THE PHYSIOLOGY OF ADDICTION

Effects of Drug-Taking Behavior on the Brain

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Thanks to Tess Jurgensen and the OTF of Franklin County
and North Quabbin for organizing these forums
HIJACKING THE BRAIN

New research suggests that the brain's reward system has different mechanisms for craving and pleasure. Craving is driven by the neurotransmitter dopamine. Pleasure is stimulated by other neurotransmitters in "hedonic hot spots." When the craving circuitry overwhelms the pleasure hot spots, addiction occurs, leading people to pursue a behavior or drug despite the consequences.

PATHWAYS TO CRAVING
Desire is triggered when dopamine, which originates near the top of the brain stem, travels through neural pathways to act on the brain. Drugs increase the flow of dopamine.

Dorsal striatum
Neurons here help form habits by identifying enjoyable patterns, such as the anticipation of buying drugs.

Prefrontal cortex
The amino acid glutamate, produced here, interacts with dopamine to spark visualizations that cue cravings.

Amygdala
Neurons here are stimulated by learned emotional responses, such as memories of cravings and pleasure.

Orbital frontal cortex
This hot spot gives a sense of gratification but is also the first to shut down if a person has indulged too much.

Nucleus accumbens
A hot spot within this key part of the craving circuitry amplifies the response to pleasure.

PLEASURE HOT SPOTS
A system of small hedonic hot spots, unrelated to dopamine, provides temporary sensations of pleasure and forms a feedback loop with the reward system that controls desire.
EAT, DRINK, HAVE SEX
(AND USE DRUGS)

Lizard brain advice
- Run!
- Fight!
- Get Laid!

Cortex advice
- Listen deeply
- Have patience
- Set respectful boundaries
- Innovate!
- Create
- Take the long view.
DOPAMINE & SEROTONIN
Location and Function

**Dopamine Pathways**
- Frontal cortex
- Nucleus accumbens
- VTA

**Serotonin Pathways**
- Striatum
- Substantia nigra
- Raphe nuclei
- Hippocampus

**Functions**
- Reward (motivation)
- Pleasure, euphoria
- Motor function (fine tuning)
- Compulsion
- Perseveration

**Functions**
- Mood
- Memory processing
- Sleep
- Cognition
IT IS SAD TODAY.
How Cocaine Works
How Heroin Works
Functionally...

Dopamine D2 Receptors are Decreased by Addiction
Genetics Account for 50% of Risk of Addiction
Addiction is a Developmental Pediatric Disease

Source: NIAAA National Epidemiologic Survey on Alcohol and Related Conditions, 2003
Teen Alcohol Use Wires The Brain For Addiction

40% of kids who begin drinking at age 15 will become alcoholics.

Only 7% of those who begin drinking at age 21 become alcoholics.


* Photo courtesy of NIAAA and MADD
Percentage of U.S. 12th Grade Students Reporting Past Month Use of Cigarettes and Marijuana, 1975 to 2013

Percent

1975 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07 09 11 13

Cigarettes
Marijuana
Percentage of U.S. 12 Grade Students Reporting Daily Marijuana Use vs. Perceived Risk of Regular Marijuana Use

Source: The Monitoring the Future study, the University of Michigan
Brain Development

Source: Tapert & Schweinsburg, 2005
Synaptic Refinement
Myelination
This is Normal Development

Act First, Think Later

More Risky Impulsive Behavior

Preference for Physical Activity and Sensation Seeking

Emotions Felt Very Intensely

Less than Optimal Planning

Less Consideration of Negative Consequences

Strongly Influenced by Friends and Peers
Rate of Change

Brain Development

Source: Tapert & Schweinsburg, 2005
Marijuana (Tetrahydrocannabinol)

Drug

THC

Endo-cannabinoid (Anandamide)

Brain's Chemical

Anandamide

Source: NIDA
Deficits in Cognitive Functioning Among Active Marijuana Users

Many studies show that adolescents who use marijuana heavily tend to score worse than non-users on tests of:

- attention
- verbal learning
- memory
- processing speed

... even when they are not high.

Messinis, et al 2006
New Zealand study showing relationship between cannabis use and social outcomes

% gained university degree (by age 25)
- Never: 36%
- 1 to 99: 27%
- 100 to 199: 19%
- 200 to 299: 11%
- 300 to 399: 9%
- 400+: 2%

% unemployed (ages 21-25)
- Never: 52%
- 1 to 99: 42%
- 100 to 199: 41%
- 200 to 299: 25%
- 300 to 399: 23%
- 400+: 21%

% welfare dependent (ages 21-25)
- Never: 57%
- 1 to 99: 42%
- 100 to 199: 41%
- 200 to 299: 25%
- 300 to 399: 23%
- 400+: 21%

Source: Fergusson and Boden. Addiction, 103, pp. 969-976, 2008 [New Zealand study]
Loss of Adult IQ with Marijuana Dependence in Adolescence

Findings:

• Those who developed marijuana dependence before age 18 showed IQ decline in adulthood.

• The longer their dependence persisted, the greater the decline, with a decline of 8 IQ points for the most persistent users.

• Those who began using in adulthood did not show IQ decline.

• Quitting in adulthood did not restore functioning in those who began in adolescence.
Average THC & CBD levels in the US: 1960 - 2011

Data from the NIDA-sponsored Potency Monitoring program at the University of Mississippi, showing average THC and CBD levels in samples of marijuana seized by federal, state and local governments in each year shown.
THC Concentrates

“Green Crack” wax

“Ear Wax”

Butane Hash Oil (BHO)

Hash Oil Capsules

“Budder”

“Shatter”
Ways to consume marijuana

SMOKING
- Pipe
- Bong
- Bubbler
- Dab
- Joint
- Blunt

EDIBLES
- Candy
- Ice cream
- Baked goods

VAPORIZING
- Desktop vaporizer
- Portable vaporizer

BEVERAGES
- Tea
- Soda
- Alcohol
- Milk

OTHER
- Capsules
- Spray
- Tincture
Big Marijuana — Lessons from Big Tobacco

Kimber P. Richter, Ph.D., M.P.H., and Sharon Levy, M.D., M.P.H.

The United States is divided over the legalization of marijuana. Arguments in favor include protection of individual rights, elimination of criminal sentencing for minor offenses, collection of tax revenue, and elimination of the black market. Counterarguments include the

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It took the medical and public health communities 50 years, millions of lives, and billions of dollars to identify the wake of illness and death left by legal, industrialized cigarettes. The free-market approach to tobacco clearly failed to protect the public’s welfare and the common good: in spite of recent federal regulation, tobacco use remains the leading cause of death in the United States.

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History and current evidence suggest that simply legalizing marijuana, and giving free rein to the resulting industry, is not the answer. To do so would be to once again entrust private industry with safeguarding the health of the public — a role that it is not designed to handle.
Think you drink a lot?

**Time for a stiff drink**

Average number of drinks per capita consumed in the past week, by decile, among adults aged 18 and over.

- 30 percent of American adults don’t drink at all. Another 30 percent consume, on average, less than one drink per week.

- On the other hand, the top 10 percent of American adults - 24 million of them - consume an average of 74 drinks per week, or a little more than 10 drinks per day.

Source: "Paying the Tab," by Philip J. Cook
Low-risk drinking limits

**MEN**
- On any single DAY: No more than 4 drinks on any day
- Per WEEK: No more than 14 drinks per week

**WOMEN**
- On any single DAY: No more than 3 drinks on any day
- Per WEEK: No more than 7 drinks per week

To stay low risk, keep with BOTH the single-day AND weekly limits.

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12 fl oz of regular beer = 8–9 fl oz of malt liquor (shown in a 12 oz glass) = 5 fl oz of table wine = 1.5 fl oz shot of 80-proof spirits ("hard liquor"—whiskey, gin, rum, vodka, tequila, etc.)

- about 5% alcohol
- about 7% alcohol
- about 12% alcohol
- about 40% alcohol
Adverse Childhood Experiences – ACEs

*Emotional Neglect*
*Abuse*
*Household Dysfunction*
Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults

The Adverse Childhood Experiences (ACE) Study

Vincent J. Felitti, MD, FACP, Robert F. Anda, MD, MS, Dale Nordenberg, MD, David F. Williamson, MS, PhD, Alison M. Spitz, MS, MPH, Valerie Edwards, BA, Mary P. Koss, PhD, James S. Marks, MD, MPH

Background: The relationship of health risk behavior and disease in adulthood to the breadth of exposure to childhood emotional, physical, or sexual abuse, and household dysfunction during childhood has not previously been described.

Methods: A questionnaire about adverse childhood experiences was mailed to 13,494 adults who had completed a standardized medical evaluation at a large HMO; 9,508 (70.5%) responded. Seven categories of adverse childhood experiences were studied: psychological, physical, or sexual abuse; violence against mother; or living with household members who were substance abusers, mentally ill, suicidal, or ever imprisoned. The number of categories of these adverse childhood experiences was then compared to measures of adult risk behavior, health status, and disease. Logistic regression was used to adjust for effects of demographic factors on the association between the cumulative number of categories of childhood exposures (range: 0–7) and risk factors for the leading causes of death in adult life.

Results: More than half of respondents reported at least one, and one-fourth reported ≥2 categories of childhood exposures. We found a graded relationship between the number of categories of childhood exposure and each of the adult health risk behaviors and diseases that were studied (P < .001). Persons who had experienced four or more categories of childhood exposure, compared to those who had experienced none, had 4- to 12-fold increased health risks for alcoholism, drug abuse, depression, and suicide attempt; a 2- to 4-fold increase in smoking, poor self-rated health, ≥50 sexual intercourse partners, and sexually transmitted disease; and a 1.4- to 1.6-fold increase in physical inactivity and severe obesity. The number of categories of adverse childhood exposures showed a graded relationship to the presence of adult diseases including ischemic heart disease, cancer, chronic lung disease, skeletal fractures, and liver disease. The seven categories of adverse childhood experiences were strongly interrelated and persons with multiple categories of childhood exposure were likely to have multiple health risk factors later in life.

Conclusions: We found a strong graded relationship between the breadth of exposure to abuse or household dysfunction during childhood and multiple risk factors for several of the leading causes of death in adults.

Finding Your ACE Score

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household often or very often... 
   Swear at you, insult you, put you down, or humiliate you? 
   or 
   Act in a way that made you afraid that you might be physically hurt? 
   │ Yes  No  If yes enter 1  □

2. Did a parent or other adult in the household often or very often... 
   Push, grab, slap, or throw something at you? 
   or 
   Ever hit you so hard that you had marks or were injured? 
   │ Yes  No  If yes enter 1  □

3. Did an adult or person at least 5 years older than you ever... 
   Touch or fondle you or have you touch their body in a sexual way? 
   or 
   Attempt or actually have oral, anal, or vaginal intercourse with you? 
   │ Yes  No  If yes enter 1  □

4. Did you often or very often feel that... 
   No one in your family loved you or thought you were important or special? 
   or 
   Your family didn’t look out for each other, feel close to each other, or support each other? 
   │ Yes  No  If yes enter 1  □

5. Did you often or very often feel that... 
   You didn’t have enough to eat, had to wear dirty clothes, and had no one to protect you? 
   or 
   Your parents were too drunk or high to take care of you or take you to the doctor if you needed it? 
   │ Yes  No  If yes enter 1  □

6. Were your parents ever separated or divorced? 
   │ Yes  No  If yes enter 1  □

7. Was your mother or stepmother: 
   Often or very often pushed, grabbed, slapped, or had something thrown at her? 
   or 
   Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard? 
   or 
   Ever repeatedly hit at least a few minutes or threatened with a gun or knife? 
   │ Yes  No  If yes enter 1  □

8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs? 
   │ Yes  No  If yes enter 1  □

9. Was a household member depressed or mentally ill, or did a household member attempt suicide? 
   │ Yes  No  If yes enter 1  □

10. Did a household member go to prison? 
    │ Yes  No  If yes enter 1  □

Now add up your “Yes” answers: _____  This is your ACE Score.
ACExs are ADVERSE CHILDHOOD EXPERIENCES

HOW PREVALENT ARE ACExs?

The ACE study revealed the following estimates:

**ABUSE**
- Physical Abuse: 26.3%
- Sexual Abuse: 20.7%
- Emotional Abuse: 10.3%

**NEGLECT**
- Emotional Neglect: 10.8%
- Physical Neglect: 9.9%

**HOUSEHOLD DYSFUNCTION**
- Household Substance Abuse: 26.9%
- Parental Divorce: 23.3%
- Household Mental Illness: 19.4%
- Domestic Violence in Household: 12.7%
- Incarcerated Household Member: 4.7%

Of 17,000 ACE study participants:
- 26% have experienced 3 ACEs
- 10% have experienced 2 ACEs
- 5.5% have experienced 1 ACE
- 36% have experienced 0 ACEs
- 9.5% have at least 1 ACE

WHAT IMPACT DO ACExs HAVE?

As the number of ACExs increases, so does the risk for negative health outcomes:

0 ACExs, 1 ACEx, 2 ACExs, 3 ACExs, 4+ ACExs

Possible Risk Outcomes:

- Physical & Mental Health
  - Severe obesity
  - Diabetes
  - Depression
  - Suicide attempts
  - STDs
  - Heart disease
  - Cancer
  - Stroke
  - COPD
  - Broken bones

- Behavior
  - Lack of physical activity
  - Smoking
  - Alcoholism
  - Drug use
  - Mixed work
LAST TWO DECADES OF ALCOHOL, CIGARETTE, AND ILLICIT DRUG USE*

*Past-month use

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<th>Alcohol</th>
<th>Cigarettes</th>
<th>Illicit drugs</th>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>35.3% of 12th graders</td>
<td>11.4% of 12th graders</td>
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<td>21.5% of 10th graders</td>
<td>6.3% of 10th graders</td>
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<tr>
<td>9.7% of 8th graders</td>
<td>3.6% of 8th graders</td>
<td>8.1% of 8th graders</td>
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NIH National Institute on Drug Abuse

WWW.DRUGABUSE.GOV
Figure 1. Estimated percentage of high school students who currently use any tobacco products, any combustible tobacco products, ≥2 tobacco products, and selected tobacco products – National Youth Tobacco Survey, United States. 2011-2016.
Have Smartphones Destroyed a Generation?

More comfortable online than out partying, post-Millennials are safer, physically, than adolescents have ever been. But they’re on the brink of a mental-health crisis.

JEAN M. TWENGE

SEPTEMBER 2017 ISSUE
Addiction and anguish

"It's easier to get a fix of heroin than it is to live a clean life. It's a whole different world out there." - lady from town.

Heroin cuts a wide swath

A slide into addiction

Prescriptions a path to heroin

The way out of addiction

IRS boss ousted

What do Deerfield private schools pay the town?

PUSHING BACK

We can't arrest our way out of this

6 dead as tornados whip through North Texas

Hearing the cries for help

OPIOID Task Force
of Franklin County and the North Quabbin Region
They’re the most **powerful painkillers** ever invented.

And they’re creating the worst addiction crisis America has ever seen.

By Massimo Calabresi
Standard daily opioid dose for every 1 million people

Source: United Nations International Narcotics Control Board
Credit: Sarah Frostenson
Drug Deaths in America Are Rising Faster Than Ever

By JOSH KATZ  JUNE 5, 2017

New data compiled from hundreds of health agencies reveals the extent of the drug overdose epidemic last year.

AKRON, Ohio — Drug overdose deaths in 2016 most likely exceeded 59,000, the largest annual jump ever recorded in the United States, according to preliminary data compiled by The New York Times.

The death count is the latest consequence of an escalating public health crisis: opioid addiction, now made more deadly by an influx of illicitly manufactured fentanyl and similar drugs. Drug overdoses are now the leading cause of death among Americans under 50.

Although the data is preliminary, the Times’s best estimate is that deaths rose 19 percent over the 52,404 recorded in 2015. And all evidence suggests the problem has continued to worsen in 2017.

Drug overdose deaths, 1980 to 2016

*Estimate based on preliminary data
Deaths Ripples Across America

By HAЕYOUN PARK and MATTHEW BLOCH  JAN. 19, 2016

Overdose deaths per 100,000

2003  2004  2005  2006
2007  2008  2009  2010
2011  2012  2013  2014
TOURISTS!!
THANK GOD!
MAY I SUGGEST
RESTAURANTS,
HOTELS,
DESTINATIONS?

WE'RE
JUST HERE
TO BUY SOME
PAIN PILLS.
At an Aug. 15 news conference, Florida officials displayed prescription drugs that were surrendered to the state by pain clinics.

BY LIZETTE ALVAREZ
Published: August 31, 2011

WEST PALM BEACH, Fla. — Florida has long been the nation’s center of the illegal sale of prescription drugs: Doctors here bought 89 percent of all the OxyContin sold in the country last year. At its peak, so many out-of-staters flocked to Florida to buy drugs at more than 1,000 pain clinics that the state earned the nickname “Oxy Express.”

But with the help of tougher laws, officials have moved aggressively this year to shut down so-called pill mills and disrupt the pipeline that moves the drugs north. In the past year, more than 400 clinics were either shut down or closed their doors.

Prosecutors have indicted dozens of pill mill operators, and nearly 80 doctors have seen their licenses suspended for prescribing mass quantities of pills without clear medical need.
A cap, containing what looks like a dusting of heroin, sells for $10.
Map 2. Percentage of 2015 NDTs Respondents Reporting Heroin as Greatest Drug Threat, by OCDETF Region

- Pacific 33.4%
- West Central 15.5%
- Southwest 4.3%
- Great Lakes 87.4%
- Midwest 77.1%
- New England 63.4%
- New York/New Jersey 48.4%
- Florida/Caribbean 7.8%

Source: 2015 National Drug Threat Survey
Opioid pain reliever prescribing rates vary by state

Some states have more painkiller prescriptions per person than others.


CDC Vital Signs, July 2014. Rates per 100 people in 2012
6. A large part of the problem has been the rise of painkillers and heroin, especially in the Northeast.

(Map shows the drug most commonly cited in drug treatment admissions in each state)
Opioid deaths in 2015
Age-adjusted death rates (per 100,000) for overdose deaths from all opioid drugs

Source: CDC WONDER
Figure 2: High school ACL injury rates

High school anterior cruciate ligament (ACL) injury rates per 100,000 athlete exposures (AEs) by sport and sex. (An athlete exposure is 1 athlete participating in 1 practice or competition.)

<table>
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<th>Sport</th>
<th>Girls</th>
<th>Boys</th>
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<td>Girls' soccer</td>
<td>11.7</td>
<td>4.7</td>
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<td>Boys' soccer</td>
<td>11.2</td>
<td>2.4</td>
</tr>
<tr>
<td>Girls' basketball</td>
<td>2.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Boys' baseball</td>
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Adapted from Comstock RD, et al.³
Save a Life
Learn how to respond to an overdose emergency

Get Naloxone Now is an online resource to train people to respond effectively to an opioid-associated overdose emergency. Get Naloxone Now advocates for widespread access to overdose education and training in how to administer naloxone, the life-saving antidote for opioid-associated overdose. Get Naloxone Now seeks to increase the number of lives saved by bystanders and professional first responders (police officers, firefighters and EMTs). Find out how you can contribute to reducing overdose deaths by accessing our online training modules.

INDIVIDUALS-GET TRAINED!
In as little as 20 minutes, you can learn techniques to save the life of a loved one, friend, co-worker, neighbor — anyone — who is experiencing an overdose caused by prescription narcotics or heroin. You can also find out where you can obtain the lifesaving, easy-to-use antidote, naloxone, as well as access relevant...
What It Takes To Get Better

- Stable & Sober Housing
- Medicine
- Mental Health Treatment
- Positive Relationships
- Physical Movement
- Having a Sense of Purpose
- Methadone
- Buprenorphine
- Naltrexone
What It Takes To Get Better

- Stable & Sober Housing
- Mental Health Treatment
- Working
- Growing into an Adult Brain
- Hope
- Having a Sense of Purpose
- Positive Relationships
- Parenting
- Getting Treatment for Trauma
- Self Love
- Medicine
- Physical Movement
- Going to 12 Step Recovery
- Feeling Accountable
Dr. Potee joins the Home Podcast to talk about addiction and stigma

Dr. Potee speaks with The Boston Globe about the lack of medication assisted treatment

Dr. Potee on the impact of the opioid crisis upon children

CNN’s Anthony Bourdain discusses addiction with Dr. Potee

Dr. Potee on opioid addiction among high school students

ruthpotee.com
NEVER. LOSE. HOPE.