

LECTURE 2

USE TO ABUSE: SUBSTANCE USE DISORDERS (SUD_s) AND THE BRAIN

KEY CONCEPTS

Textbook makes two points worth (re-)highlighting as we begin:

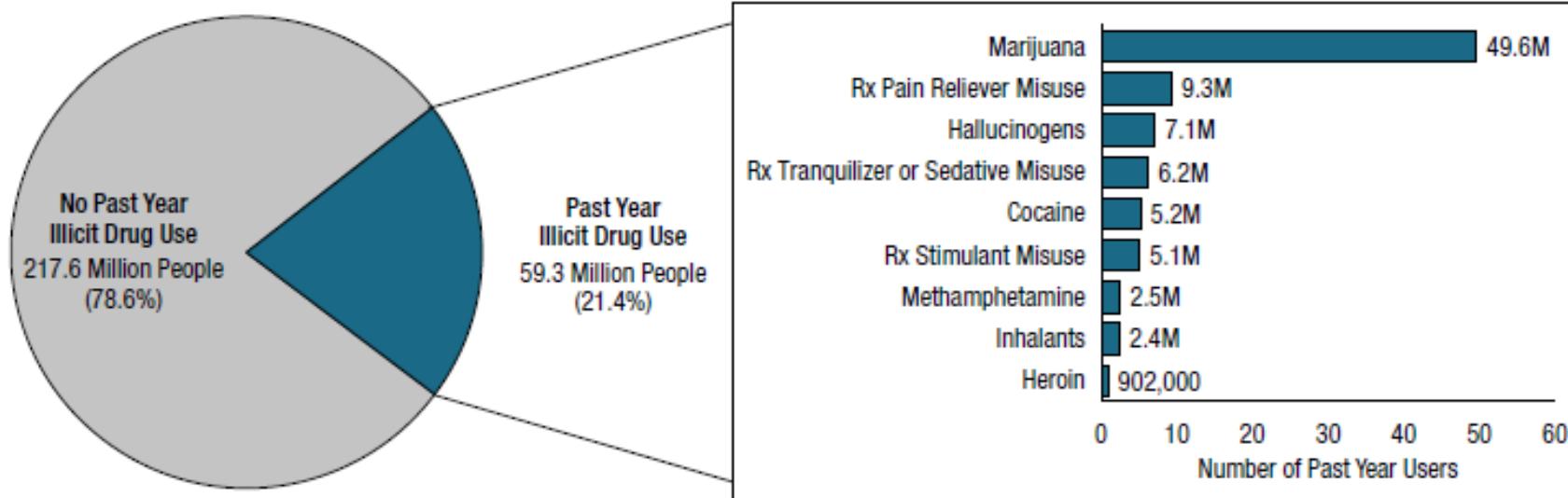
I) Different types of drug-taking behavior apply to all drugs

For *less familiar* drugs, we have a tendency to assume that if a person uses it at all, they are “addicted”.

2) However, most people who use any drug are *not* addicted

Why do some people get addicted, but not others?

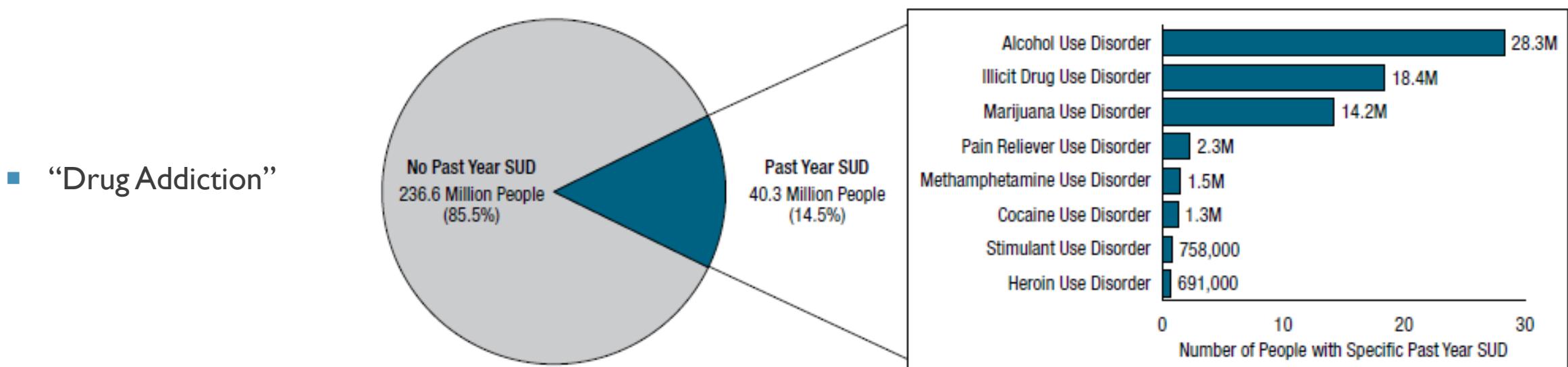
Figure 9. Past Year Illicit Drug Use: Among People Aged 12 or Older; 2020



Rx = prescription.

Note: The estimated numbers of past year users of different illicit drugs are not mutually exclusive because people could have used more than one type of illicit drug in the past year.

Figure 27. People Aged 12 or Older with a Past Year Substance Use Disorder (SUD); 2020



Note: The estimated numbers of people with substance use disorders are not mutually exclusive because people could have use disorders for more than one substance.

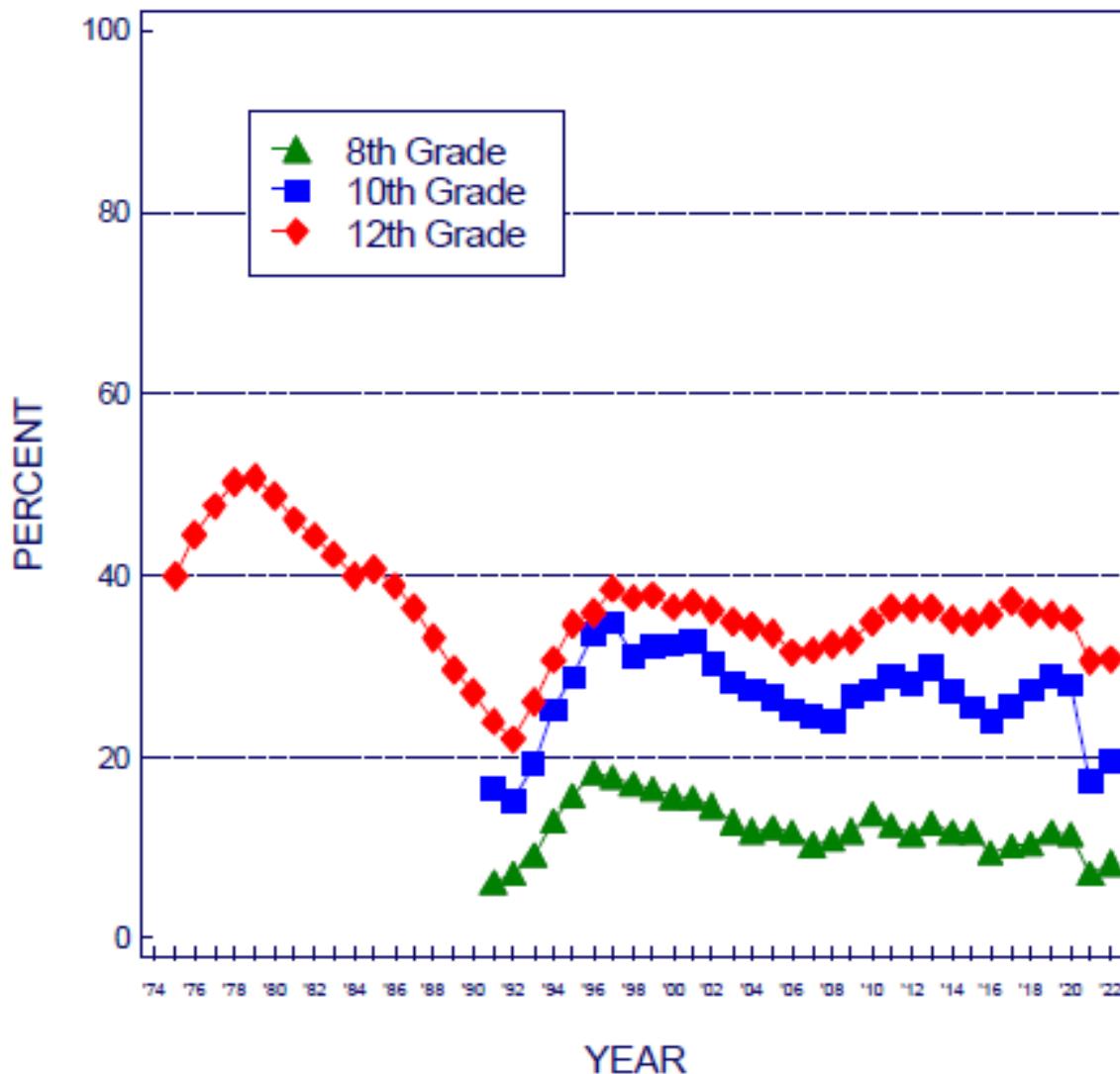
DRUG USE TO ABUSE

- **Gateway** - One of the first drugs used by a typical drug user.
 - Alcohol and tobacco (followed by marijuana) are sometimes considered gateway drugs.
- Gateway substances are perhaps best thought of as early indicators of a general pattern of behavior resulting from a variety of psychosocial risk factors.



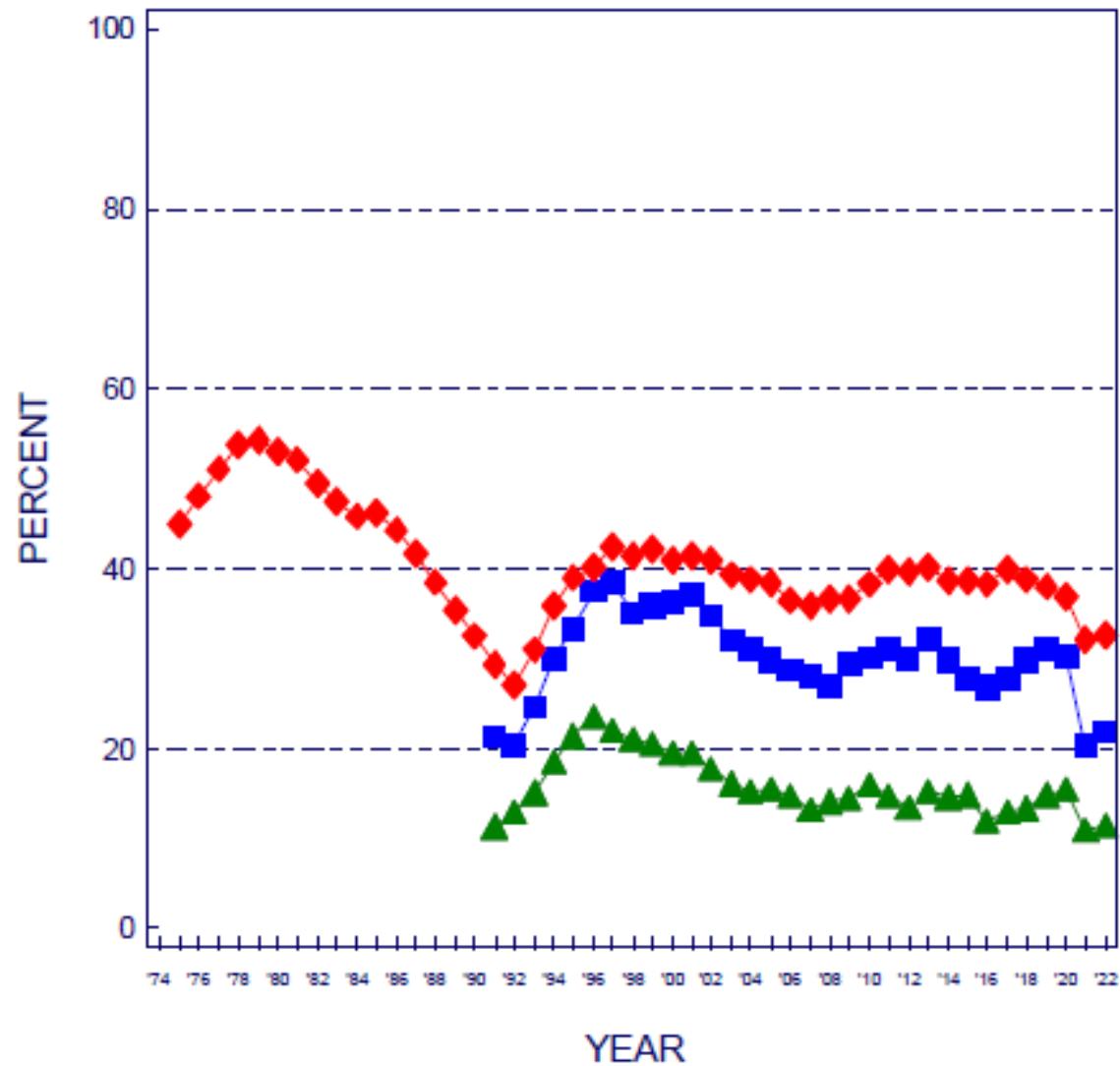
Marijuana Use

% who used in last 12 months



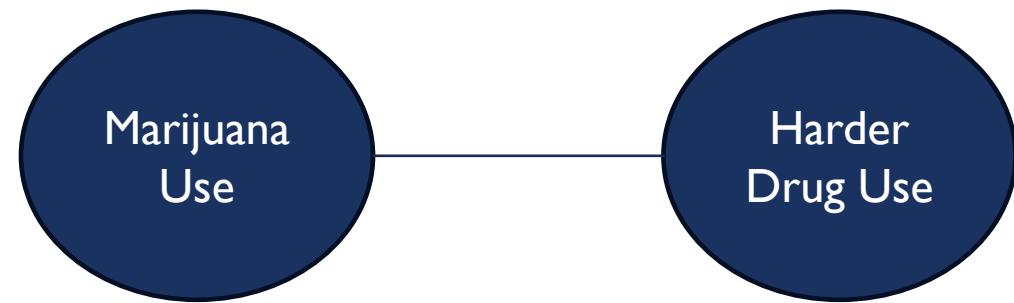
Use

% who used **any illicit drug** in last 12 months



IS MARIJUANA A GATEWAY DRUG?

- There *is* a positive correlation between marijuana use and use of “harder” drugs (heroin, cocaine, etc)



GATEWAY HYPOTHESIS

- Where did it come from?
- A **correlational** study from the 1970s....

DENISE KANDEL

Biometrics Research, New York State Psychiatric Institute, and School of Public Health and Department of Psychiatry, Columbia University, New York 10032

- Gateway Hypothesis describes a sequence of drug use:
 - 1) alcohol & tobacco
 - 2) marijuana
 - 3) harder illicit drugs

Stages in Adolescent Involvement in Drug Use

Abstract. Two longitudinal surveys based on random samples of high school students in New York State indicate four stages in the sequence of involvement with drugs: beer or wine, or both; cigarettes or hard liquor; marihuana; and other illicit drugs. The legal drugs are necessary intermediates between nonuse and marihuana. Whereas 27 percent of high school students who smoke and drink progress to marihuana within a 5- to 6-month follow-up period, only 2 percent of those who have not used any legal substance do so. Marihuana, in turn, is a crucial step on the way to other illicit drugs. While 26 percent of marihuana users progress to LSD, amphetamines, or heroin, only 1 percent of nondrug marihuana users and 4 percent of legal drug users do so. This sequence is found in each of the 4 years in high school and in the year after graduation. The reverse sequence holds for regression in drug use.

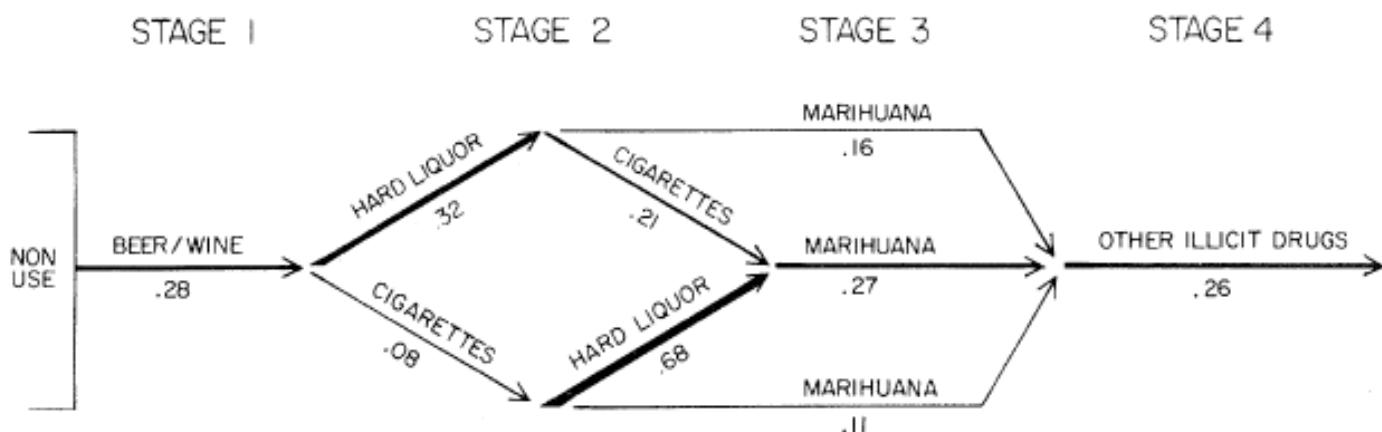
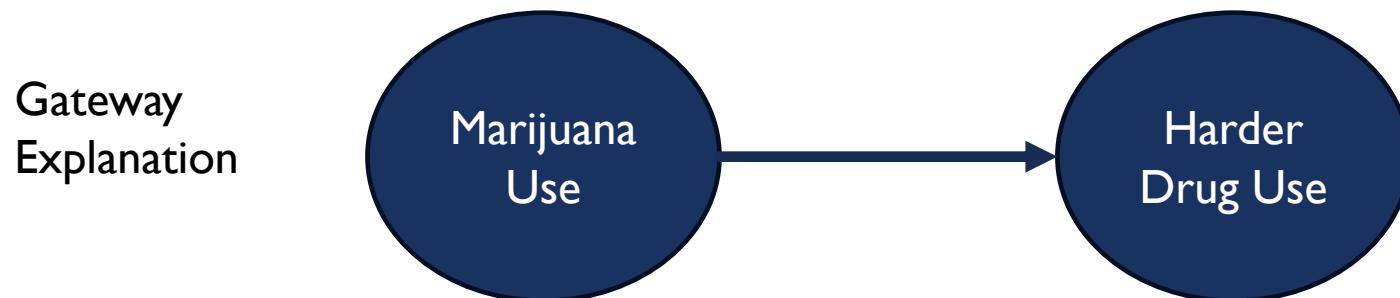


Fig. 1. Major changes of adolescent involvement in drug use. Probabilities of moving from one stage to another based on changes between fall 1971 and spring 1972 in a cohort of New York State high school students, 14 to 18 years old. Youths who started using more than one drug within the follow-up interval were distributed in a sequential order which reproduced the proportions of known exclusive starters of each drug.

WHY? (EXPLANATIONS OF GATEWAY SEQUENCE)



I) Causal (often neurobiological) explanation

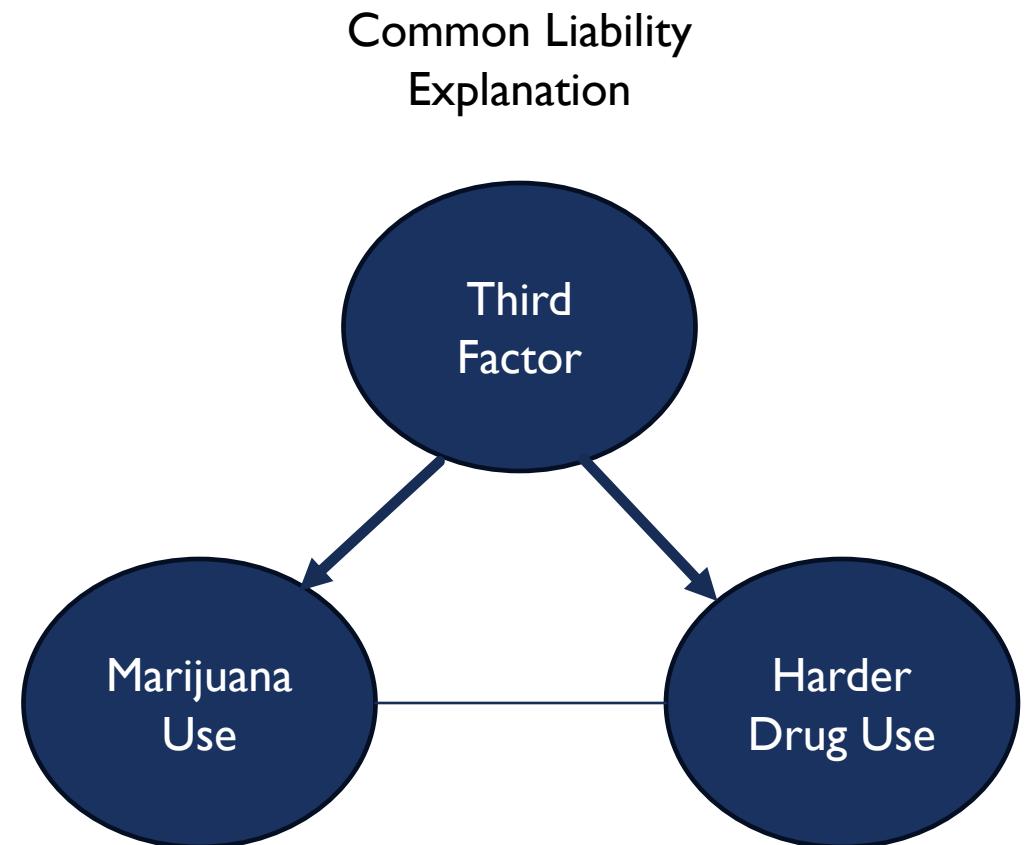
- “Marijuana changes the brain in ways that make use of harder drugs more likely.”
- But the data we have is purely correlational.

Design an experiment to describe what would have to be done to say that there's causation?

If interested - some thoughts from your textbook author on the gateway hypothesis:
https://www.youtube.com/watch?v=SKiMeiU33jk&t=466s&ab_channel=WIRED

COMMON LIABILITY EXPLANATION

- Alternative to neurobiological ‘explanation’ of Gateway Sequence
- 2) A third factor causes both early marijuana use and later “hard drug” use
- But what is that factor?
 - Textbook talks about a “general deviance-prone pattern of behavior”



ADDICTION

MISUSE - TWO CATEGORIES OF PROBLEMS

- Problems directly related to **taking a drug**.
 - Risk of developing drug dependence.
 - Risk of overdose.
- Problems related to **continued use of certain drugs**
 - Arrests, fines, and jailing (deviant acts)

ADDICTION

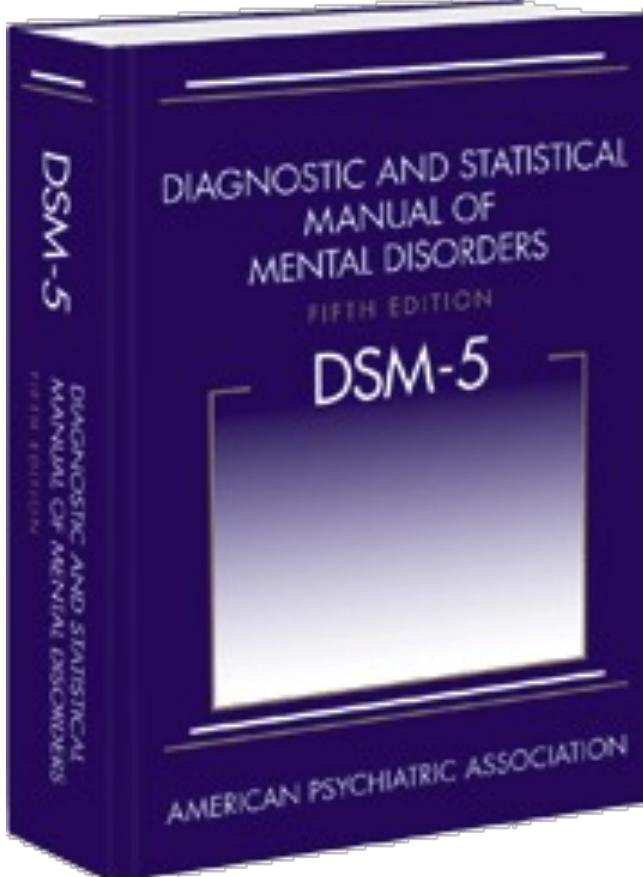
- “Addiction” is not an official diagnosis
 - But “addiction” is widely used both in scientific research and by the general public, so we will use it.
- Substance Use Disorder (SUD) (opioid use disorder, stimulant use disorder, alcohol use disorder, etc.) is the official diagnosis as of 2013.
 - Previously, a person suffering from addiction would be diagnosed with “substance dependence”.

SUBSTANCE USE DISORDER –

- **Dependence** is very hard to define
 - When does a drug user go from “recreational user” to someone who has developed a dependence?
-
- Does it matter:
 - What drug is ingested?
 - What is the frequency of the drug intake?
 - How much drug is ingested?



DSM-5 – SUBSTANCE USE DISORDER



Psychiatric diagnosis of substance use disorders:

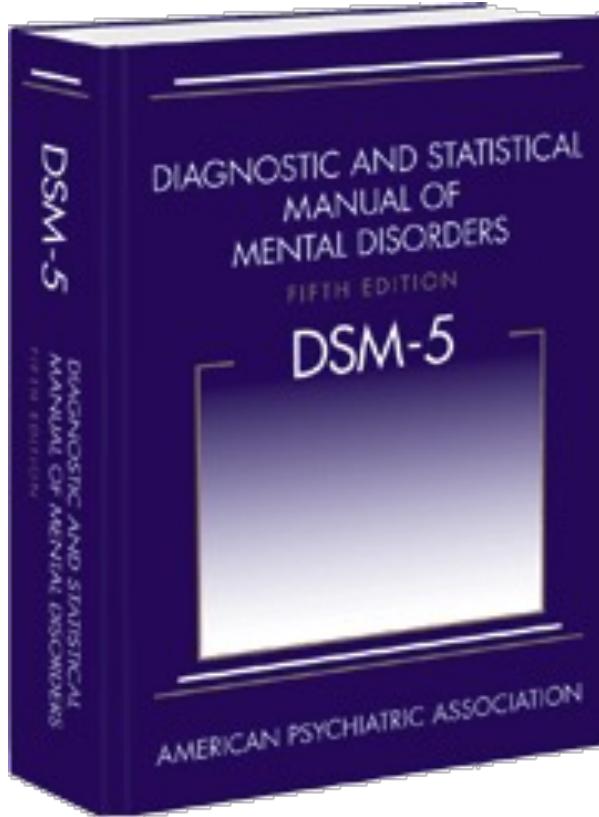
- *Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5).*
 - Developed by the American Psychiatric Association.
 - Provides definitions of substance use disorder.
 - Focuses on complex behavioral definitions.

DSM-5 “Substance Use Disorder” Diagnostic Criteria

A pattern of drug use leading to **clinically significant impairment or distress**, as manifested by **at least two** of the following **11** criteria, occurring within a 12-month period:

1. The drug is often taken in larger amounts or over a longer period than was intended.
2. There is a persistent desire or unsuccessful efforts to cut down or control drug use.
3. A great deal of time is spent in activities necessary to obtain the drug, use the drug, or recover from its effects.
4. Craving, or a strong desire or urge to use the drug.
5. Recurrent drug use resulting in a failure to fulfill major role obligations at work, school, or home.
6. Continued drug use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the drug.

-
-
-
7. Important social, occupational, or recreational activities are given up or reduced because of drug use.
 8. Recurrent drug use in situations in which it is physically hazardous.
 9. Drug use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the drug.
 10. Tolerance, as defined by either of the following:
 - A need for markedly increased amounts of the drug to achieve intoxication or desired effect.
 - A markedly diminished effect with continued use of the same amount of the drug.
 11. Withdrawal, as manifested by either of the following:
 - The characteristic withdrawal syndrome for the drug.
 - The drug (or a closely related substance) is taken to relieve or avoid withdrawal symptoms.



Diagnosis is complex:

- Nine of the possible symptoms are behavioral.
 - Two of the possible symptoms are physiological.
 - Physiological symptoms do **not** need to be present to receive diagnosis.
-
- **Severity:**
 - One symptom could indicate an individual is at risk.
 - Two or three criteria point to a mild substance use disorder.
 - Four or five symptoms show someone has a moderate substance use disorder.
 - Six or more criteria indicate “a severe substance use disorder, which signals an addiction to that substance.”

SUBSTANCE DEPENDENCE PROCESSES DEFINED BY RESEARCHERS

- Three basic processes that (may) occur with repeated drug use:
 - 1) Tolerance.
 - 2) Physical dependence.
 - 3) Psychological dependence.

I) TOLERANCE

- A phenomenon in which repeated exposure to the same dose of a drug results in a lesser effect.
 - It can be overcome by increasing the dose of the drug.
- Our body develops ways to compensate for the chemical imbalance caused by a drug.
 - Results in needing more of the drug for the same effect
- Tolerance typically precedes physical dependence.



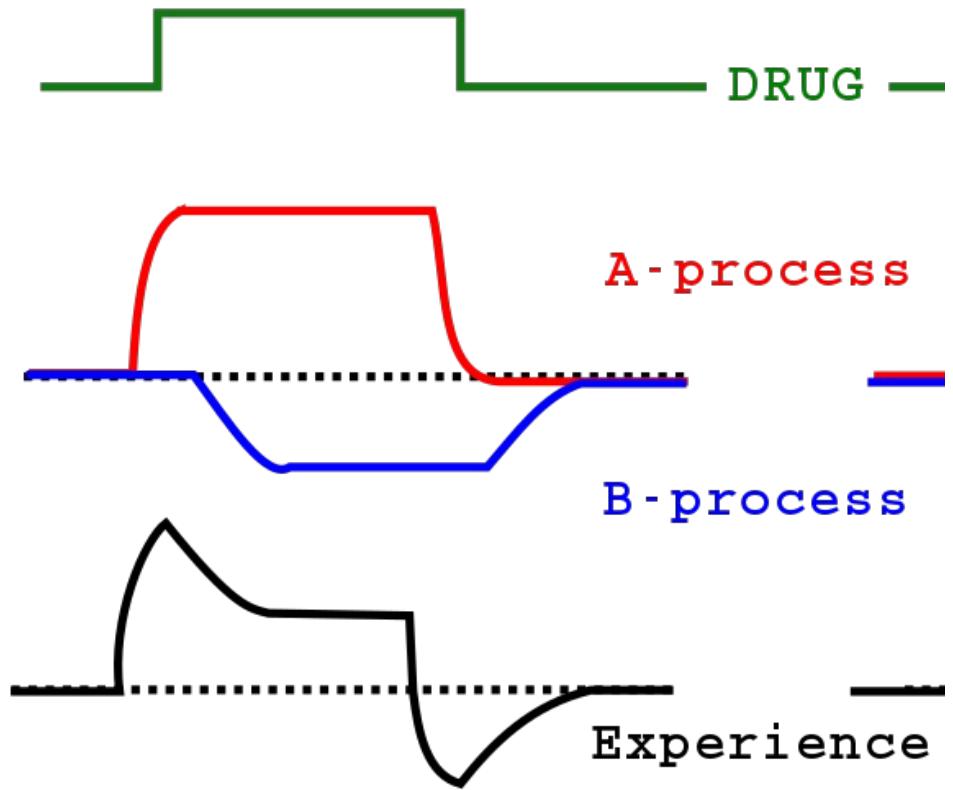
2) PHYSICAL DEPENDENCE

- Physical dependence means the body has adapted to the presence of the drug.
- Physical dependence is defined by the occurrence of a **withdrawal syndrome**.
 - If drug use is stopped suddenly, drug withdrawal symptoms occur, ranging from mild to severe.
 - Discontinuation of drug produces set of (usually unpleasant) symptoms
 - <https://www.youtube.com/watch?v=NaMgdIUcsko> (tw)

WHAT EXPLAINS TOLERANCE AND WITHDRAWAL?

- **Opponent-Process Theory**
 - Essentially the concept of homeostasis - the tendency toward a relatively stable equilibrium between interdependent elements, especially as maintained by physiological processes.

Early in drug use.....

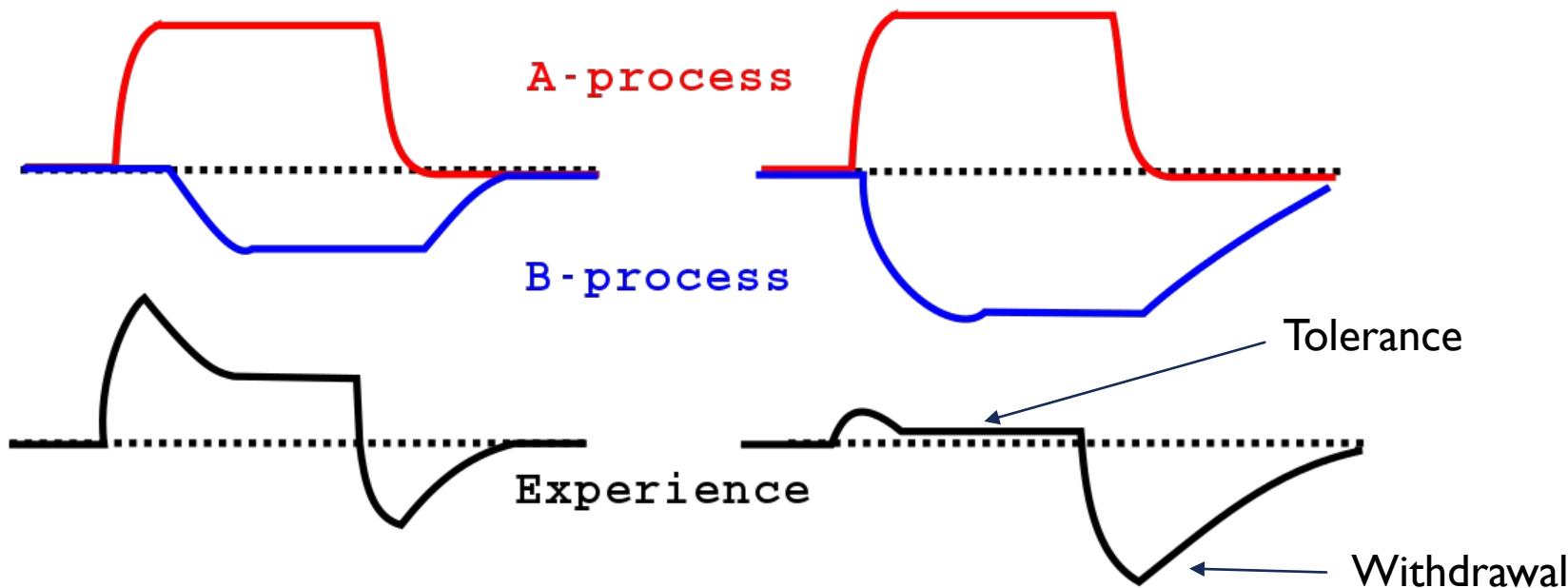


- A: process is the **effect** of the drug
 - Creates an imbalance, disturbing homeostasis
- B: process is the compensating
 - (“opposing”) response of **brain/body**, attempting to restore homeostasis
- Actual experience of the drug is : A-process minus the B-process

Early in drug use:



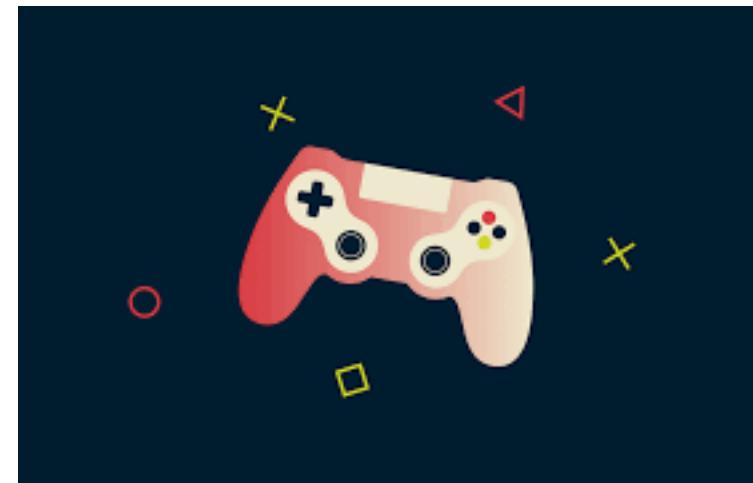
After chronic drug use:



- After chronic use, the body's compensating response gets stronger – this causes tolerance.
- If drug is suddenly withdrawn, body's compensating response continues....but there is no drug to oppose.
 - Now there is an imbalance in the opposite direction
- Experiencing this compensating ("opposing") response without drug is what causes withdrawal symptoms

WHAT ABOUT DRUGS WITH NO CLEAR WITHDRAWAL SYMPTOMS? CHANGING VIEWS OF ADDICTION

- Old mantra – ‘True’ addiction involves physical dependence.
- More current model - Positive reinforcement model
 - Drugs can **reinforce** behavior without physical dependence.
 - Sometimes helpful to think of “non-drugs” to see the difference...

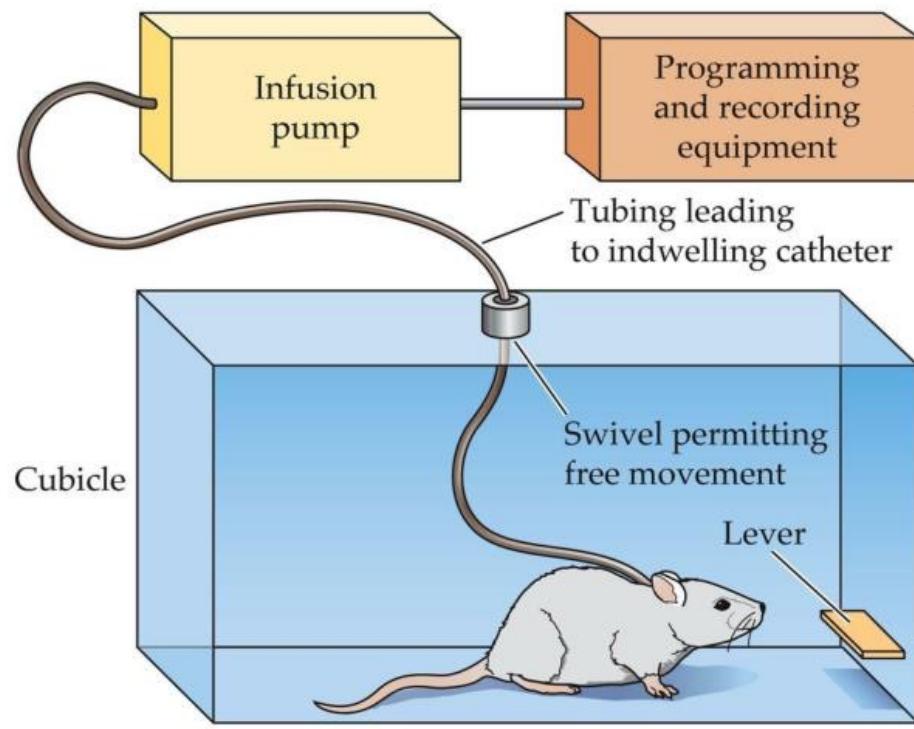


3) PSYCHOLOGICAL (BEHAVIOURAL) DEPENDENCE

- Psychological dependence, based on **reinforcement**, is increasingly viewed as the driving force behind repeated drug use.
 - Behavioral psychology contextualizes psychological dependence.
- Often indicated by/defined in terms of observable behavior:
 - Frequency of using a drug or by the amount of time or effort spent in drug-seeking behavior.
 - Reports of craving the drug or its effects.

RESEARCH EVIDENCE FOR PSYCHOLOGICAL DEPENDENCE

4.24 The drug self-administration method



PSYCHOPHARMACOLOGY, Figure 4.24 © 2005 Sinauer Associates, Inc.

- **Administration of certain drugs can reinforce the behaviors that led to the drug's administration.**
 - Studied in the lab with “drug self-administration” method.
 - Laboratory animals press levers when the only consequence of lever pressing is a small intravenous injection of heroin, cocaine, or another drug.
- **Psychological dependence with positive reinforcement:**
 - If rat presses a lever and gets food, the rat is more likely to keep pressing the lever
 - The food strengthened (“reinforced”) the lever press behavior
 - positive reinforcement because the food was added (positive) after the lever press

All drugs self-administered by animals have addiction potential in humans.

- Cocaine
 - Heroin
 - Morphine
 - Codeine
 - Oxycodone
 - Amphetamine
 - Methamphetamine
 - Ecstasy (MDMA)
 - Alcohol
 - Barbiturates
 - Benzodiazepines
 - Nicotine
 - Caffeine
 - THC
 - PCP
-
- Drugs not self-administered by animals, but used by humans:
 - LSD
 - Psilocybin
 - Mescaline

WHAT CAUSES ADDICTION (SUBSTANCE USE DISORDER)?

Nobody can say for sure

We do know about correlates of addiction.

- 1) **personality characteristics (e.g., impulsivity)**
- 2) *other disorders* (e.g., depression)
- 3) genetic/brain characteristics (e.g., number of dopamine receptors)

IS THERE AN ‘ADDICTIVE’ PERSONALITY?

- Impulsivity (tendency to act quickly without much regard to long-term consequences) and “sensation-seeking” personality traits have been associated with greater risk for abuse of stimulants
- Sensation-seeking scale measures a person’s preference for variety, risk, and various physical sensations.

- Alcohol use disorder often exists within dysfunctional families and relationships.
 - Evidence suggests these may be risk factors that may play a role in dependence.

There is no way to know if a drug or drug use changes an individual’s personality.

WHAT ARE THE MOST ADDICTIVE DRUGS?

Table 2.2: Addiction Potential of Alcohol, Nicotine, Cocaine, and Marijuana

Substance	After 1 Year of Use	After 10 Years of Use	Lifetime Estimate
Alcohol	2.0%	11.0%	22.7%
Nicotine	2.0%	15.6%	67.5%
Cocaine	7.1%	14.8%	20.9%
Marijuana	2.0%	5.9%	8.9%

IS ADDICTION CAUSED BY THE SUBSTANCE?

- Some drugs are more likely than others to result in dependence.
 - Heroin and cocaine are both likely to lead to compulsive use.
- Some substances are more “addictive” than others.
- However, many other factors influence dependence, and thus, the substance itself cannot be seen as the entire cause of the problem.

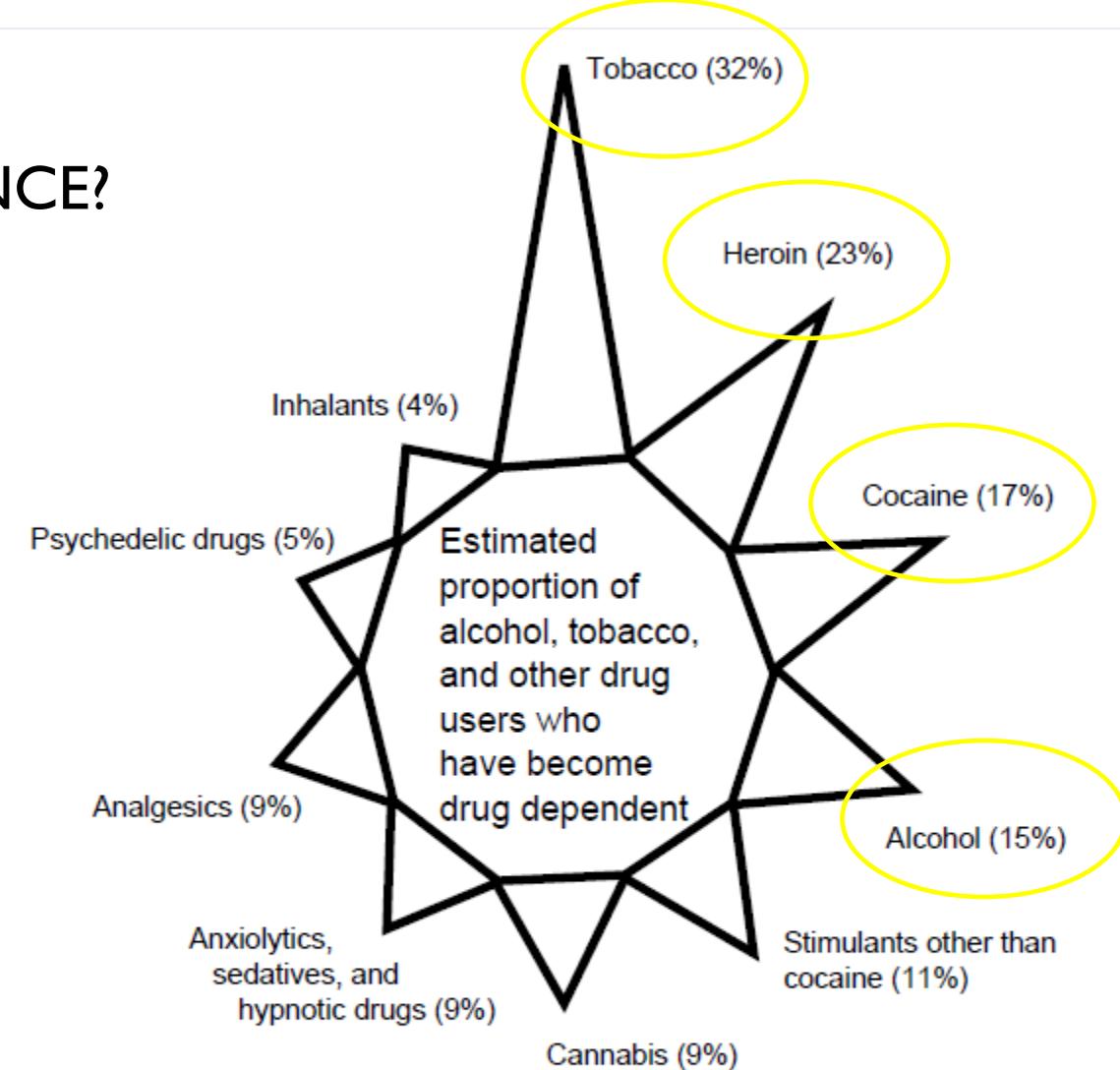
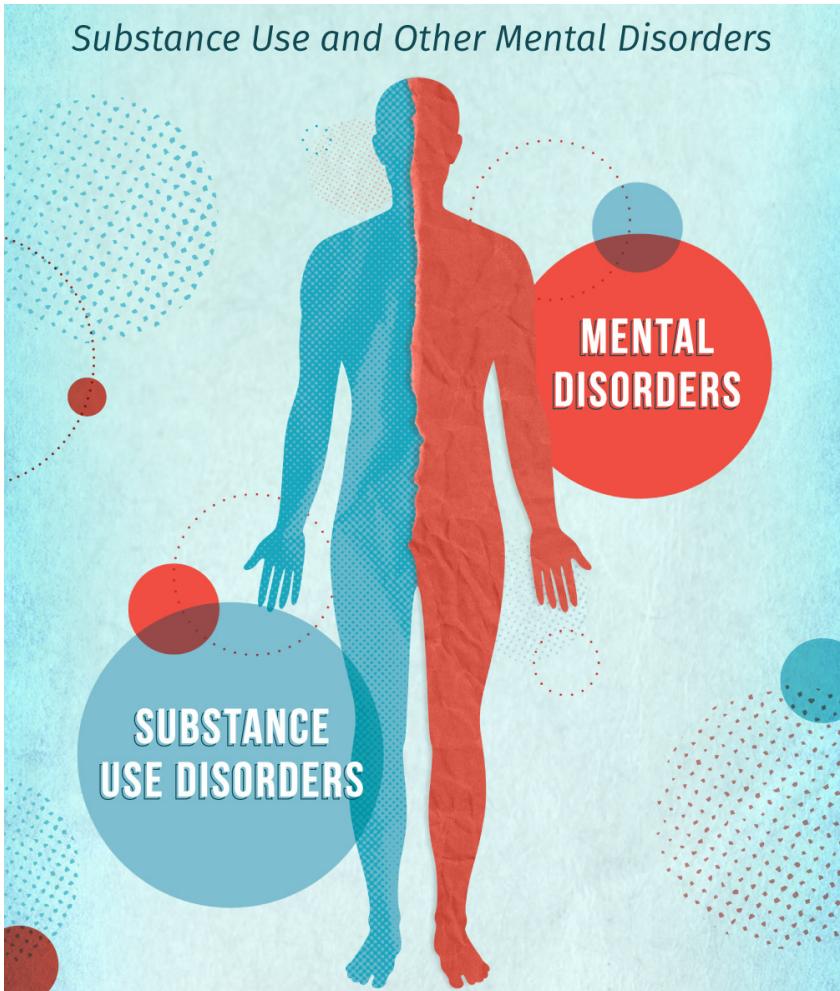


Figure 2 Estimated proportion of alcohol, tobacco, and other drug users who have developed clinical syndromes of drug dependence as defined according to the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised*. The data were obtained from the National Comorbidity Survey, 1990–1992.

Percentages in fig pertain to people ages 15–24

WHAT CAUSES ADDICTION (SUBSTANCE USE DISORDER)?

- Although the drug taken is a factor, nobody can say for sure
- We do know about correlates of addiction, though.
 - 1) personality characteristics (e.g., impulsivity)
 - 2) **other disorders (e.g., depression)**
 - 3) genetic/brain characteristics (e.g., number of dopamine receptors)



SUDs and COMORBIDITY

COMORBIDITY AND SUBSTANCE USE

- **Comorbidity:** having two disorders at the same time
- Very high rates of comorbidity between substance use disorder and many other psychological disorders.

WHO IS AFFECTED?

**7.7
MILLION**

Of the 20.3 million adults with **substance use disorders**,

37.9%

also had **mental illnesses**.



Source: Han, et al. Prevalence, Treatment, and Unmet Treatment Needs of US Adults with Mental Health and Substance Use Disorders. 2017.

Among the 42.1 million adults with **mental illness**,

18.2%

also had **substance use disorders**.

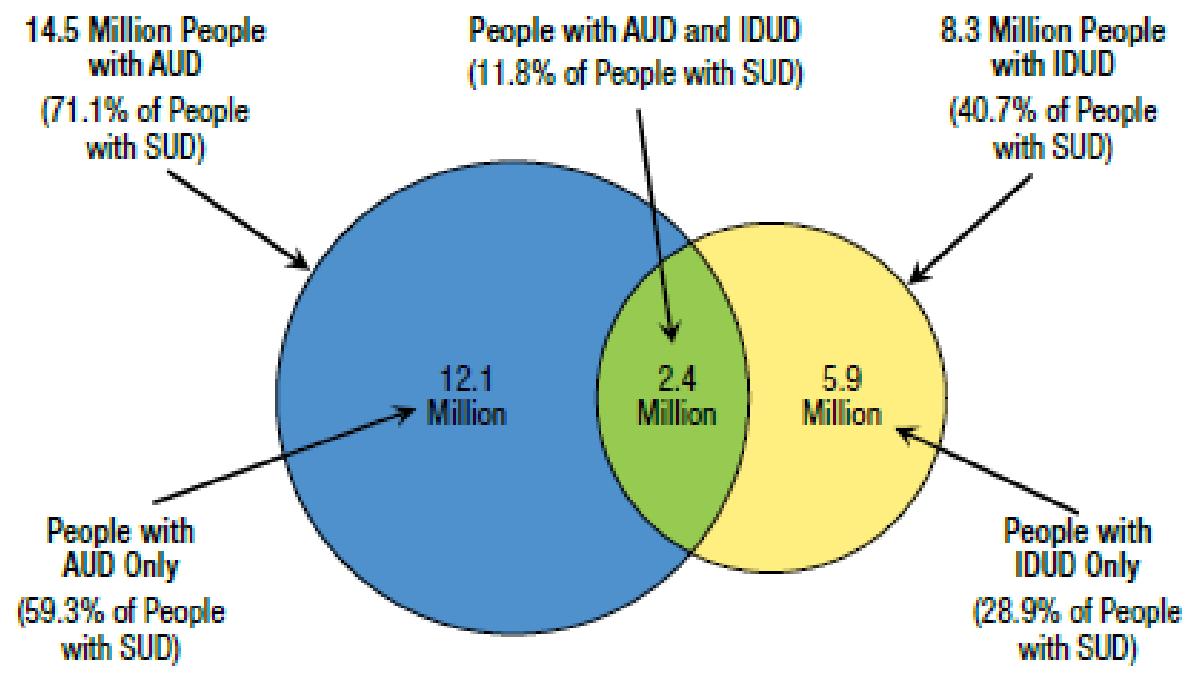


National Institute
on Drug Abuse

For more information about finding treatment for yourself or a loved one, visit drugabuse.gov/related-topics/treatment.

COMORBIDITY AND SUBSTANCE USE (MULTIPLE SUDS)

Figure 47. Alcohol Use Disorder (AUD) and Illicit Drug Use Disorder (IDUD) in the Past Year among People Aged 12 or Older with a Past Year Substance Use Disorder (SUD): 2019

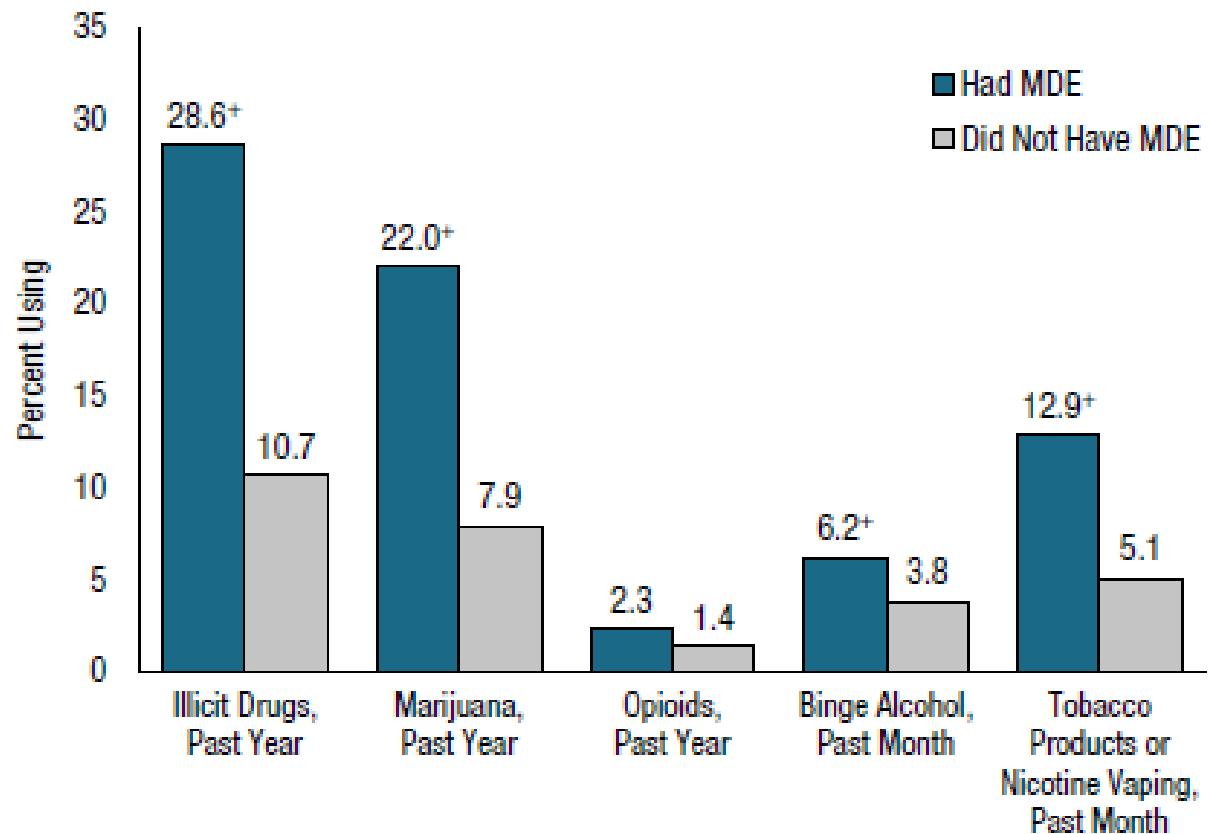


- 30% of people with Illicit Drug Use Disorder also had Alcohol Use Disorder vs. 6% of general population 12+

20.4 Million People Aged 12 or Older with Past Year SUD

COMORBIDITY AND SUBSTANCE USE (DEPRESSION)

Figure 34. Substance Use: Among Youths Aged 12 to 17; by Past Year Major Depressive Episode (MDE) Status, 2020



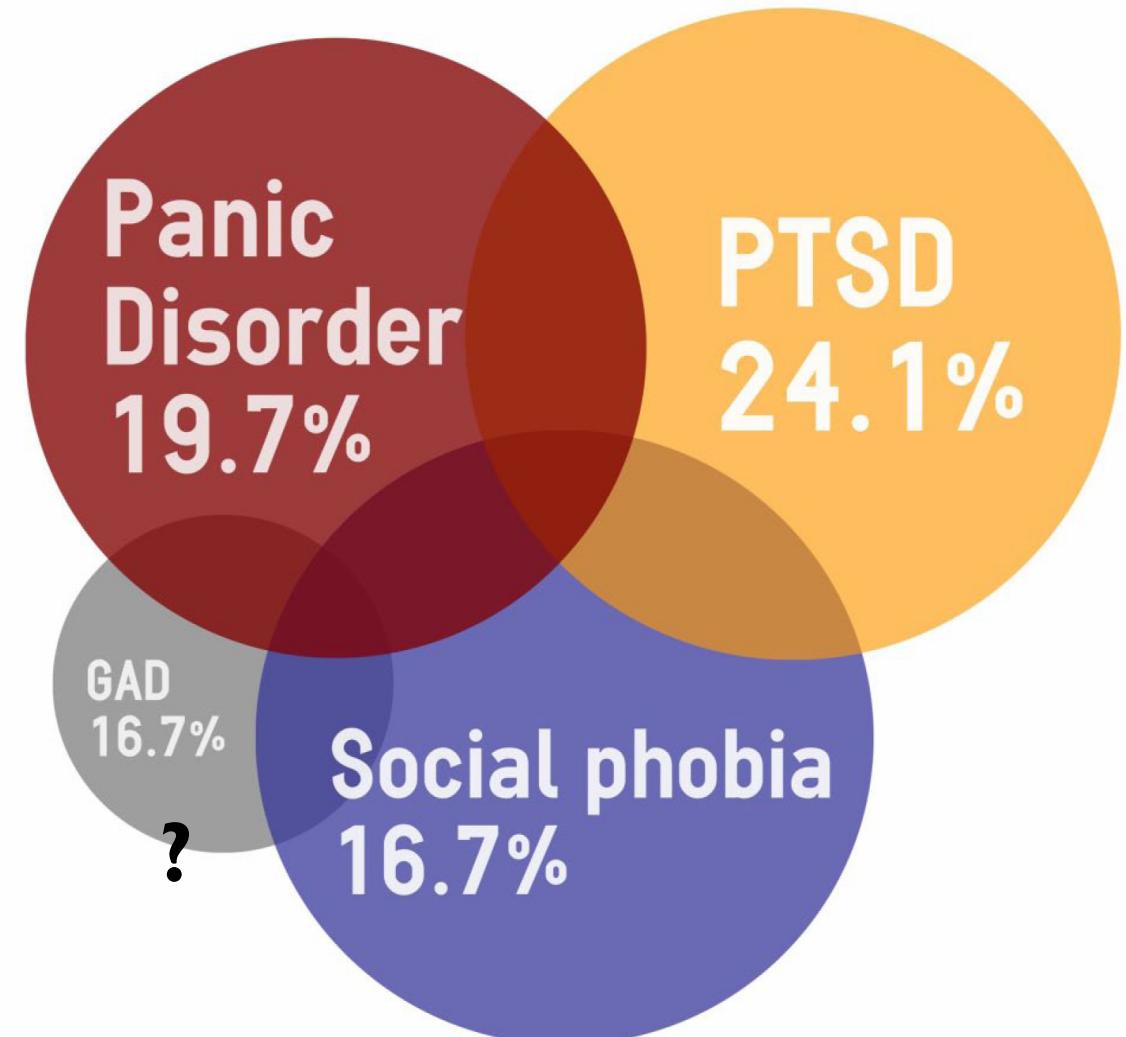
MDE is a risk factor for using drugs, alcohol, and cigarettes, about twice as likely to use

COMORBIDITY AND SUBSTANCE USE (ANXIETY DISORDERS)

- Research has shown that up to 50% of individuals receiving treatment for problematic alcohol use also met DSM criteria for one or more anxiety disorders.

ALCOHOL USE CO-MORBIDITY

12 month prevalence of alcohol use disorders in individuals with an anxiety disorder



WHAT CAUSES ADDICTION (SUBSTANCE USE DISORDER)?

- Nobody can say for sure
- We do know about correlates of addiction, though.
 - 1) personality characteristics (e.g., impulsivity)
 - 2) *other disorders* (e.g., depression)
 - 3) **genetic/brain characteristics (e.g., number of dopamine receptors)**



IS ADDICTION A BRAIN DISEASE?

BREAK

THEORIES (EXPLANATIONS) OF ADDICTION

- **Older views:**
 - 1) moral failing, “vice”
 - Addiction is due to a “weak will”, or low morals
 - 2) physical dependence
 - Being physically dependent (withdrawal) *caused* you to be addicted.
 - a person can be addicted without having withdrawal syndrome
 - a person can have withdrawal syndrome without being addicted
- **Newer views:**
 - 1) Brain Disease
 - 2) Choice/Biopsychosocial

IS ADDICTION A BRAIN DISEASE?

- Dr. Nora Volkow says “yes”
 - Director of the National Institute on Drug Abuse (NIDA), the NIH institute responsible for funding the majority of drug abuse science *in the world (not just U.S.A!)*
- Addiction is a chronic, relapsing, disease.

http://www.youtube.com/watch?v=5fLie_lt8wM

Research | Medical & Health Professionals | Patients & Families | Parents & Educators | Children & Teens

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Frequently Asked Questions

Revised October 2019

Nora D. Volkow, M.D., became Director of the National Institute on Drug Abuse (NIDA) at the National Institutes of Health in May 2003. NIDA supports most of the world's research on the health aspects of drug abuse and addiction.

Dr. Volkow's work has been instrumental in demonstrating that drug addiction is a disease of the human brain. As a research psychiatrist and scientist, Dr. Volkow pioneered the use of brain imaging to investigate the toxic effects and addictive properties of abusable drugs. Her studies have documented changes in the dopamine system affecting, among others, the functions of frontal brain regions involved with motivation, drive, and pleasure in addiction. She has also made important contributions to the understanding of the neurobiology of drug abuse and its effects on the brain.



Photo by Mary Noble Ours

- Evidence for addiction as a brain disease?
 - Various kinds, but often cited is changes in the brains evidenced in people with addiction

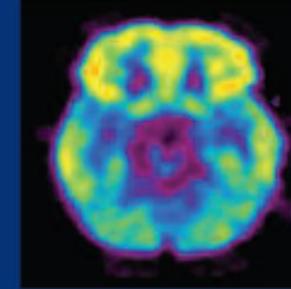
What is drug addiction?

Addiction is defined as a chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences. It is considered a brain disease because drugs change the brain—they change its structure and how it works. These brain changes can be long lasting, and can lead to the harmful behaviors seen in people who abuse drugs.

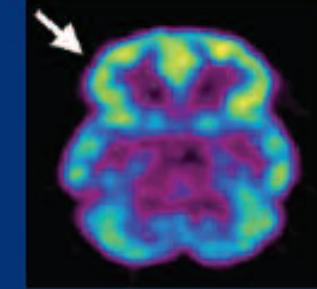
Addiction is similar to other diseases, such as heart disease. Both disrupt the normal, healthy functioning of the underlying organ, have serious harmful consequences, are preventable, treatable, and if left untreated, can last a lifetime.

Source: From the laboratories of Drs. N. Volkow and H. Schelbert.

DECREASED BRAIN METABOLISM IN DRUG ABUSER



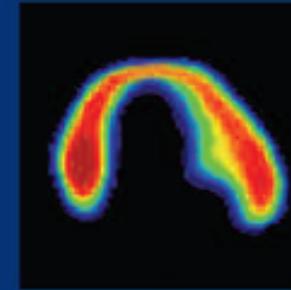
Healthy Brain



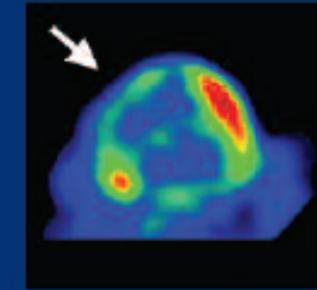
Diseased Brain/Cocaine Abuser



DECREASED HEART METABOLISM IN HEART DISEASE PATIENT



Healthy Heart



Diseased Heart

VOLKOW'S THEORY – ADDICTION AS BRAIN DISEASE

Hypotheses:

- 1) Drug use causes brain changes
- 2) Those brain changes cause loss of self-control
- 3) Loss of self-control causes continued drug taking

Evidence: Numerous studies in both animals and humans have shown that there are genetic influences on drug use, effects, and dependence.

- Data suggest that genetic factors play a role in developing dependence, but the specific genes and the biological mechanisms causing dependence are still being determined.

HART'S VIEW - ADDICTION IS NOT A BRAIN DISEASE

Not everybody agrees with brain disease theory.

- Evidence: Substance use disorders do not have many of the characteristics of medical diseases.
 - There are no tests to reveal the underlying cause.

When the brain disease view began, it was thought it would destigmatize addiction. Dr. Carl Hart argues that it does the opposite – and much worse.

https://www.youtube.com/watch?v=90MHzbXrmY0&ab_channel=BigThink

ALTERNATIVE TO BRAIN DISEASE : CHOICE

Choice/Biopsychosocial perspective - Addiction might be related to dysfunctions of biology, personality, social interactions, or a combination of these factors.

- Instead, instances of drug-taking behavior are viewed as **contingency-based choices**
 - if choice to take drugs happens so often that it interferes with life, may result in substance use disorder
- The choice view **doesn't** say that people **choose to have an addiction**

Gene Heyman: <https://www.youtube.com/watch?v=jh0ZAUxuQSo> (0:24-6:20)



CHOICE/BIOPSYCHOSOCIAL PARADIGM

- Evidence for choice view of addiction:
 - 1) very high spontaneous remission (i.e., quitting without treatment) rate
 - Also called “natural recovery”
 - Don’t see this with other diseases
 - 2) drug-taking behavior can be determined by consequences (costs/benefits), even in people with diagnosed SUDs
 - Reasons given for quitting: “what will my family think?”, “will I lose my job?”
 - Contingency Management Lab Studies:

EVIDENCE FOR: CHOICE/BIOPSYCHOSOCIAL PARADIGM

Cocaine vs. money choice in humans

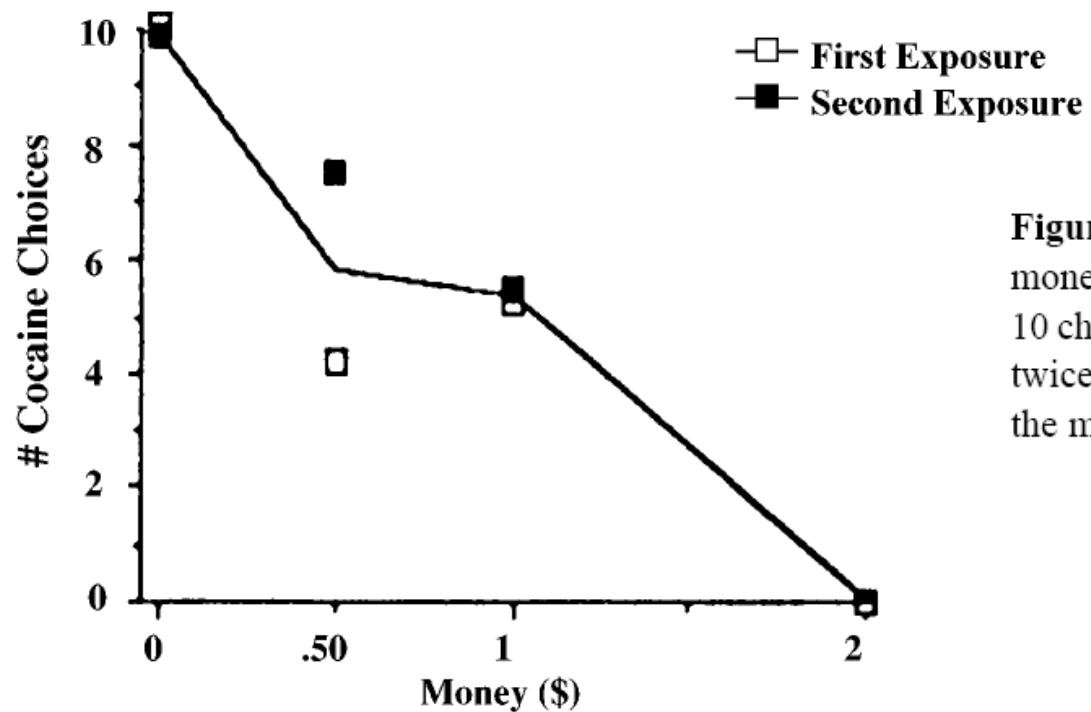


Figure 1 *Upper panel:* Number of cocaine choices as a function of the amount of money offered per choice as an alternative to cocaine. Subjects made a maximum of 10 choices between cocaine and money per session. Each monetary amount was tested twice, with the results from first and second tests shown by separate symbols and the mean of the two tests by the solid line. Reprinted from Higgins et al. 1994a with

EVIDENCE FOR: CHOICE/BIOPSYCHOSOCIAL PARADIGM

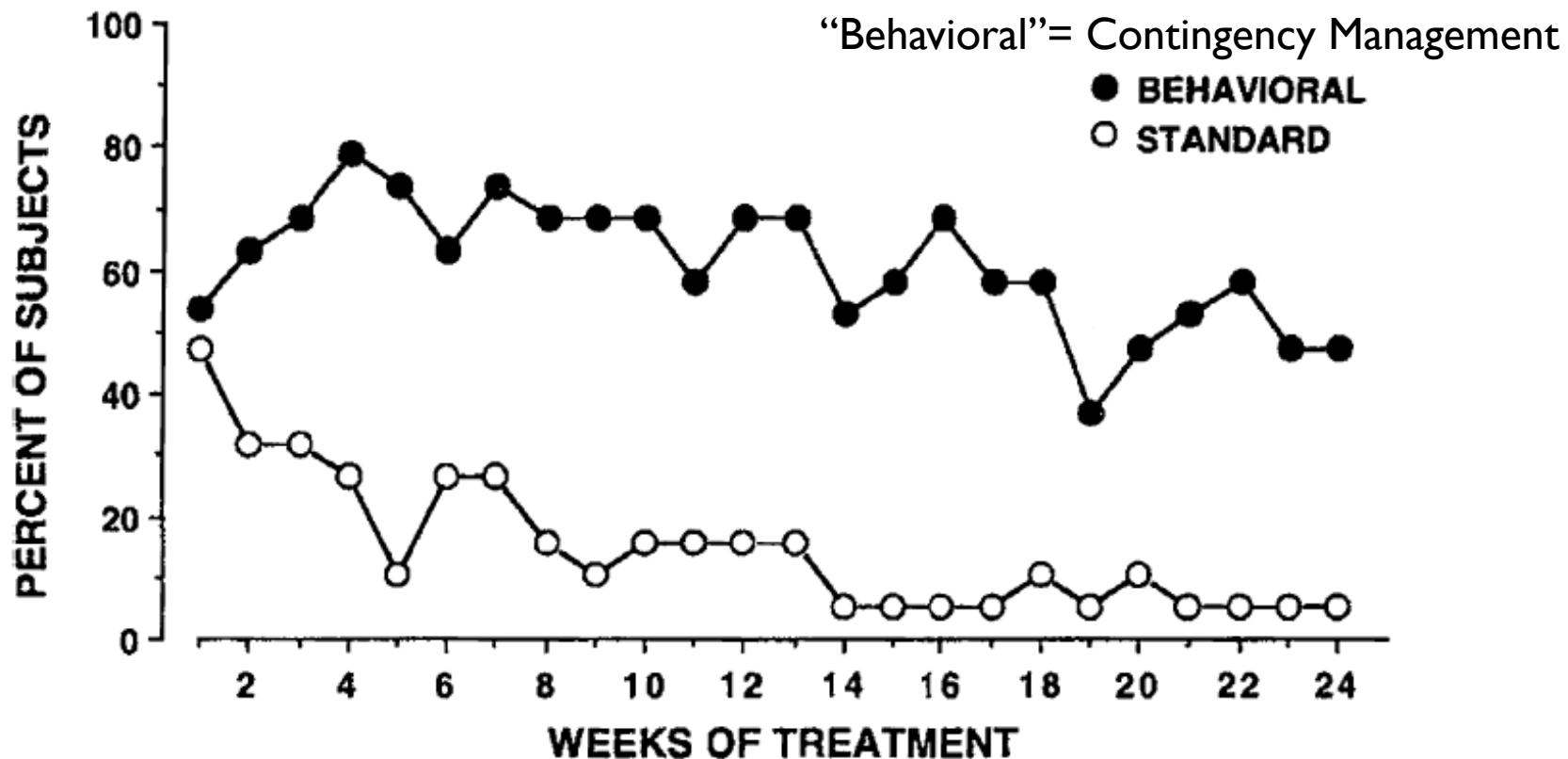


Figure 4 Percent of subjects abstinent from cocaine use in CRA + vouchers (behavioral) and standard (drug abuse counseling) conditions plotted as a function of consecutive treatment weeks. Reprinted from Higgins et al. 1993 with permission.

NeuroView

Exaggerating Harmful Drug Effects on the Brain Is Killing Black People

Carl L. Hart^{1,2,3,*}

¹Departments of Psychology and Psychiatry, Columbia University, New York, NY, USA

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<https://doi.org/10.1016/j.neuron.2020.06.019>

“This is why you don’t do drugs kids.” That admonishment—directed at bystanders who watched in horror as police manhandled George Floyd’s 46-year-old, defeated black body—spoke volumes about what kind of people we are and our warped values. Drug researchers with neuroscience leanings, me included, have helped shape and perpetuate this sick ethos in which police, as well as others, believe that it’s okay to brutalize a Black person, so long as they are suspected of having used or sold a “recreational” drug.

It took me a long time to see the damage my field was doing to communities like the one from which I came. I was too busy for too long being a soldier in the regime, caught up in the cause of “proving” how damaging drug use is to the brain. And because my intense actions aligned with the dominant perspective held at the National Institute on Drug Abuse (NIDA)—my primary funder—I personally benefited. I was awarded multimillion-dollar grants to conduct my research, and I served on some of the most prestigious committees in the area of neuropsychopharmacology. I also was awarded tenure at my university, which, importantly, allows me to speak so freely here and elsewhere.

Even more pernicious is the fact that NIDA unabashedly touts the baseless notion that drug addiction is a brain disease. To date, there has been no identified neurobiological substrate to differentiate non-addicted persons from addicted individuals (Hart et al., 2012). Simply put, there is no solid evidence that human recreational drug use causes brain damage; nor is there credible evidence showing that addiction is caused by a brain abnormality. Unfortunately, this fact has not tempered dire warnings in the neuroscientific literature regarding the harmful impact of drug use on the human brain.

Consider the following claim by Volkow et al. (2016): “If early voluntary drug use goes undetected and unchecked, the re-

sulting changes in the brain can ultimately erode a person's ability to control the impulse to take addictive drugs." The first clause of this sentence encourages people, including cops, to be paranoid about any drug use, even the nonproblematic recreational use that characterizes the experience of the overwhelming majority who use these drugs. The paranoia this

statement provokes was on full display when police admonished witnesses to stay off drugs while their brother in blue used his knee to cut off the dying Floyd's last breath. The second clause is perhaps even more disturbing because it argues that there are inevitable brain changes in response to drug use that cripple the user's self-control. There is absolutely no scientific evidence in humans to justify this statement. As I have noted previously, the pretty pictures produced by brain imaging without data are not evidence, but they are misleading (Hart et al., 2012).

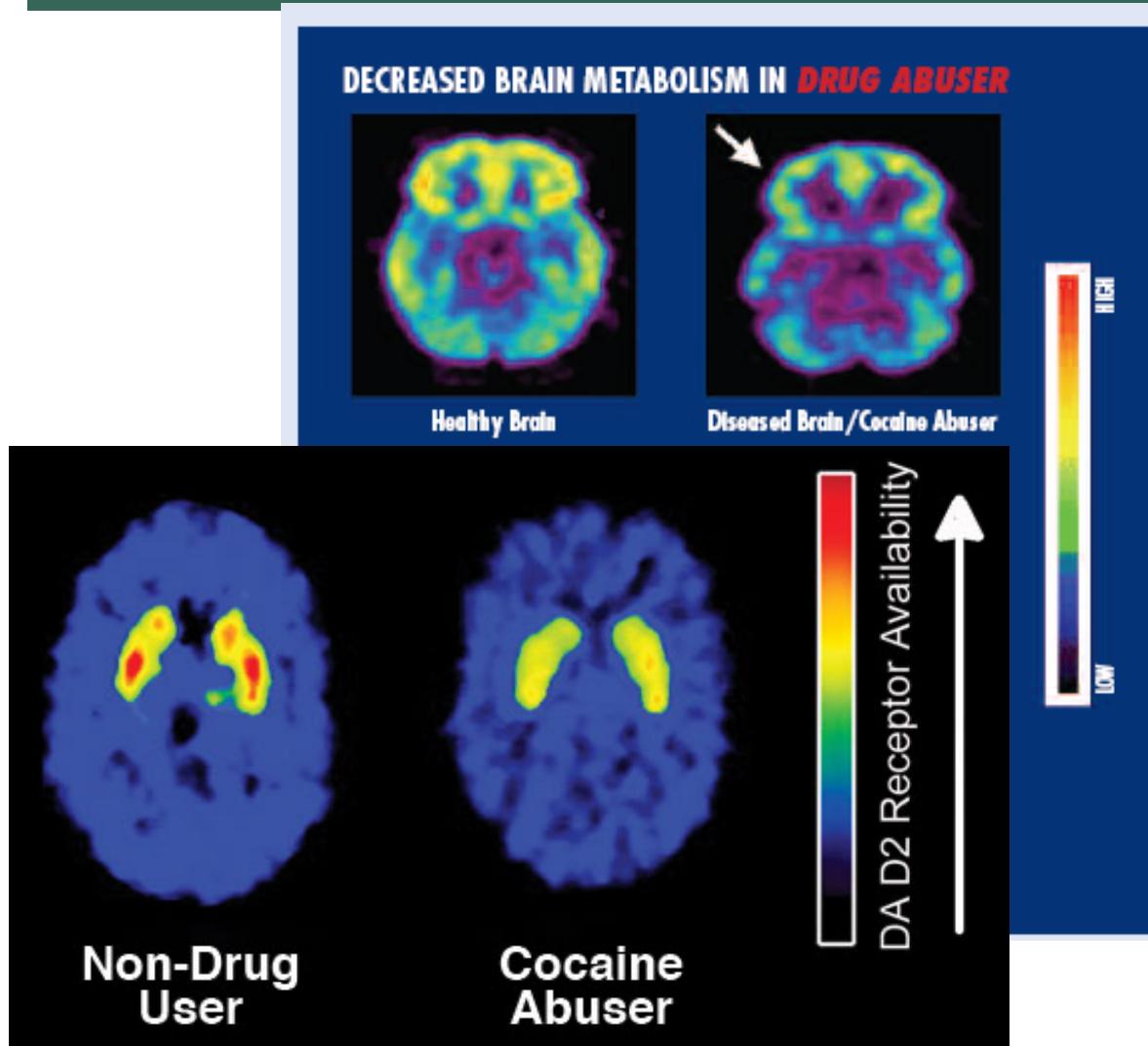
it. In 2017, I published an editorial in *Nature Human Behavior* entitled, "Viewing addiction as a brain disease promotes social injustices." Truth be told, the piece was an open letter to NIDA imploring them and others to stop overstating the negative impact of human drug use on the brain, because Black lives were literally at stake. It fell on deaf ears. So, here we are.

Even more pernicious is the fact that NIDA unabashedly touts the baseless notion that drug addiction is a brain disease. To date, there has been no identified neurobiological substrate to differentiate non-addicted persons from addicted individuals ([Hart et al., 2012](#)). Simply put, there is no solid evidence that human recreational drug use causes brain damage; nor is there credible evidence showing that addiction is caused by a brain abnormality. Unfortunately, this fact has not tempered dire warnings in the neuroscientific literature regarding the harmful impact of drug use on the human brain. Consider the following claim by [Volkow et al. \(2016\)](#): "If early voluntary drug use goes undetected and unchecked, the re-

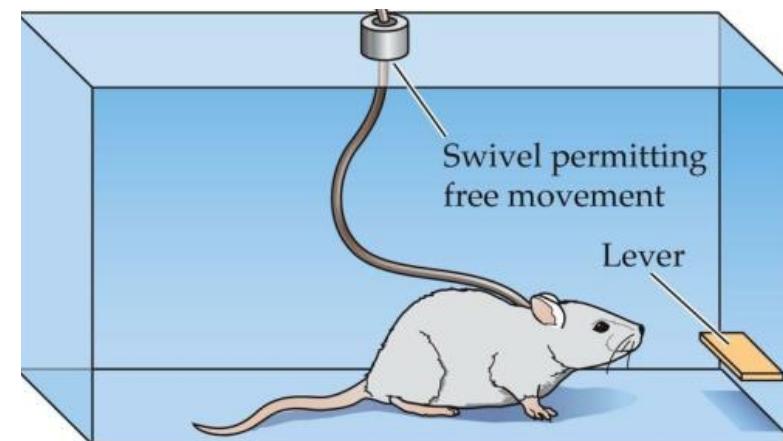
IS ADDICTION A BRAIN DISEASE?



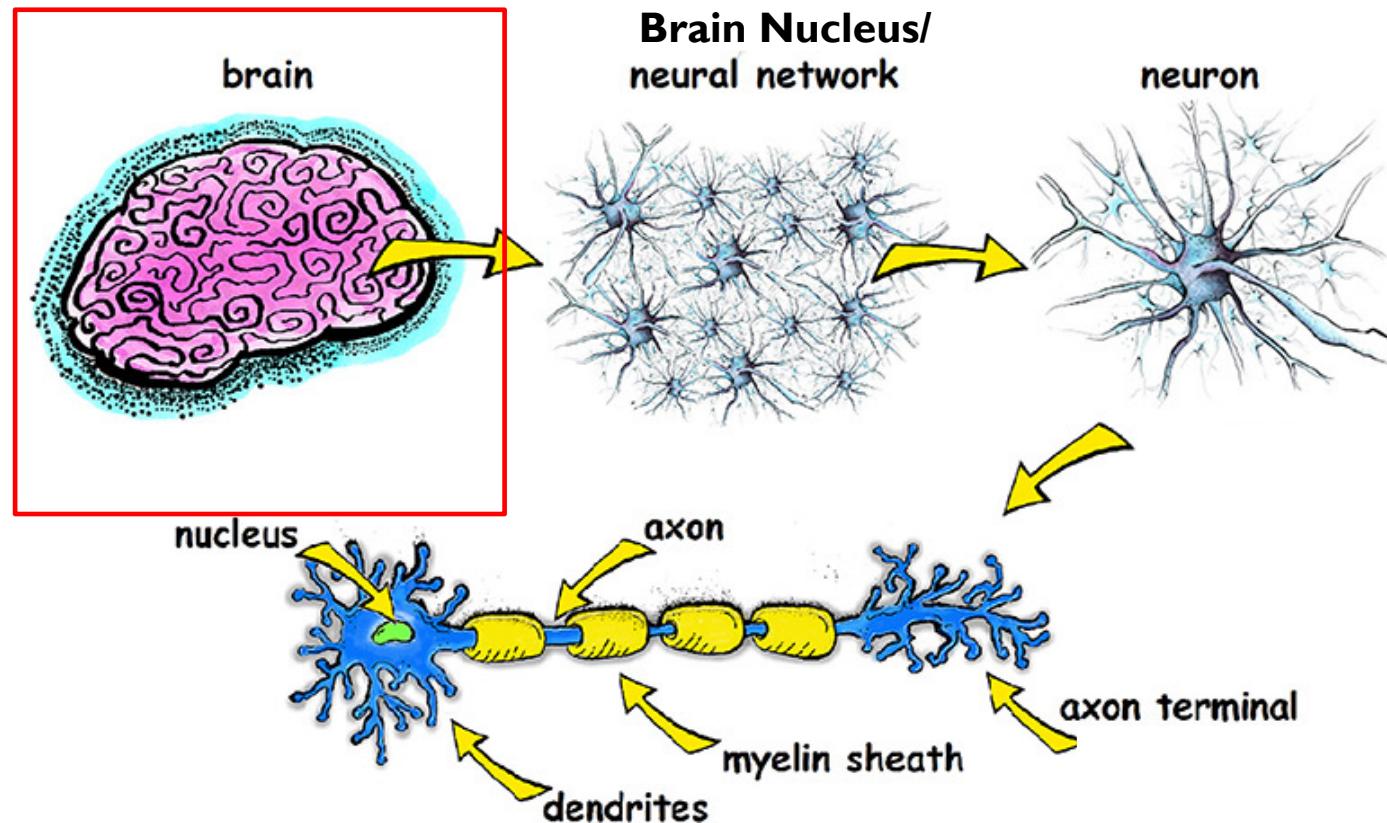
DRUGS INARGUABLY ALTER THE BRAIN.



Even if it is NOT a brain “disease”, the brain and drug-related neurochemistry is clearly involved in many ways...

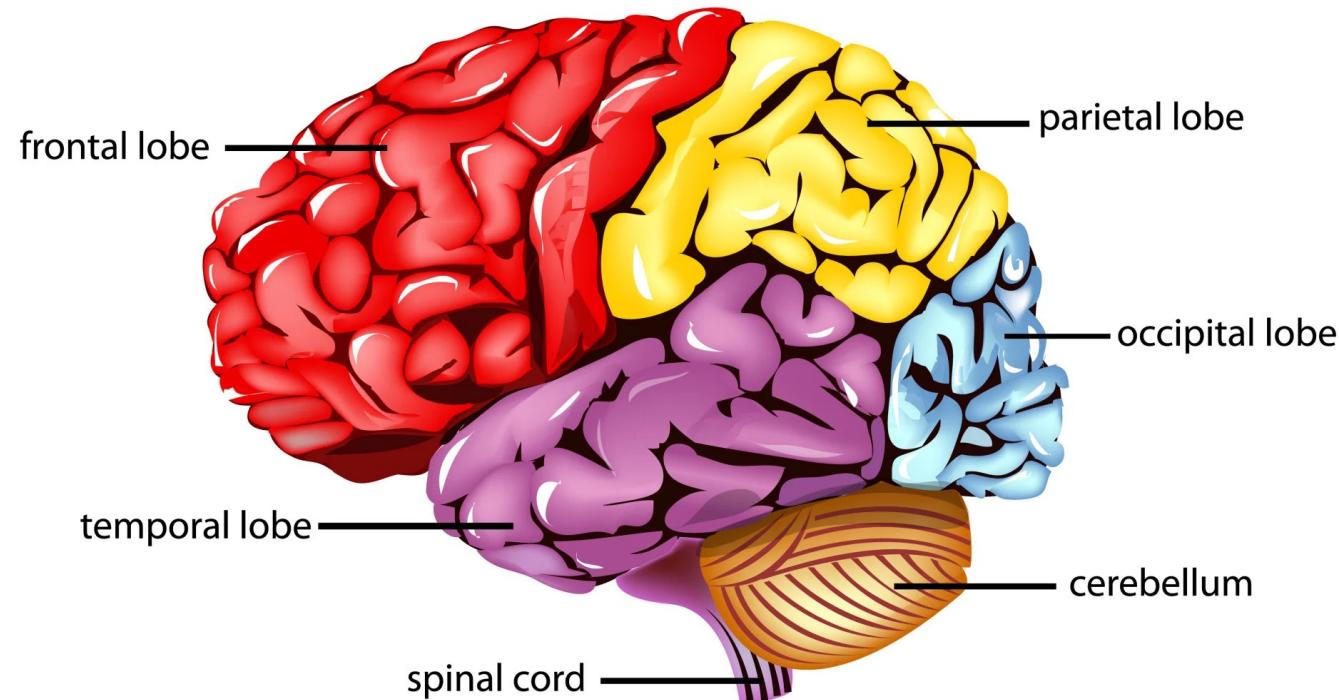


OUTLINE : NEUROANATOMY



ANATOMICAL LOBES OF THE HUMAN BRAIN

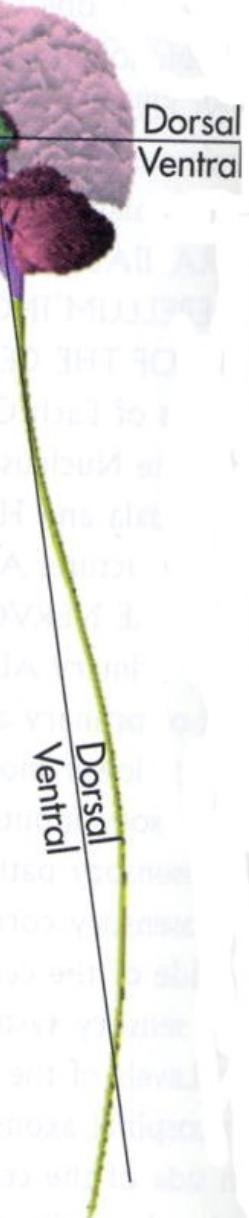
Parts of the Human Brain



ANATOMICAL TERMS OF DIRECTION



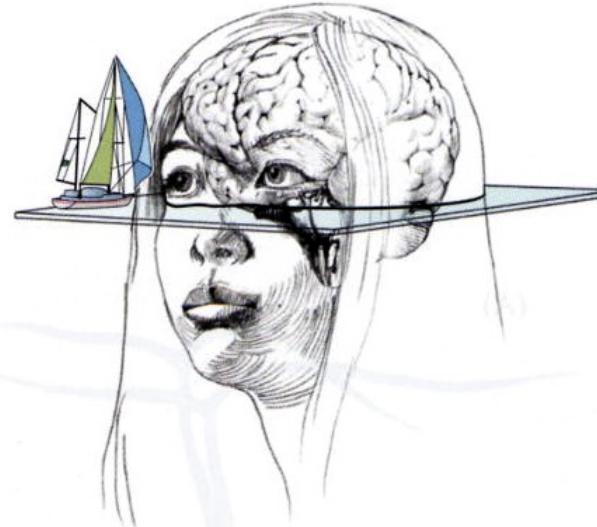
Always superior
Always anterior
Always posterior
Always inferior



COMMON PLANES OF BRAIN SECTIONS:

- A) HORIZONTAL
- B) CORONAL
- C) SAGITTAL

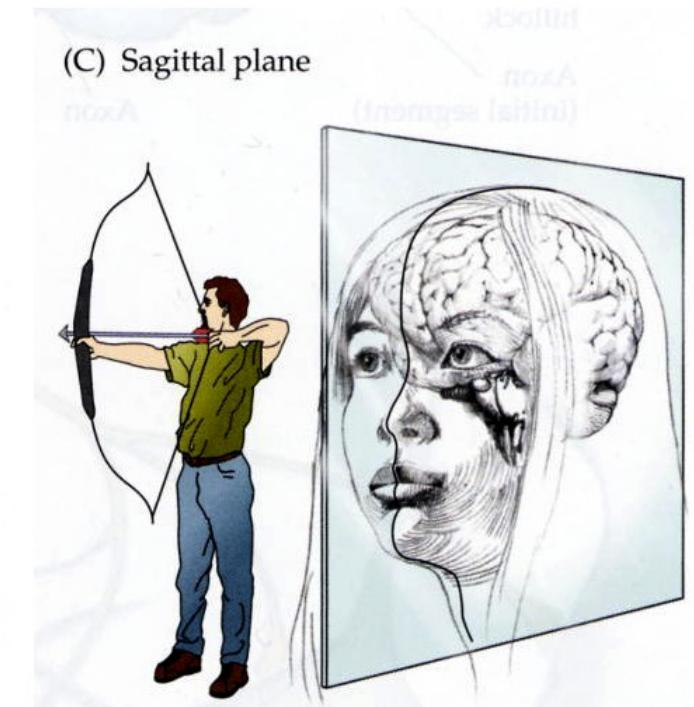
(A) Horizontal plane



(B) Coronal plane



(C) Sagittal plane



THE HUMAN BRAIN: MAJOR STRUCTURES/REGIONS

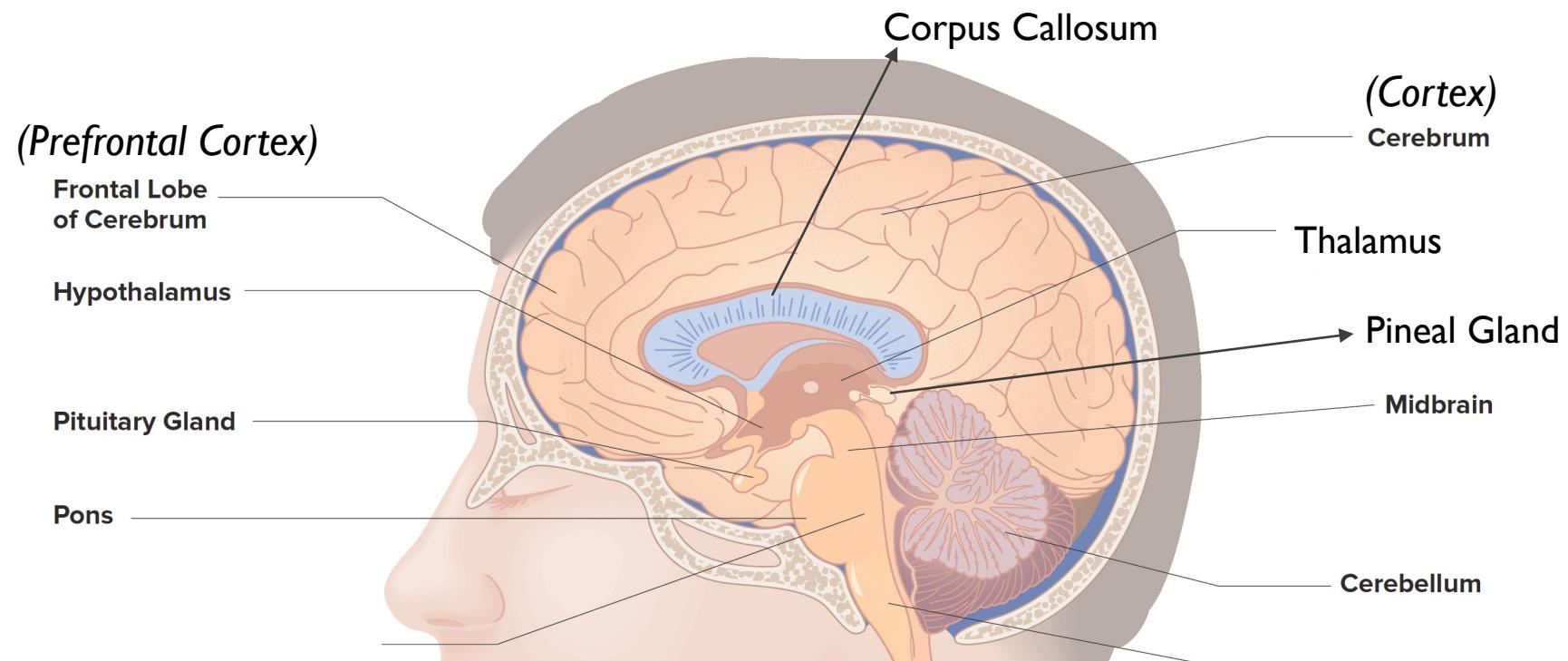
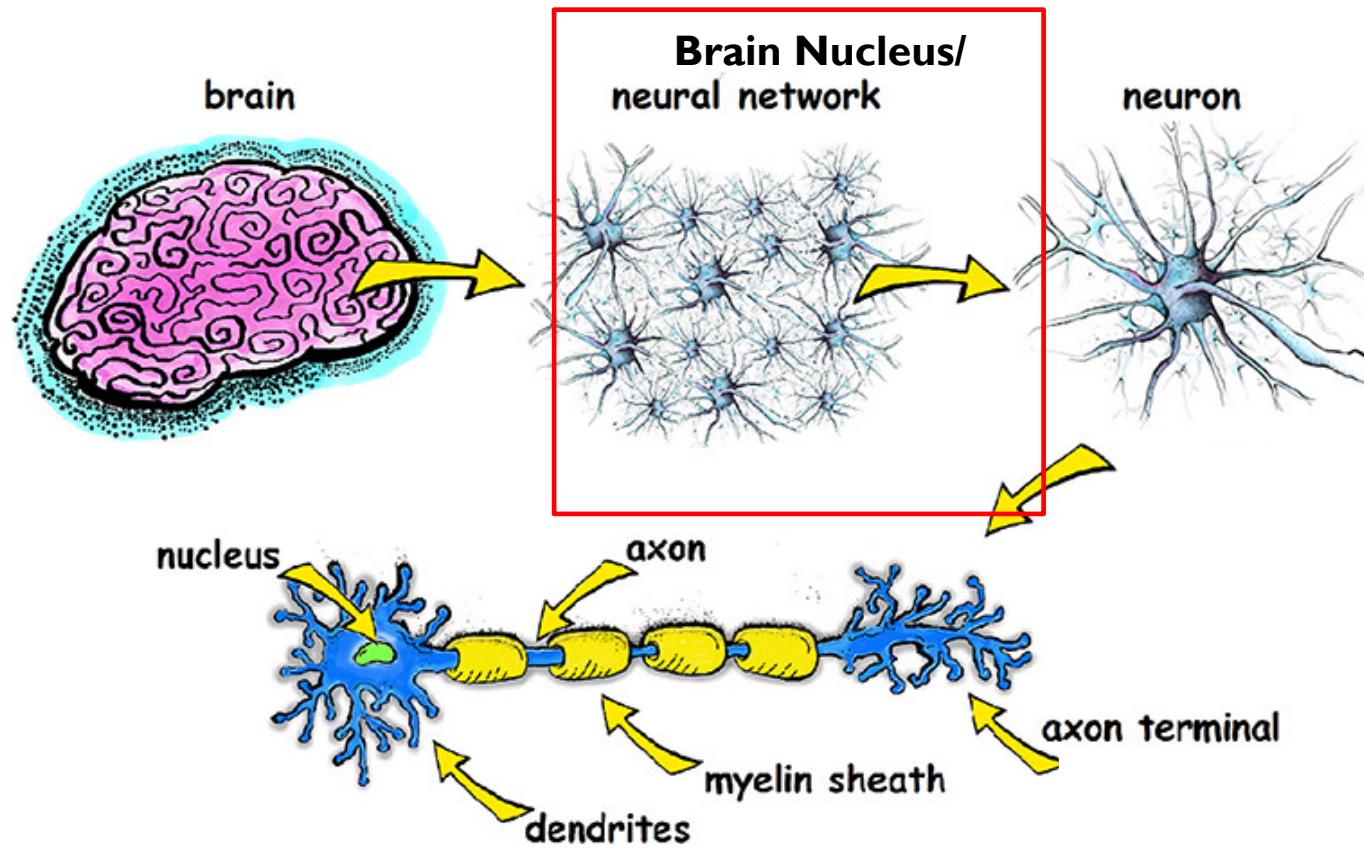


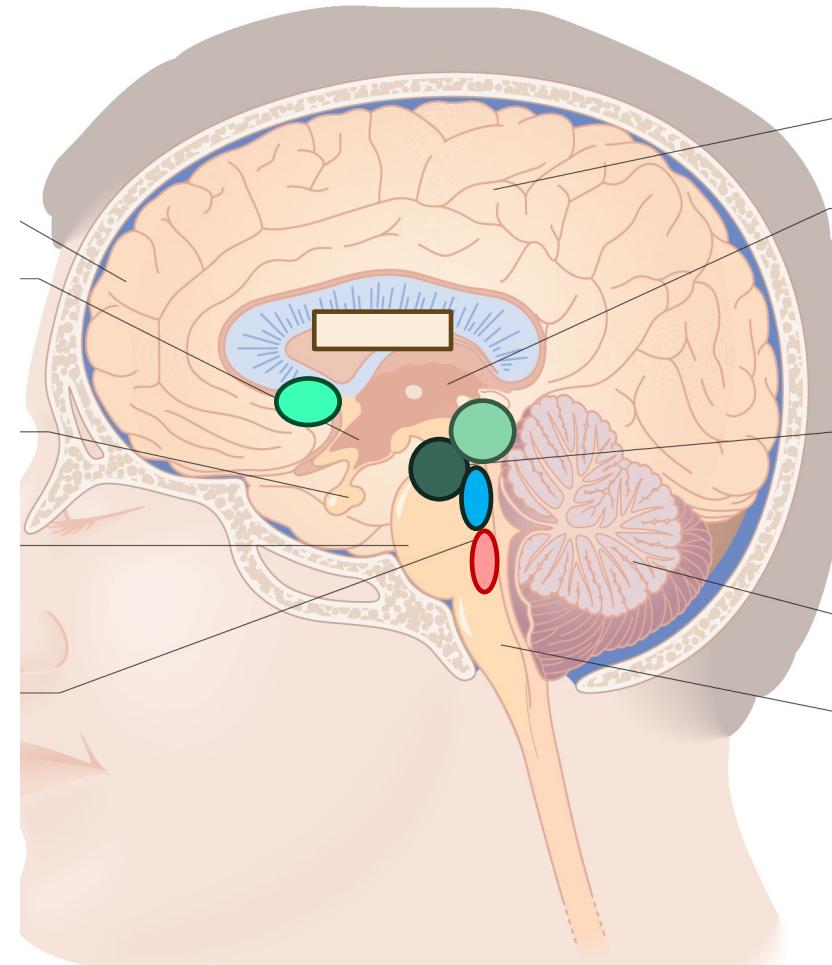
Figure 4.4

NEUROANATOMY



THE BRAIN: CRITICAL NUCLEI FOR DRUGS EFFECTS

- In neuroanatomy, a nucleus (pl. : nuclei) is **a cluster of neurons, located deep within the cerebral hemispheres and brainstem.**
- The neurons within one nucleus usually have roughly similar connections and functions.



THE BRAIN: KEY NUCLEI

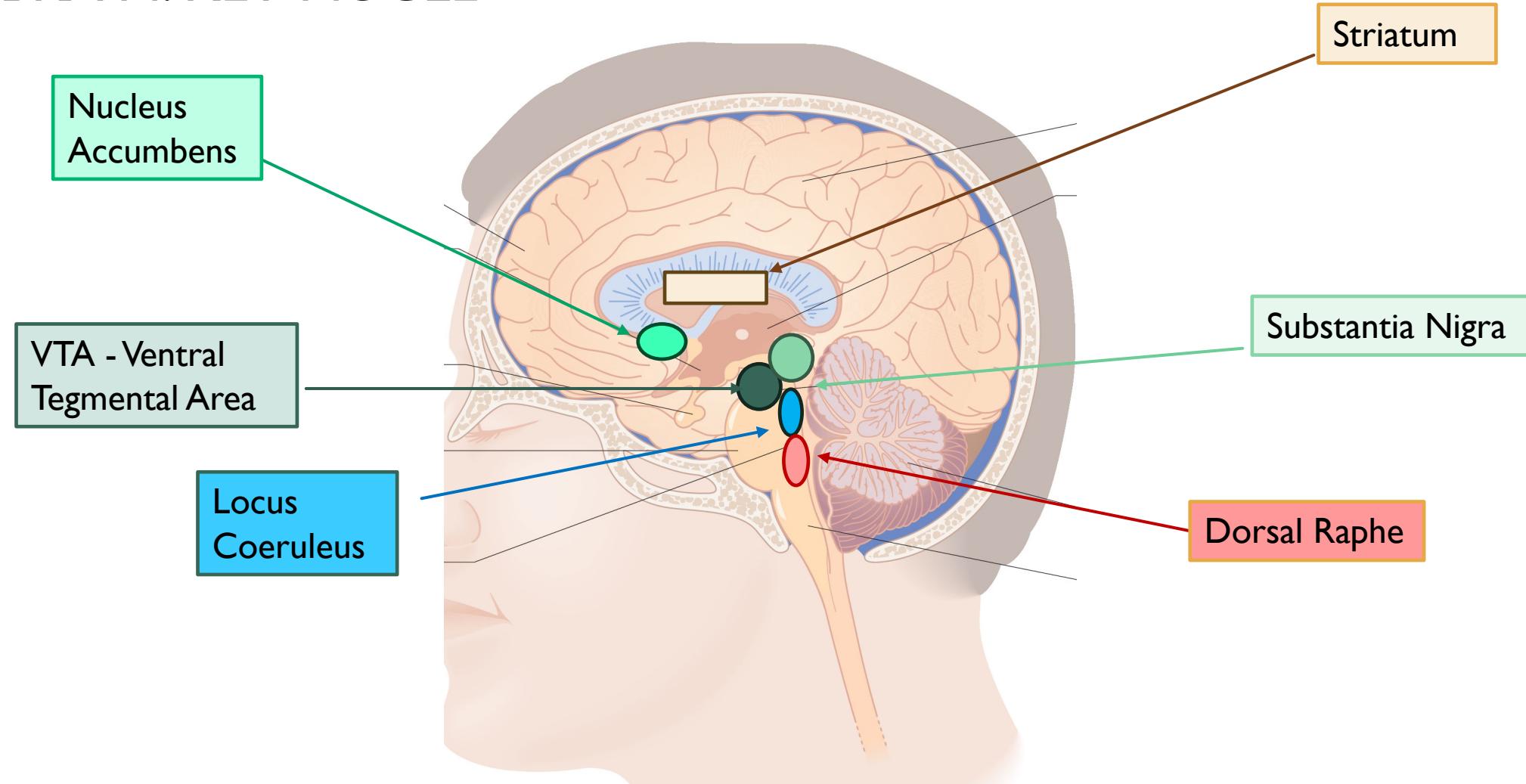
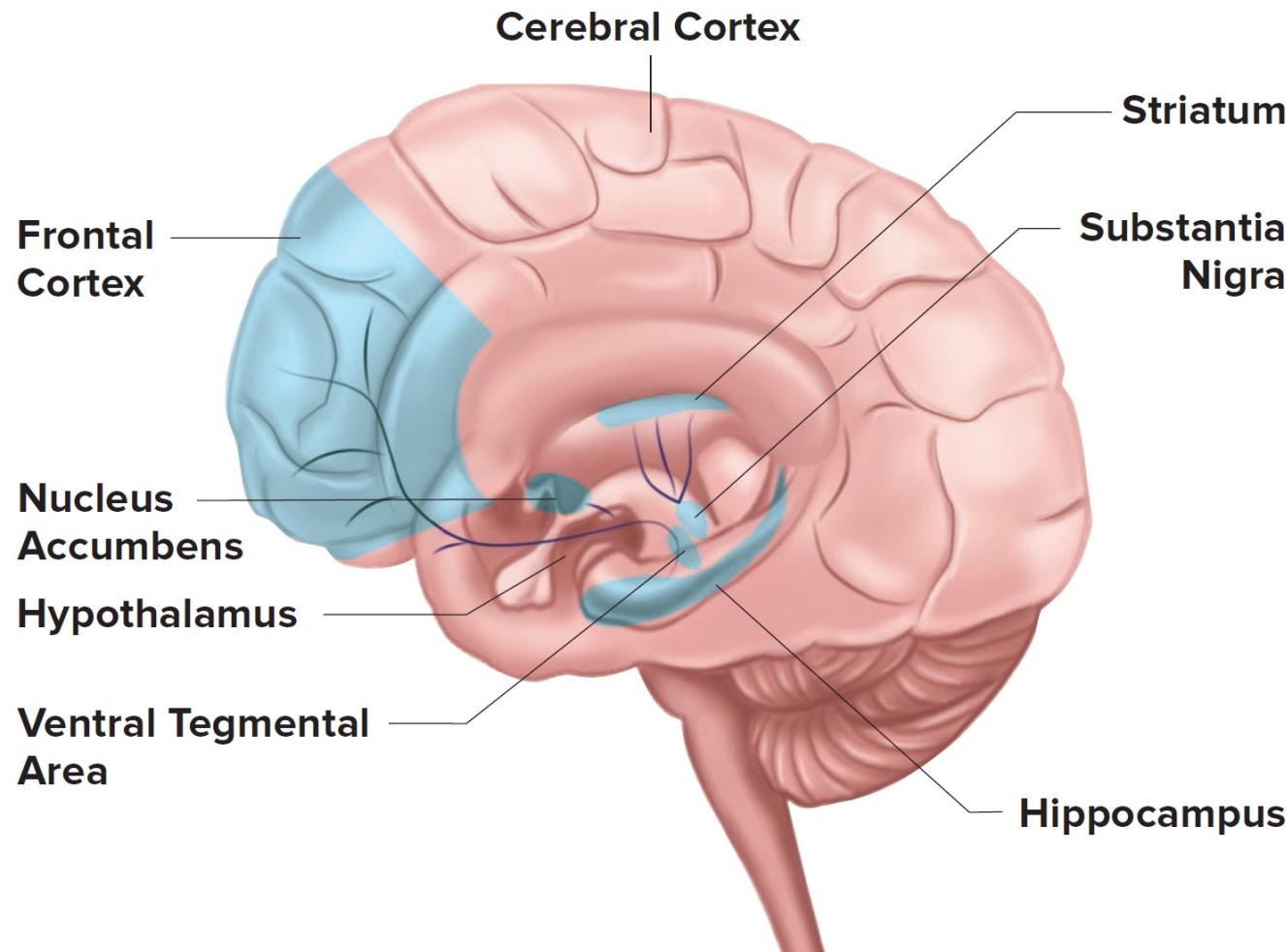
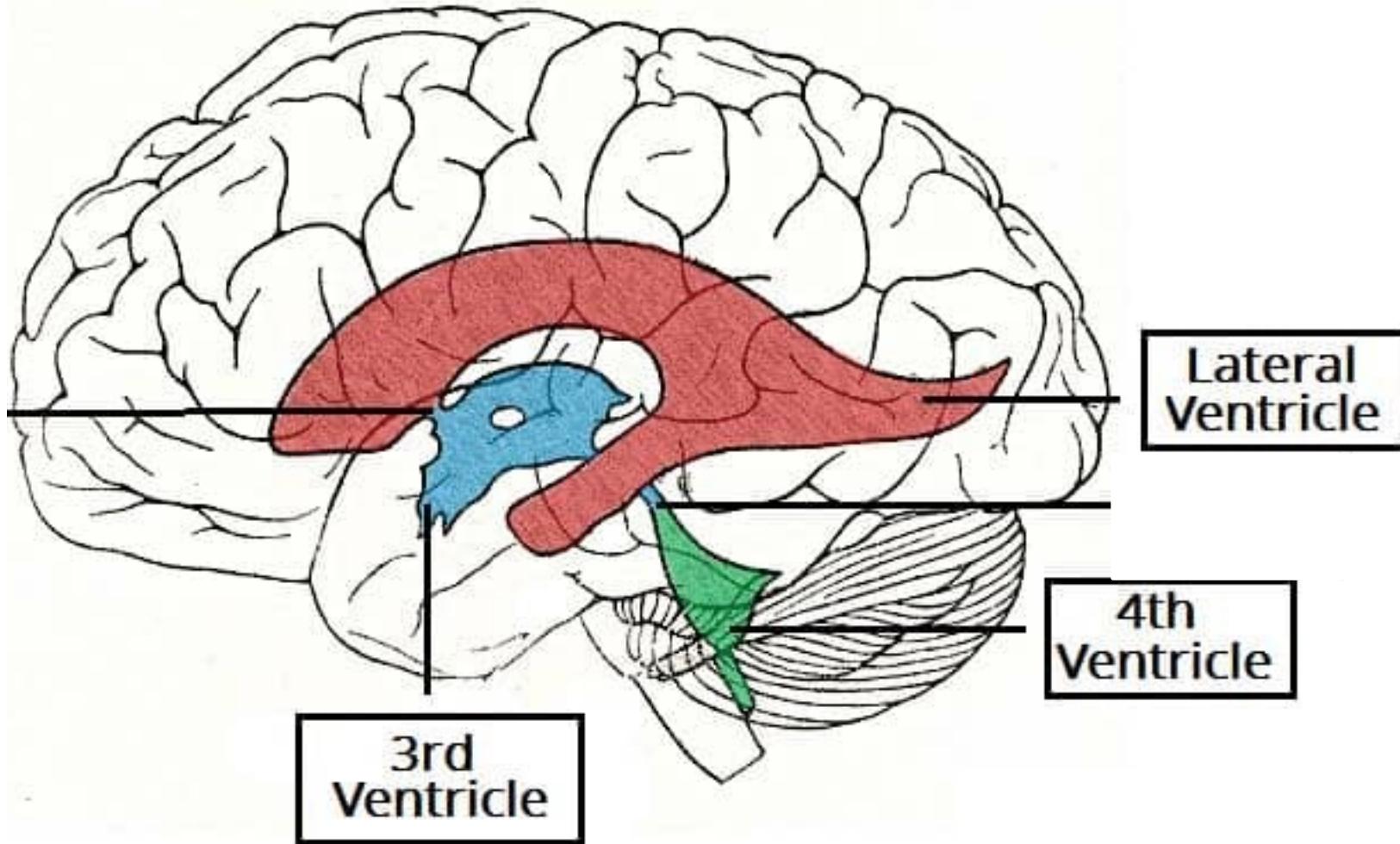


Figure 4.4
(ignore any black lines without →)

FYI – YOUR BOOK SHOWS SOME OF THESE WITH THIS FIGURE 4.3:



VENTRICLES



Def: a hollow part or cavity in an organ.

wrt to the Brain:

1. each of the four connected fluid-filled cavities in the center of the brain.

RESEARCH ON THE HUMAN BRAIN AND BEHAVIOUR

How do we visualize the human brain
and changes in neural activity?

BRAIN IMAGING TOOLS

■ Structure

- MRI
- CT

■ Function

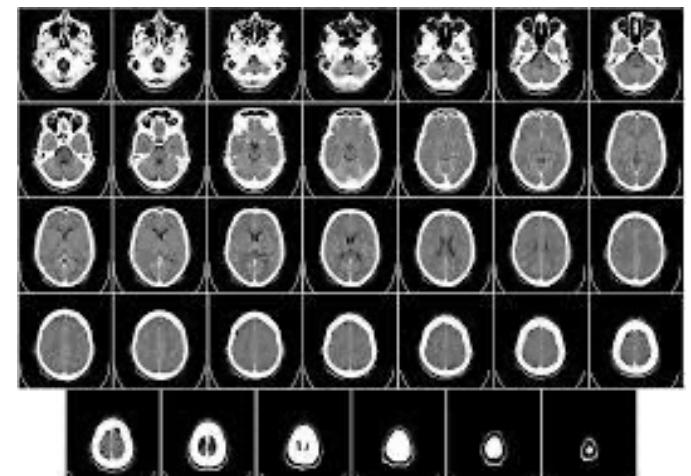
- EEG
- PET
- fMRI

BRAIN IMAGING TECHNIQUES: CT (COMPUTERIZED TOMOGRAPHY)/CAT SCAN

- Technique that takes X-ray photos of the brain

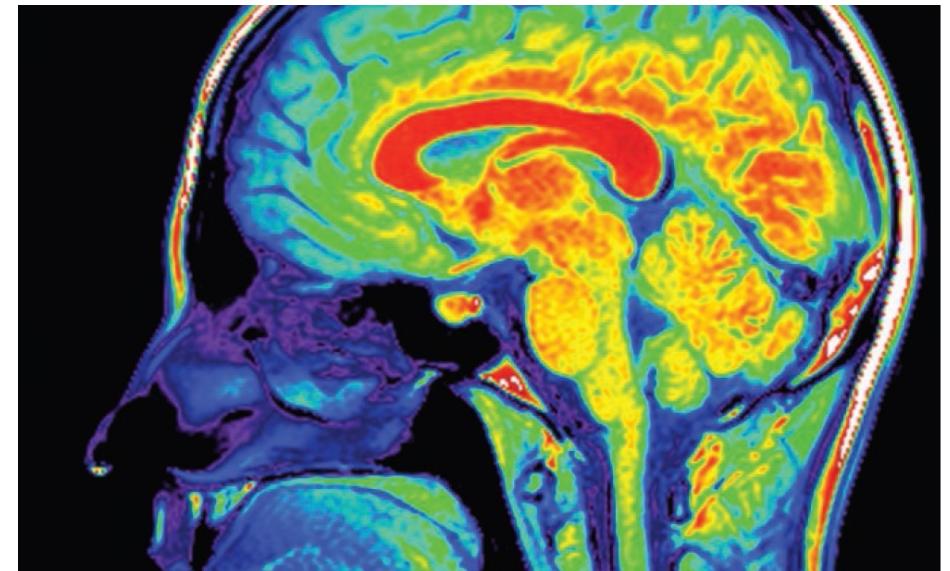
- Benefits.
 - Used primarily to assess brain damage
 - Fast and cheap

- Limitation.
 - Uses radiation
 - Provides no information about brain functioning.



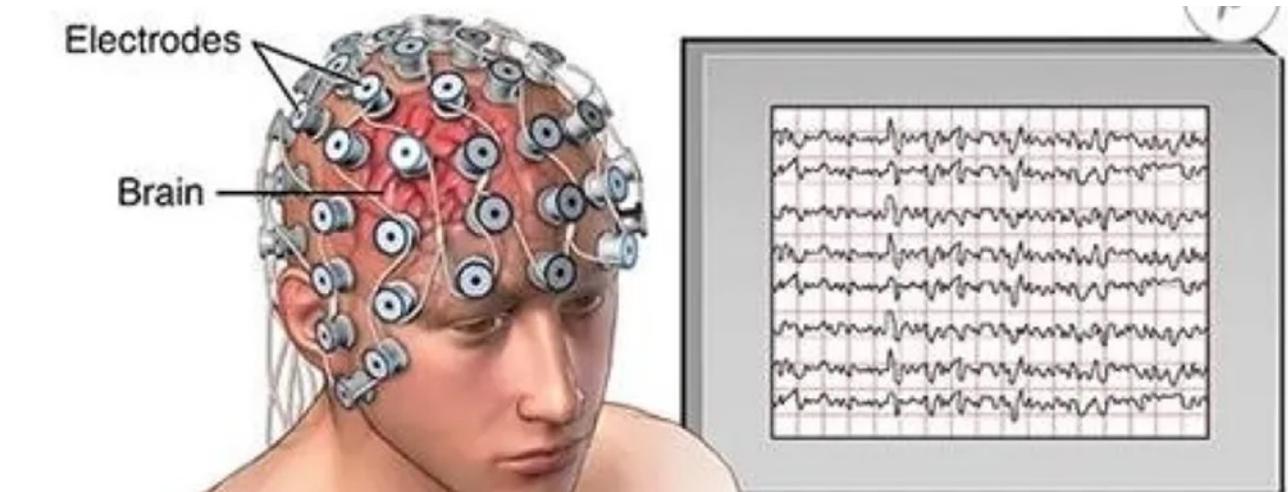
BRAIN IMAGING TECHNIQUES: MAGNETIC RESONANCE IMAGING, OR MRI

- Technique that uses powerful magnets to determine the amount of hydrogen atoms at different locations in the body.
- Benefits.
 - Provides a high-resolution image of the brain's anatomy.
 - Could detect cysts, tumors, bleeding, inflammation/infection
 - Is noninvasive, superior image to CT scan.
- Limitation.
 - Provides no information about brain functioning.

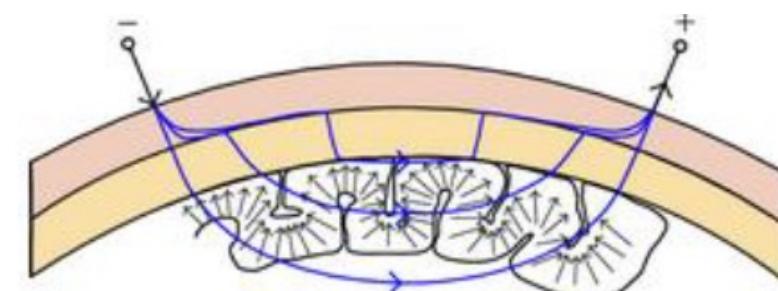


EEG (ELECTROENCEPHALOGRAM)

- Uses electrodes to record electrical activity “brainwaves” within the brain.
- Can confirm or rule out behavioral changes due to sleep disorders, seizures/epilepsy, head injury, encephalitis, stroke, etc

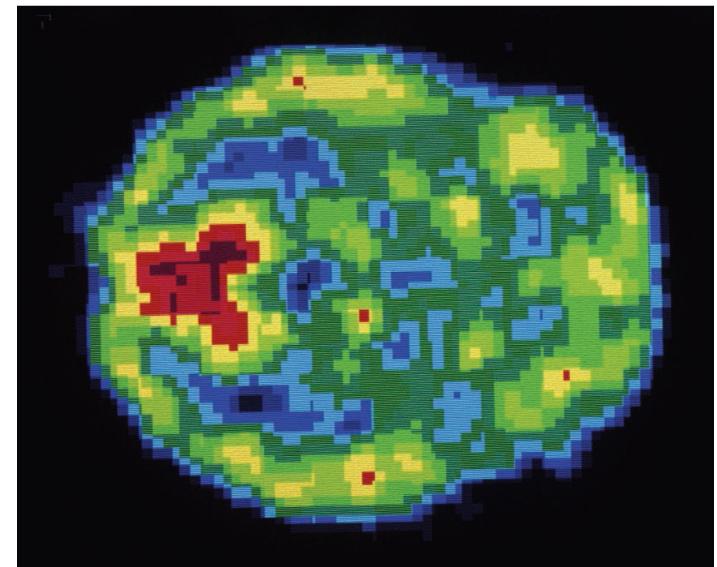


EEG reading

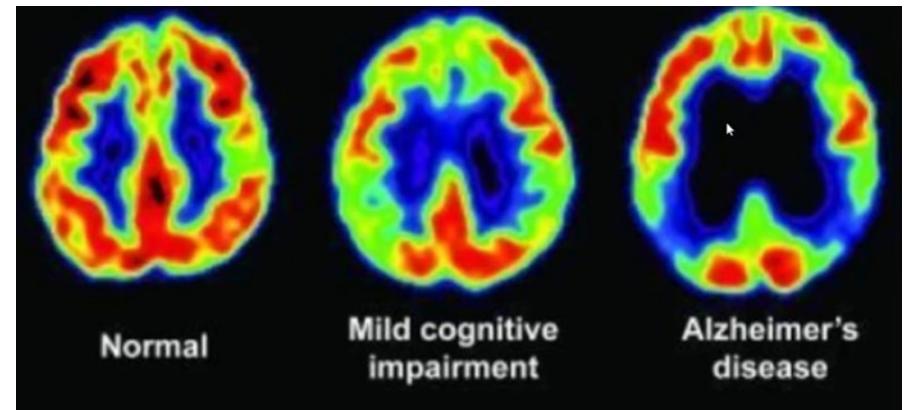


BRAIN IMAGING TECHNIQUES: POSITRON EMISSION TOMOGRAPHY, OR PET

- A radioactively labeled chemical is injected into the bloodstream, and a computerized scanning device then maps out the relative amounts of the chemical in various brain regions.
- Benefit.
 - Provides a direct measure of brain activity and an indirect measure of potential toxicity to specific neurons
- Limitation.
 - Requires the injections of radioactive chemicals
 - No structural information



Warmer colors = more active



BRAIN IMAGING TECHNIQUES: FUNCTIONAL MAGNETIC RESONANCE IMAGING, OR FMRI

- Provides real-time information about changes in brain blood flow as an individual performs behavioral or cognitive tasks.
 - This is in the form of a “BOLD” signal (Blood-Oxygen-Dependent signal)
- Benefits.
 - Gives real-time information about changes in brain blood flow.
 - Noninvasive, great pictures/resolution.
 - Functional technique but can still see structure at ‘CT level’
- Limitation.
 - VERY expensive, also noisy
 - Does not provide any information about the anatomy of the brain.

