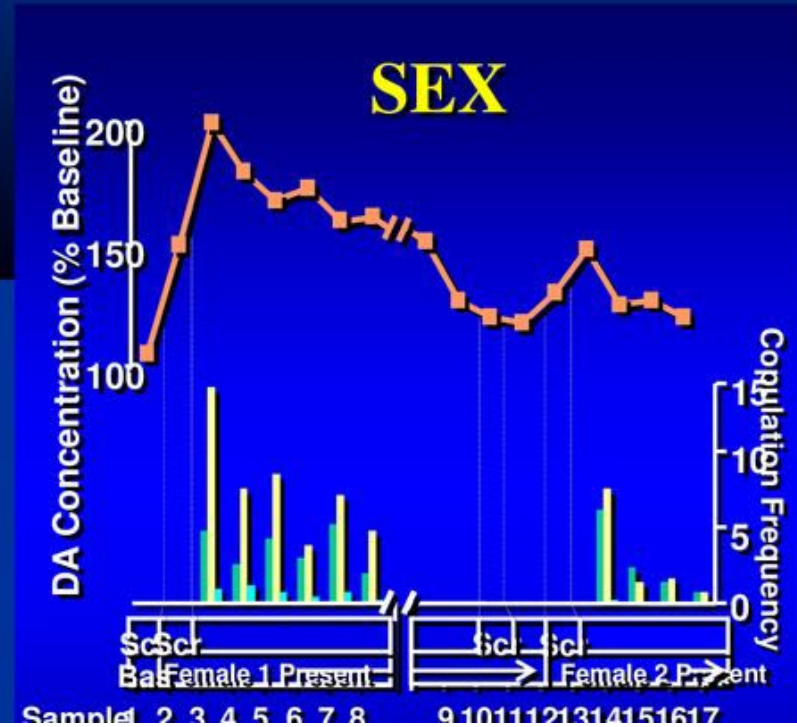
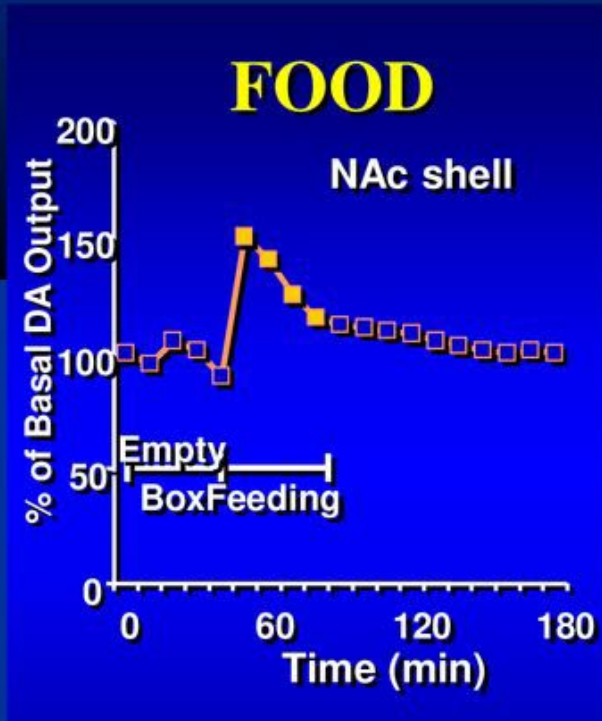
REWARD CENTER

Sex

Social  
Interaction

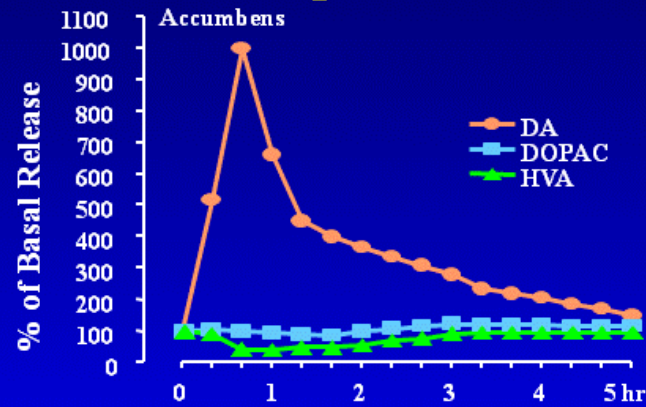


# Natural Rewards Elevate Dopamine Levels

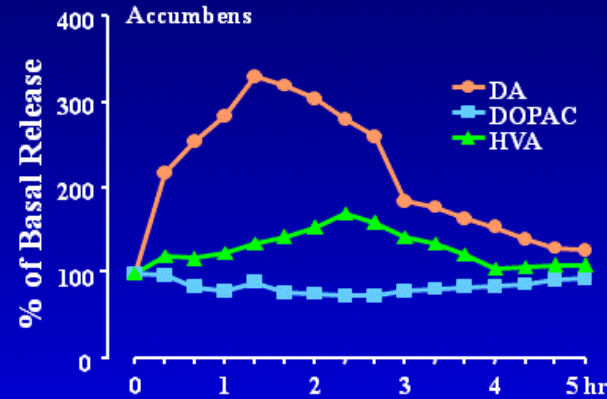


# Effects of Drugs on Dopamine Release

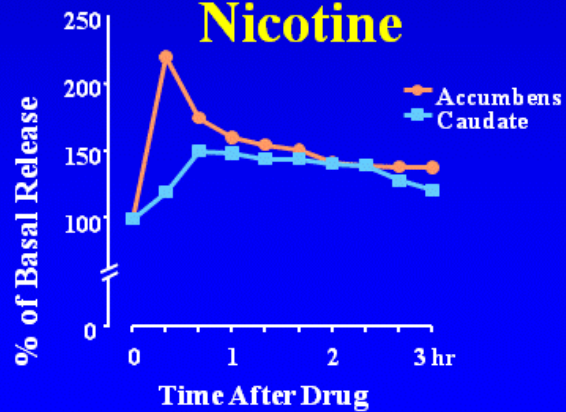
## Amphetamine



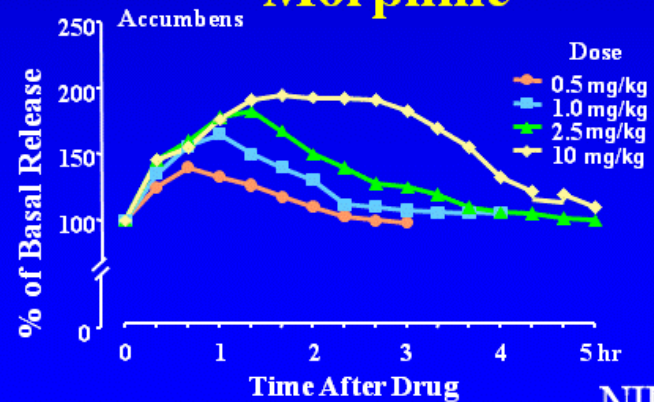
## Cocaine



## Nicotine



## Morphine



# Other Considerations

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- Childhood is important
- Genetics is the most important factor
- Do not fall for the fallacy that some patients can be safely exposed to an addictive substance based on their background





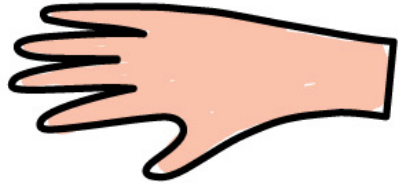


# Adverse Childhood Experiences

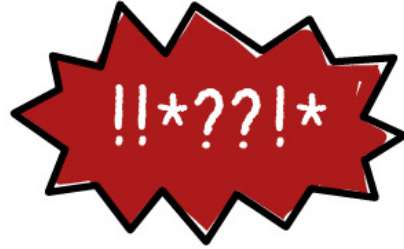
## Abuse



Physical abuse



Sexual abuse



Verbal abuse

## Neglect



Emotional neglect



Physical neglect

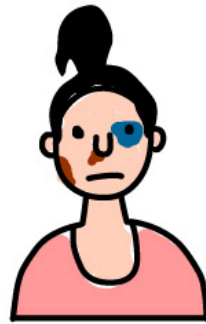
## Growing up in a household where:



There are adults with alcohol and drug problems



There are adults with mental health problems



There is domestic violence



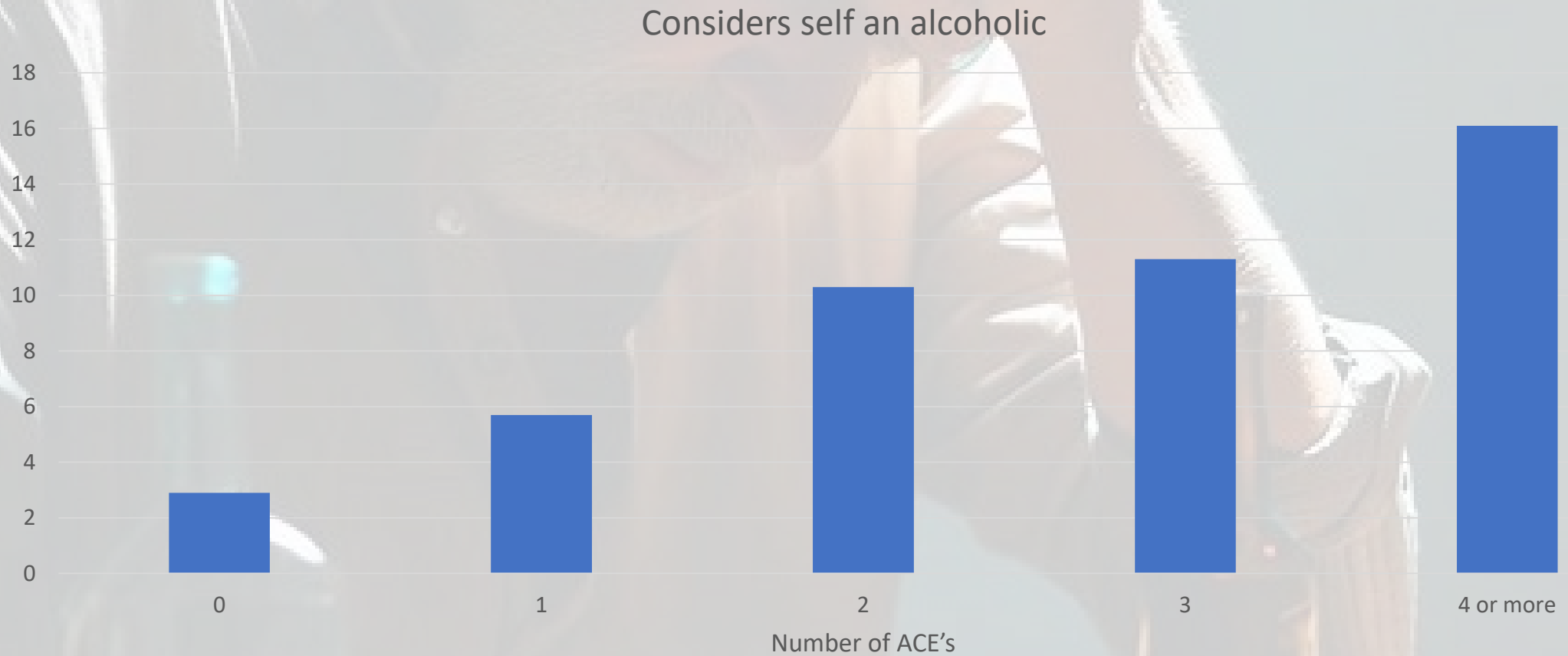
There are adults who have spent time in prison



Parents have separated

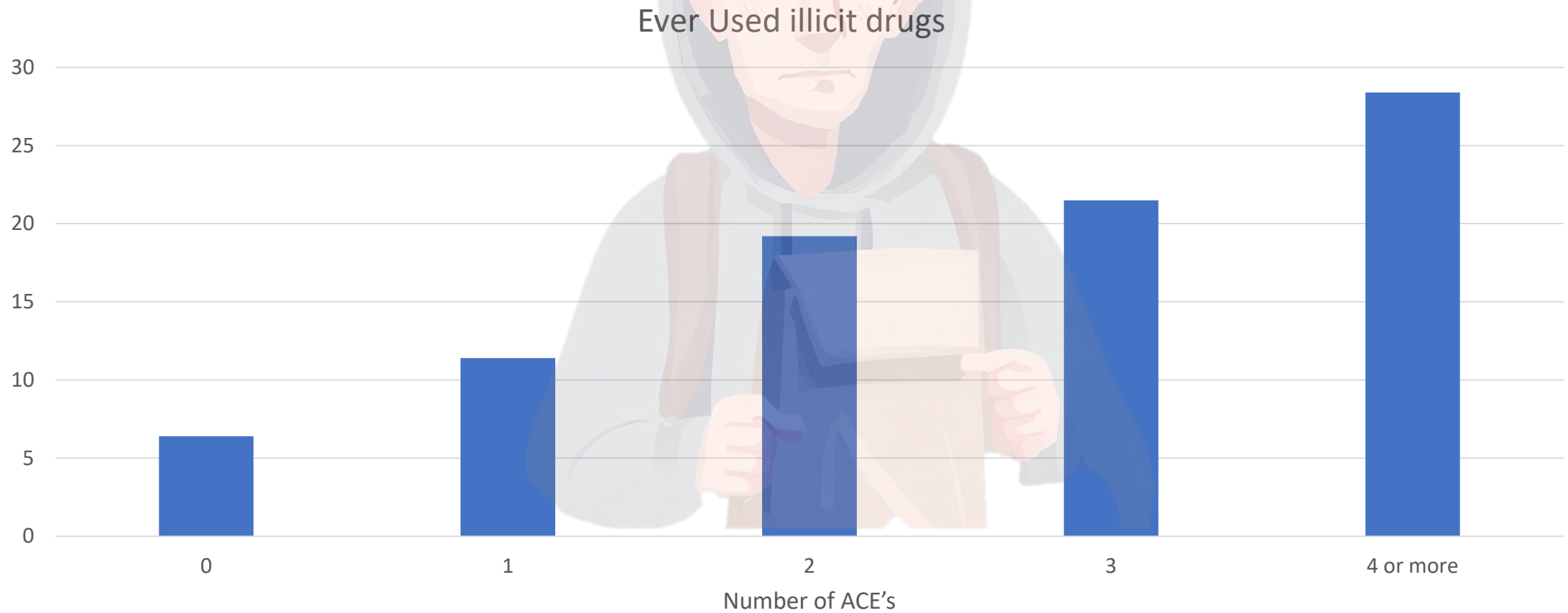
# ACE's and Addiction

## -The Original Ace's Study



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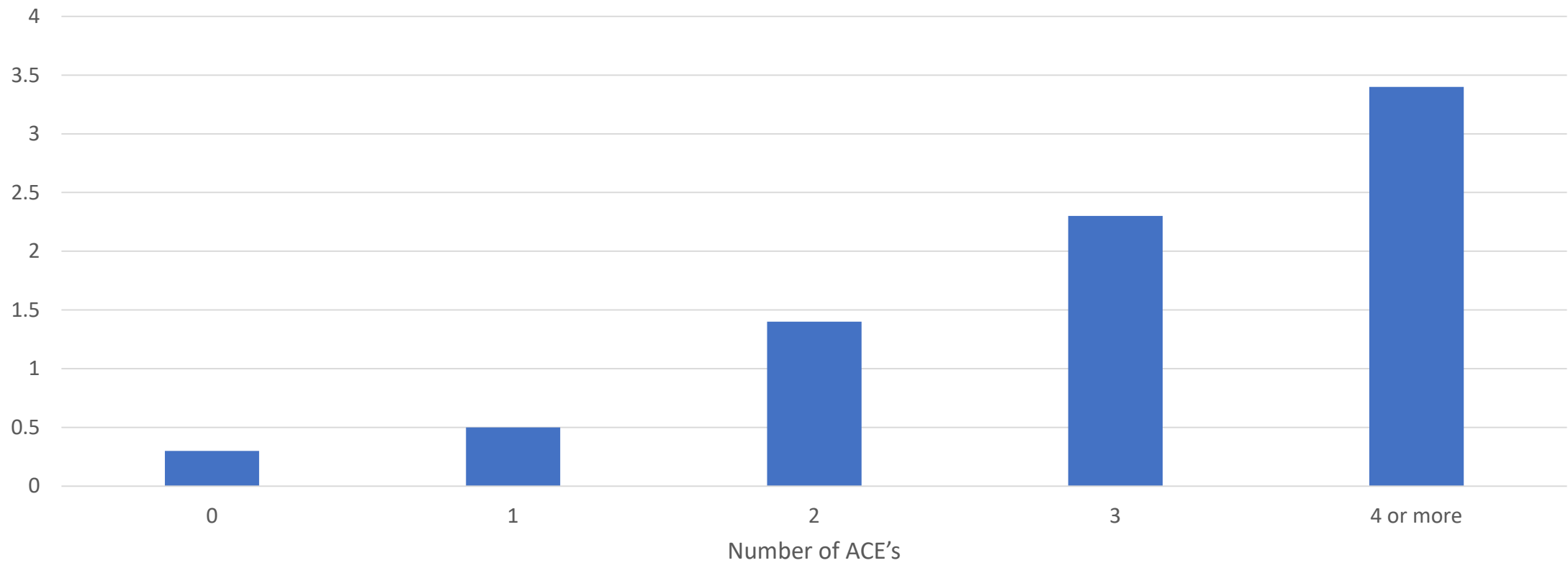


# ACE's and Addiction

## -The Original Ace's Study



Ever injected drugs



# Other Studies

- Early initiation of drug use
  - Each ACE increases risk 2-4 fold
- Drug use problems, addiction, and parenteral drug use
  - 5 or more ACE's increase risk 7-10 fold

Overall Addiction Risk  
Attributed to ACE's

• 67%



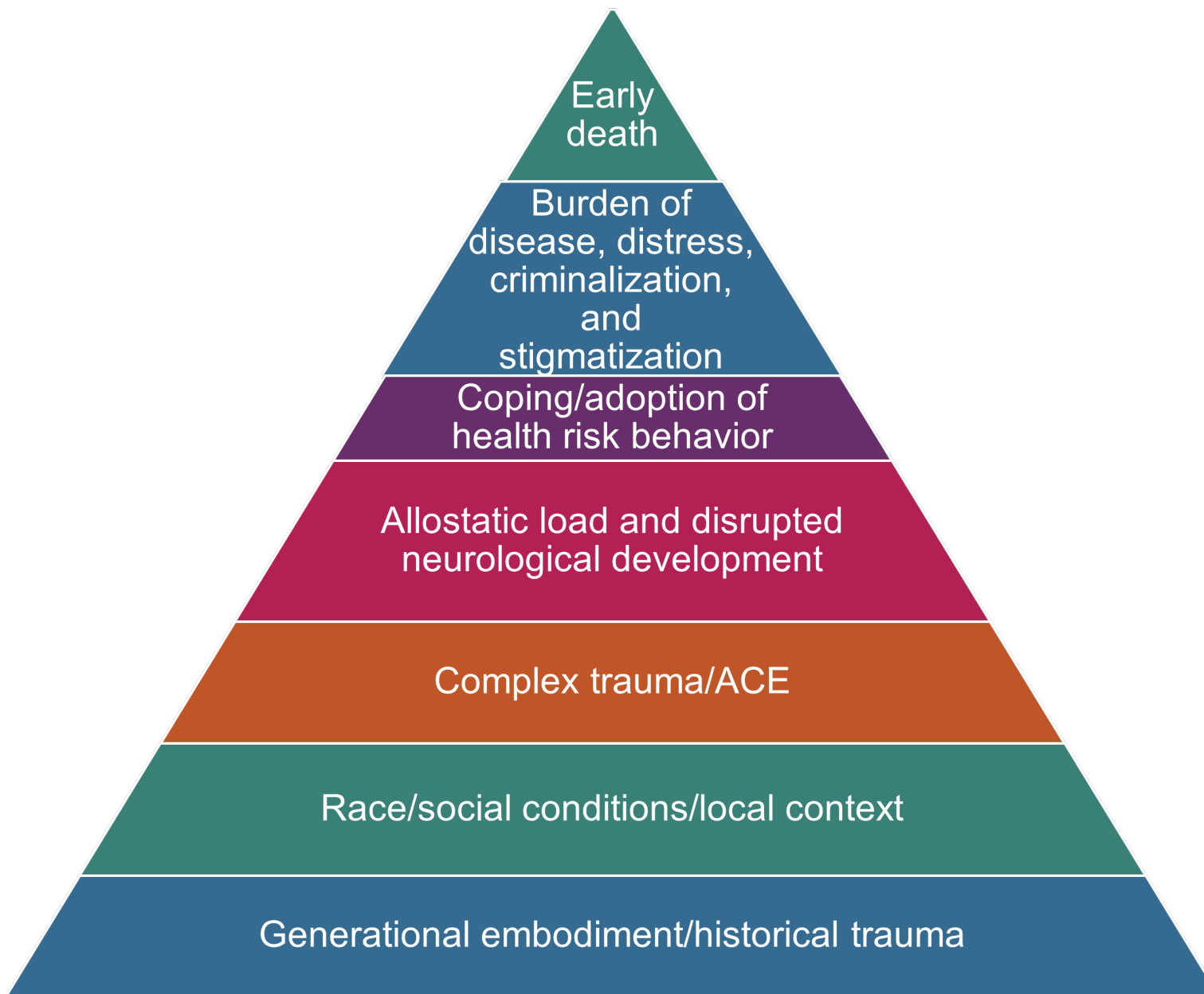
# ACE's in Individuals Entering Treatment

A 1-point increase in the ACE is associated with a 1.1. factor increase in reporting a lifetime overdose

Higher ACEs were associated with lower age at initiation







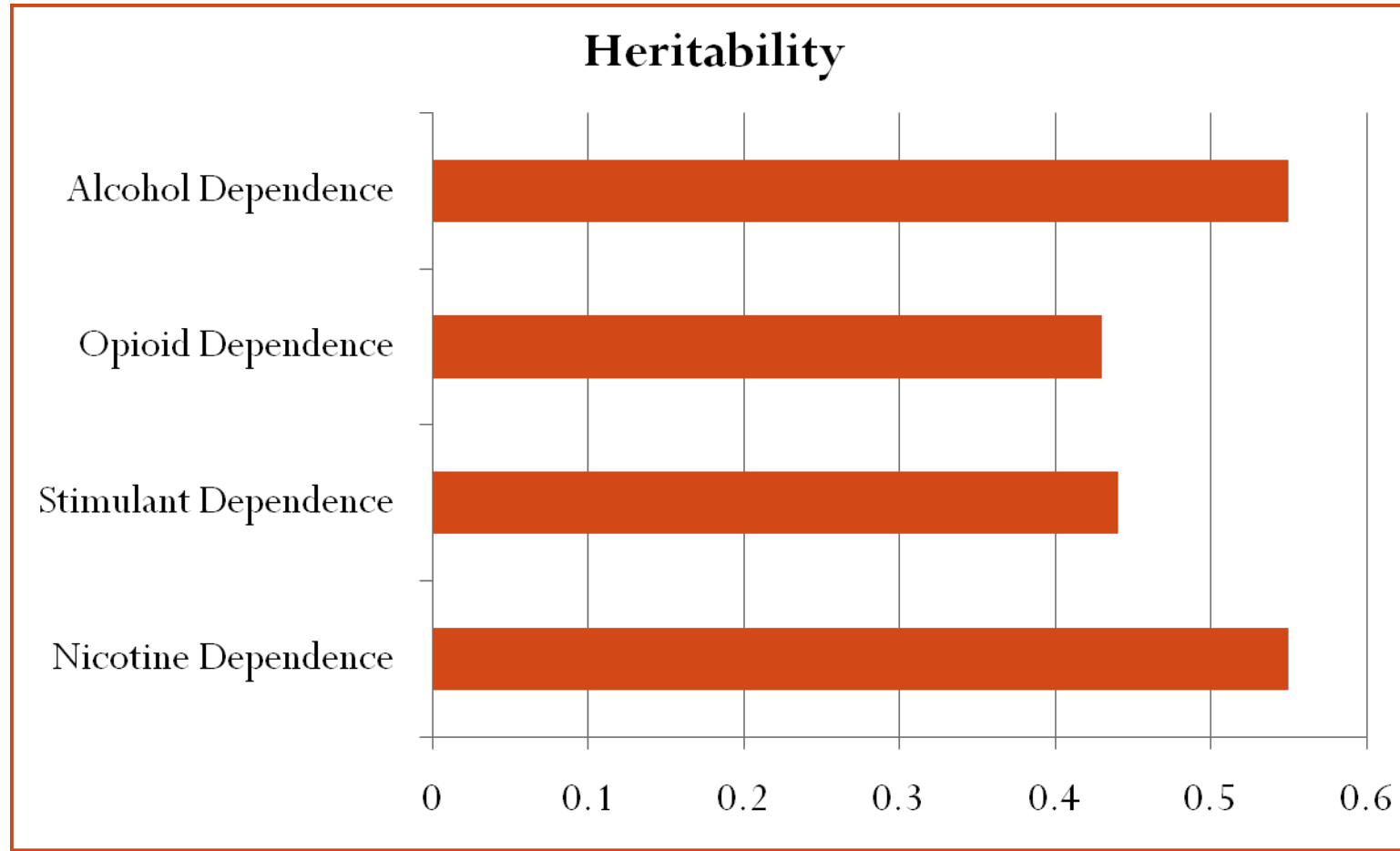


# GENETICS

## **Research suggests that:**

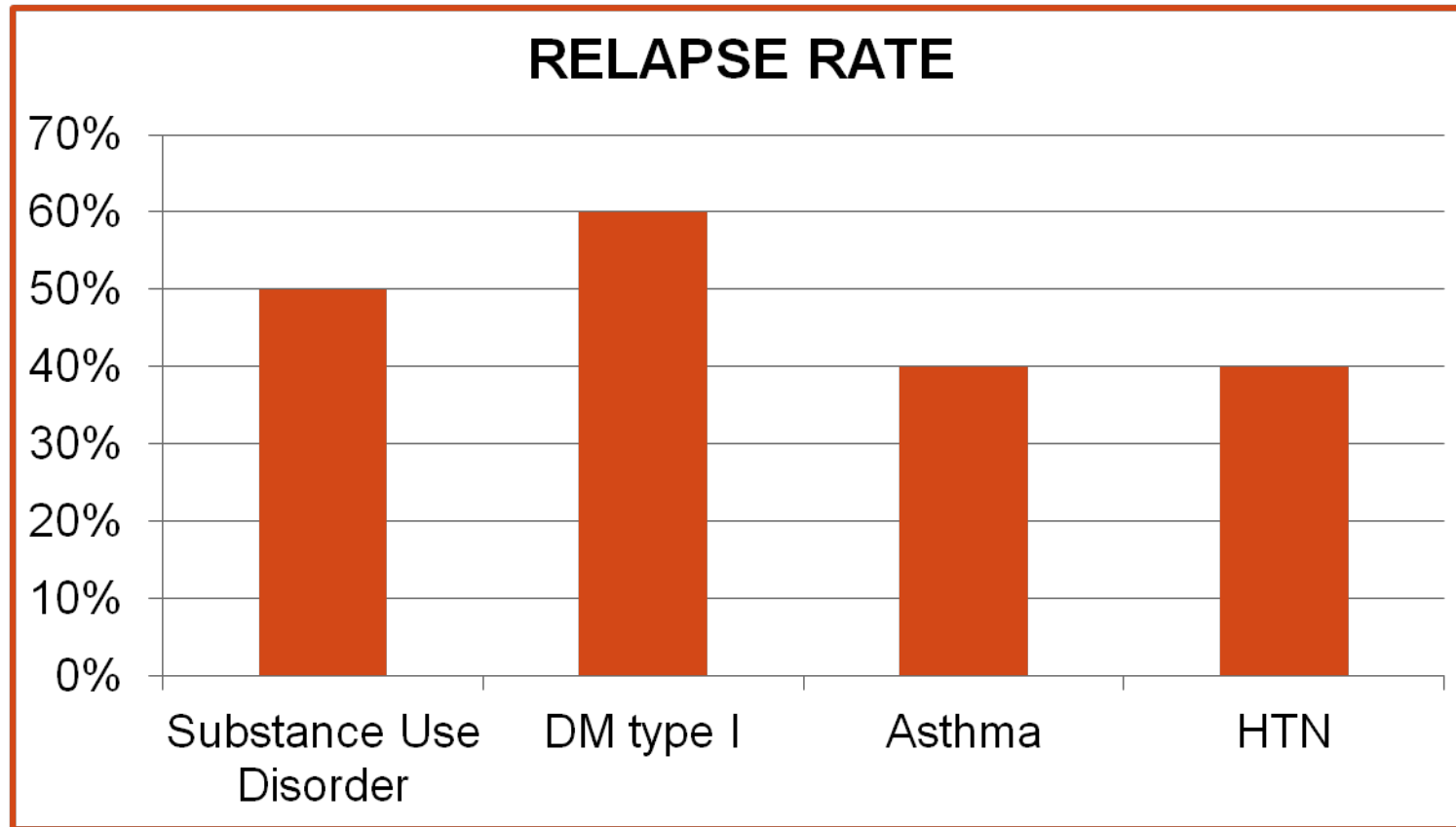
- Genetics account for 40-60% of a person's risk of developing a substance use problem.
- Alcohol addiction is about 50% heritable, while addiction to other drugs is as much as 70% heritable.
- Shared genetic risk variants across different substance use disorders provide insight into the mechanisms that underlie these disorders.

# Genetics of Addiction





# Substance Use Disorder As Chronic Illness



# Epigenetics

- Epigenetics is the regulation of gene expression. Epigenetic mechanisms include: DNA modifications, DNA methylation, Histone modifications.

- **Epigenetic adaptations can affect:**

- Susceptibility to addiction
- Response to drugs of abuse
- Response to pharmacotherapy for addictions
- Health
- Expression of traits passed to children

# CONCLUSIONS

- **Addiction is a disease caused by several factors**
- **Addiction is inevitable in certain situations**
- **Addiction is created by the science of the substance (medication)**
- **All individuals (patients) are at risk**
- **Childhood is important**
- **Mother Teresa would get addicted if treated long enough**







**Questions?**

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