DATB: Addiction

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ESP Splash (Saturday)

These slides are available online, along with fun 5-minute quizzes and other materials:

http://datb.mit.edu/
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What Is Addiction?

Addiction is continued use of a substance despite harms that outweigh the benefits, with a lack of control over substance use.
Types of Harm

**Physical:** Infection, injury, brain damage

**Psychological:** Anxiety, depression, guilt, shame

**Social:** Prison, loss of employment, disowned by friends and family

**Monetary:** Bankruptcy, forced to work in prostitution or drug dealing
Evidence of Lack of Control

Broken promises to oneself: “I will only have two beers tonight.”

Broken promises to others: “I will not be late to work again.”

Feeling helpless: “I could not possibly go a week without cocaine.”
Evidence of Lack of Control

Lying, including lying to doctors, to family, or to oneself.

Lying about substance use, about level of control, about level of harm, or about level of benefit from the substance.
Dopamine signals unexpected rewards

Signal (bursts per second) vs. Time (seconds)

Eats peanut
Dopamine signals predicted/expected rewards

First trial:

“Good monkey”

Eats peanut

Tenth trial:

“Good monkey”

Eats peanut

Time (seconds)
Dopamine signals error in prediction

Tenth trial:

No peanut:

“Good monkey”

Eats peanut

No peanut

“Good monkey”

Time (seconds)
The dopamine burst motivates the animal

The dopamine motivates the child, focuses the child’s attention on the goal, and facilitates the behavior (truck chasing) that will lead to reward.
Drugs of abuse mimic natural reward

First dose:
- Sees cocaine
- Snorts cocaine

Fiftieth dose:
- Sees cocaine
- Snorts cocaine

Time (seconds)
Why does seeing cocaine cause dopamine release? Remember how conditioning normally works:

First trial:
- "Good monkey"
- Eats peanut

Tenth trial:
- "Good monkey"
- Eats peanut

Time (seconds)
Drugs of abuse mimic natural reward

When an addict sees cocaine, the dopamine burst produced by his own cells motivates him to get cocaine and snort it.

The pleasure an addict actually feels from snorting cocaine is decreased over time, due to tolerance.

Fiftieth dose:

- Sees cocaine
- Snorts cocaine

Time (seconds)
Drug addicts are insensitive to non-drug motivators

The incentive of freedom triggers a dopamine burst, which motivates the person to wash the car.

Normal person:
- "Wash my car or go to prison"

Addict:
- "Stay clean or go to prison"
- Sees cocaine
- The addict has tolerance to both cocaine and their own dopamine, so they cannot be motivated by normal incentives.
- What will the addict do?
Liking versus wanting

Addicts don’t like doing drugs as much as they used to
Addicts want to do drugs
Addicts don’t want to do anything else
Speed of onset and addiction

Drugs which take effect quickly are more addictive, because a fast spike in dopamine more closely mimics natural rewards and the drug-taking behavior is more closely associated with the reward if they come close together.
Speed of onset and addiction

Faster onset, more addictive:

- Crack cocaine
- Injected heroin
- Smoked meth (ice)

Slower onset, less addictive:

- Powder cocaine (snorted, has an 11 minute absorption half-time)
- Snorted heroin (absorbed faster than snorted cocaine. Why?)
- Snorted meth (even less addictive: swallowed meth)
Speed of onset and addiction

Faster onset, more addictive:
Xanax (the fast elimination and need for more doses also increases addiction potential. Why do frequent doses lead to stronger addiction? Discuss.)

Slower onset, less addictive:
Klonopin, Librium
Speed of onset and addiction

Faster onset, more addictive:
- Snorted Ritalin
- Vicodin
- Abused (chewed, crushed and snorted) OxyContin

Slower onset, less addictive:
- Oral Ritalin
- OxyContin
- Properly used (intact time-release tablets) OxyContin
ADHD

ADHD is treated with stimulants that boost dopamine (and norepinephrine), why does this work?

Dopamine normally facilitates goal-directed behavior by:

• Increasing motivation
• Focusing attention on the goal
• Providing energy to work towards the goal
• Speeding learning and reinforcing memory
ADHD

Why does dopamine speed learning and reinforce memory?
Discuss
Common Confusion

The following factors are not part of the definition of addiction:

- Tolerance
- Withdrawal
- Dependence
Tolerance

**Drug tolerance** is the need for increasingly large doses to reach the same effect.

Many non-addictive drugs cause tolerance, for example diphenhydramine (Benadryl).
Addiction can exist without tolerance. In fact, many addictive drugs cause the opposite of tolerance, which is called sensitization.

Classical stimulants are most noted for causing sensitization, including cocaine and methamphetamine.
Tolerance does not increase forever, there is a ceiling.

Opioids such as heroin and morphine probably display the most dramatic tolerance. In opioid addicts, 50-fold tolerance is sometimes observed. In sick people with extreme pain, opioid tolerance can grow even higher.
Tolerance

Tolerance to stimulants is much more limited and harder to gauge. Stimulant addicts may display 5- to 10-fold tolerance.

Stimulant users may display 2-fold sensitization, meaning that the drug is twice as potent as it was when they first used it. They only need a half dose. More commonly, they take a full dose and get twice as high.
Tolerance is *not* part of addiction
Withdrawal

Withdrawal is the name for unpleasant symptoms that arise when you reduce the dose or discontinue drug use.

Many non-addictive drugs cause withdrawal, including glucocorticoid steroids such as dexamethasone and blood pressure medications. In fact, dexamethasone withdrawal can be fatal.
Drug addiction can exist without withdrawal. Crack cocaine addicts almost universally can abstain from drug use for a whole day without bothersome withdrawal.
Withdrawal is not part of addiction
Dependence

Dependence means that you would experience withdrawal if you tried to stop. Thus, dependence is almost a synonym for withdrawal, and as such it is orthogonal to addiction.

Unfortunately, many people use the word dependence as a synonym for addiction, which is just awful in my opinion.
Dependence is *not* part of addiction
What Is Addiction?

Addiction is continued use of a substance despite harms that outweigh the benefits, with a lack of control over substance use.
Addiction Can Be Hard to Diagnose

The following factors can make it hard to diagnose addiction:

Lying

Uncertain harms from the substance

Uncertain benefits from the substance

Preexisting problems, which are not due to the substance
However, addiction is often very easy to diagnose.

Most of the people who use heroin or cocaine every day are clearly and unquestionably addicts.
Despite all this uncertainty about diagnosis, it is important to keep two things in mind:

First, full-blown addicts cannot plausibly remain in denial or fool their doctors and family.

Second, borderline addicts or near-addicts should be careful. They are walking a fine line, and they need to be watched, guided, and cautioned.
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