

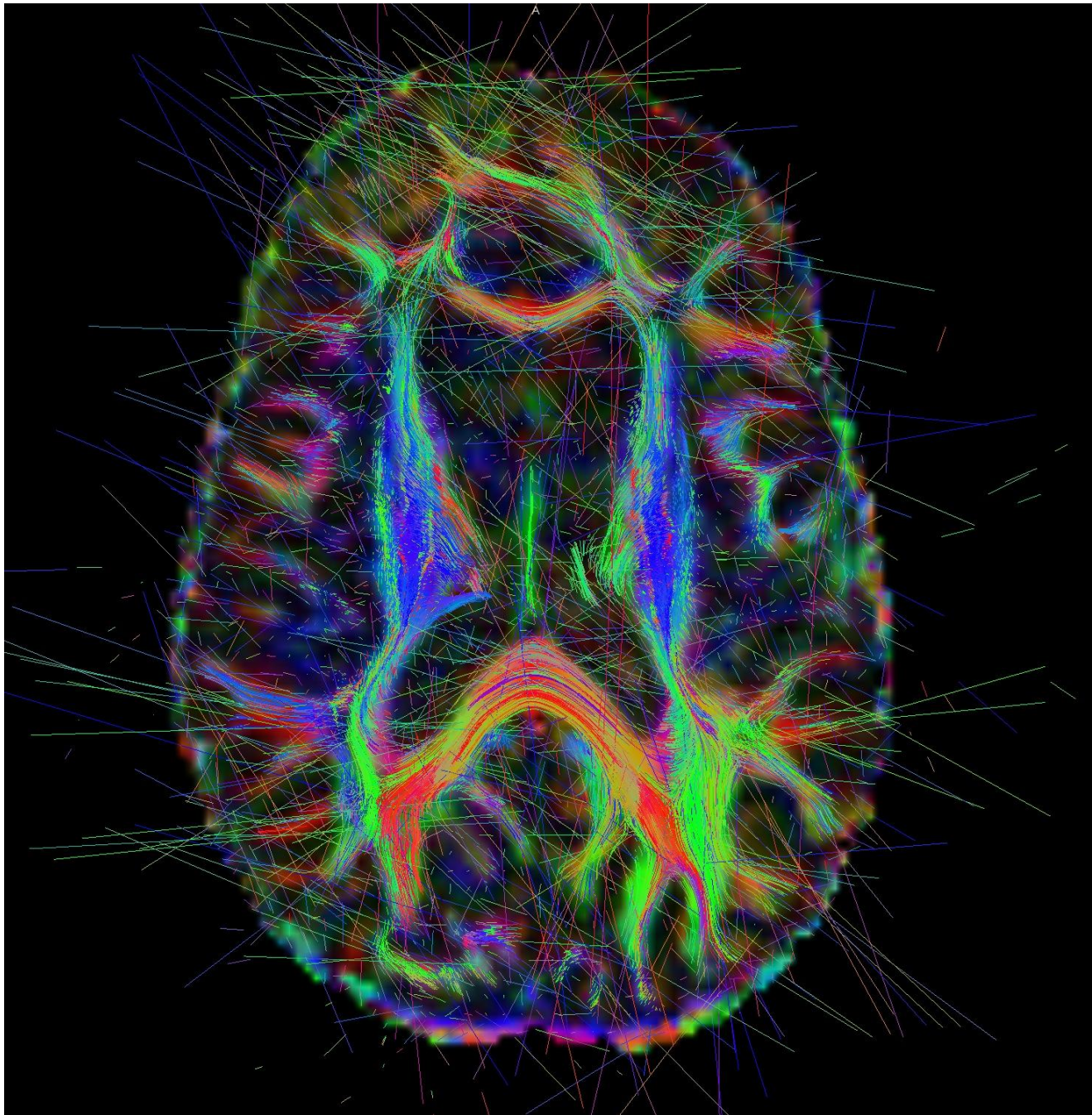
THE PHYSIOLOGY OF ADDICTION:

Addiction is a Developmental Pediatric Disorder

Ruth A. Potee, MD

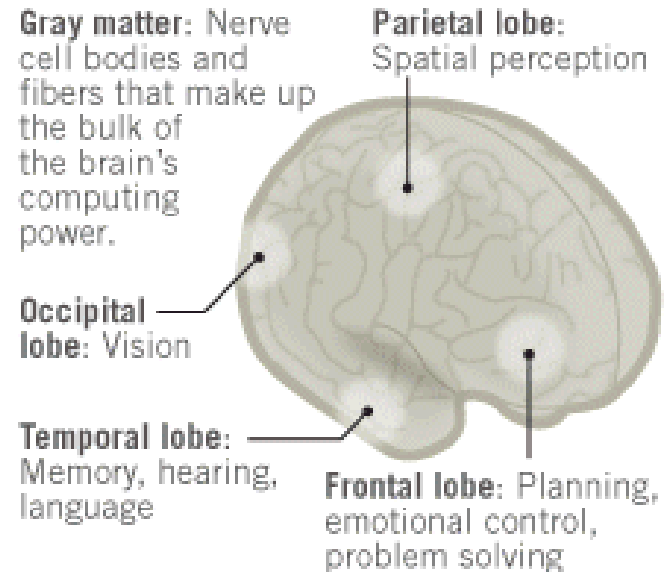
Family Physician & Addictionologist, Valley Medical Group
Medical Director, Franklin County House of Corrections
Medical Director, Franklin Recovery Center
Medical Director, Pioneer Valley Regional School District
Chair, Department of Medicine, Baystate – Franklin Medical Center
Co-Chair – Healthcare Solutions of the Opioid Taskforce

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



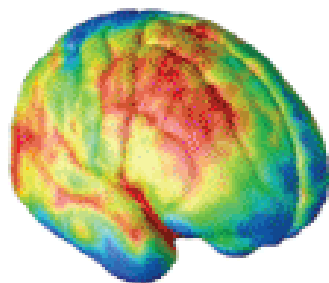
Growing a Grown-up Brain

Scientists have long thought that the human brain was formed in early childhood. But by scanning children's brains with an MRI year after year, they discovered that the brain undergoes radical changes in adolescence. Excess gray matter is pruned out, making brain connections more specialized and efficient. The parts of the brain that control physical movement, vision, and the senses mature first, while the regions in the front that control higher thinking don't finish the pruning process until the early 20s.

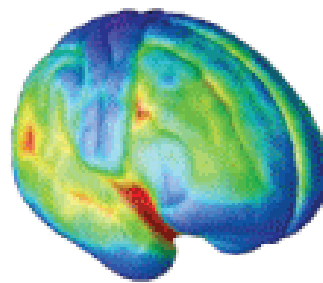
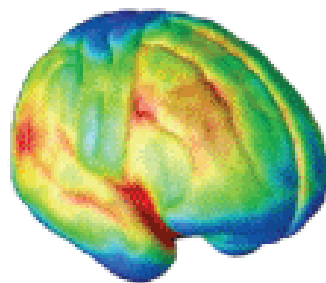


Gray matter density

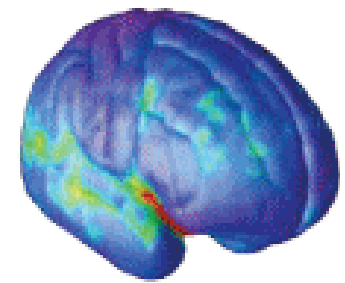
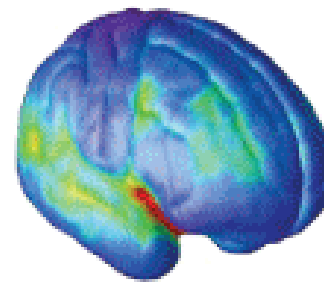
Gray matter becomes less dense as the brain matures.



Age: 5



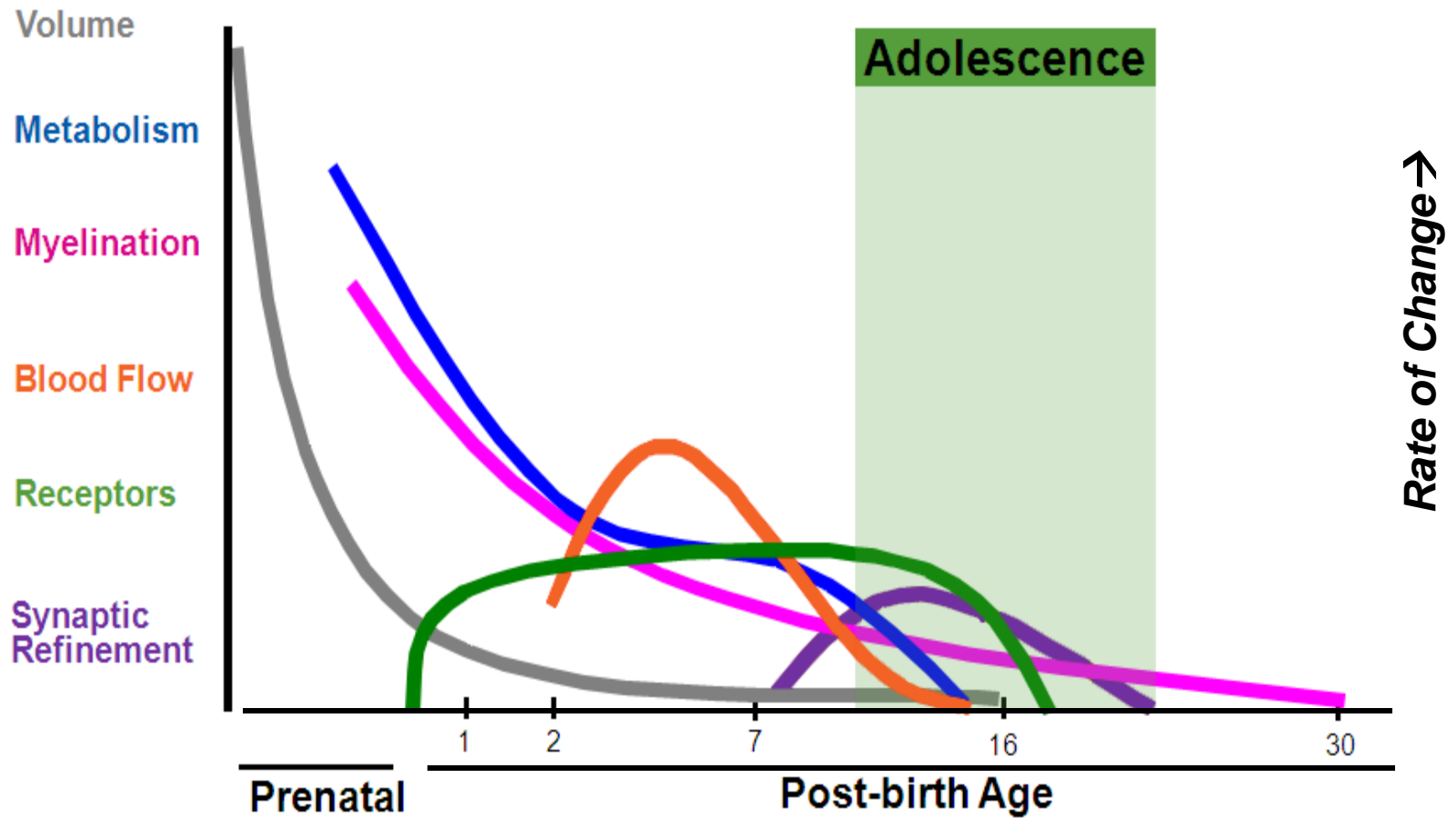
Adolescence



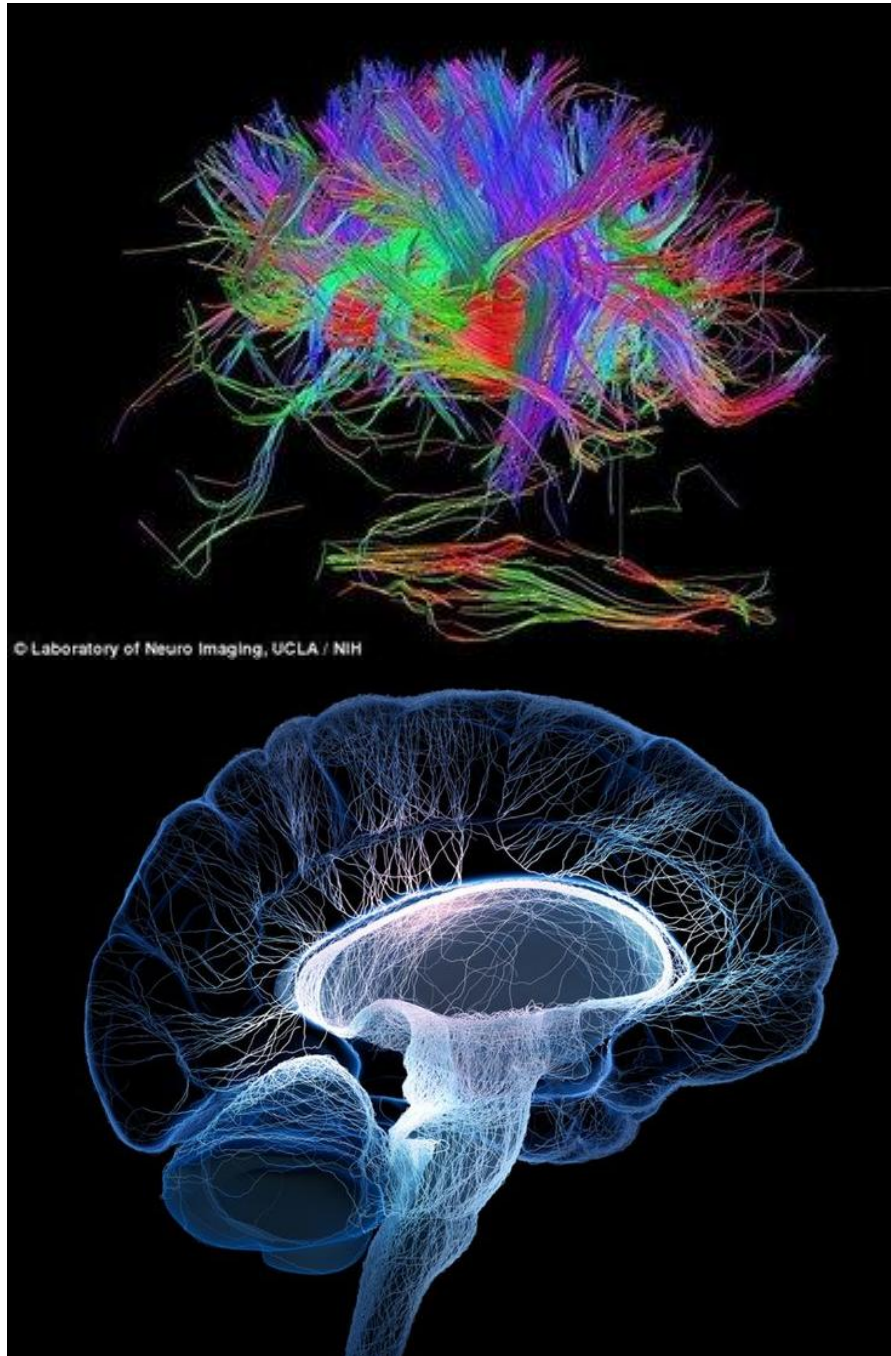
20

Source: "Dynamic mapping of human cortical development during childhood through early adulthood," Nitin Gogtay et al., *Proceedings of the National Academy of Sciences*, May 25, 2004; California Institute of Technology

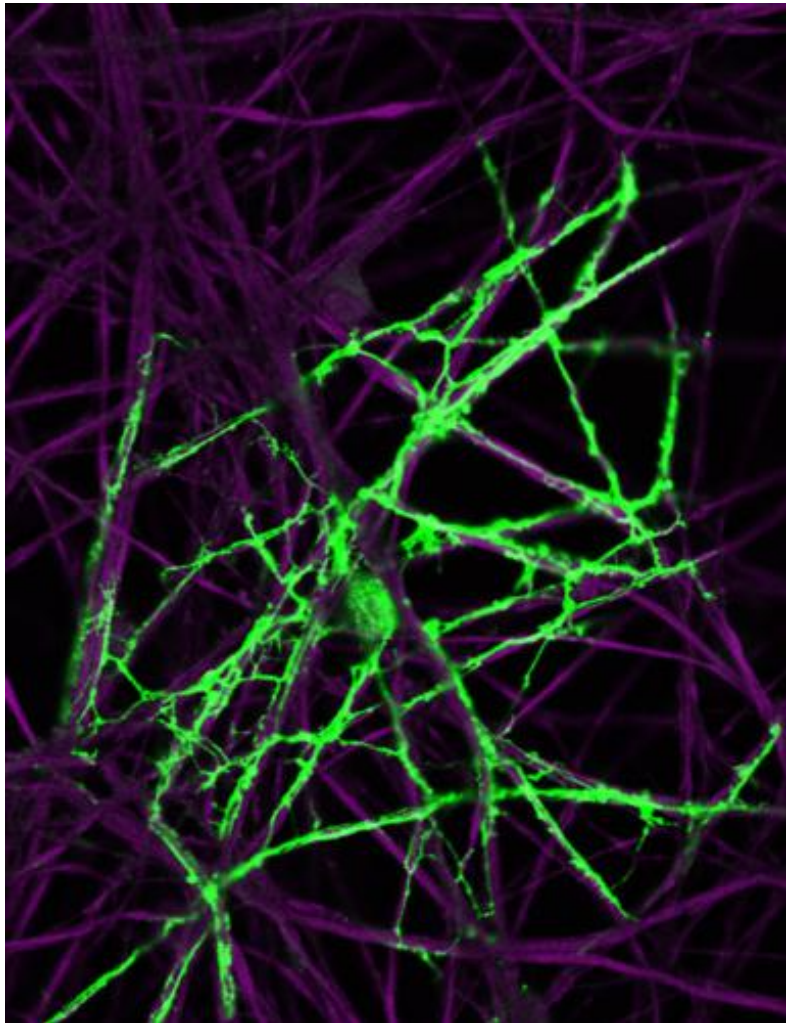
Brain Development



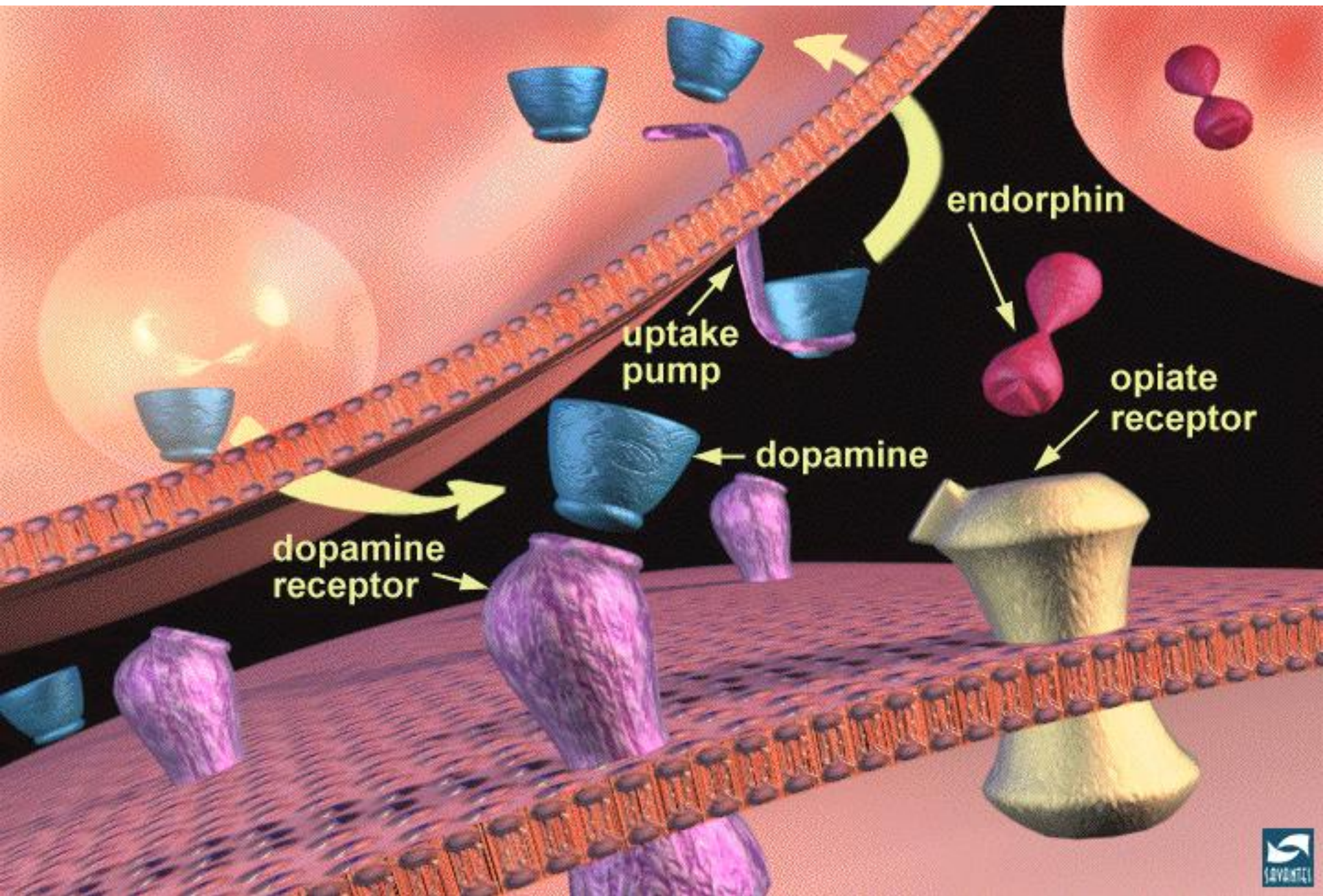
Source: Tapert & Schweinsburg, 2005

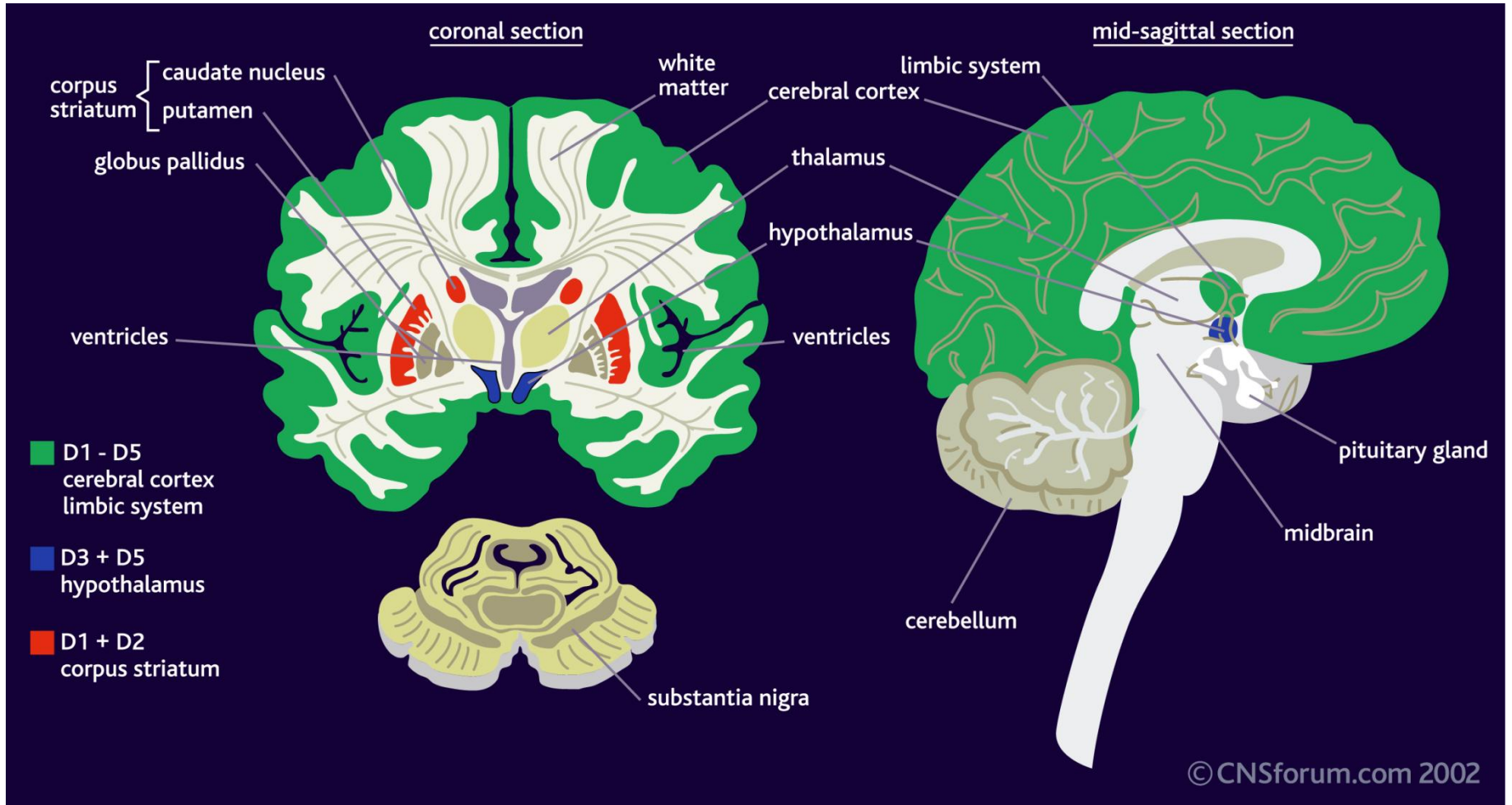


Synaptic Refinement



Myelination





Dopamine Receptors

The “use it or lose it” principle

“If a teen is doing music or sports or academics, those are the cells and connections that will be hardwired. If they're lying on the couch or playing video games..., those are the cells and connections that are going to survive.”

Jay N. Giedd, M.D., Chief of Brain Imaging,
Child Psychiatry Branch, National Institutes of Health

This is Normal Development

Act First,
Think Later

Preference
for Physical
Activity and
Sensation
Seeking

More Risky
Impulsive
Behavior

Emotions Felt
Very
Intensely



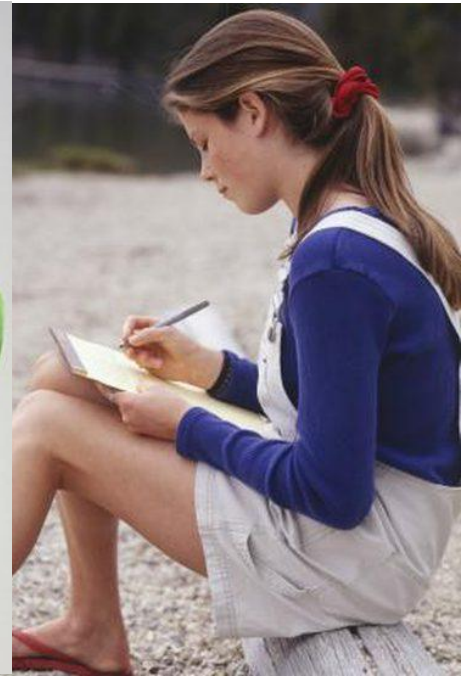
Less than
Optimal
Planning

Less
Consideration
of Negative
Consequences

Strongly
Influenced by
Friends and
Peers



© Arthur Baensch/Corbis





Genetics



Early Use



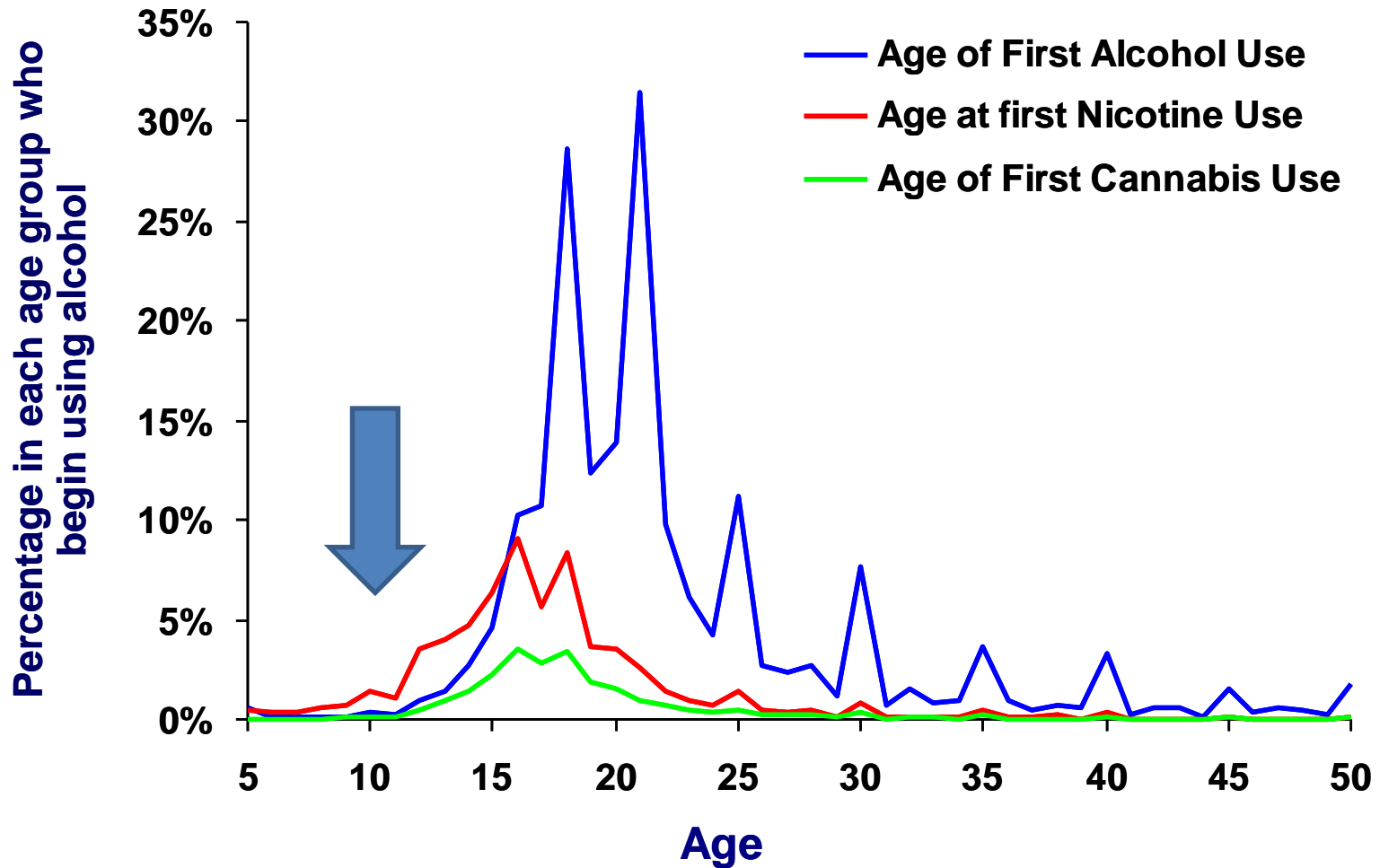
Trauma



Poor Mental Health

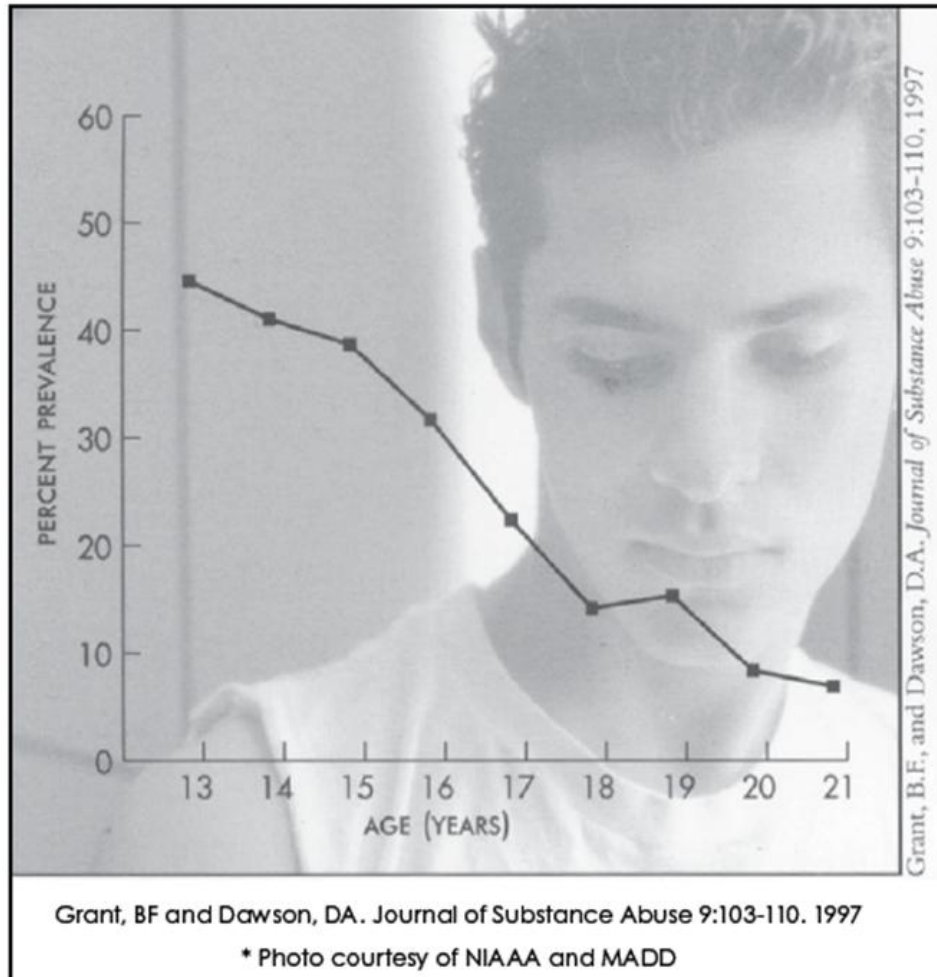


Addiction is a Developmental Pediatric Disease



Source: NIAAA National Epidemiologic Survey on Alcohol and Related Conditions, 2003

Teen Alcohol Use Wires The Brain For Addiction

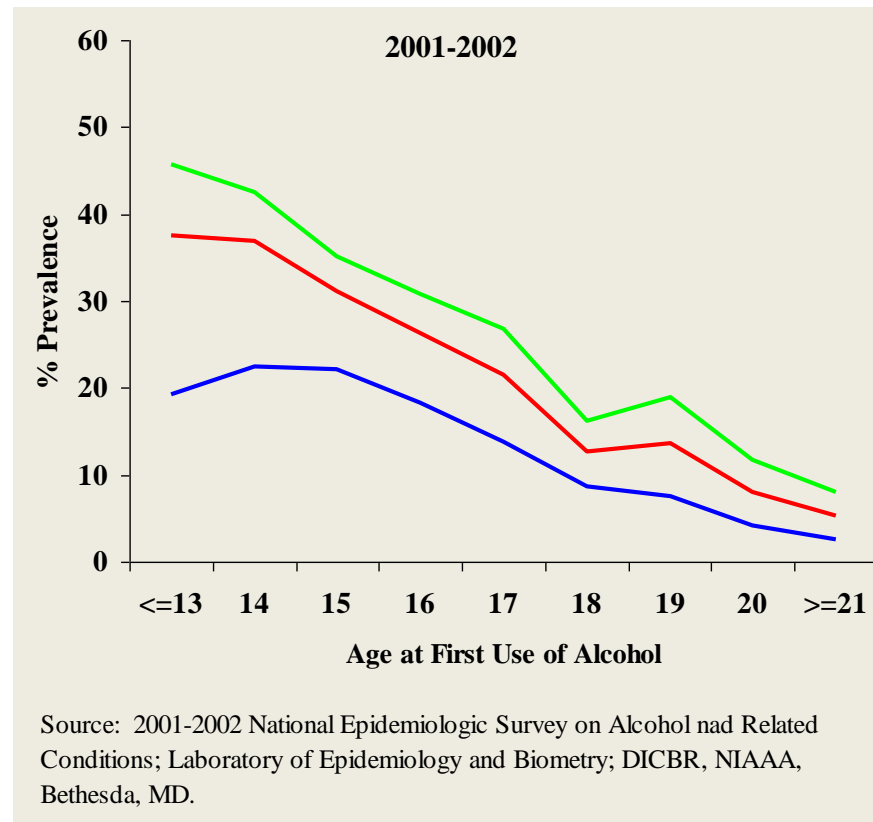


40% of kids who begin drinking at age 15 will become alcoholics.

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



Prevalence of Lifetime Alcohol Dependence by Age of First Alcohol Use and Family History of Alcoholism



- Parental History Positive
- Total
- Parental History Negative



PAST-MONTH ALCOHOL USE CONTINUES STEADY DECLINE

2016



12th graders
33.2%

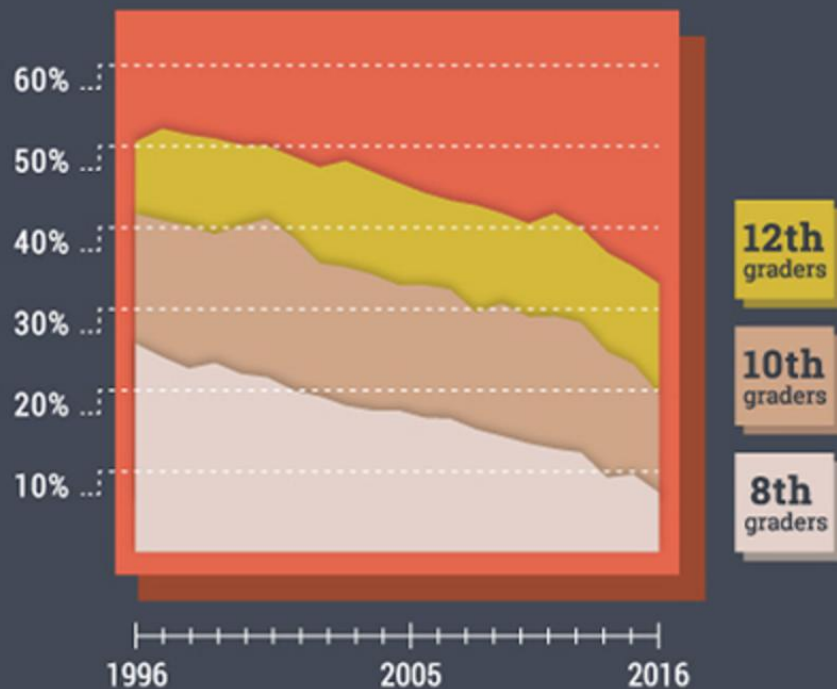


10th graders
19.9%



8th graders
7.3%

1996 – 2016

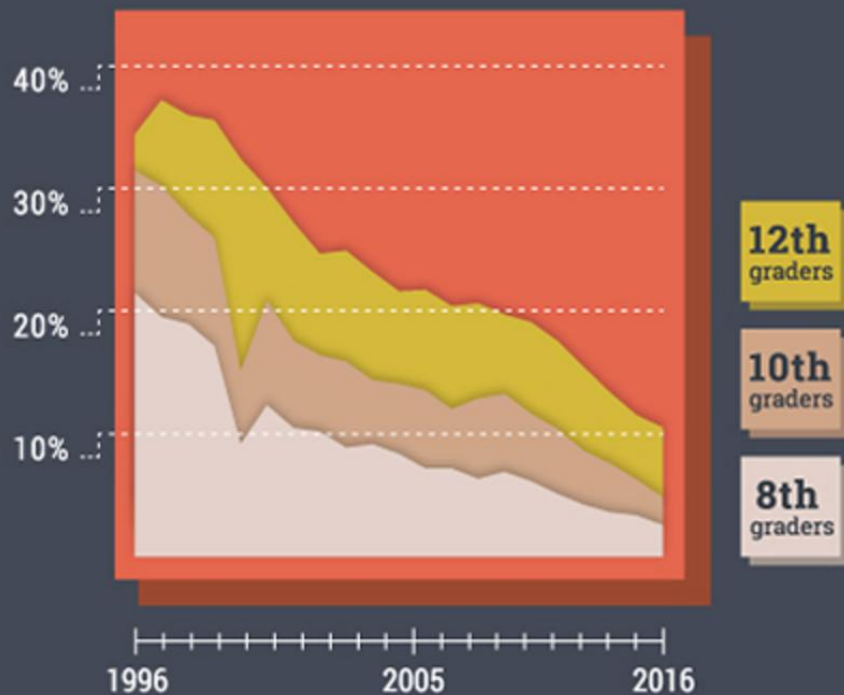


National Institute
on Drug Abuse

DRUGABUSE.GOV

PAST-MONTH CIGARETTE USE CONTINUES STEADY DECLINE

1996 – 2016



2016



12th graders
10.5%



10th graders
4.9%



8th graders
2.6%

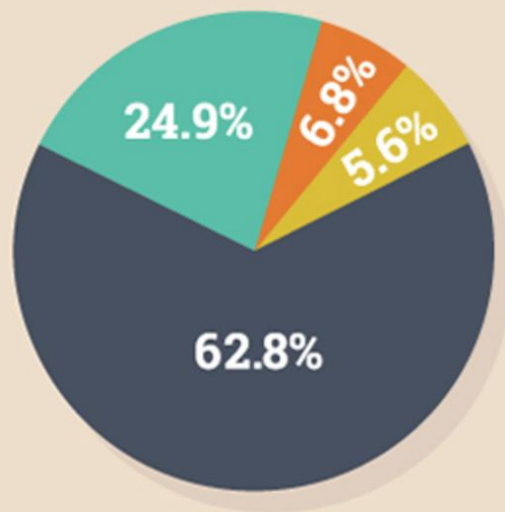
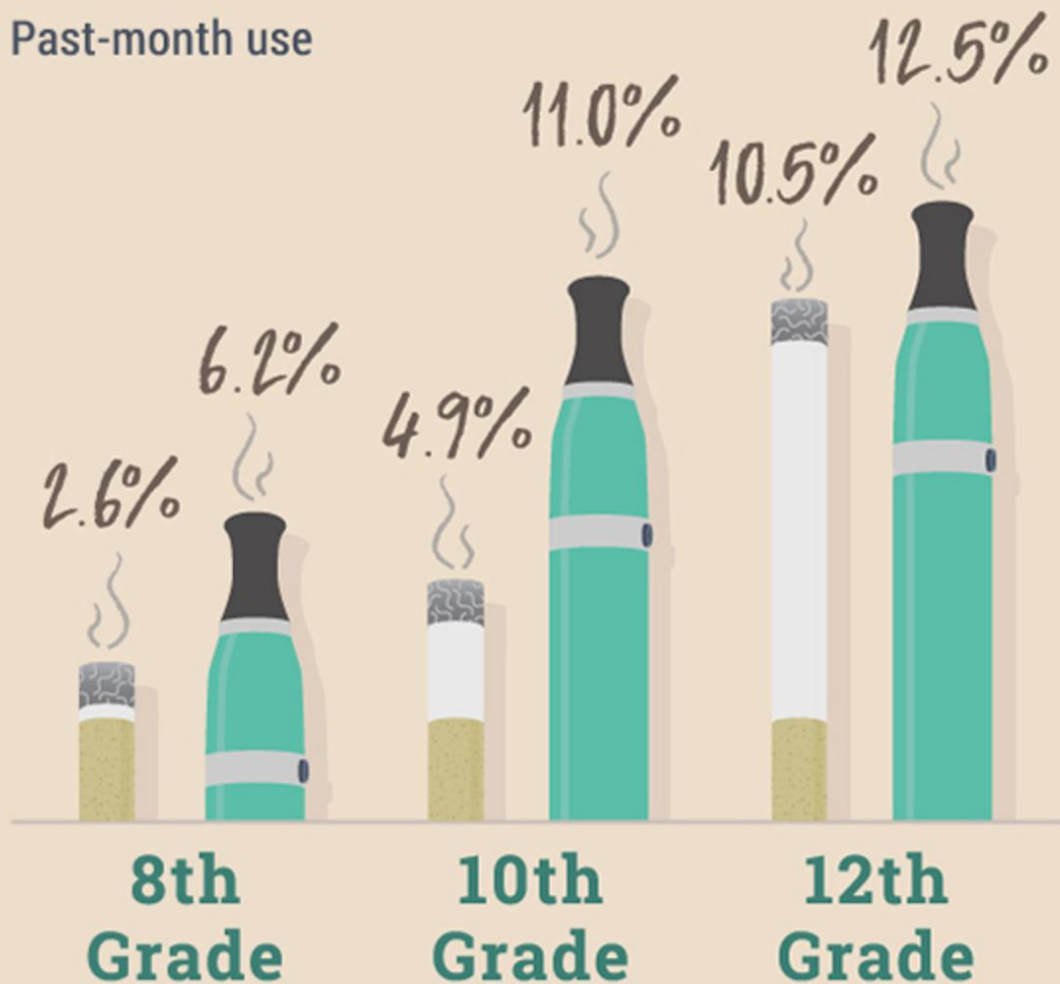


National Institute
on Drug Abuse

DRUGABUSE.GOV

TEENS MORE LIKELY TO USE E-CIGARETTES THAN CIGARETTES

Past-month use



What did 12th graders think was in the mist they inhaled from an e-cigarette? Despite the belief that the liquid used in e-cigs contains only flavoring, it also might contain nicotine.

- Flavoring
- Nicotine
- Marijuana or hash oil
- Don't know

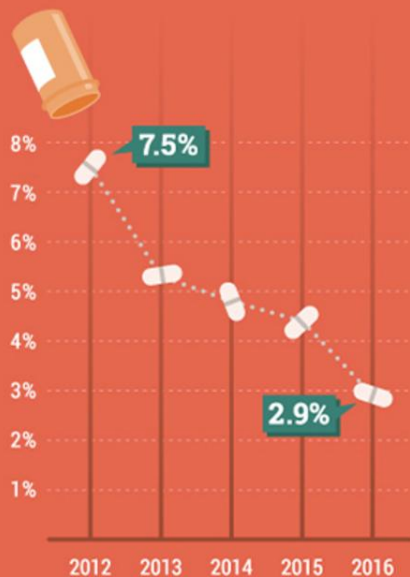


National Institute
on Drug Abuse

DRUGABUSE.GOV

PRESCRIPTION/OVER-THE-COUNTER VS. ILLICIT DRUGS

VICODIN®

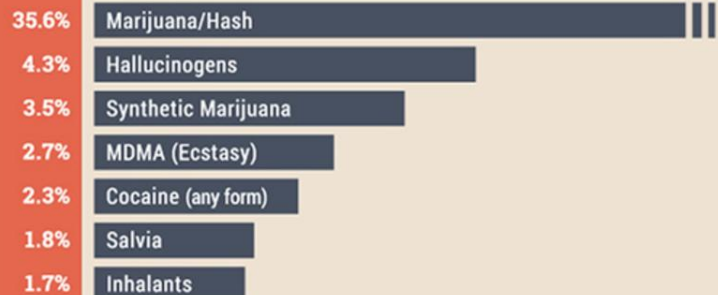


Past-year misuse of Vicodin® among 12th graders has dropped dramatically in the past 5 years. So has misuse of all Rx opioids among 12th graders despite high opioid overdose rates among adults.

PRESCRIPTION/OTC



ILLICIT DRUGS



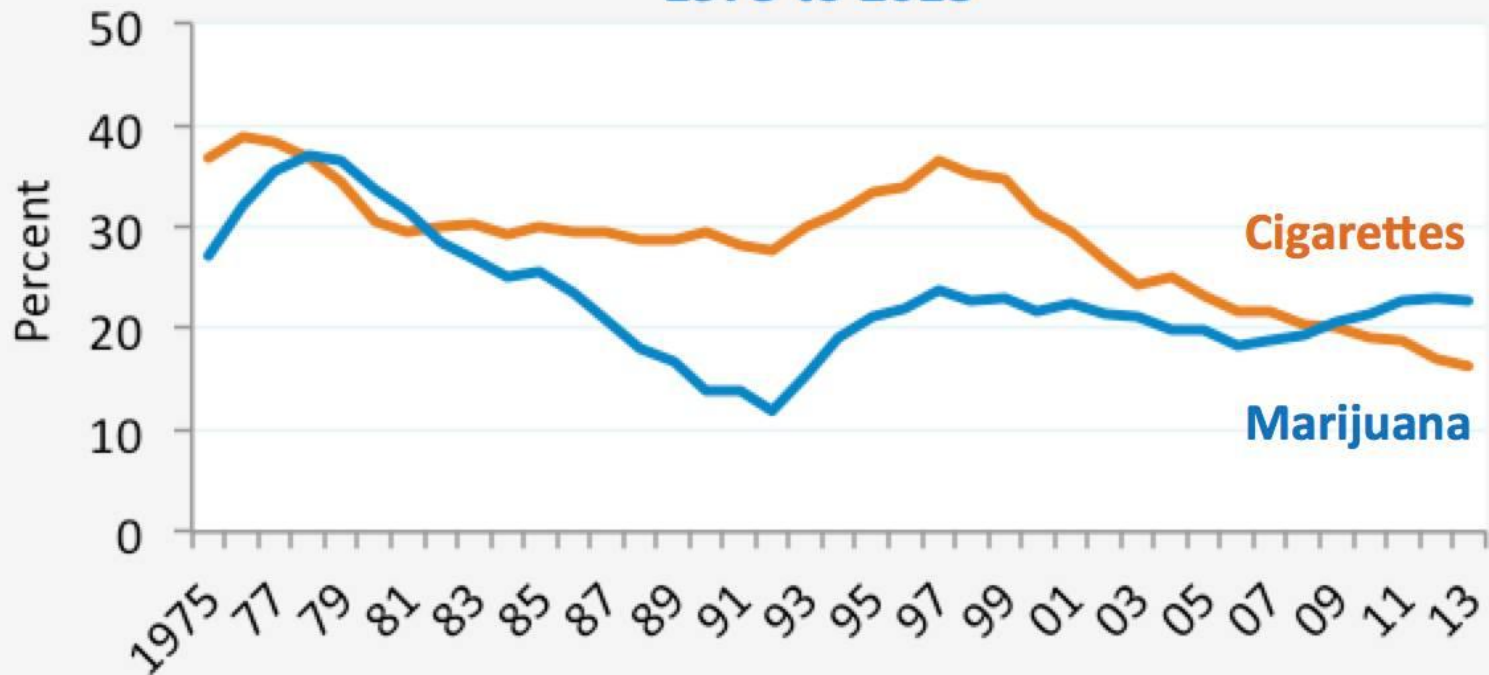
Past-year use among 12th graders

STUDENTS REPORT LOWEST RATES SINCE START OF THE SURVEY

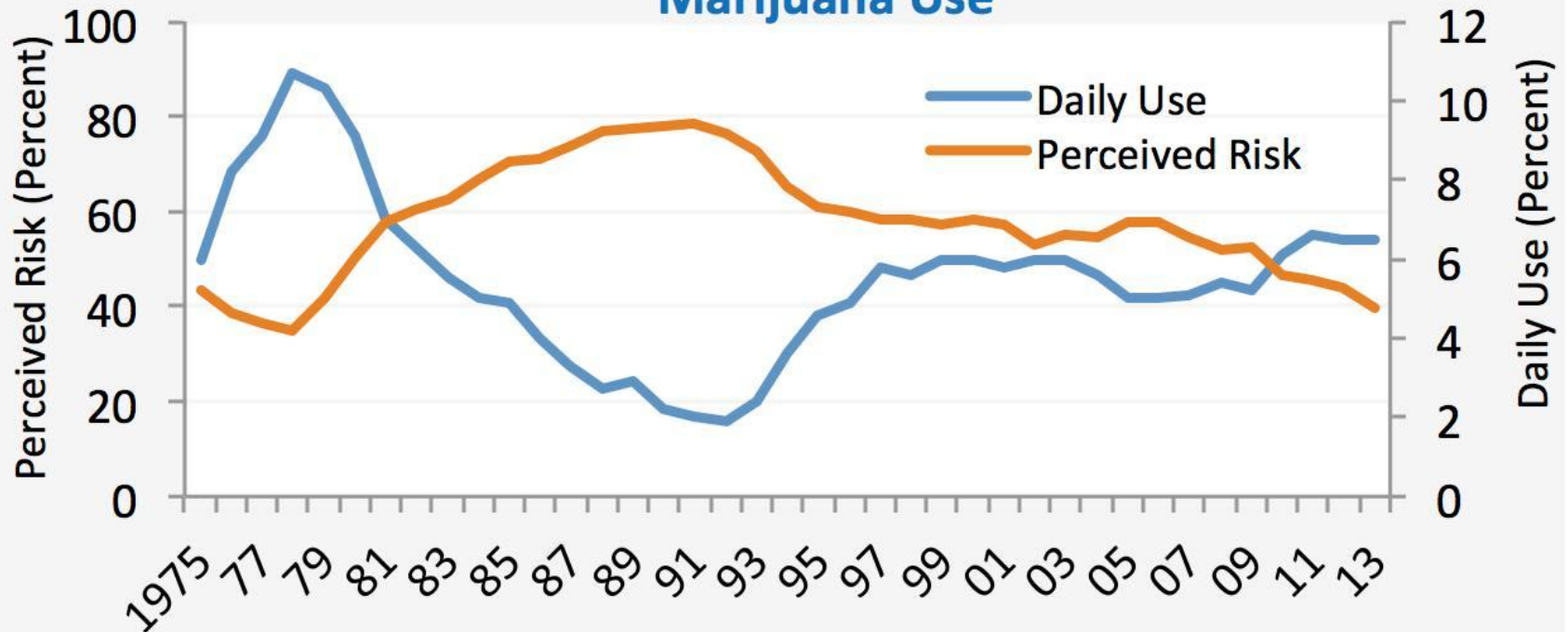
Across all grades, past-year use of inhalants, heroin, methamphetamine, alcohol, cigarettes, and synthetic cannabinoids are at their lowest by many measures.



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



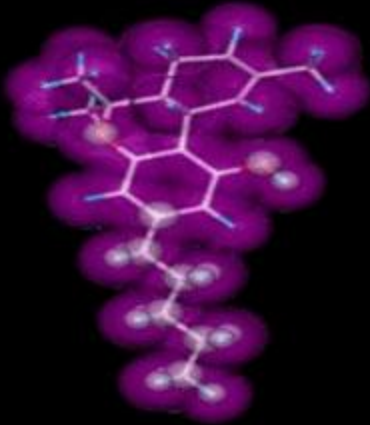
Percentage of U.S. 12 Grade Students Reporting Daily Marijuana Use vs. Perceived Risk of Regular Marijuana Use



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

Marijuana
(Tetrahydrocannabinol)

Drug



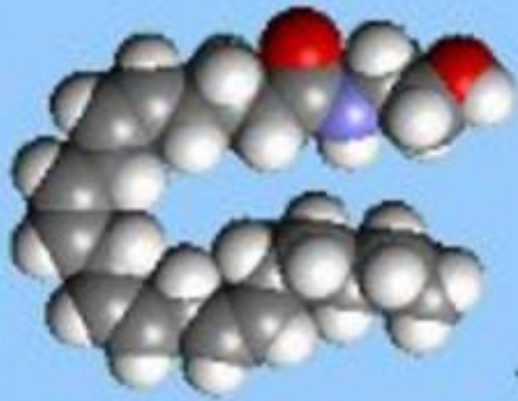
THC

Endo-cannabinoid
(Anandamide)

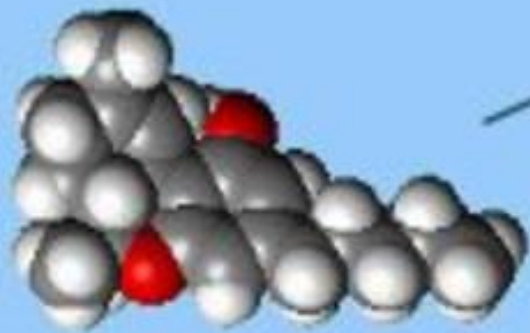
Brain's Chemical



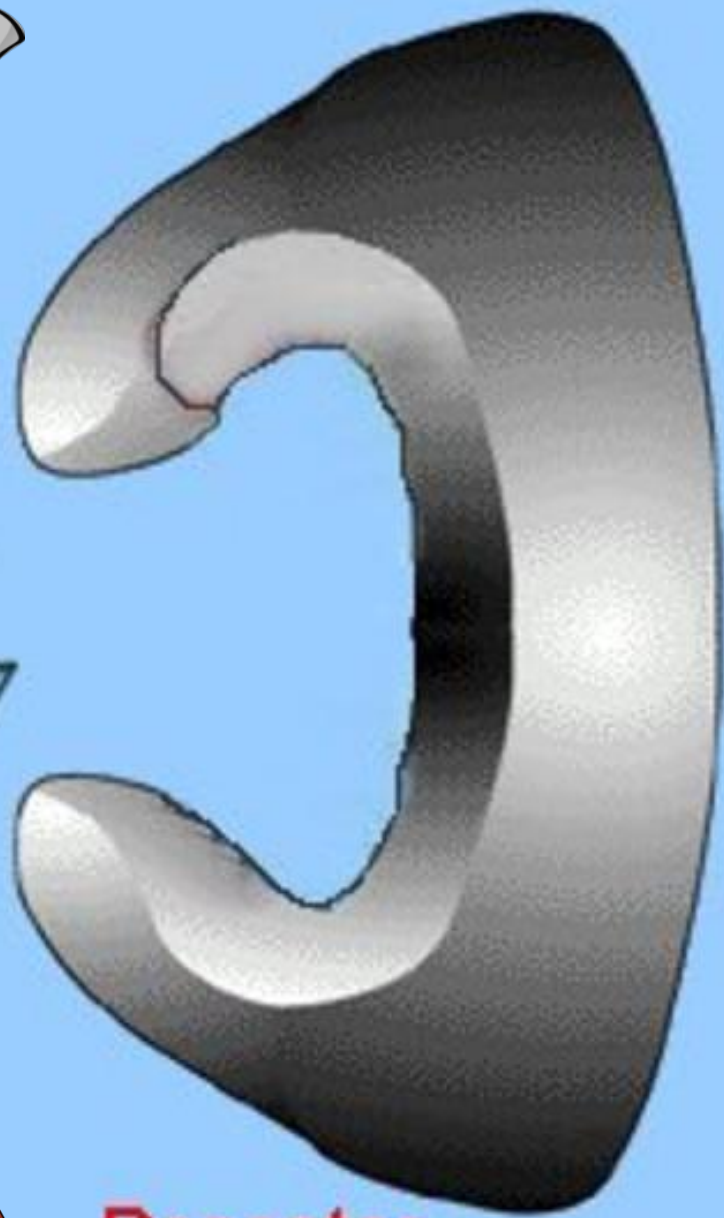
Anandamide



anandamide



THC

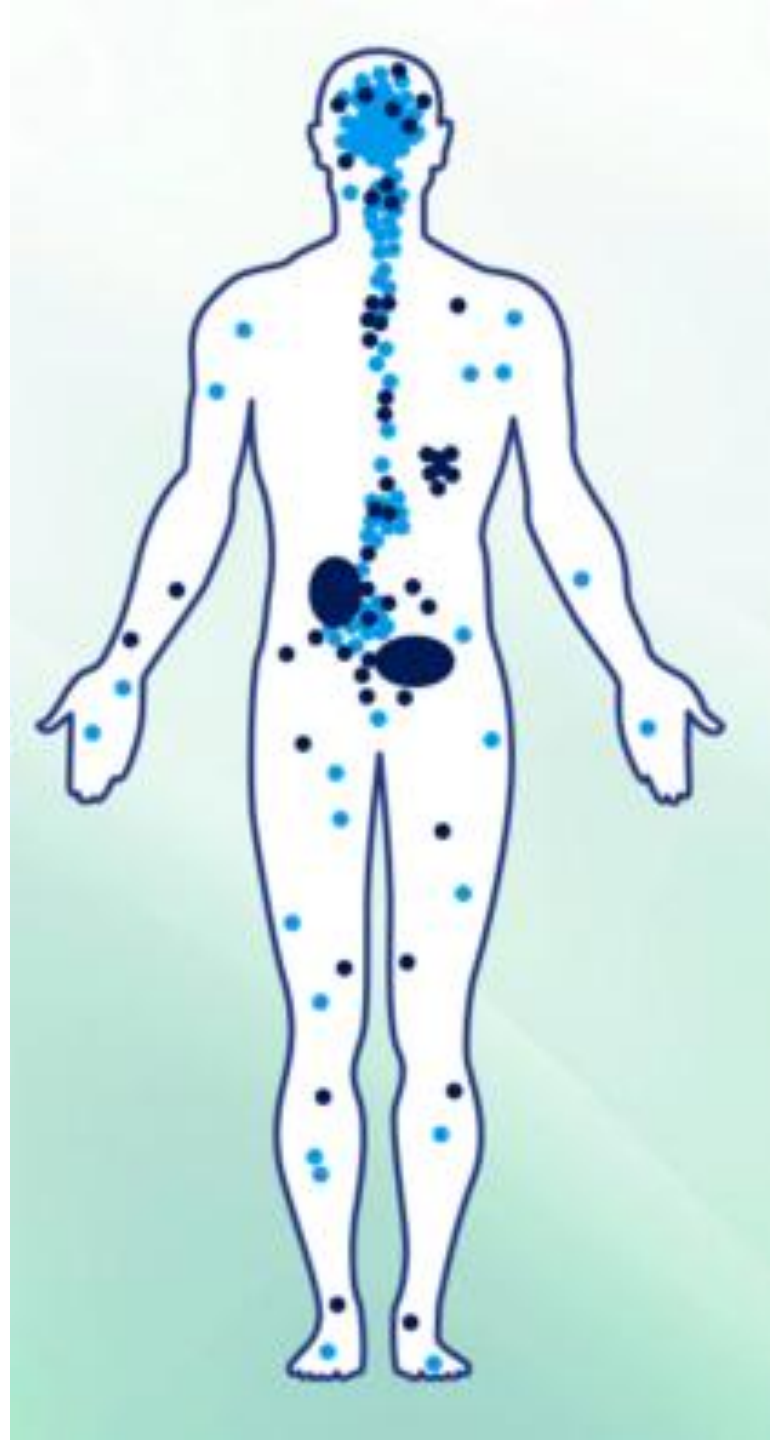


Receptor

There are receptors for these natural cannabinoids all over the body...

and throughout the brain...

and THC, CBD and other cannabinoids from marijuana can bind with them and alter natural signals.



Acute effects of using marijuana (during intoxication)

Altered judgment

Slowed reaction time

Euphoria

Increased appetite

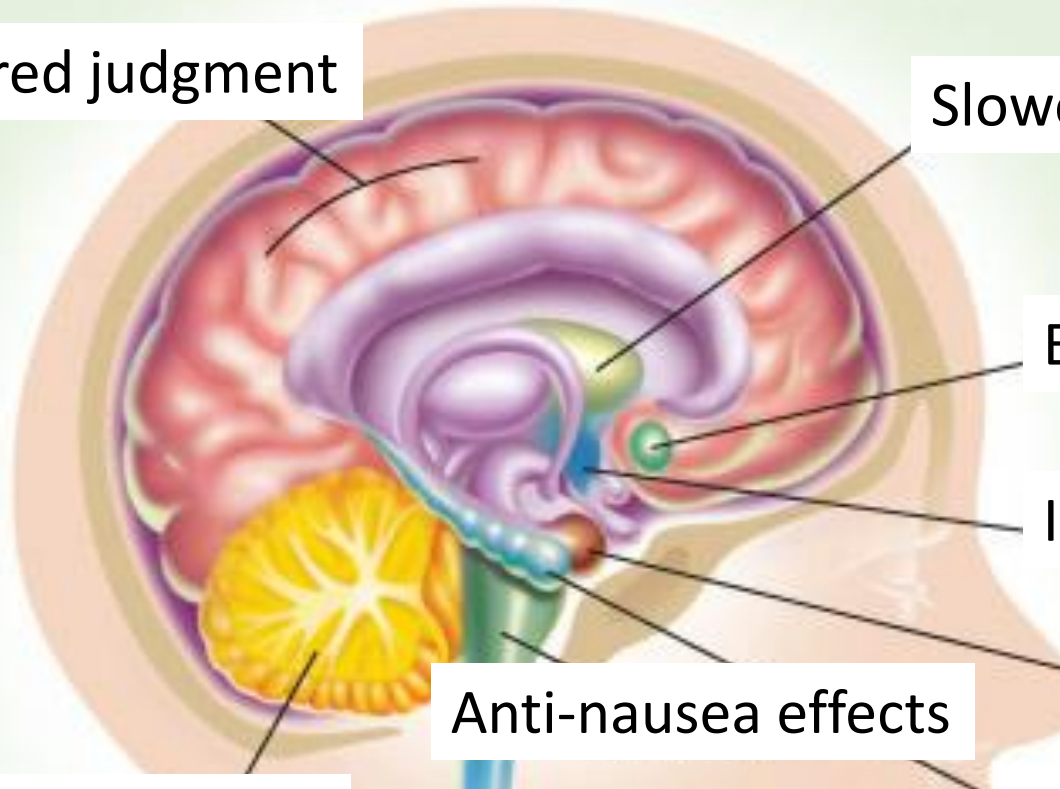
Panic/paranoia/
psychosis

Anti-nausea effects

Impaired coordination

Altered pain sensitivity

Impaired memory



Potential longer-term effects of regular marijuana use on youth development

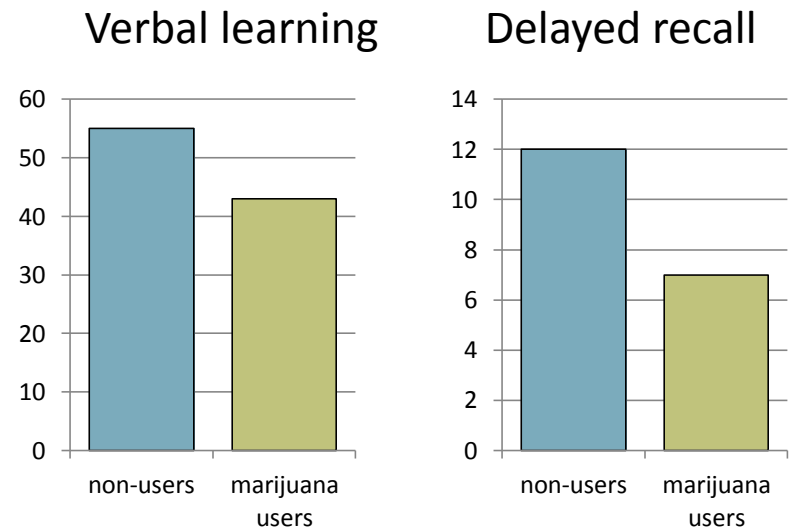
- Issues with attention, memory and learning
- Poorer educational and life outcomes
- Loss of IQ for persistent heavy users
- Potential for addiction to marijuana and increased risk of addiction to other drugs
- Increased risk of risk of psychosis

Deficits in cognitive functioning among active users

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

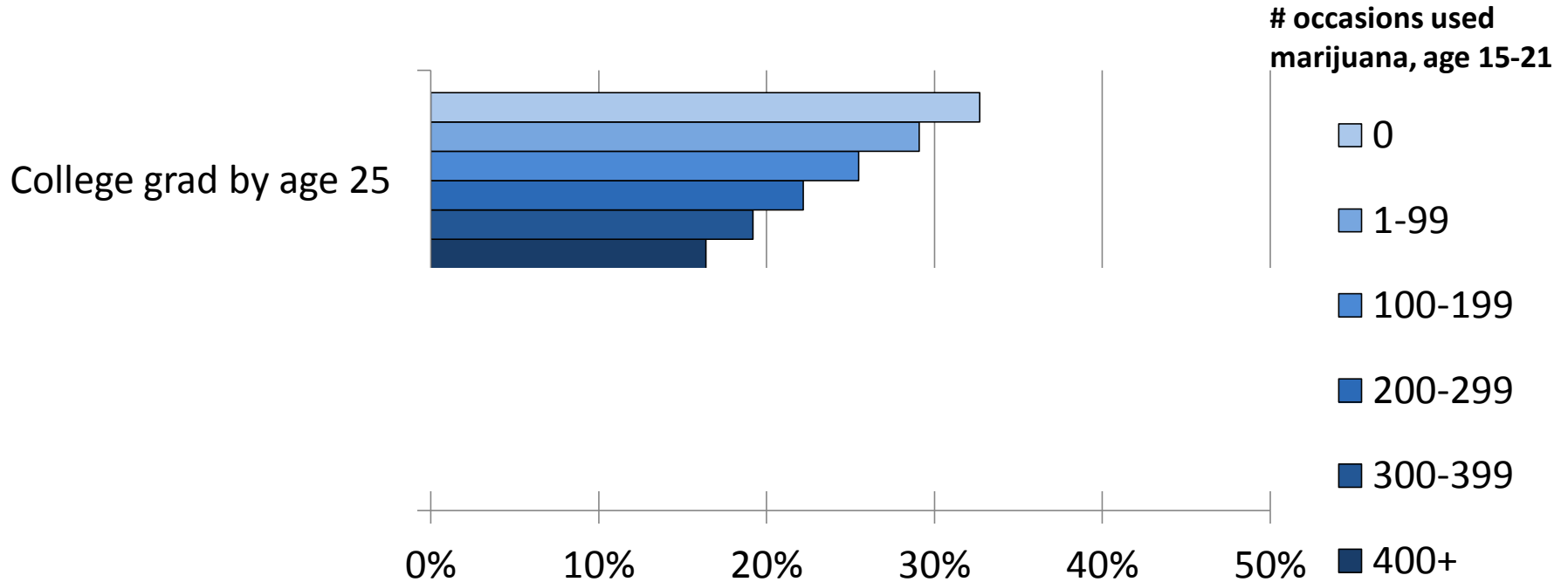
- attention
- verbal learning
- memory
- processing speed

... even when they are not high.



Messinis, et al 2006

Adult life outcomes affected by marijuana use in adolescence

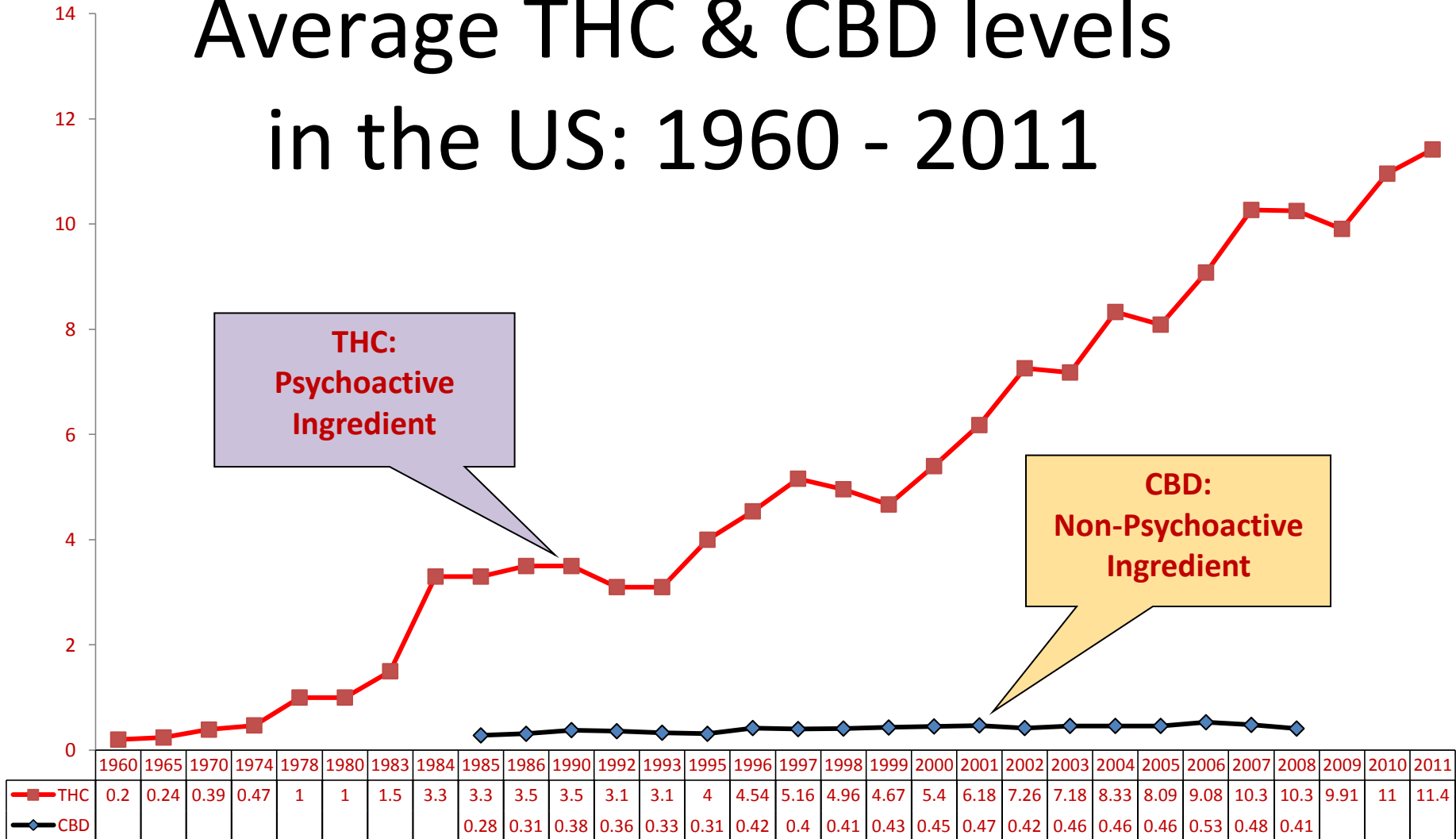


Loss of adult IQ with marijuana dependence in adolescence

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"

SMOKING



PIPE



BONG



BUBBLER



DAB



JOINT



BLUNT

BEVERAGES



TEA



SODA



ALCOHOL



MILK

Ways to consume marijuana

EDIBLES



CANDY



ICE CREAM



BAKED GOODS

VAPORIZING



DESKTOP VAPORIZER



PORTABLE VAPORIZER

OTHER



CAPSULES



SPRAY

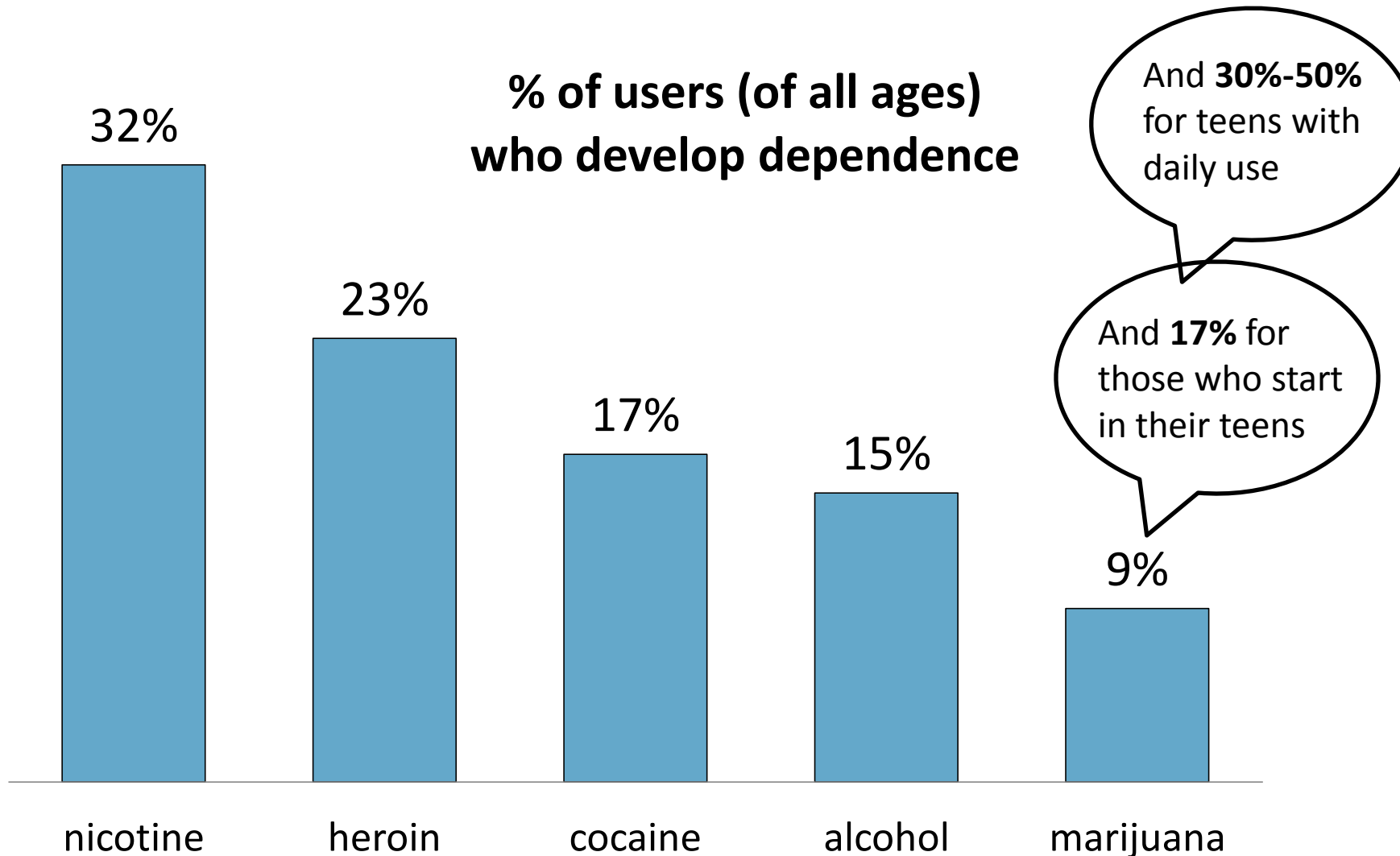


TINCTURE

Products & packaging:
Like this?



Is Marijuana Addictive?



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

N ENGL J MED 371:5 NEJM.ORG JULY 31, 2014

399

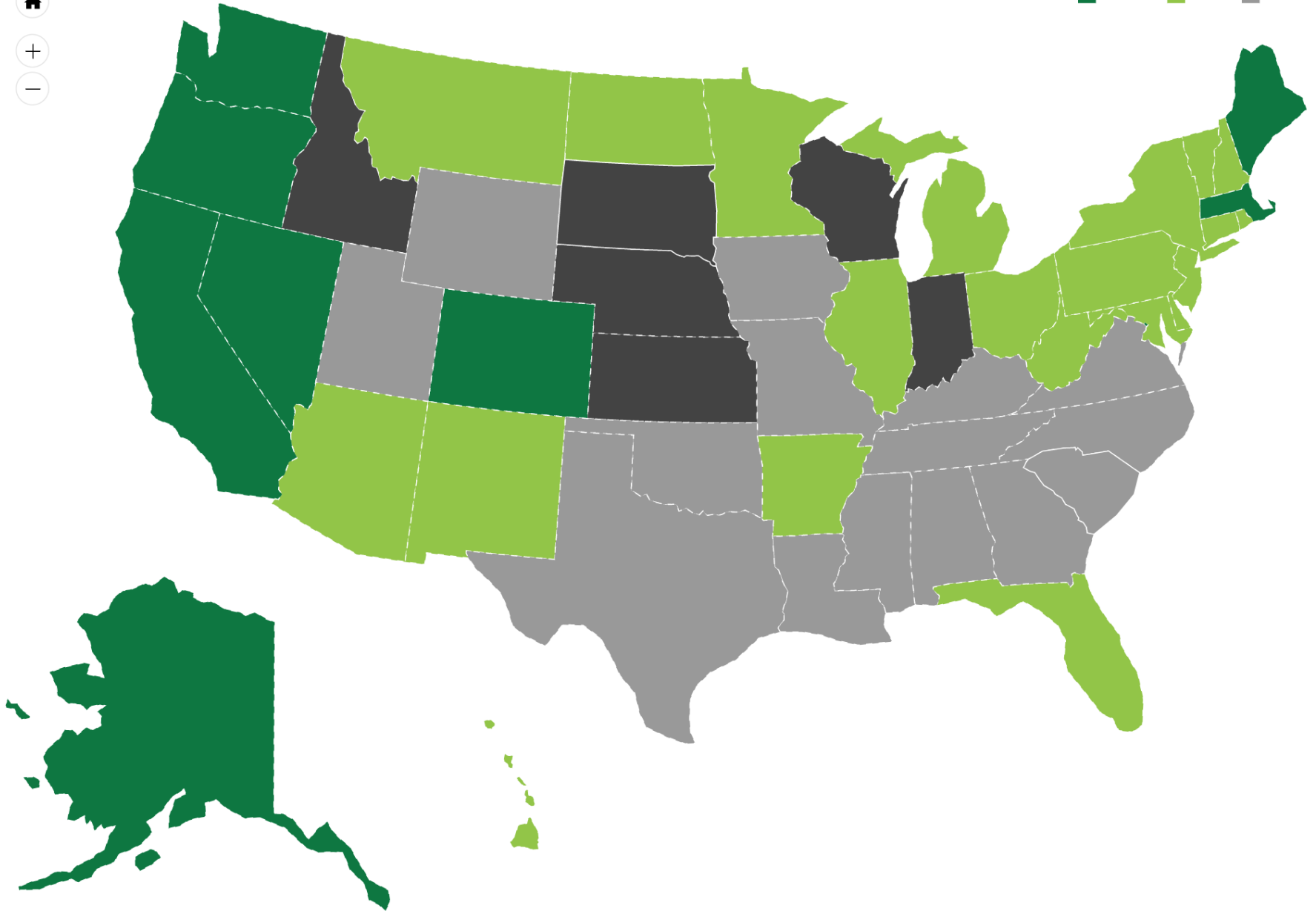
The New England Journal of Medicine

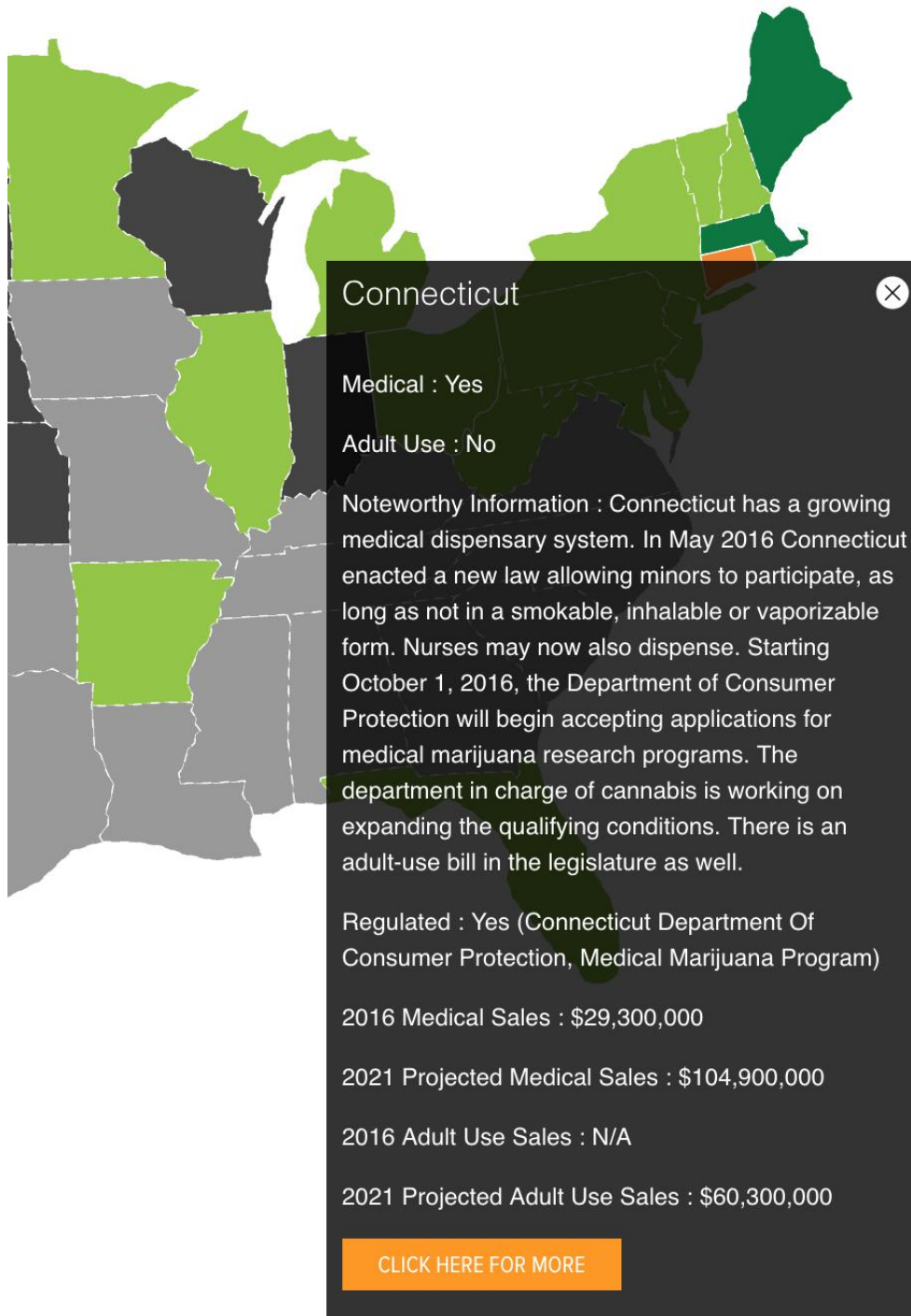
It took the medical and public health communities 50 years, millions of lives, and billions of dollars to identify the wake of illness and death left by legal, industrialized cigarettes. The free-market approach to tobacco clearly failed to protect the public's welfare and the common good: in spite of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

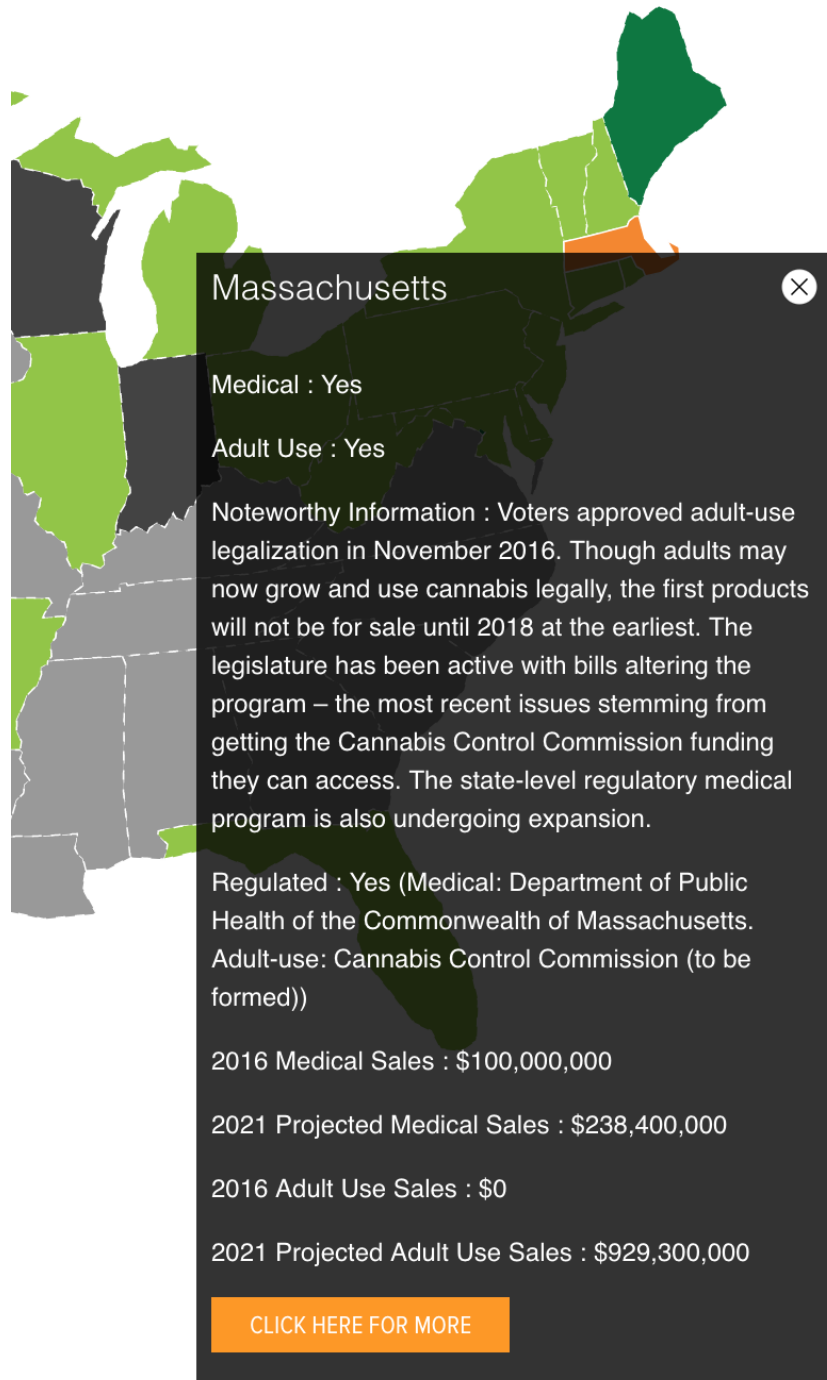
History and current evidence suggest that simply legalizing marijuana, and giving free rein to the resulting industry, is not the answer. To do so would be to once again entrust private industry with safeguarding the health of the public — a role that it is not designed to handle.



Adult-Use Medical Limited







Diagnoses for Medical Marijuana

Condition	# Patients	% Patients
HIV/AIDS	495	1%
Glaucoma	837	1%
Cachexia	1,137	1%
Seizures	1,329	2%
Cancer	2,217	3%
Severe Nausea	9,998	12%
Muscle Spasms	14,255	17%
Severe Pain	76,887	94%

*CO, 2012. Patients may report >1 debilitating condition.

REVIEW ARTICLE

Dan L. Longo, M.D., *Editor*

Adverse Health Effects of Marijuana Use

Nora D. Volkow, M.D., Ruben D. Baler, Ph.D., Wilson M. Compton, M.D.,
and Susan R.B. Weiss, Ph.D.

IN LIGHT OF THE RAPIDLY SHIFTING LANDSCAPE REGARDING THE LEGALIZATION of marijuana for medical and recreational purposes, patients may be more likely to ask physicians about its potential adverse and beneficial effects on health. The popular notion seems to be that marijuana is a harmless pleasure, access to which should not be regulated or considered illegal. Currently, marijuana is the most commonly used “illicit” drug in the United States, with about 12% of people 12 years of age or older reporting use in the past year and particularly high rates of use among young people.¹ The most common route of administration is inhalation. The greenish-gray shredded leaves and flowers of the *Cannabis sativa* plant are smoked (along with stems and seeds) in cigarettes, cigars, pipes, water pipes, or “blunts” (marijuana rolled in the tobacco-leaf wrapper from a cigar). Hashish is a related product created from the resin of marijuana flowers and is usually smoked (by itself or in a mixture with tobacco) but can be ingested orally. Marijuana can also be used to brew tea, and its oil-based extract can be mixed into food products.

The regular use of marijuana during adolescence is of particular concern, since use by this age group is associated with an increased likelihood of deleterious consequences² (Table 1). Although multiple studies have reported detrimental effects, others have not, and the question of whether marijuana is harmful remains the subject of heated debate. Here we review the current state of the science related to the adverse health effects of the recreational use of marijuana, focusing on those areas for which the evidence is strongest.

From the National Institute on Drug Abuse, National Institutes of Health, Bethesda, MD. Address reprint requests to Dr. Volkow at the National Institute on Drug Abuse, 6001 Executive Blvd., Rm. 5274, Bethesda, MD 20892, or at nvolkow@nida.nih.gov.

N Engl J Med 2014;370:2219-27.

DOI: 10.1056/NEJMra1402309

Copyright © 2014 Massachusetts Medical Society.