

# MARIJUANA'S

## Effects on Brain, Body & Behavior



**Nora D. Volkow, M.D.**  
**Director**

**National Institute on Drug Abuse**  
**National Institutes of Health**



# Marijuana is the Most Commonly Used Illicit Drug In the U.S.

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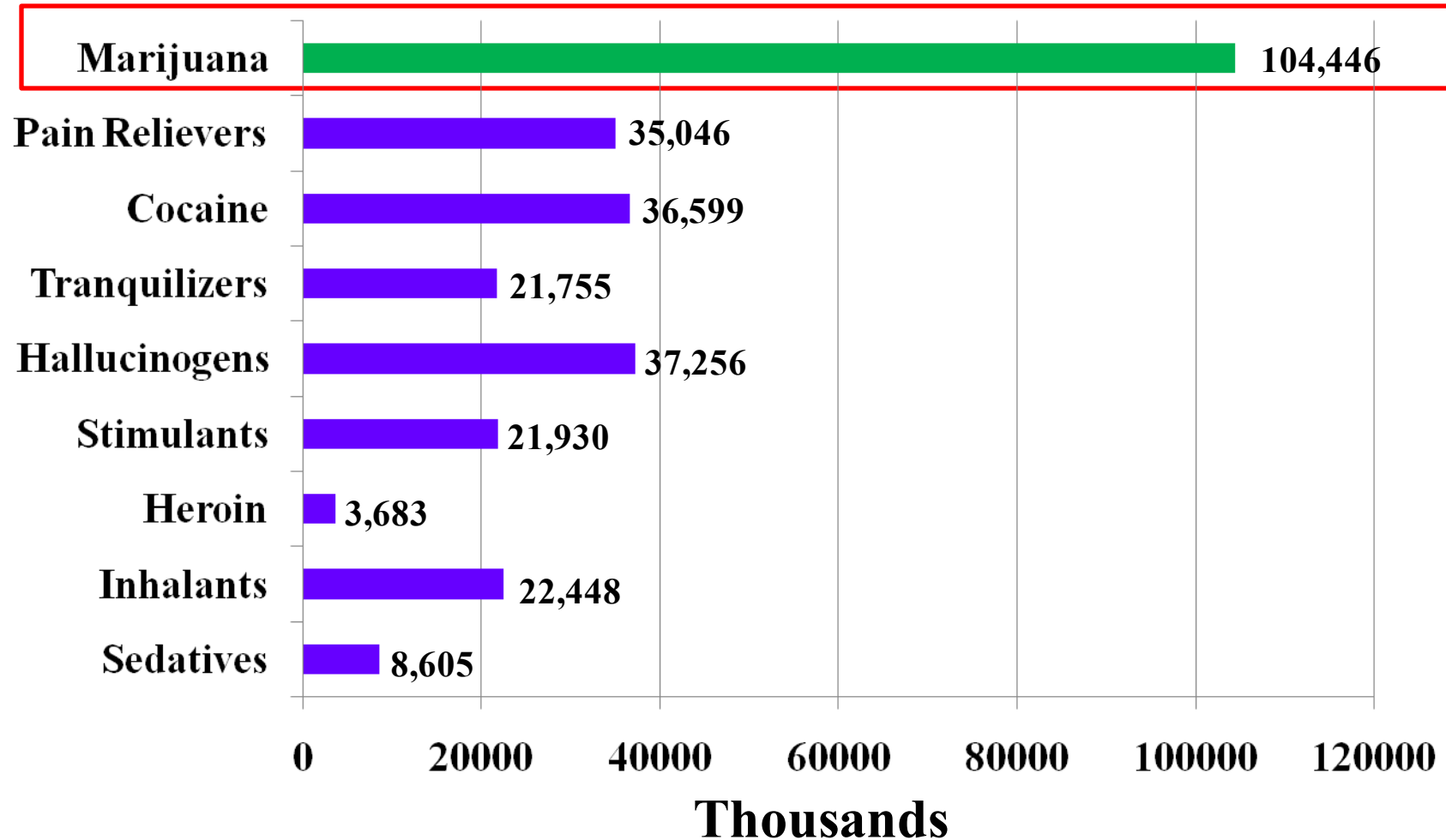
- Over **104 million** Americans have tried it at least once

- An estimated **2.4 million** Americans used it for the first time in 2009



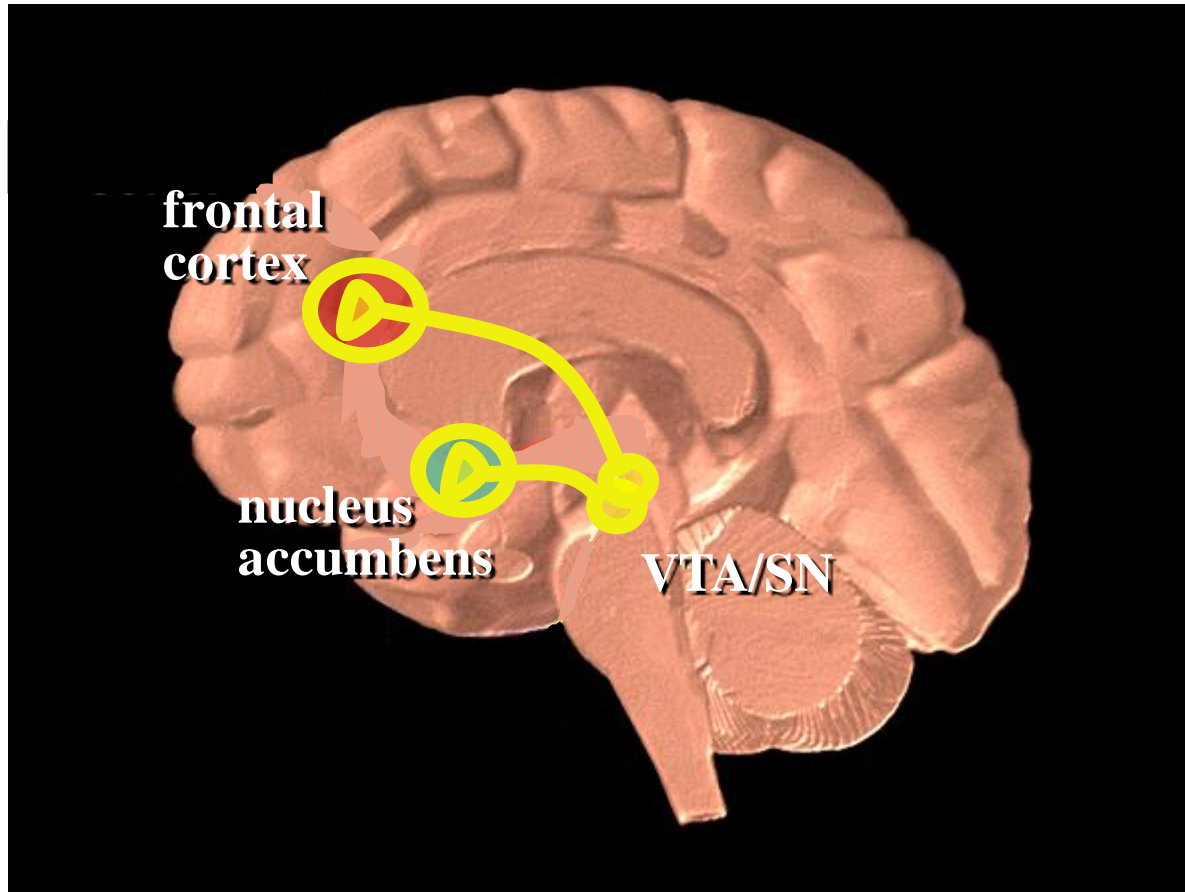
**Tetrahydrocannabinol (THC)**  
**Active Ingredient in Marijuana**

# Use of Specific Illicit Drugs in Lifetime Among Persons 12 or Older, 2009

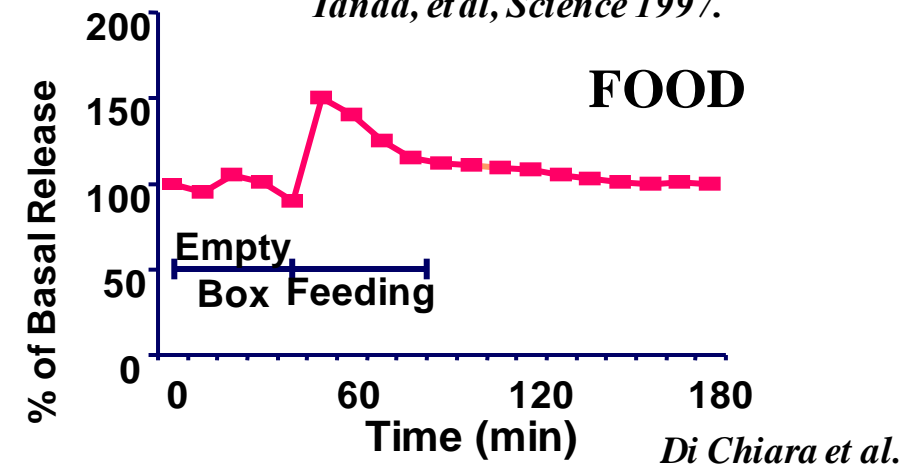
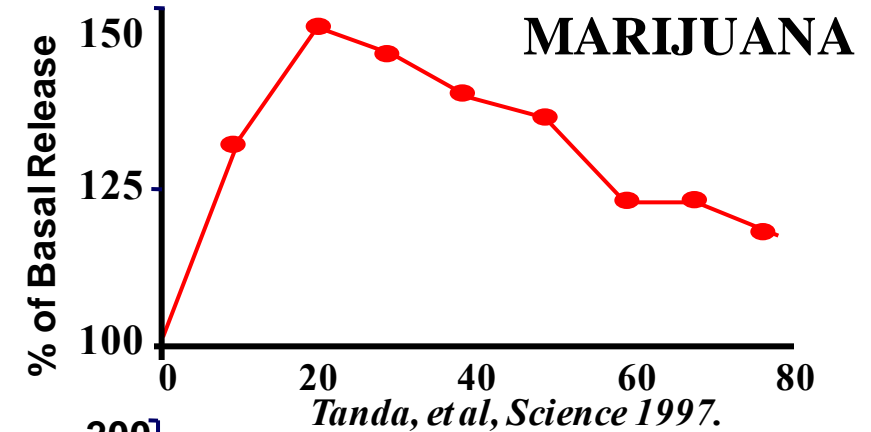
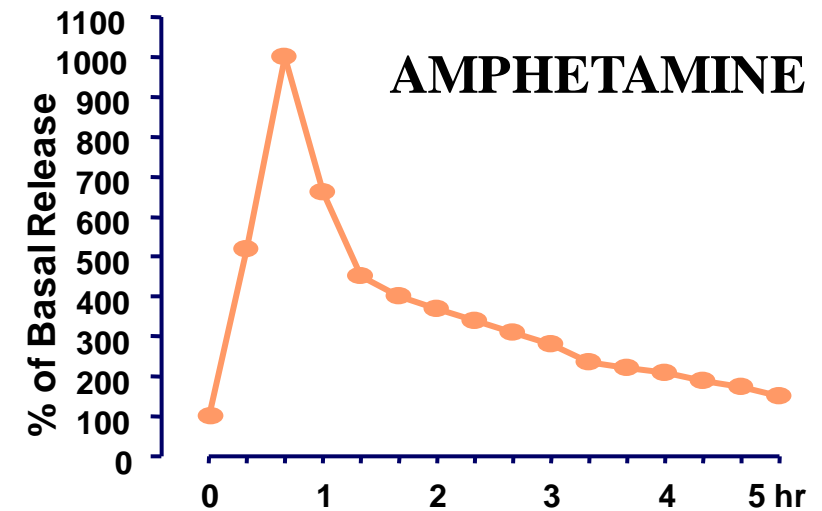


*Source: 2009 NSDUH, SAMHSA, 2010.*

# Natural and Drug Reinforcers Increase Dopamine in NAc



**Drugs of abuse increase DA in the Nucleus Accumbens, which is believed to trigger the neuroadaptations that result in addiction**

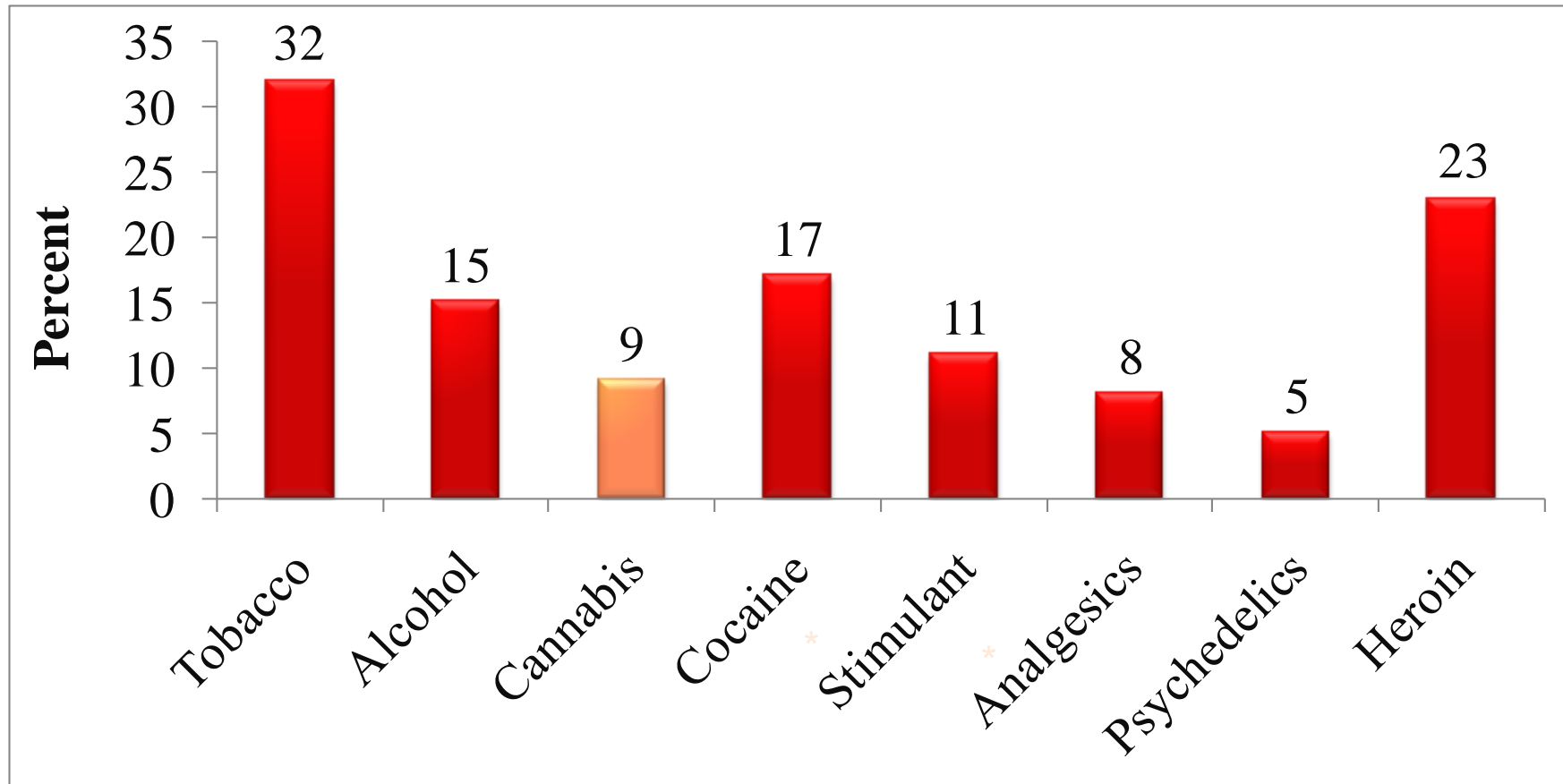


# Long Term Effects of Marijuana

**Addiction:** About 9% of users may become dependent, 1 in 6 who start use in adolescence, 25-50% of daily users

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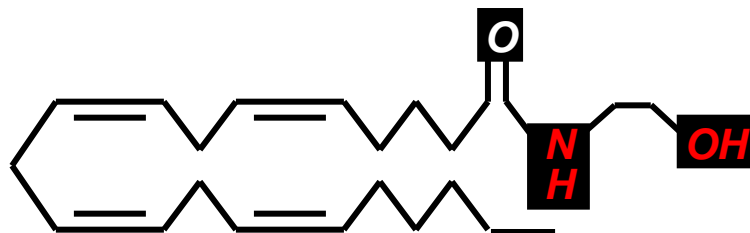
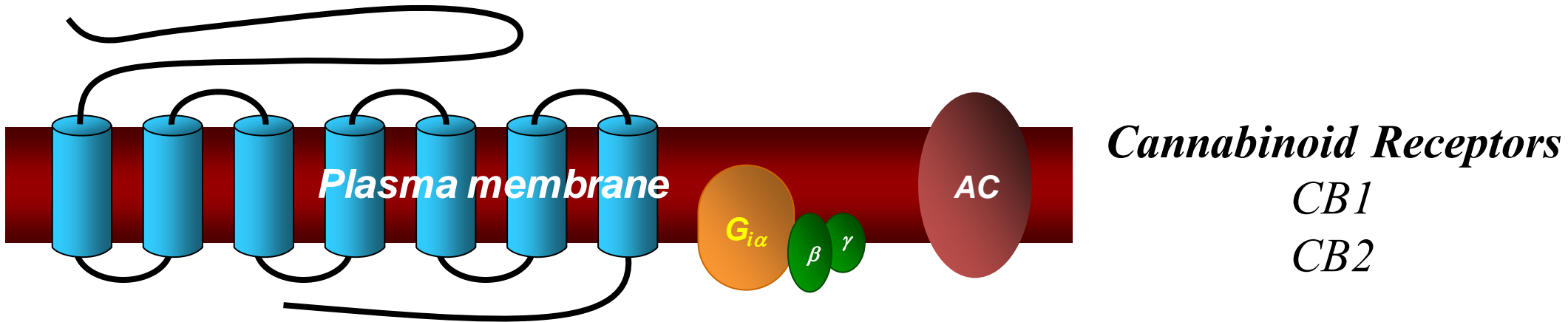
## Estimated Prevalence of Dependence Among Users



\* *Nonmedical Use*

*Source: Anthony JC et al., 1994*

# Cannabinoids in Brain

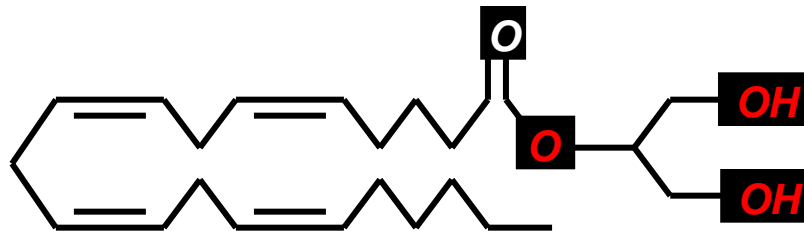


**Anandamide**

## *Endogenous Cannabinoid Ligands*

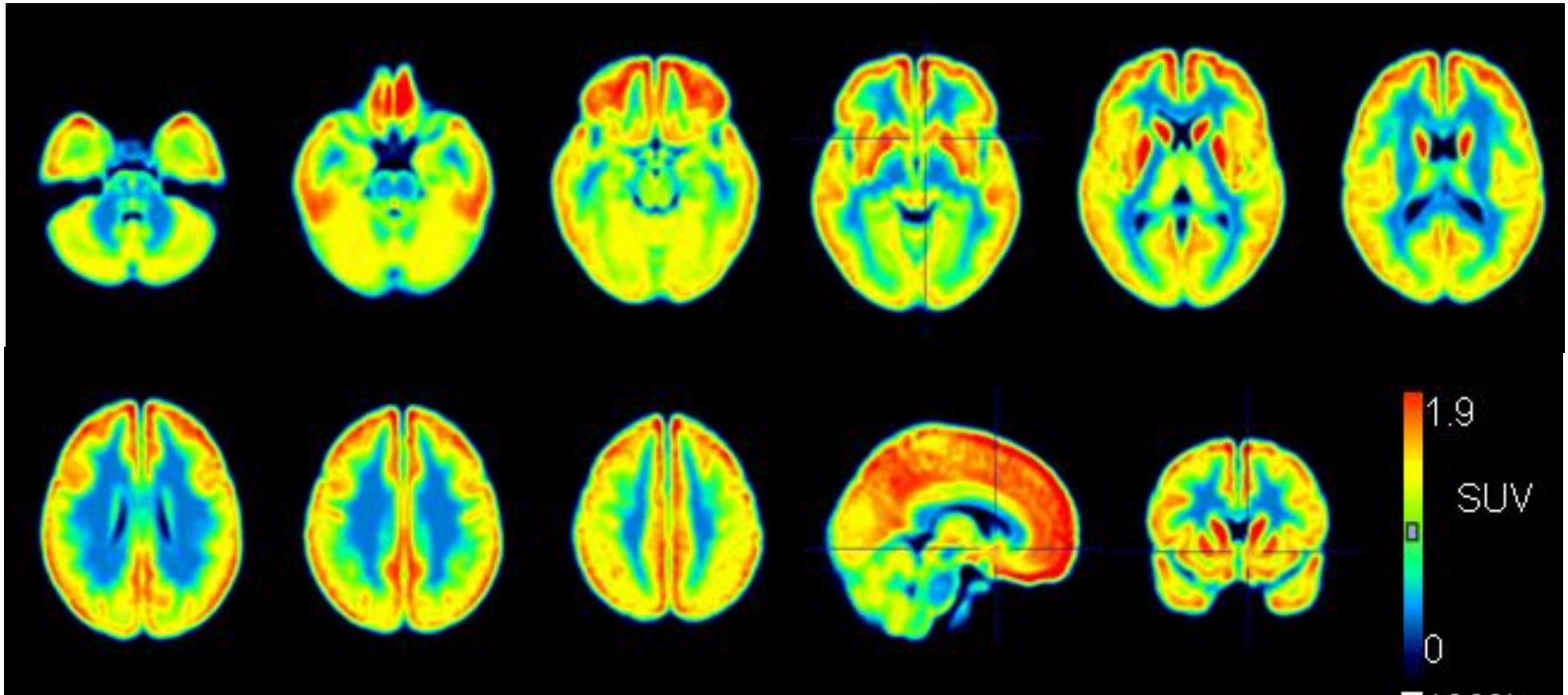
*Anandamide*

*2-Arachidonoylglycerol*



**2-Arachidonoylglycerol (2-AG)**

# Cannabinoid Receptors in Human Brain

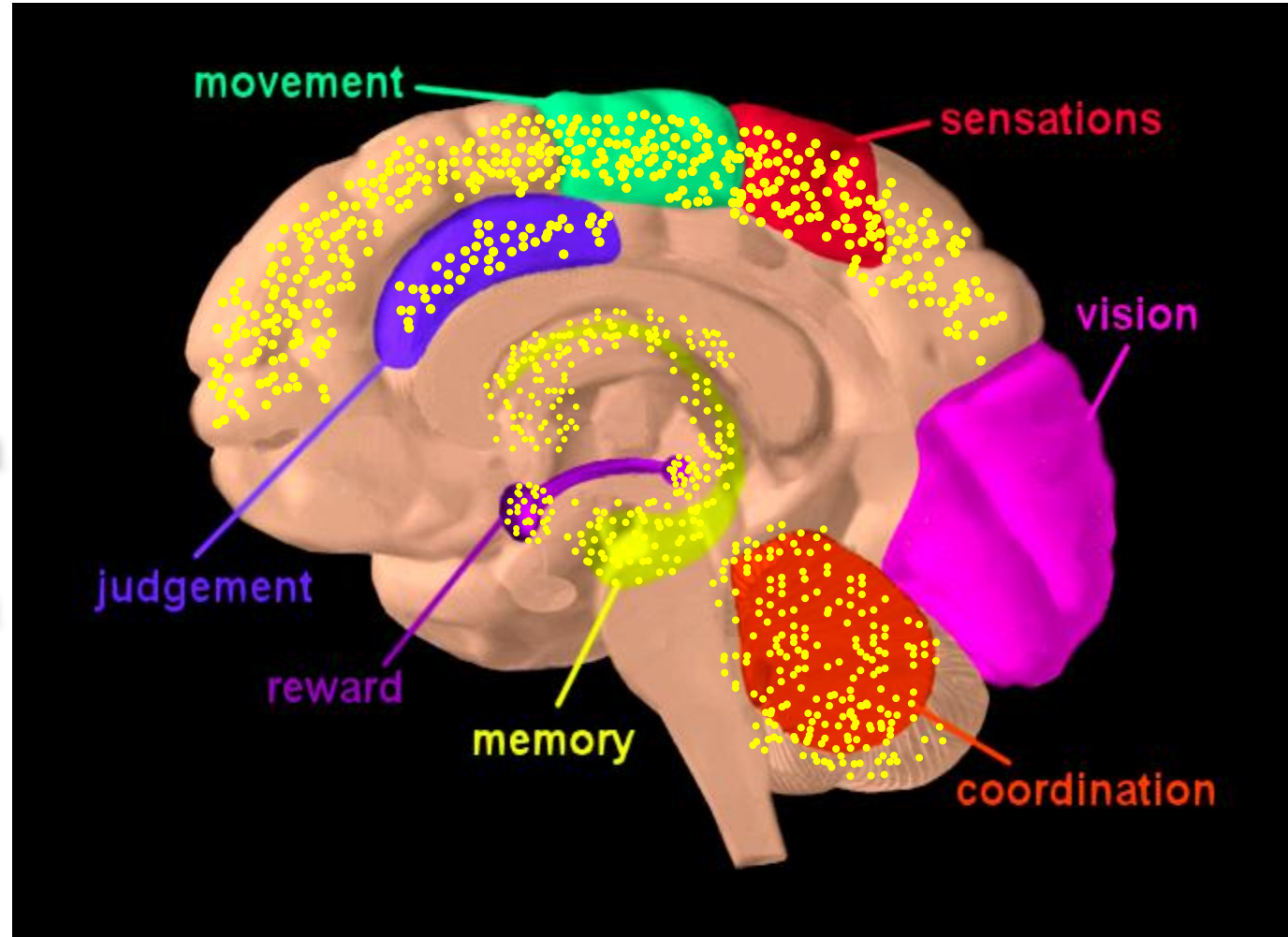


*Van Loere et al., 2007.*



# Cannabinoid Receptors Are Located Throughout the Brain and Regulate:

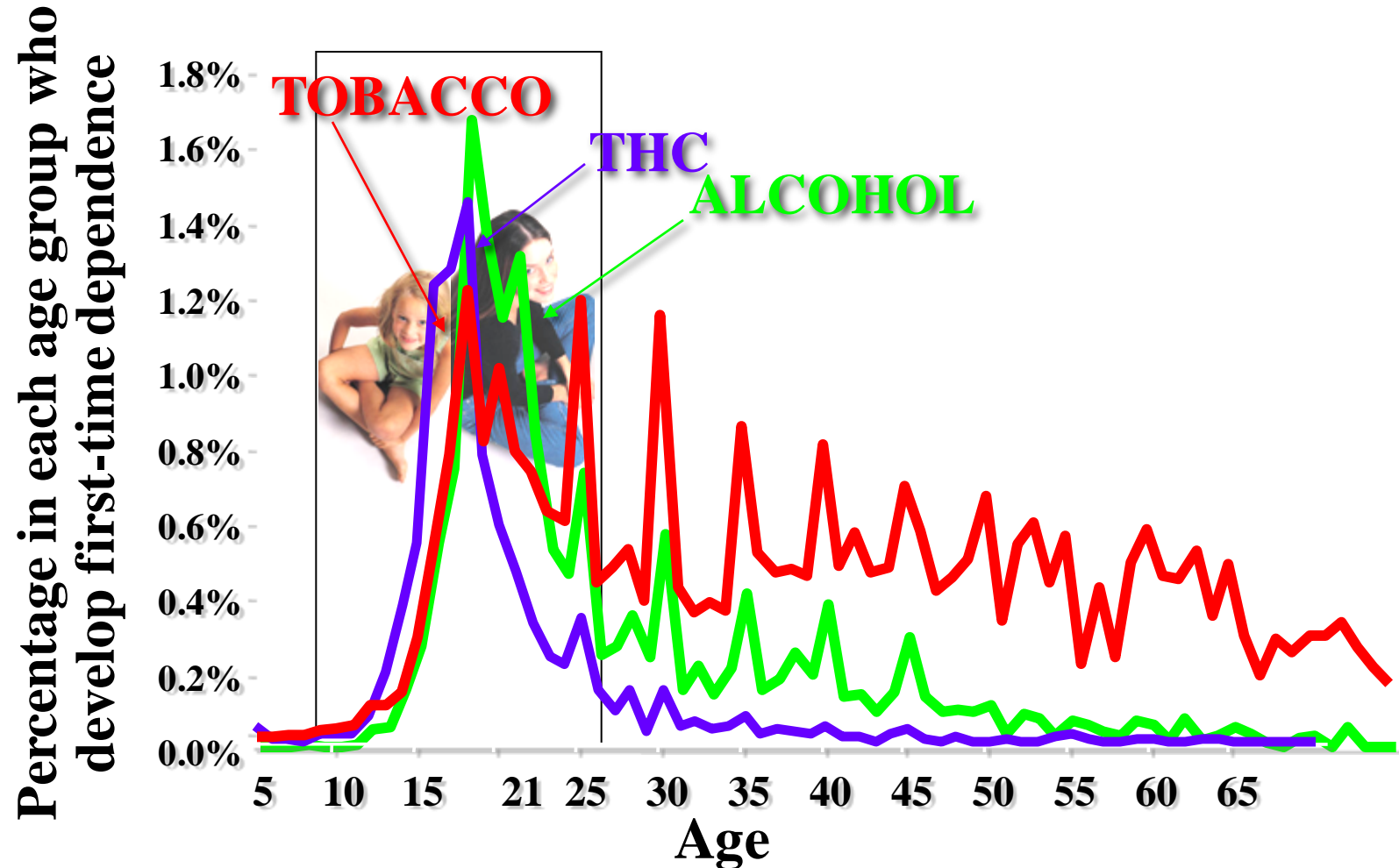
- Brain Development
- Memory and Cognition
- Motivational Systems
- & Reward
- Appetite
- Immunological Function
- Reproduction
- Movement Coordination
- Pain Regulation
- & Analgesia





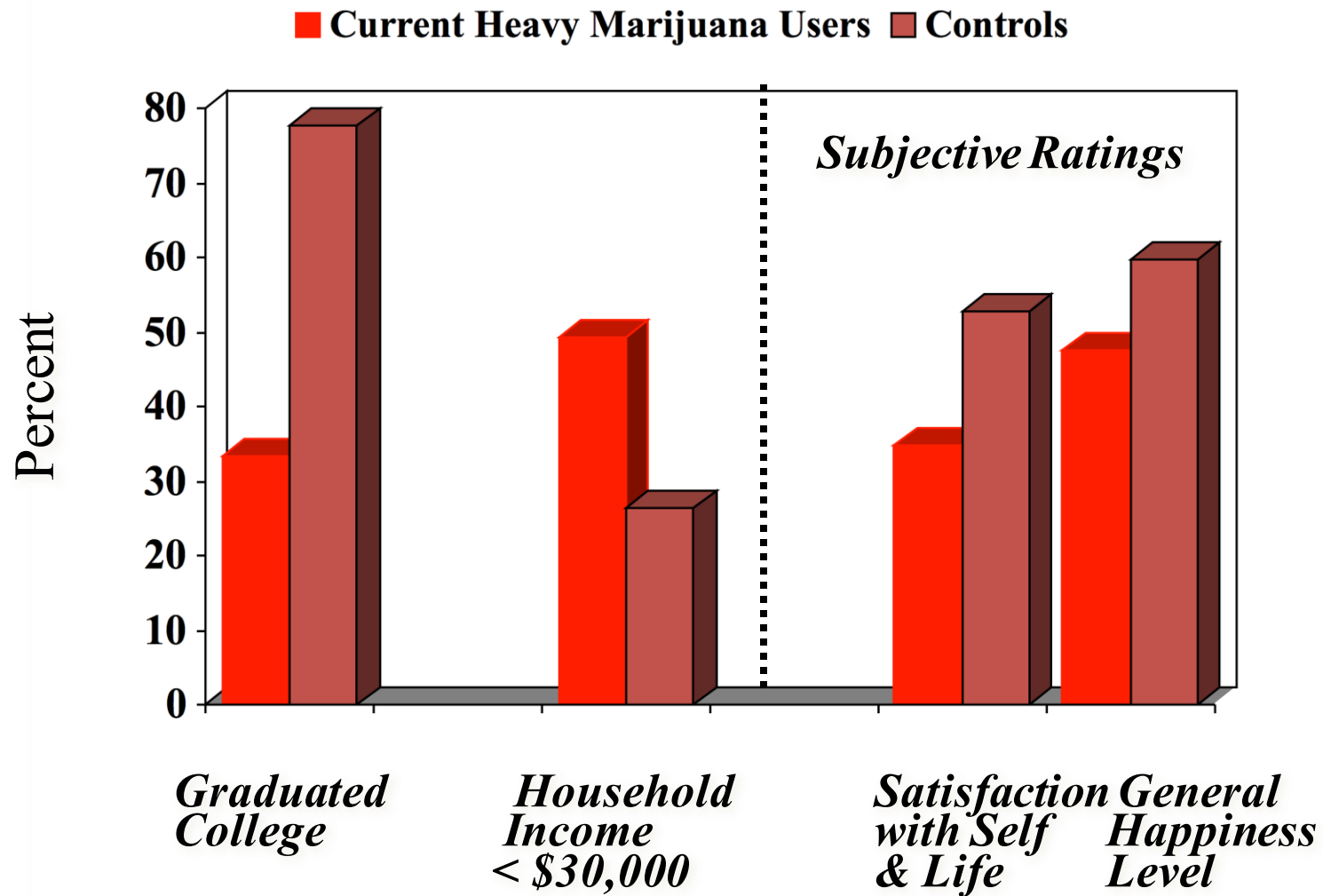
# ADDICTION IS A DEVELOPMENTAL DISEASE

*it starts in adolescence and childhood*



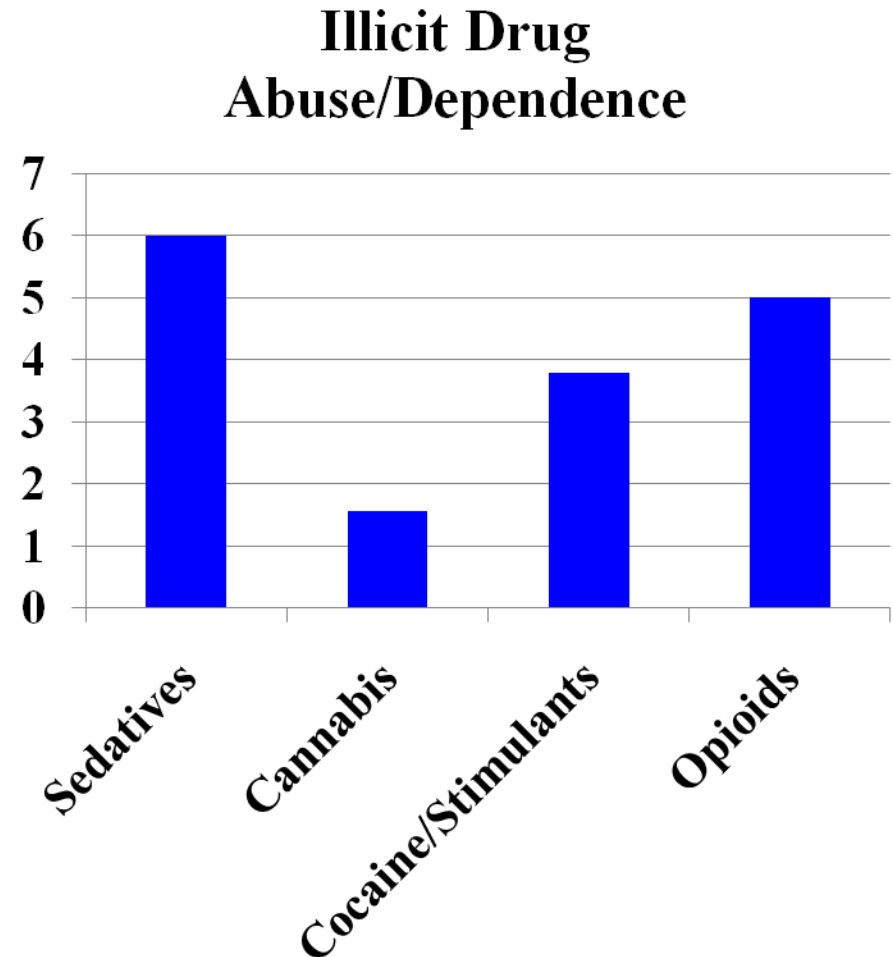
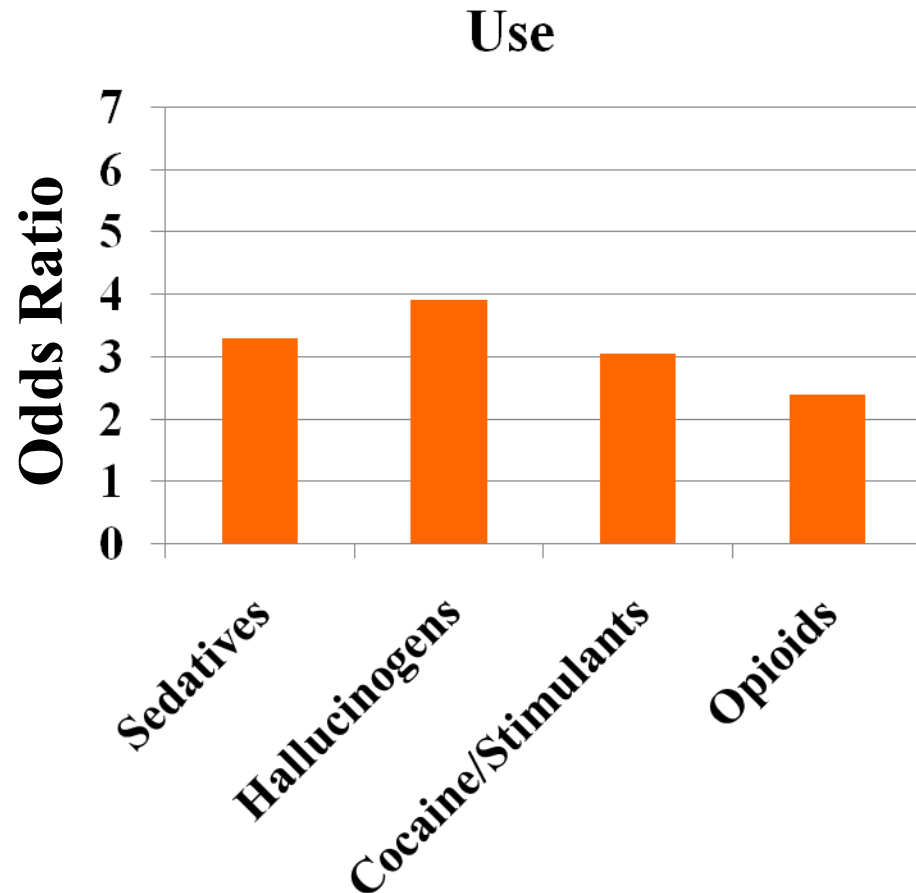
Age at **tobacco**, at **alcohol** and at **cannabis** use dependence as per DSM IV

*NIAAA National Epidemiologic Survey on Alcohol and Related Conditions, 2003.*



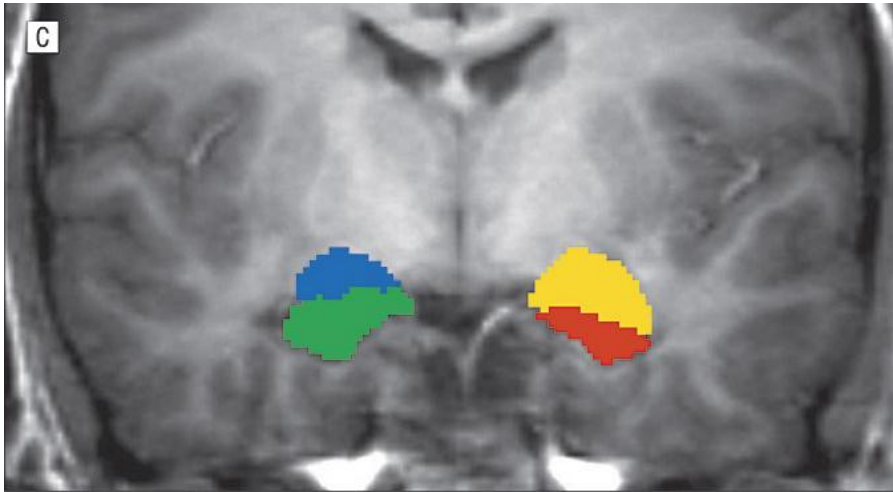
Source: Gruber, AJ et al., *Psychological Medicine*, 33, pp. 1415-1422, 2003.

# Drug Use Outcomes in Twin Pairs (n =234) Discordant for Cannabis Use Before Age 17

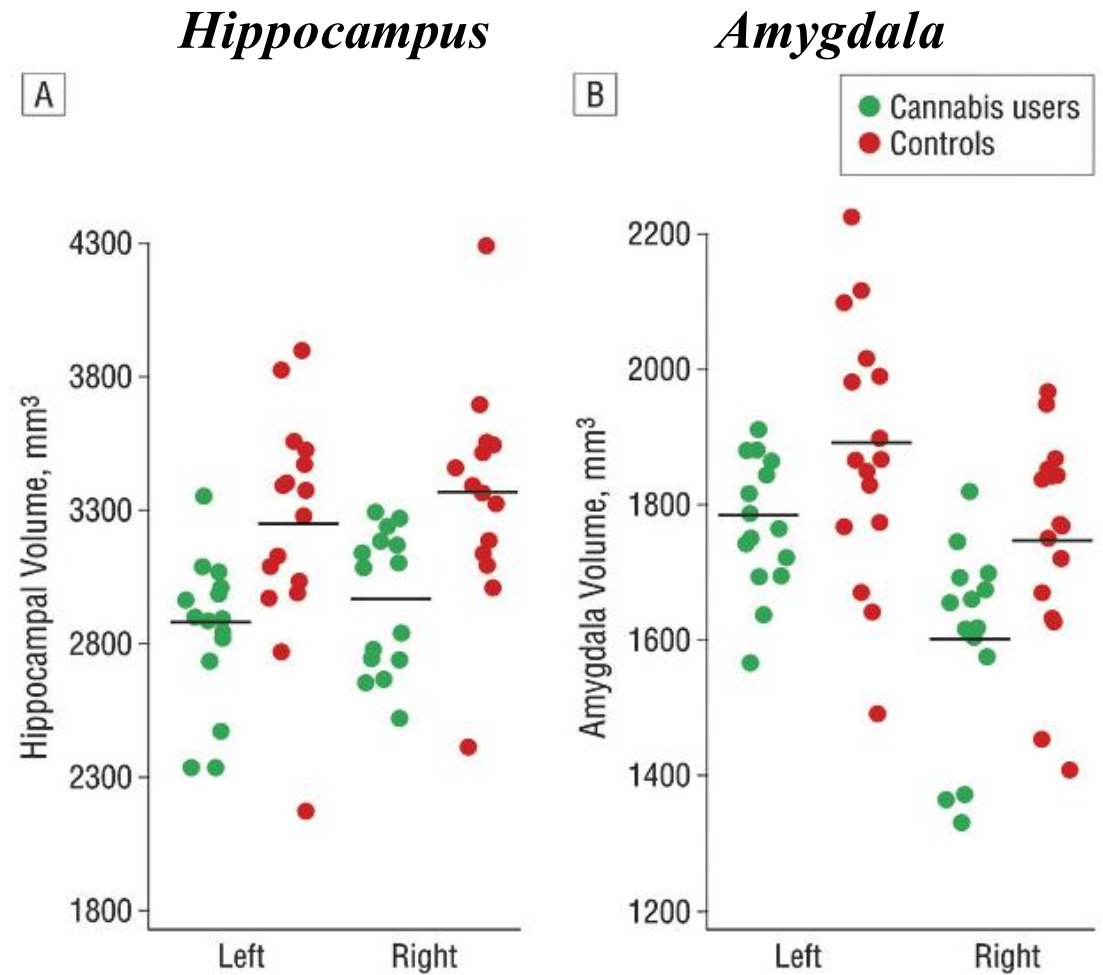


Source: Lynskey, MT et al., JAMA, 289, pp. 427-433, 2003.

# ***Brain abnormalities associated with long-term heavy cannabis use***

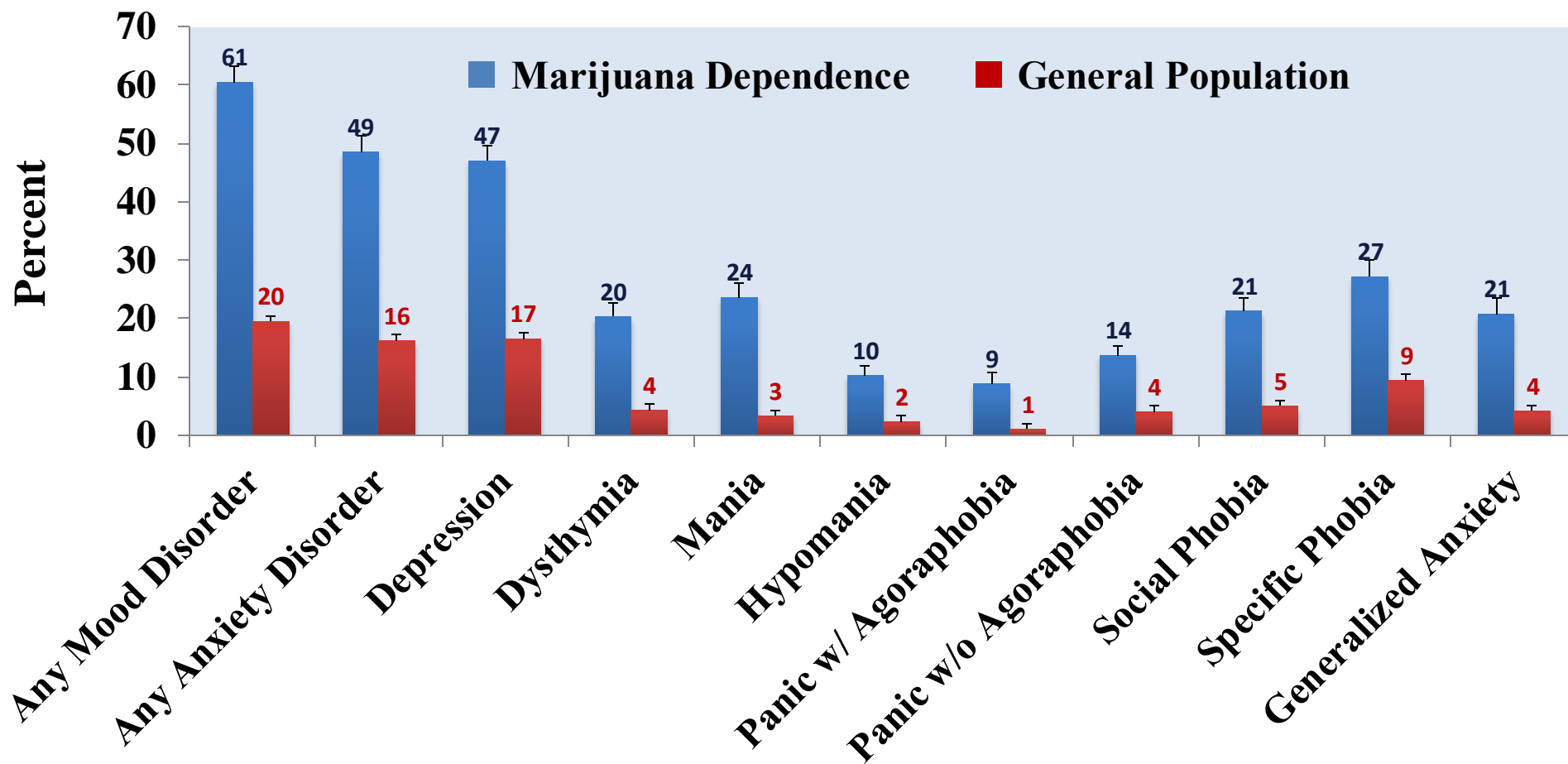


***Tracings of left (yellow) and right (blue) amygdalae and left (red) and right (green) hippocampi.***

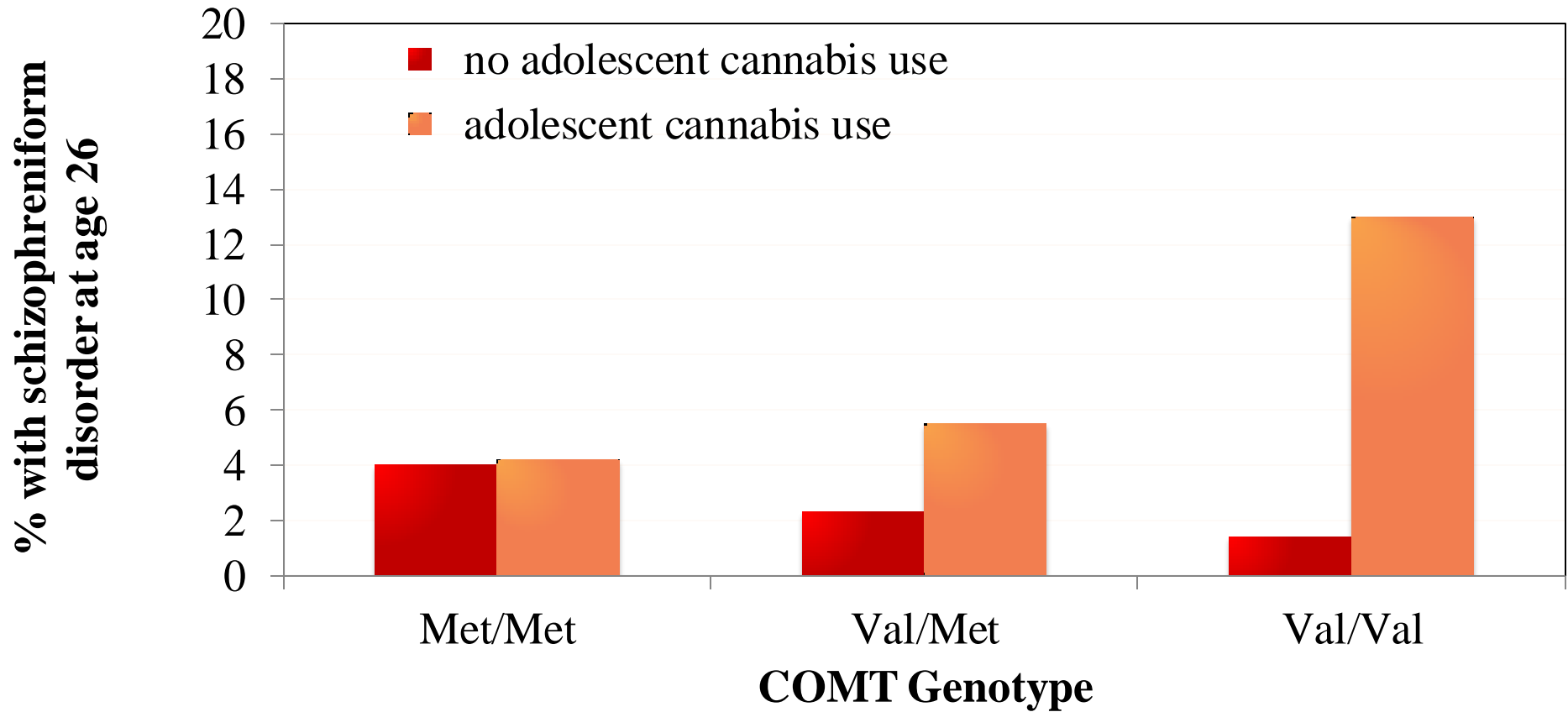


***Hippocampal (A) and amygdalar (B) volumes were smaller in cannabis users than in non using control subjects.***

# High Rates of Comorbid Mood & Anxiety Disorders Among Respondents with Marijuana Dependence (NESARC)



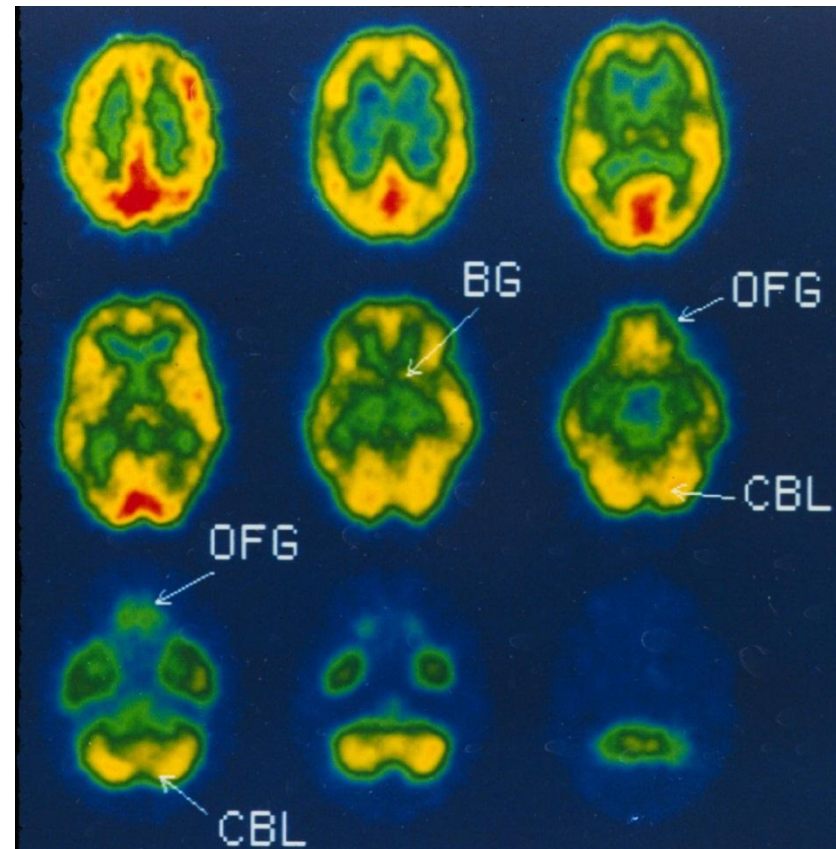
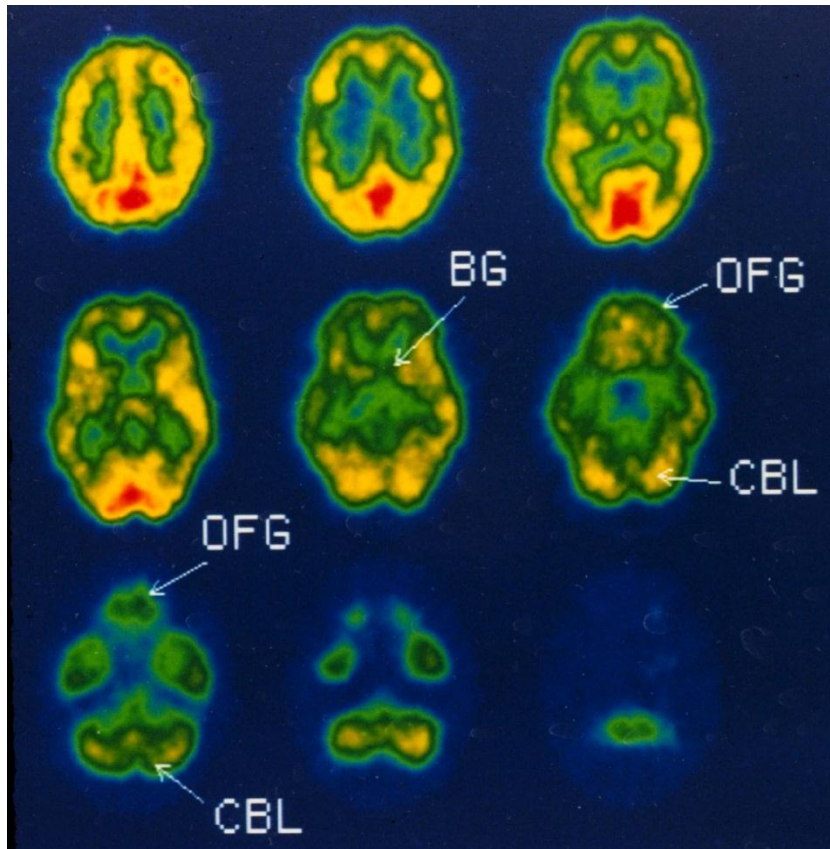
# Adolescent Cannabis Use Increases the Risk for Adult Psychosis in Genetically Vulnerable Individuals



Source: Caspi, A. et al., *Biol. Psychiatry*, 57: 1117-1127; 2005.



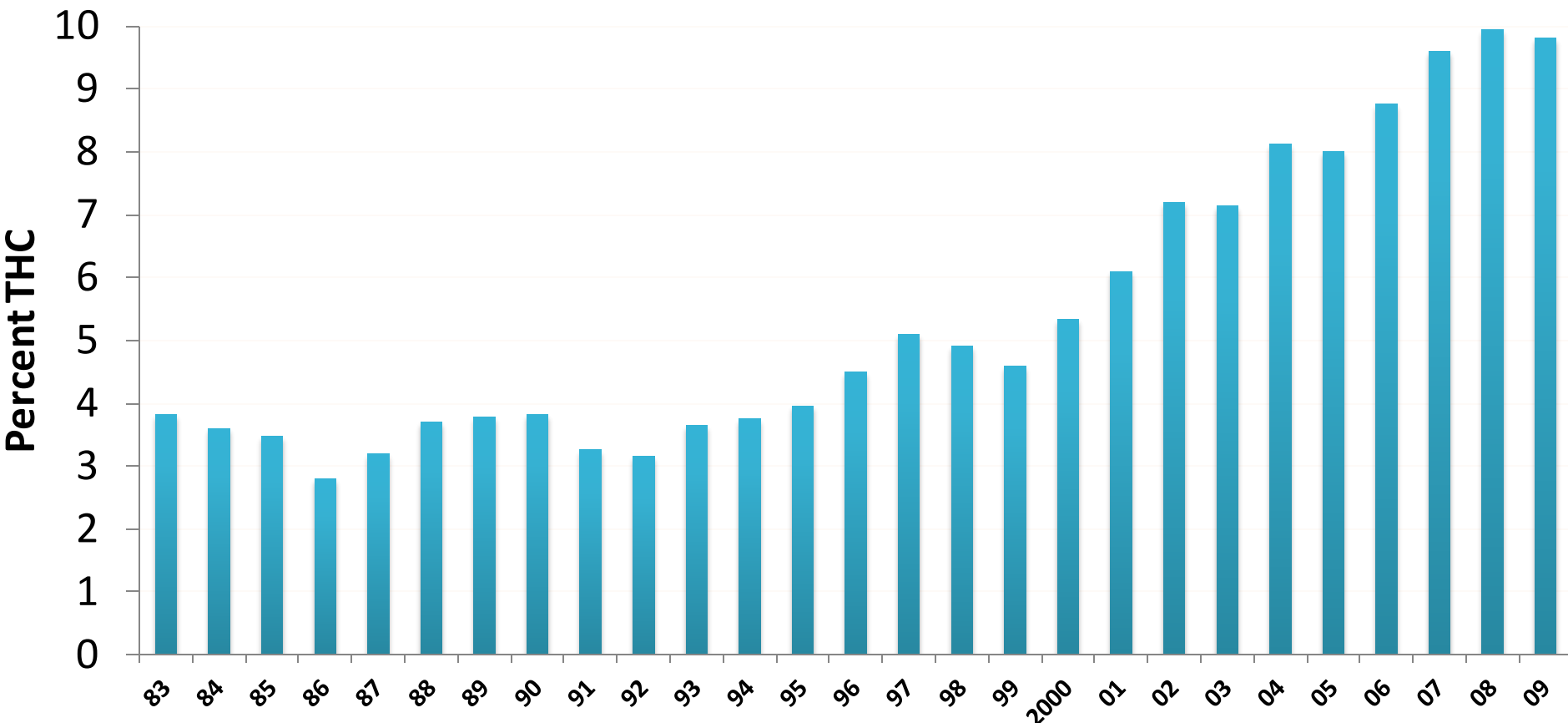
# Changes in Brain Glucose Metabolism During Marijuana Intoxication



*Cerebellar activity is impaired during intoxication*

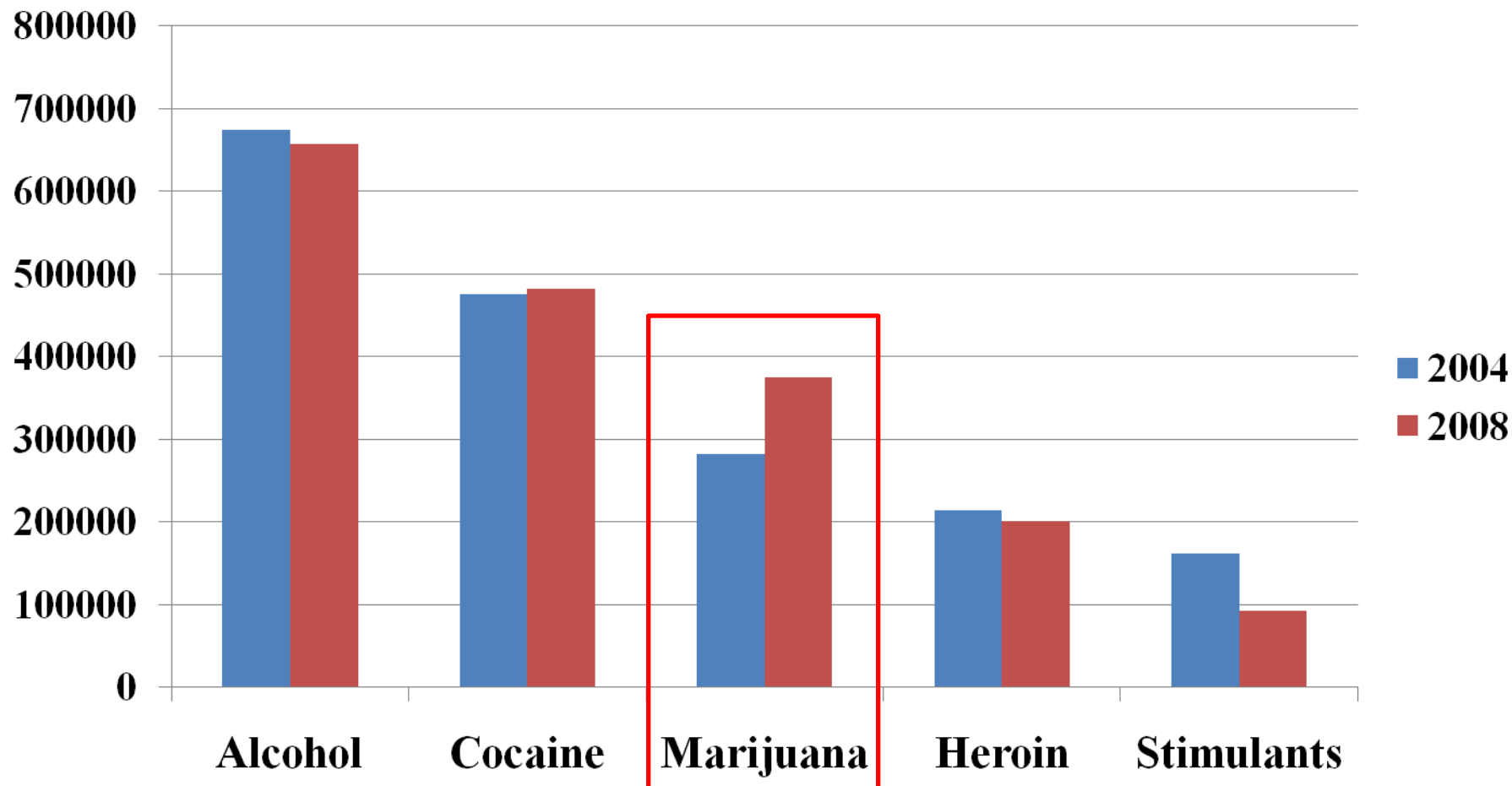
Volkow, N.D. et al., *Psychiatry Research: Neuroimaging*, 67, pp. 29-38, 1996.

# Potency: Increased THC Content in Seized Marijuana, 1983-2009



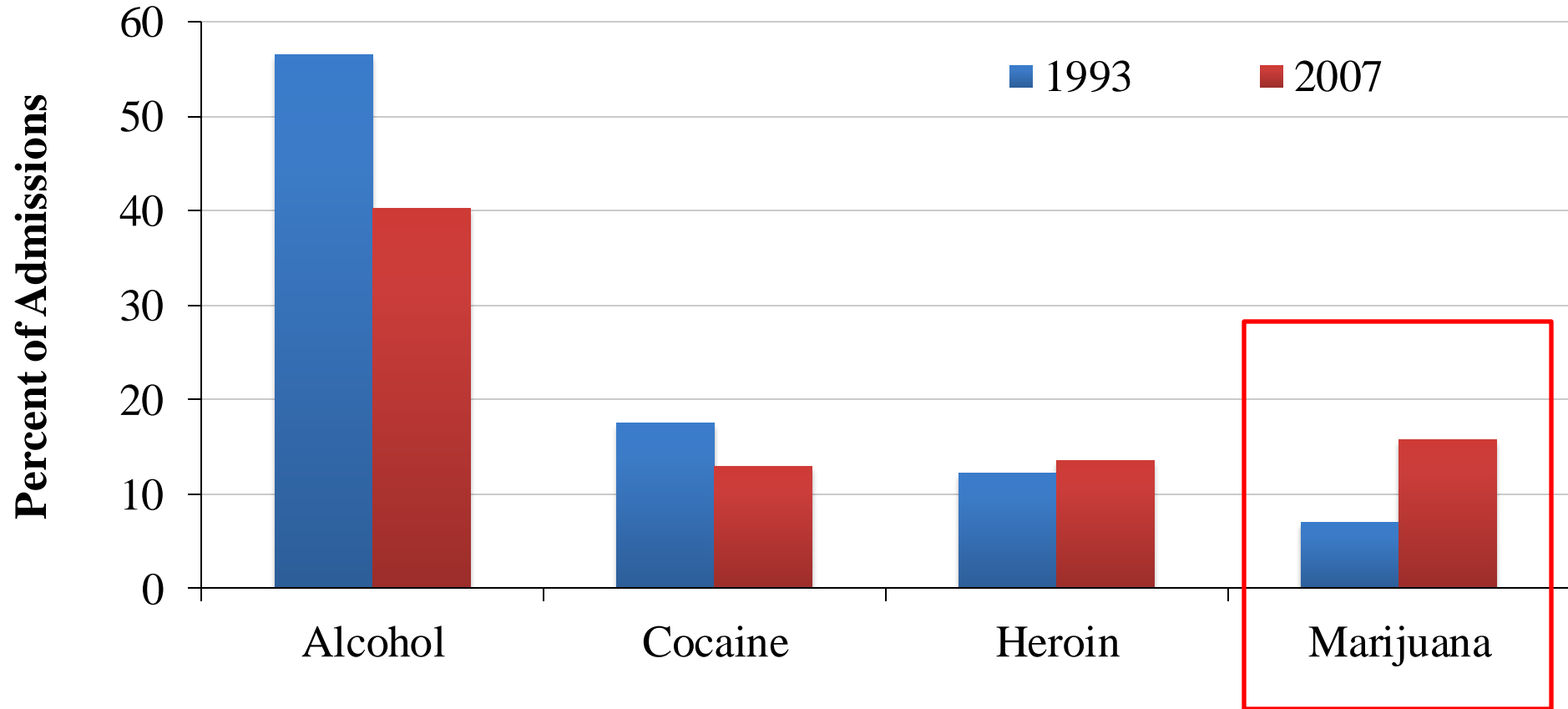
*Sources: The University of Mississippi Potency Monitoring Project*

# Emergency Department Visits Involving Selected Drugs: 2008



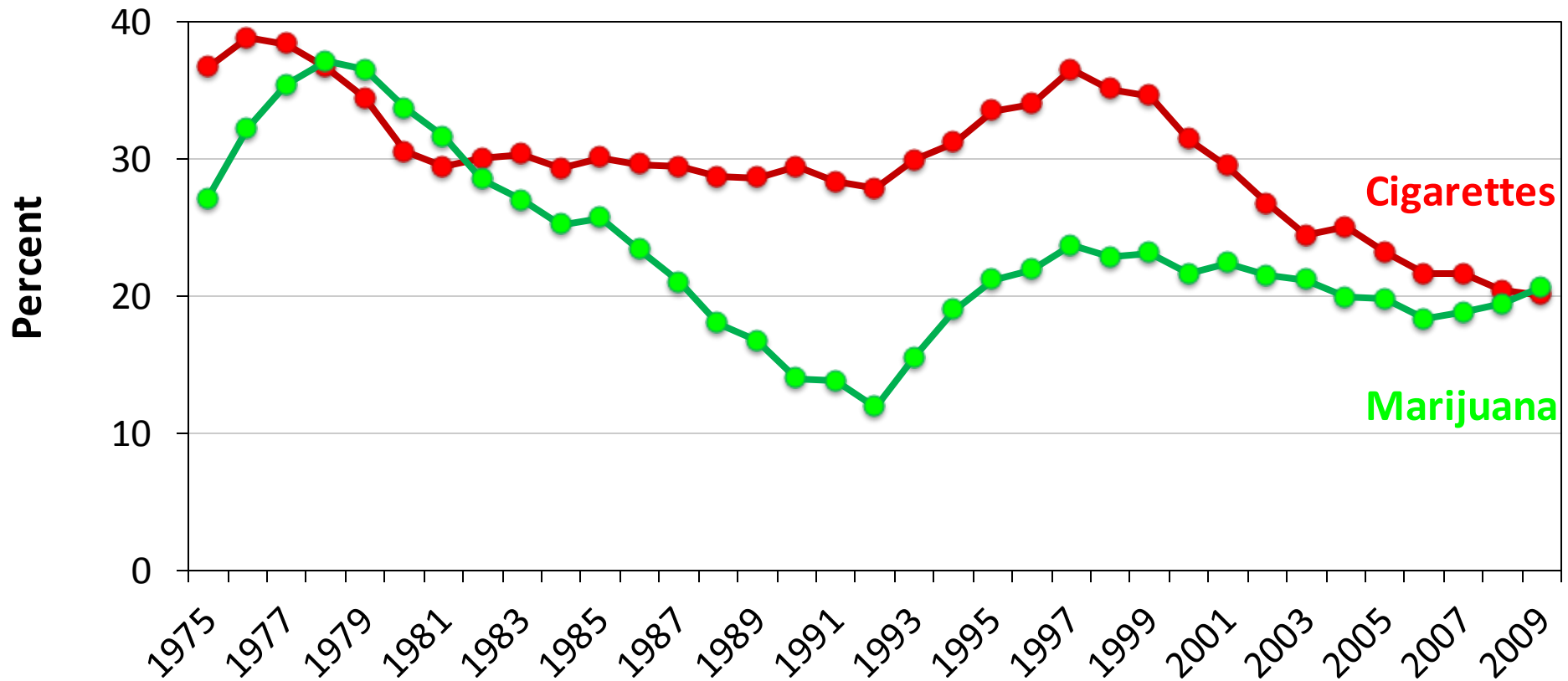
*Source: SAMHSA, 2008 DAWN.*

# Increased Marijuana Treatment Admissions 1993 and 2007



*Source: SAMHSA, TEDS 1993 & 2007*

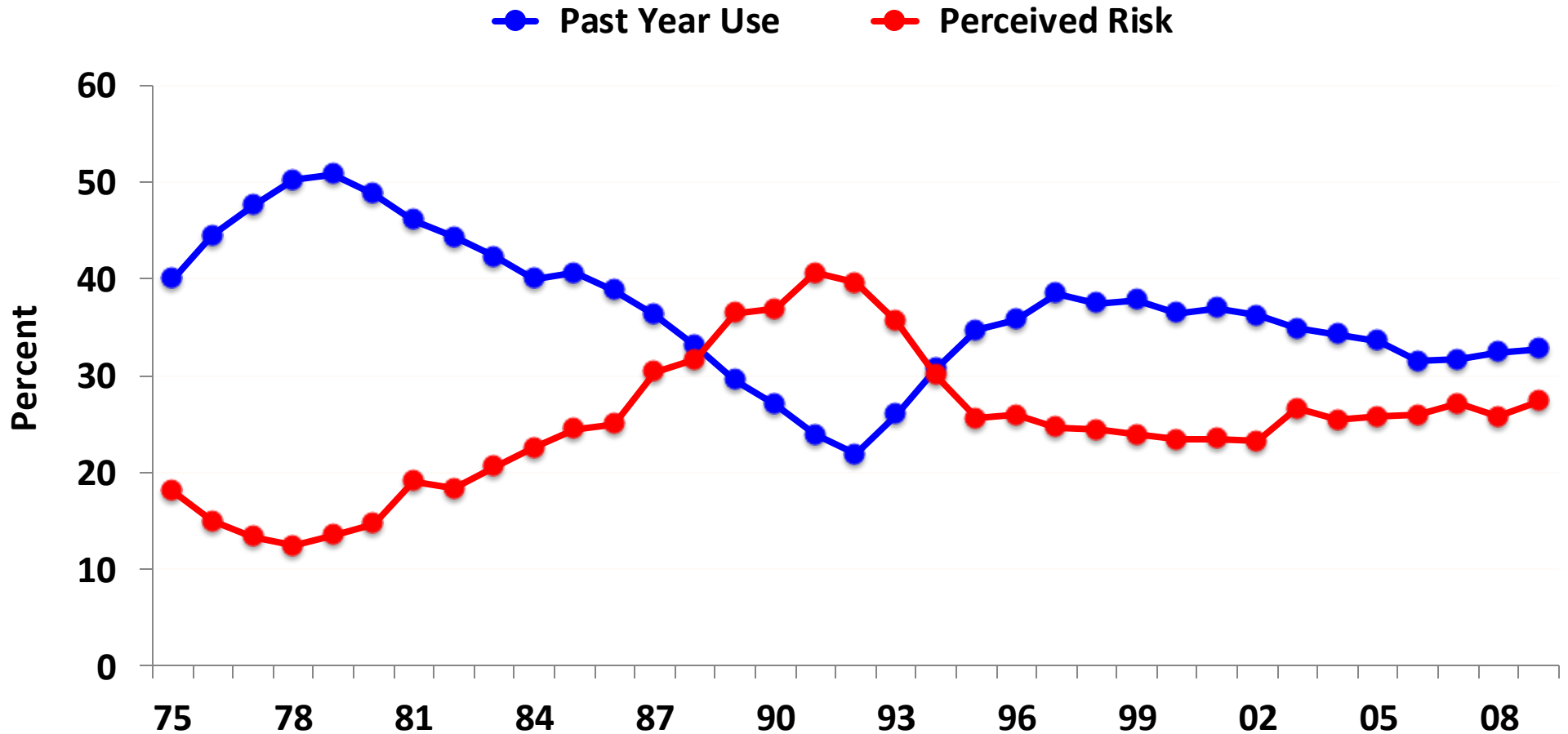
# Percentage of U.S. 12th Grade Students Reporting Past Month Use of Cigarettes & Marijuana, 1975 to 2009



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

# Changes in Attitude Lead to Changes in Use

## Marijuana Use and Perceived Risk among 12<sup>th</sup> Graders, 1975 to 2009



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



***For More Info Visit  
NIDA's Website @***

***www.drugabuse.gov***



How does marijuana  
use affect school,  
work, and social life?  
See page 7.

NIDA NATIONAL INSTITUTE  
ON DRUG ABUSE

Research Report Series

# Marijuana Abuse

## from the director:

By the time they graduate from high school, about 42 percent of teens will have tried marijuana. Although current use among U.S. teens has dropped dramatically in the past decade (to a prevalence of about 14 percent in 2009), this decline has stalled during the past several years. These data are from the Monitoring the Future study, which has been tracking drug use among teens since 1975. Still, the World Health Organization ranks the United States first among 17 European and North American countries for prevalence of marijuana use. And more users start every day. In 2008, an estimated 2.2 million Americans used marijuana for the first time; greater than half were under age 18.

The use of marijuana can produce adverse physical, mental, emotional, and behavioral effects. It can impair short-term memory and judgment and distort perception. Because marijuana affects brain systems that are still maturing through young adulthood, its use by teens may have a negative effect on their development. And contrary to popular belief, it can be addictive.

We hope that this *Research Report* will help make readers aware of our current knowledge of marijuana abuse and its harmful effects.

Nora D. Volkow, M.D.  
Director  
National Institute on Drug Abuse

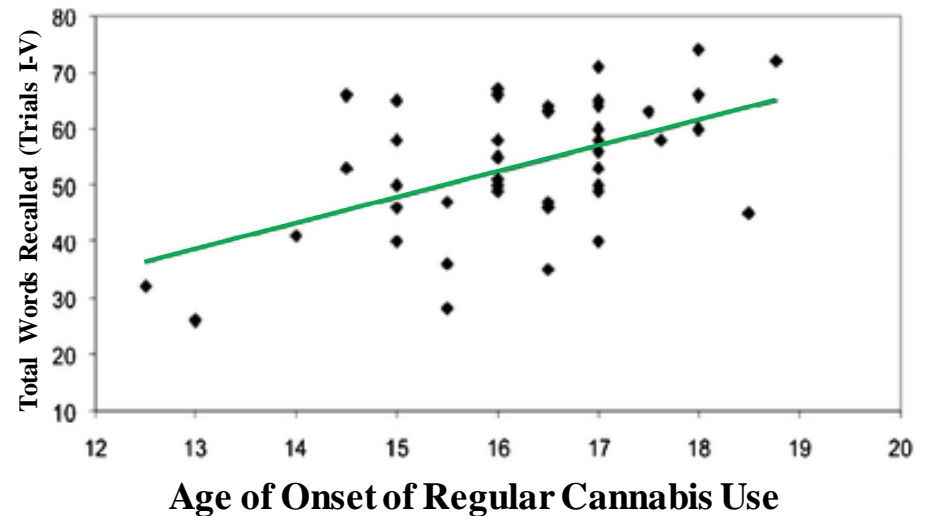
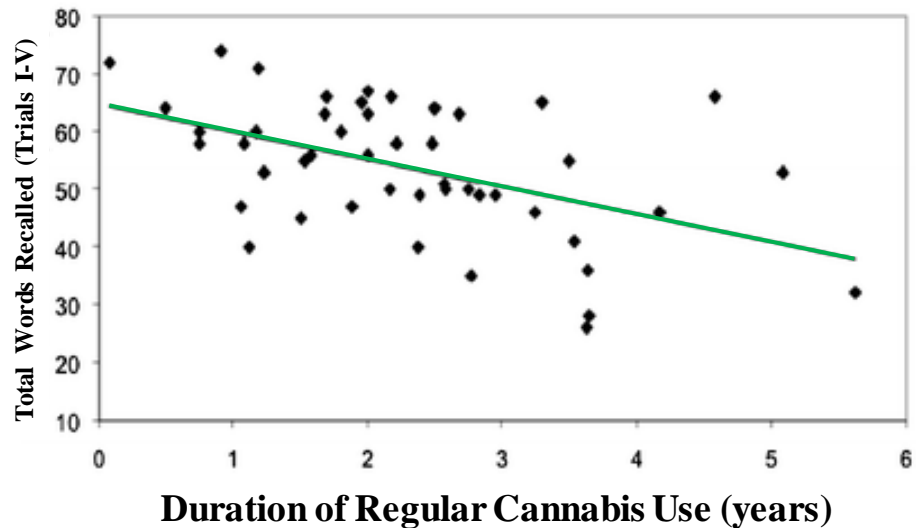
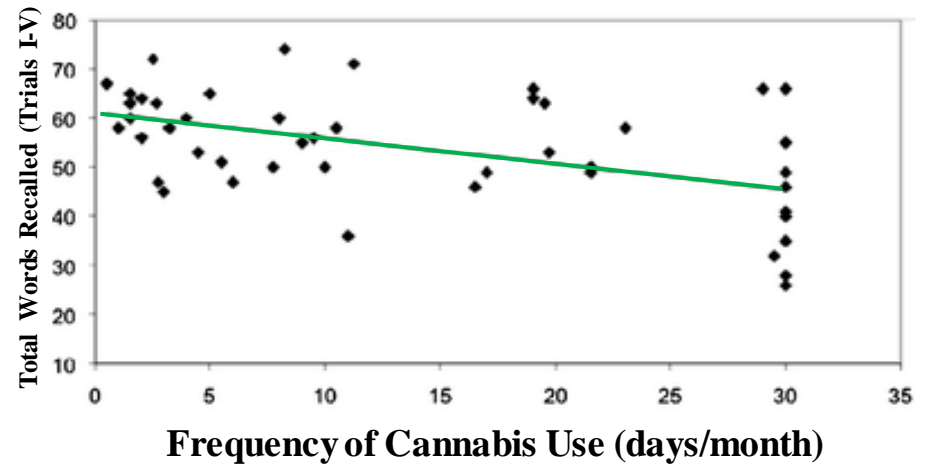
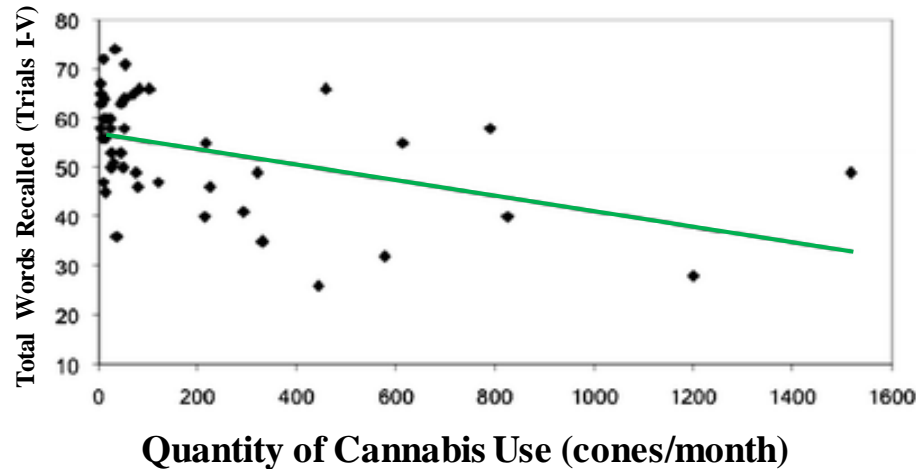
## What Is Marijuana?

**M**arijuana—often called *pot*, *grass*, *reefer*, *weed*, *herb*, *Mary Jane*, or *MJ*—is a greenish-gray mixture of the dried, shredded leaves, stems, seeds, and flowers of *Cannabis sativa*—the hemp plant. Most users smoke marijuana in hand-rolled cigarettes called *joints*, among other names; some use pipes or water pipes called *bongs*. Marijuana cigars, or *blunts*, are also popular. To make blunts, users slice open cigars, remove some of the tobacco, and mix the remainder with marijuana (Timberlake 2009). Marijuana also is used to brew tea and sometimes is mixed into foods.

*continued inside*

U.S. Department of Health and Human Services | National Institutes of Health

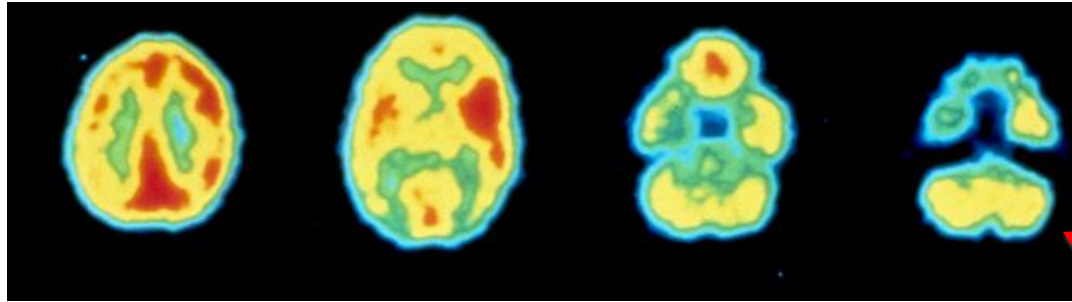
# Relationships Between Total Words Recalled and Quantity, Frequency, Duration and Age of Onset of Regular Cannabis Use



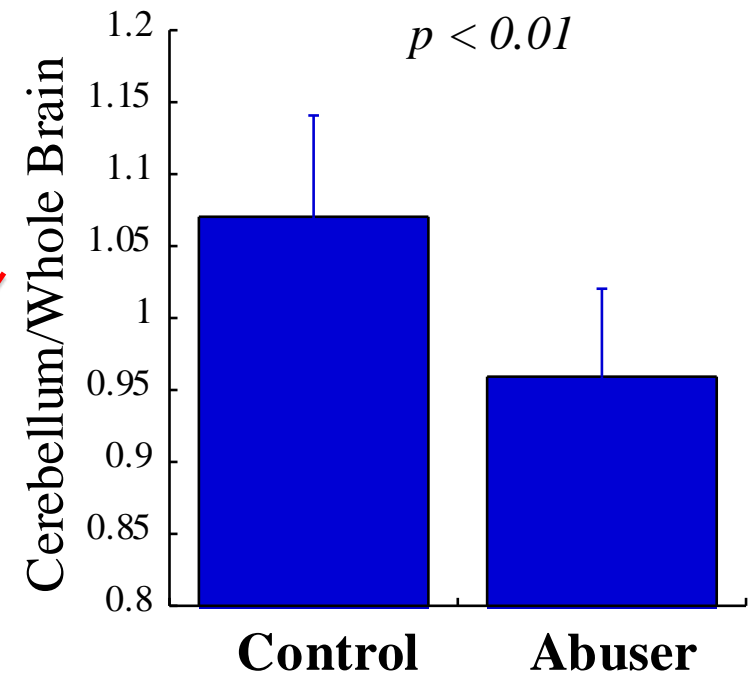
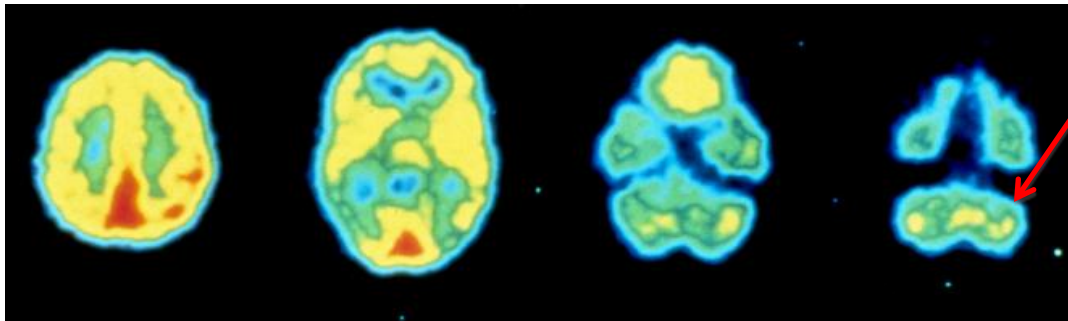
Source: Solowij N et al. *Psychopharmacology (Berl.)* 2011 Feb 17 [Epub ahead of print].

# Brain Glucose Metabolism in Controls and Marijuana Abusers

Control

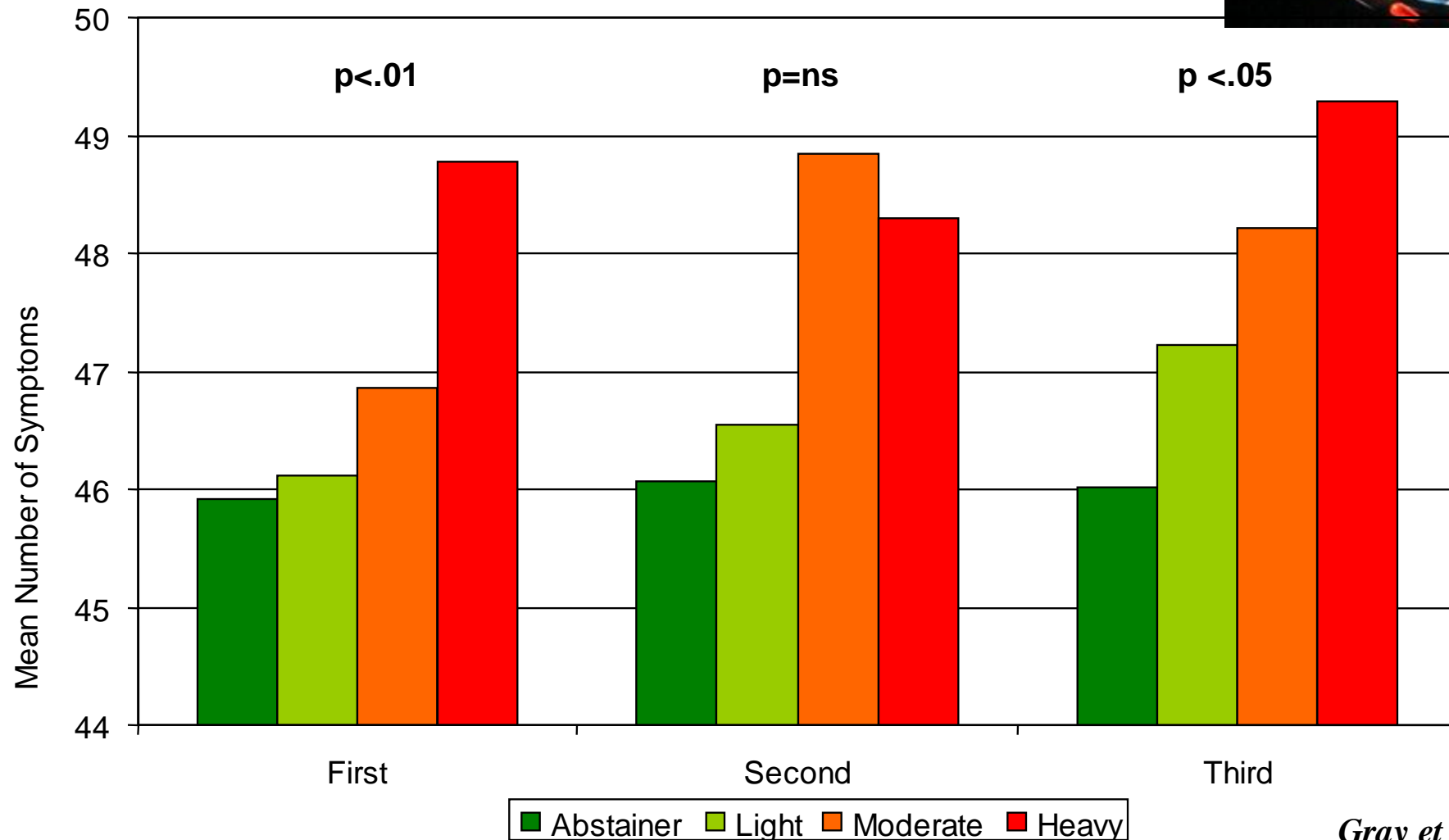


Marijuana Abuser



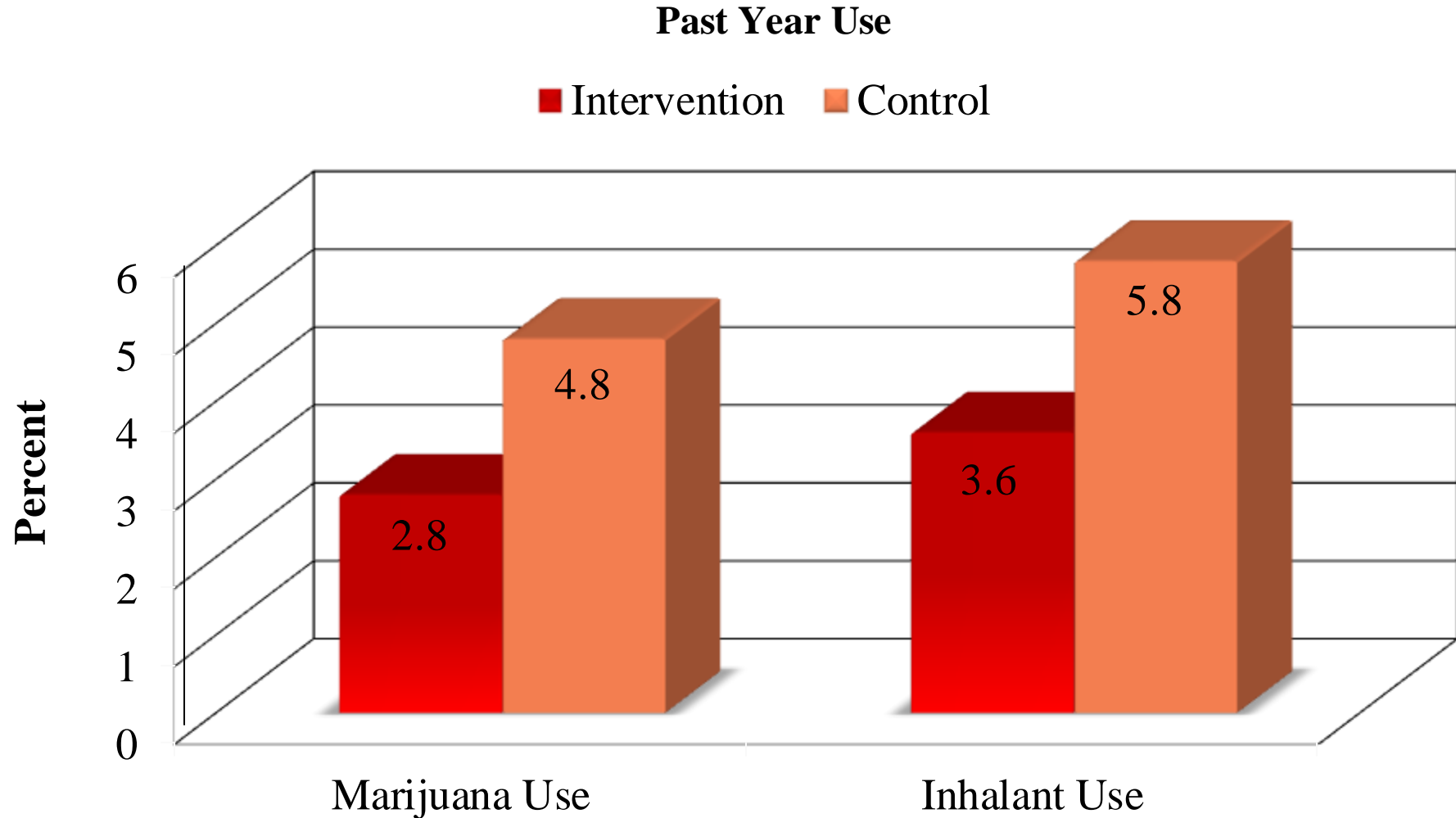
*Cerebellar metabolism is decreased in Marijuana Abusers*

# Depression Symptoms at Age 10 by Trimester of Prenatal Marijuana Exposure



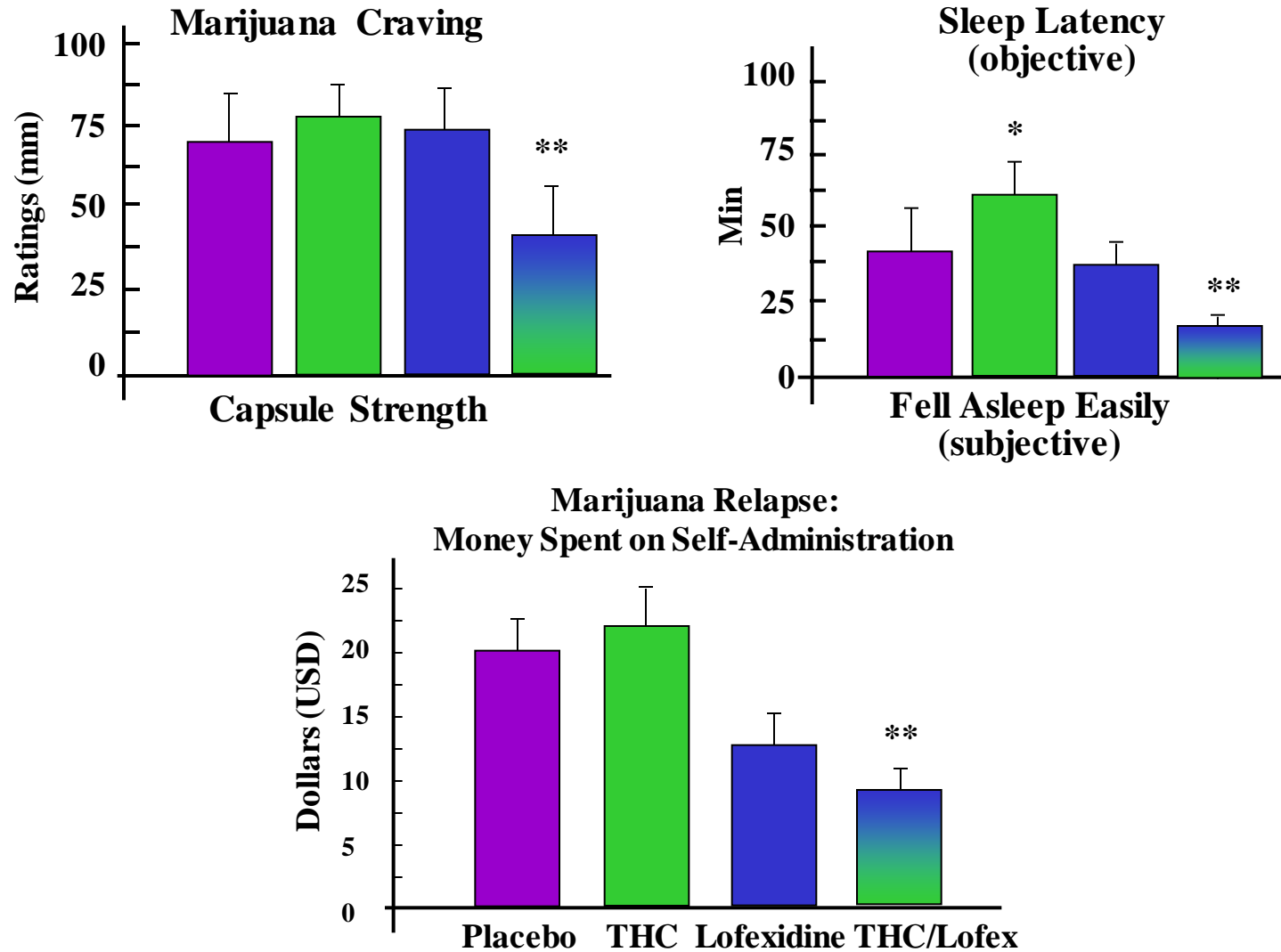
*Gray et al., 2005.*

# Prosper Multisite Community Study: Less MJ & Inhalants 1.5 Yrs Past Baseline



*Spoth, Redmond, Shin, Greenberg, Clair, Feinberg (2007). Am J Prev Med, 32(5), 395-402.*

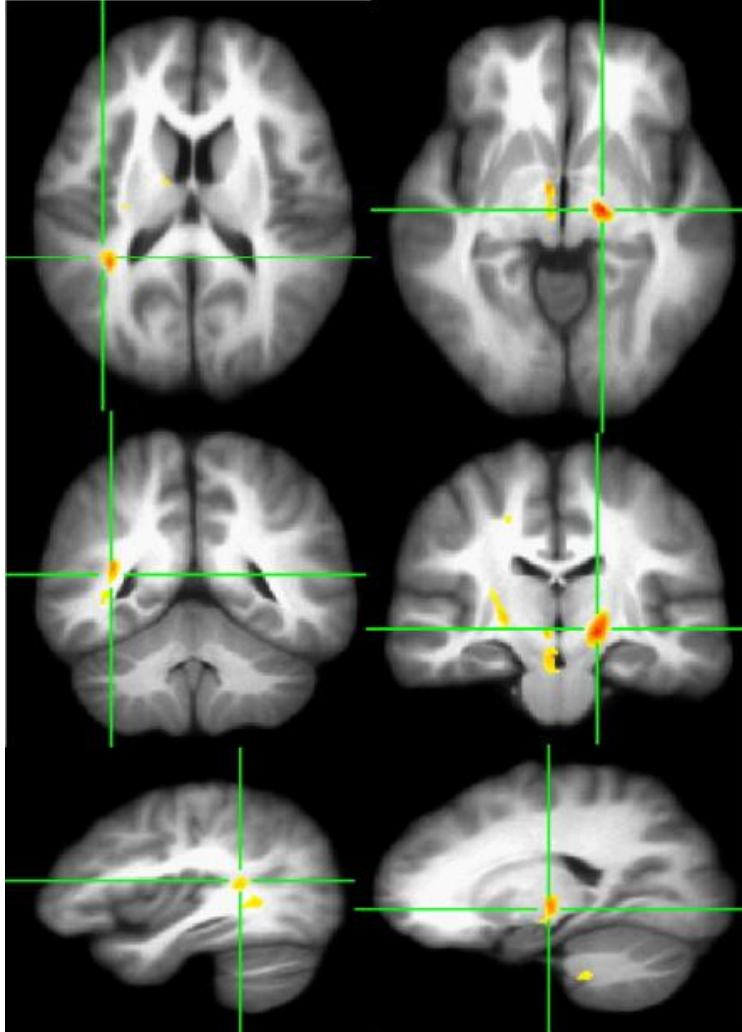
# Effects of THC and Lofexidine in a Human Laboratory Model of Marijuana Withdrawal and Relapse



Source: Haney, M et al., *Psychopharmacology*, 197, pp. 157-168, 2008.



***Areas where Adolescents with Heavy Marijuana Use  
(n=15) Showed Decreased Connectivity Compared to  
Non Drug Users (n=15)***



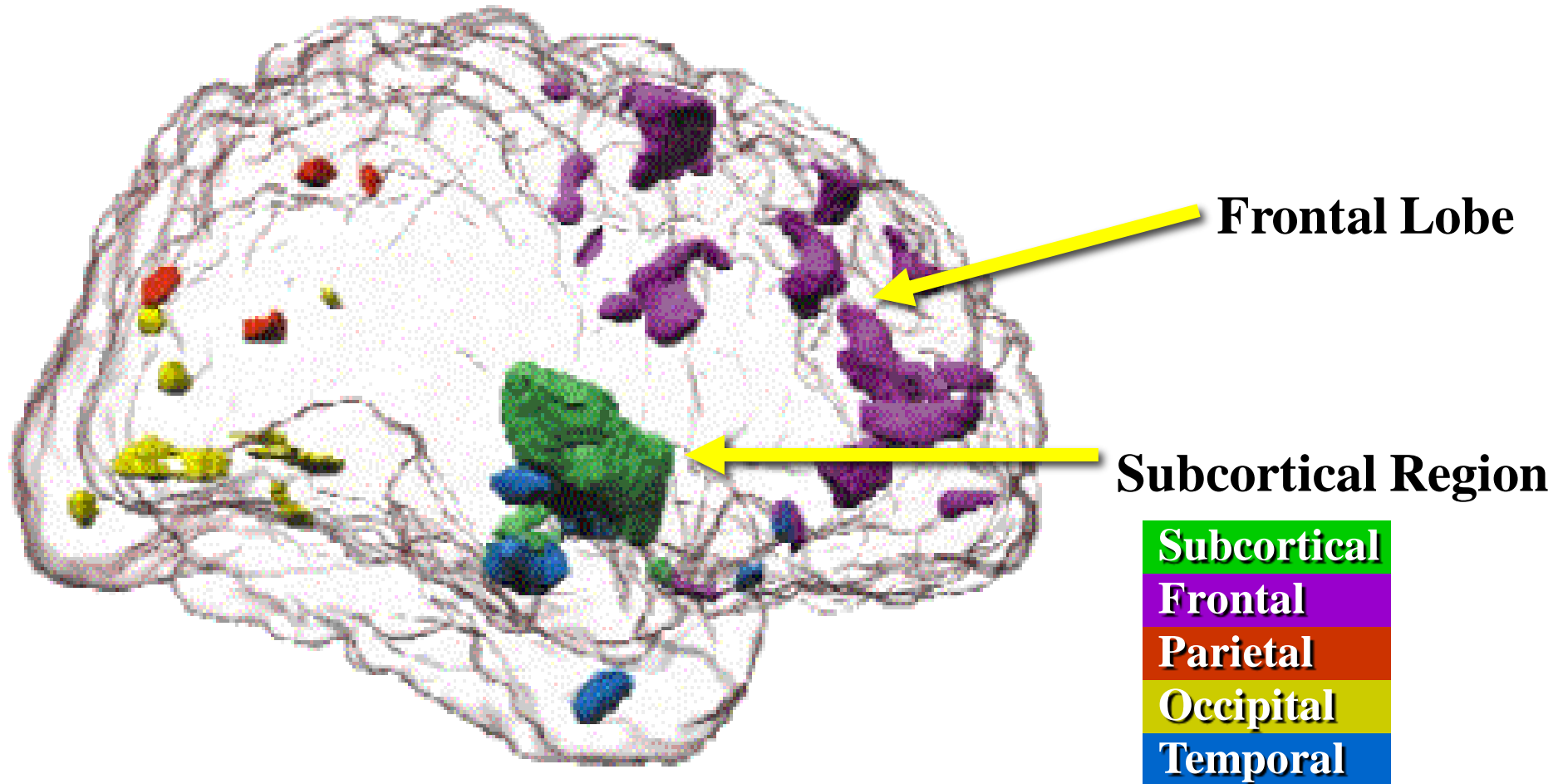
***Decreased axial diffusivity is depicted the right superior temporal gyrus (first column), the left posterior internal capsule/thalamic radiations (second column).***

*Ashtari et al., J Psychiatr Res. 43(3):189-204 2009.*

# Differences in Gray Matter Density Between Adolescence and Young Adulthood

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Differences between: 16 year olds (adolescents)  
and 23-30 year olds (young adults)



Source: Sowell, E.R. et al., *Nature Neuroscience*, 2(10), pp. 859-861, 1999