Understanding Addiction: The Intersection of Biology and Psychology

Robert Heimer, Ph.D.
Yale University School of Public Health
Center for Interdisciplinary Research on AIDS
New Haven, CT, USA

November 2013

Outline of My Talk

- Defintion of Terms
- Neurobiological Considerations
- Psychological Presentation
- Implications for Treatment

Definitions

- There is a difference between use of addictive drugs and addiction.
- Terms such as dependence, tolerance, and withdrawal refer to how the body responds to the drug.
- Addiction refers to the impact of the drug on the life of the person taking the drug.

Dependence, Tolerance, Withdrawal, and Craving

- Dependence refers to a physical or psychological need to continue taking drugs, whether addictive or non-addictive (for example, insulin for diabetes or anti-hypertensives to control blood pressure)
- For many drugs, tolerance develops and the amount of drug needed to produce its desired effect increases.
- Withdrawal is the set of unpleasant symptoms associated with cessation of drug use in tolerant users.
- Craving is the longer-term feelings that make the resumption of drug use hard to resist.

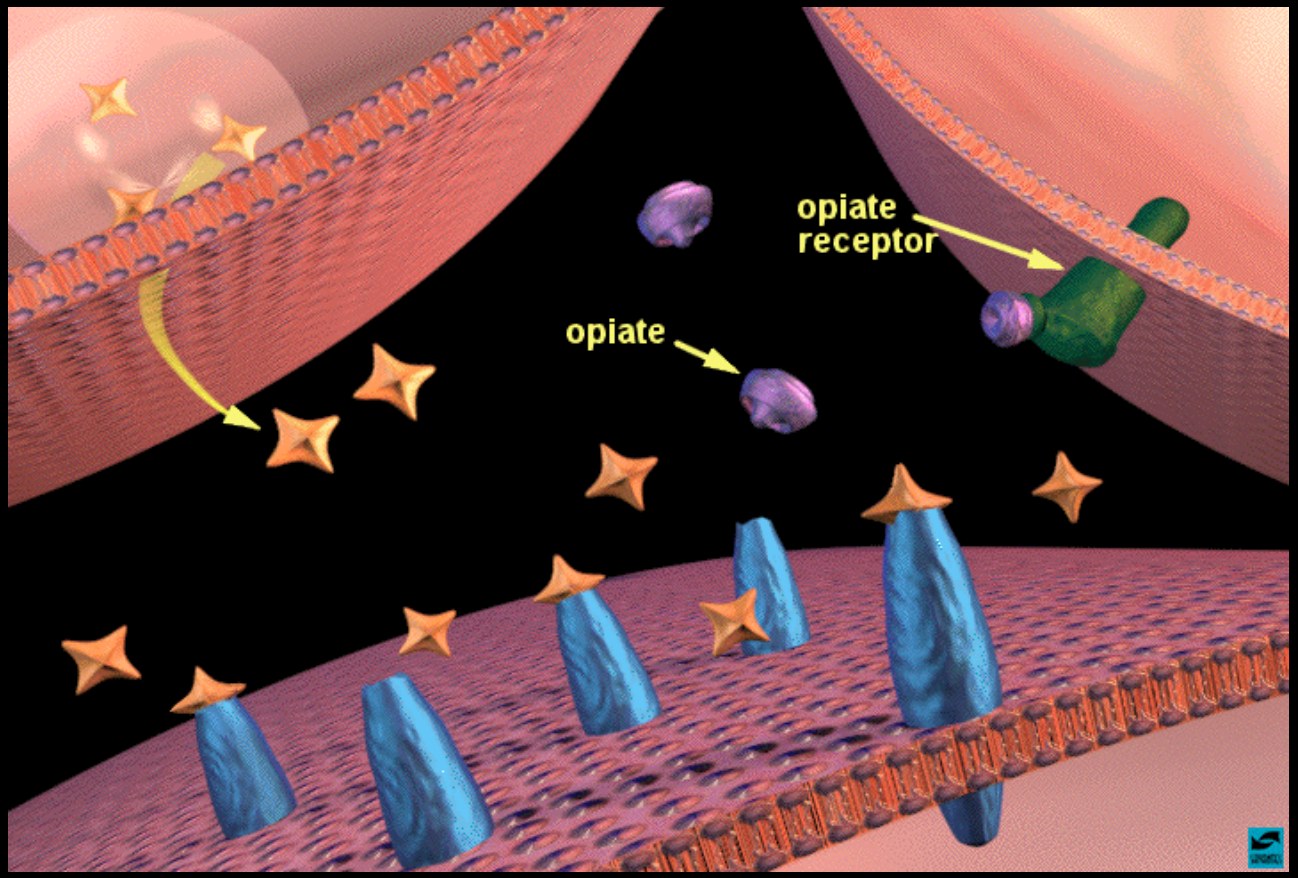
Psychotropic Drugs Can Cause Dependence and Addiction

- Stimulants
  - Cocaine
  - Methamphetamine and its relatives
- Opioid Narcotics
  - Heroin
  - Pharmaceutical opioids

Biology of Drug Addiction (1)

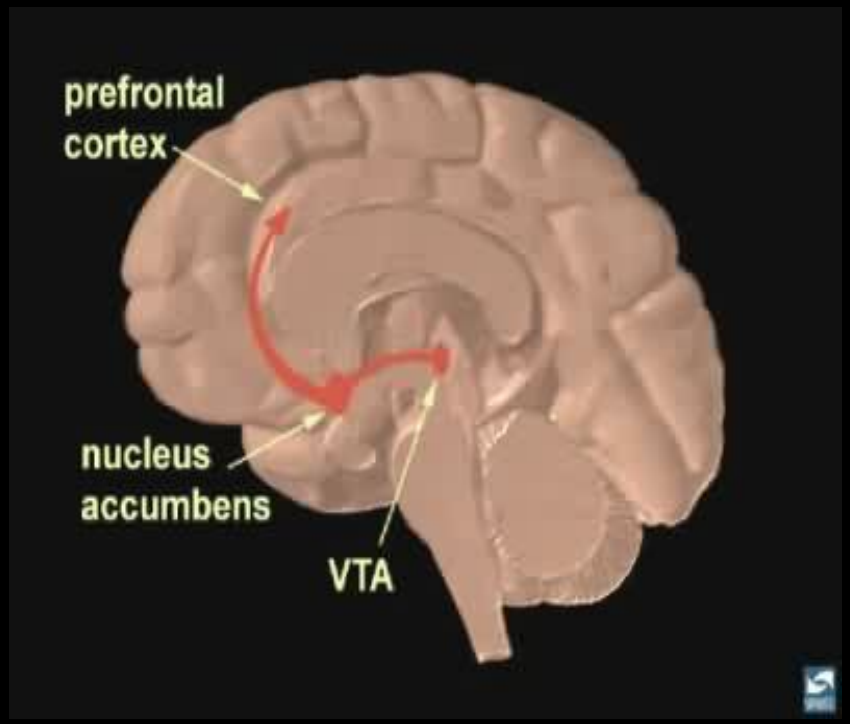
- The effects of drugs on the brain have been extensively studied and the mechanisms of dependence and addiction have been investigated in animals and humans.
- The signaling systems and the molecular events are increasingly understood.
- All involve systems that use dopamine as the neurotransmitter and are part of the brain's "reward system."

Biology of Drug Addiction (2)



Most drugs of addiction work directly or indirectly on dopamine receptors in the brain

Biology of Addiction (3)



The reward pathway:

Opioids activate receptors in the ventral tegmentum (VTA) which causes dopamine release by the nucleus accumbens (NA).

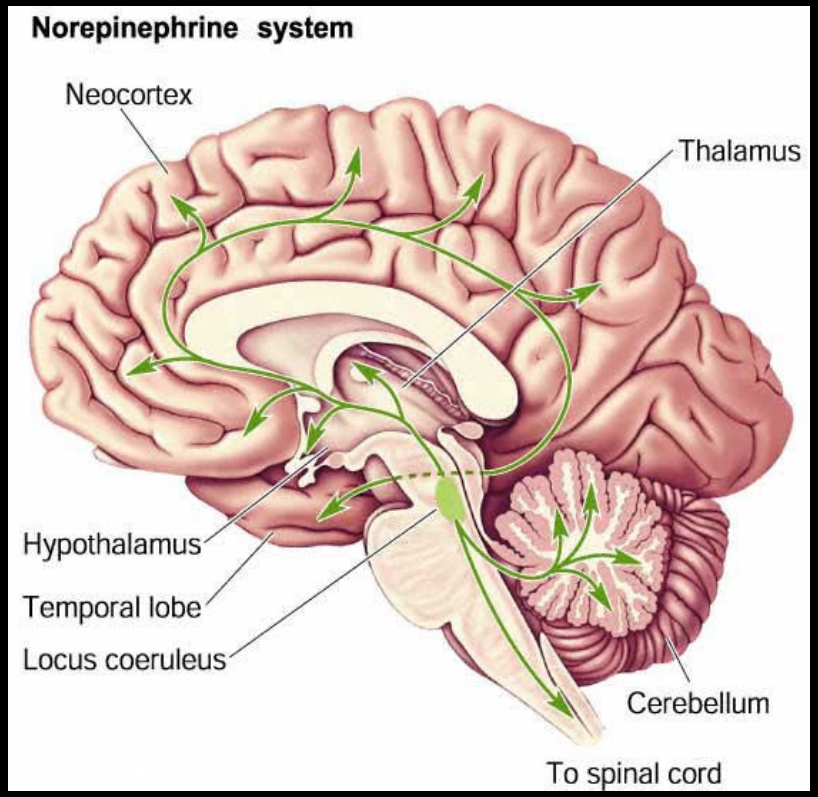
This is associated with intense euphoria.

The memory of the experience is maintained in the hippocampus and other areas of the brain.

Molecular Changes during Addiction

- Animal models and human studies have demonstrated long-term changes in the brain associated with addiction:
  - changes in the number and density of receptors for addictive drugs (why tolerance develops), and
  - changes in intracellular signaling molecules and protein expression that are long-term, all but irreversible -- explaining the persistent craving that follows withdrawal
- Addiction is a chronic disease that cannot be successfully treated by short-term methods such as detoxification.

Biology of Opiate Action



The Locus Ceruleus:

Neurons produce norepinephrine (NE) and opioids suppress the release of NE leading to respiratory depression and drowsiness.

Excessive depression results in drug overdoses.

During withdrawal there is rebound NE release by these neurons causing anxiety, tremor, hypertension, tachycardia, and other withdrawal symptoms.

Heroin

- Heroin is the most commonly abused illegal psychoactive addictive drug in Russia

“China White”

“Brown Sugar”

“Black Tar”

How Is Heroin Used?

- Injected
  - into a vein (‘mainlining’)
  - into a muscle (‘skin popping’)
- Smoked
  - in a water pipe or standard pipe
  - mixed in a marijuana joint or regular cigarette
  - inhaled through a straw (‘chasing the dragon’)
- Snorted as powder

Immediate Effects of Heroin Use

- Euphoria or rush
  - Injected into a vein: euphoria in 7-8 seconds
  - Injected into a muscle: euphoria in 5-8 minutes
  - Sniffed/snorted or smoked: euphoria in 10-15 minutes
  - This is the result of actions in the ventral tegmentum
- Drowsiness or nodding
  - After the initial euphoria, abusers become drowsy for several hours
  - This is a result of the actions in the locus ceruleus

Heroin Cessation in Dependent Users

- Withdrawal or “Crashing”
  - Physical symptoms of withdrawal may occur within a few hours after last drug is taken
  - Major withdrawal symptoms peak 24 – 48 hours after the last dose of heroin and subside after about a week
- Craving
  - Intense feeling to relive the euphoria
  - These feelings can persist for many years

Life Histories of Heroin Users

- Use begins most often in adolescence or early adulthood.
- Dependence often follows if use becomes regular.
- In the U.S., first encounter with treatment occurs, on average, 5-7 years after first use.
- Slow rate of stopping
  - Without proper treatment (substitution), individuals who do stop do so only after relapsing repeatedly

Heroin Use and Addiction

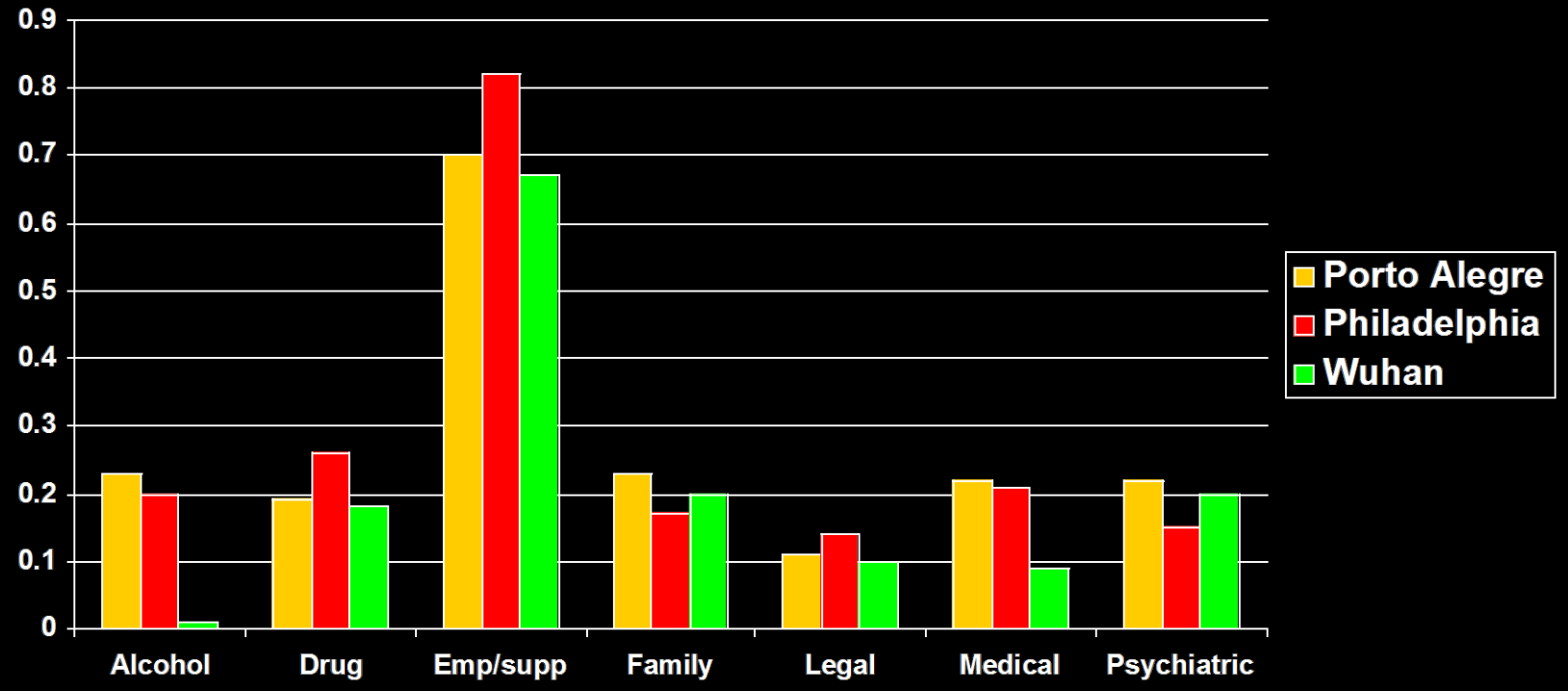
- People start and continue to use heroin for
  - recreation and experimentation,
  - self-medication, or
  - social relationships/peer pressure.
- Patterns of heroin abuse include
  - social use on infrequent occasions,
  - regular, controlled use without addiction, or
  - addiction.
- Insufficient research into which people will exhibit which pattern.

Psychological Features of Opiate Addiction (1)

- Physiologic dependence includes tolerance and withdrawal after abstaining.
- A diagnosis of addiction also requires:
  - preoccupation with opiates (craving),
  - continued use despite adverse effects, and
  - loss of control - compulsive use, inability to stop or abstain, use more than intended or when not intended.

Psychological Features of Opiate Addiction (2)

- While some cultural elements have an impact on addiction, much about addiction is universal.



Psychological Features of Opiate Addiction (3)

- Chronic disorder; high risk of persistence, relapse and recurrence
- Multi-factor etiology
  - Genetic risk
  - Psychological factors (e.g., classical and operant conditioning)
  - Social factors (e.g., family, peers, stress)
  - Psychiatric co-morbidity (e.g., depression, anxiety)
  - Neurobiology-- acute and chronic effects on brain reward, anxiety and stress systems

Dangers of Heroin Use and Addiction

- Premature death from overdose, infections, accidents, homicide, and suicide
- High morbidity -- endocarditis, hepatitis, phlebitis, TB, HIV, injection site abscesses, and other infectious diseases
- Adverse impact on family and community
- Vocational disruption
- Violence and crime

Dangers among Heroin Users in St. Petersburg

- Annual mortality rate from heroin overdoses ranges between 3-5%.
- Between 37 and 44% have been in prison.
- Hepatitis C prevalence exceeds 90%; 75% are chronically infected.
- HIV prevalence has climbed steadily and is approaching 60%.

Treatment for Opioid Addiction

- Primary treatment is detoxification in Russia and many other parts of the world
  - Failure rates >90% at 6 months have been found for more than 90 years universally.
  - Should not be surprising when applying a acute treatment for a chronic disease.
- Adding psychotherapy to detoxification reduces failure rates to ~75% at 12 months, regardless of the kind of psychotherapy used.

Detoxification Is Unethical

- It makes no logical sense to treat a chronic illness as though it was an acute condition.
- It is the least effective form of treatment, but it remains the first-line therapy.
- May cause greater harm than no treatment
  - There is a three-fold greater likelihood of overdose death following its completion.
  - The craving to resume use may result in unsafe adminisration such as injected with a virus-contaminated syringe.

Opioid Agonist Maintenance Treatment

- Substitute long-acting oral or sublingual medication (administered daily) for short-acting drug used by injection (3-4 times per day)
- Steady-state plasma levels -- no “rush,” “nod” or withdrawal during maintenance
- Although low daily doses (30-40 mg methadone) are sufficient to prevent withdrawal, higher doses (>80 mg methadone) are needed to prevent continued opioid abuse.

METHADONE

- A synthetic opioid agonist with a 24-36 hour half-life
- Usual effective dose: 80-120 mg
  - range: 30 to >200 mg, with clinical response guiding dose
  - Induction starts with 30 mg and increases until effective dose is achieved.
- Methadone maintenance is usually accompanied by counseling and other services

Psychological Counseling as Part of Methadone Treatment

	Treatment Retention	Negative Urines for >16 Weeks
Methadone alone (60-90 mg/day)	31%	0%
Methadone plus standard counseling	59%	28%
Methadone plus enhanced counseling	81%	55%

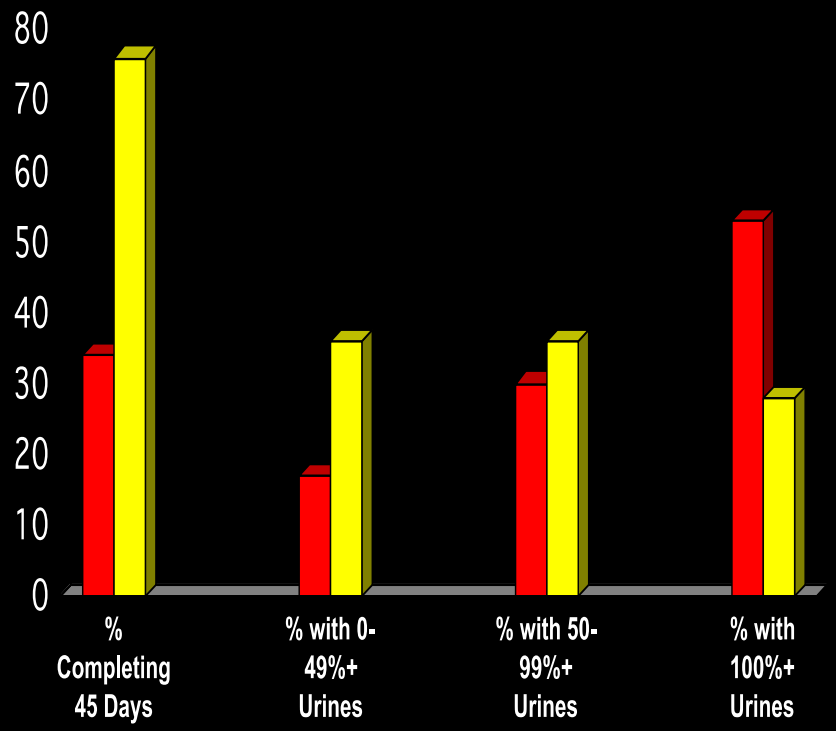
McLellan, JAMA,1993

Methadone Provides Proven Effective Treatment

- Randomized controlled clinical trials provide strong evidence for the benefits of methadone treatment with reasonable effect sizes:
  - Reduces drug-related crime by 61%
  - Reduces opioid consumption by 68%
  - Reduces injection and risk taking by 78%
  - Reduces overdose deaths by 75%
  - Reduces HIV incidence by 73%
  - Improves retention in treatment for HIV+ patients

Stopping Methadone Maintenance

- Most individuals who leave methadone maintenance will return to heroin use, therefore long-term treatment is indicated.
- Neither 45 nor 180 day tapering dose detoxification keeps those addicted from returning to heroin abuse



Conclusions

- Addiction is a chronic relapsing medical condition in which drug consumption will continue despite negative consequences.
- Long term changes in the human brain make overcoming addiction a lifelong struggle.
- Failure to overcome addiction without medical assistance is unlikely.
- While battling to control addiction, individuals need psychological assistance to reduce the chances of experiencing the negative medical consequences.