Marijuana and the Brain

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Adolescent Brain Development

• Adolescence is period of opportunity and vulnerable for the brain, particularly for developing brain connectivity

• Brain activity and exposures during adolescence can have life-long effects

• Brain development in adolescence makes teens more susceptible to the addictive substances
The Teen Brain

What is going on in there?

Source: US News & World Report, 2005
Endocannabinoid System Functions

• The neuron’s “volume control” system: dials down neuron activity when too strong

• Regulates levels of neurotransmitters that affect pleasure, mood, pain, appetite, motivation, memory
  – Dopamine
    • Dopamine, a neurotransmitter, works in the pleasure center of the brain
    • Pleasurable experience is reinforced by new brain circuits or ‘a shortcut’
  – Glutamate, endorphins, serotonin, GABA
Cannabinoids: Primary Psychoactive Ingredient in Marijuana

• Cannibis sativa’s cannabinoid profile is dominated by high THC levels and low CBD levels. Cannibus indica has a balanced- moderate THC levels and higher levels of CBD

• Examples of cannabinoid chemicals
  – Delta-9-tetrahydrocannabinol (THC)
  – Delta-8-tetrahydrocannabinol
  – Cannabidiol
  – Cannabinol
  – Cannabichromene
Marijuana Pharmacokinetics

• Bioavailability is 5-20%
• Time to peak effect varies by mechanism of use
  – After smoking, Tmax is 30 minutes
  – After eating, Tmax is 2 hours
• Half-life variable but about 30 hours
• Don’t drive/care for children for at least 3 hours

Borgelt et al. (2013), Pharmacotherapy 33:195-209
Brain regions affected by THC

Source: NIDA
Both dial down neuron activity to change neurotransmitter release
THC has a MUCH STRONGER, LONGER effect than anandamide
THC interferes with cell function and growth
Marijuana Associated Changes in Brain Structure and Functioning

• Brain function
  – Reduced Cognition (lower IQ)
  – Reduced attention / executive functioning
  – Behavior change (increased impulsivity)

• Brain structure changes
  – ↓ prefrontal cortex volume
  – ↓ white matter integrity in prefrontal cortex
  – ↓ prefrontal cortex thickness
  – ↓ total gray matter

Meier et al., 2012; Pope et al., 2003 Ehrenreich et al., 1999 Huestegge et al., 2002 Fontes et al., 2011 Solowij et al., 2012 Churchwell et al., 2010 Gruber et al., 2011 Lopez-Larson et al., 2011 Wilson et al., 2000 Becker et al., 2010a Gruber et al., 2012 Jager et al., 2010
Average IQ at Ages 13 to 38 by Marijuana Use (N=1037)

- **Never used marijuana**
  - Age 13: 99.8
  - Age 38: 100.6

- **Used marijuana 3+ years**
  - Age 13: 99.7
  - Age 38: 93.6

The Dunedin Study (New Zealand) Meier et al. PNAS, 2012
Is Marijuana Addictive For Adults?

• 9% of marijuana users become dependent
  – Colorado has seen a 5 percent increase since the state legalized recreational use
• 15% of individuals who consume alcohol become dependent
• 17% of cocaine users become dependent
• 32% of tobacco users become dependent
• Some experts suggest waiting until at least 18 to start using marijuana lessens the chances of becoming dependent, as does avoiding heavy use of potent pot products
• Stopping heavy marijuana use can trigger mild withdrawal symptoms similar to quitting tobacco, including irritability and sleep issues

National Institute on Drug Abuse
• 1 in 6 teen users develop addiction
• Regular marijuana use during adolescence increases risk 2 to 7 times of developing psychosis, schizophrenia, anxiety, and depression
• Similar altered white matter structure found in the brains of people dx with schizophrenia and teen marijuana users


Marijuana Addiction and Psychiatric Hospital Admissions

- 66% of MH admissions for 15-17 year olds
  - 16% of admissions for SUD treatment
  - 74% are male

- 2/3rds of adolescents in treatment report MJ withdrawal
  - Intensity of MJ withdrawal is the equivalent of tobacco withdrawal

- MJ exposure for children < 6 years increased > 6X in states that legalized marijuana for medical use
  (7% admitted to ICU)

Vandrey et al. (2008), Drug Alcohol Depend 92:48-54
www.dasis.samhsa.gov/teds07/tedshigh2k7.pdf;
The Impact of In Utero Marijuana Exposure

↓IQ by 5 points at age 6 years
↑hyperactivity, impulsivity, inattention at age 10
↓achievement at age 14
  (Composite WIAT 83.9 v 89.9, p=0.003)
↑depression at age 10 (35% v 17%, p<0.01)
↑odds of MJ use by age 14

Day et al. (2006), Addiction 101:1313-1322
Reproductive/Growth Hormones

• Marijuana affects glands, organs and hormones involved in overall growth, pubertal development, and energy levels

• Can lower fertility of males and females through lowered sperm count and egg damage

• Increases risk for testicular cancer

THC Content Increase => Increase in Adverse Effects:

- Paranoia
- Anxiety and panic
- Hallucinations
- Hyperemesis
- Erratic mood swings
- Aggressive behavior

Emergency Department Visits Caused by Marijuana Use (Rate per 100,000 people)

Marijuana As Changing Substance

http://www.ocregister.com/articles/marijuana-724934-use-people.html
Estimates of Societal Impact of MJ

• Use in pregnancy:
  – 5.3% to 19.9%
  – 4,248,000 births
  – 225,000 to 850,000 children born exposed to marijuana every year

• Adolescent addiction:
  • Over 200,000 teens go on to develop cannabis use disorder every year

• Adult risks
  – 4X ↑ risk of MI after using marijuana
  – Cannabis dependence doubles risk of bronchitis, wheezing, chronic cough
  – May increase risk of head/neck, lung, testicular cancer
The Risk to Youth from Legalization is Not Yet Significant But Is Higher and Trending Up in CO and WA

(includes post-legalization 2014 data)

Adolescent use is trending up at a greater pace in CO and higher new use in young teens >.05
MJ and Motor Vehicle Accidents

• A survey of French accident data showed drivers with cannabis in their system were twice as likely to be involved in a crash as sober ones.

• National Highway Traffic Safety Administration found that after controlling for factors such as age and alcohol consumption, the data “did not show a significant increase in levels of crash risk” for drivers with cannabis alone in their systems.

• Fatal crashes involving drivers who recently used marijuana doubled after the drug was legalized in both Washington and Colorado.

• An Assembly bill introduced in February would establish a legal driving limit for marijuana users at 5 nanograms per milliliter of blood – the same as in Colorado and Washington.
Colorado 2014 Driving Experience Portends Harm to CA Teens by MVAs

• MJ legalized in CO in 1/14
• CO had a 32% increase in marijuana-related traffic deaths (all ages) in 2014, contrary to 2014 national trend
  – The risk of motor vehicle crashes is higher among 16-19-year-olds than among any other age group
  – The risk for older teens is nearly 3X > than likely than all other drivers and 2,524 US teenagers ages 13-19 died in motor vehicle crashes in 2013
  – The CO recent increase is contrary to the national trend of a steady reduction in adult and teen driving deaths

http://www.cdc.gov/motorvehiclesafety/teen_drivers/teendrivers_factsheet.html
U.S. Department of Transportation's Fatality Analysis Reporting System
Rocky Mountain High Intensity Drug Trafficking Area; September 2015
National Highway Traffic Safety Administration, 2015
Colorado Historical Fatal Crash Trends - Updated 2/8/2016

Colorado Fatal Crash Reduction Since 2002

Note: Data is preliminary as of release of this Report!
Source of Data: Colorado DOT & "As Reported" to NHTSA by FARS

MVMT = Million Vehicle Miles Travelled
MJ Legalization in CO
Students Tell Us Legalized Status Matters

• HS Seniors were queried on MJ use
  – Current users
  – Non-users
• Findings:
  – If marijuana were legalized, there would be a 5.6 percent absolute increase in lifetime prevalence of marijuana use among seniors, from 45.6 percent (44.6, 46.6) to 51.2 percent (50.2, 52.2)
  – Of students who reported already using marijuana, 18% stated that were marijuana legalized, they would use it more frequently

Monitoring the Future; Palamar et al 2015 DOI:10.3109/00952990.2015.1045977;
Is Marijuana A Gateway Drug?

- Most people who try marijuana first use cigarettes and alcohol
- The majority of people who try marijuana never move on to other more powerful, addictive drugs
- The majority of people who try substances such as cocaine or heroin say they first used pot
  - Nearly 8.5 percent of the population used marijuana in the past month
  - 2.5 percent said they’d used the next most common substance (prescription medications)
  - < 1 percent had tried drugs such as cocaine, LSD or heroin.
- What correlations may exist appear to be tied more to social factors, such as peer pressure and family environment, than physiological ones
- Study by Federal Institute of Medicine: “There is no conclusive evidence that the drug effects of marijuana are causally linked to the subsequent abuse of other illicit drugs.”

NSDU and Health Survey
Marijuana and Medicine: Assessing the Science Base (1999
California:
Use by teens in last month:
Marijuana 16%
Binge drinking 14%
Analysis of Likely Ballot Initiative (Adult Use of Marijuana Act)

• Treats marijuana like tobacco, – legalizes under a public health framework as a response to the social inequities and large public costs of the failed War on Drugs

• Findings: the initiative is:
  – Written primarily to create a new business and only include minimal protections for the public
  – Unlikely to prevent public health harms caused by the burgeoning marijuana industry

A Public Health Analysis of Two Proposed Marijuana Legalization Initiatives for the 2016 California Ballot: Creating the New Tobacco Industry; UCSF Center for Tobacco Control Research and Education

Barry, RA, Glantz, SA(2/16)
Will AUMA Harm More Students?

- As of 2015, almost half of US states allow medical marijuana, and 4 states allow recreational marijuana
- Colorado has found that legalization led to no increase in self report of MJ use
  - Teens report lower rates than they did in 2009
  - Colorado had a high baseline pattern of use
- Legalization is linked to increased childhood MJ poisoning
  - The median of children was 2.4 years (IQR, 1.4-3.4)
  - Pediatric marijuana cases increased more than 5-fold from 2009 (9) to 2015; poisonings associated with poor supervision, inadequate child resistant containers
Are Colorado Youth Using More MJ?

• Comparison done between the two-year average of full legalization (2013/2014) vs. the two-year average just prior to legalization (2011/2012)

• The two 2013/2014 average increased 20% compared to 2011/2012
  – Nationally youth past month marijuana use declined 4% during the same time
  – The latest results show Colorado youth ranked #1 in the nation for past month marijuana use, up from #4 in 2011/2012

Data from the National Survey on Drug Use and Health (NSDUH), sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA)
Youth Ages 12 to 17 Years Old
Past Month Marijuana Use
National vs. Colorado

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<th>Year</th>
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<th>Colorado Average</th>
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Past Month Usage by 12 to 17 Years Old, 2013/2014

As of 2014:
- Legalized Recreational/Medical Marijuana State
- Legalized Medical Marijuana State
- Non-Legalized Medical Marijuana State

SOURCE: SAMHSA.gov, National Survey on Drug Use and Health 2013 and 2014

NOTE:
* Oregon and Alaska voted to legalize recreational marijuana in November 2014
** States that had legislation for medical marijuana signed into effect during 2014
Adverse Childhood Events are…

- Very common
- Hidden by time, shame, social taboos
- Strong predictors of later health risks and diseases
- Leading determinants of the health and social well-being of nation

Three Types of ACEs

**ABUSE**
- Physical
- Emotional
- Sexual

**NEGLECT**
- Physical
- Emotional

**HOUSEHOLD DYSFUNCTION**
- Mental Illness
- Incarcerated Relative
- Mother treated violently
- Substance Abuse
- Divorce
Q & A on the CA AUMA Initiative

• Q: What would be the penalty for violating the new laws?
  • A: The California initiative lays out a range of penalties for violating the proposed marijuana laws, from community service up to possible jail time.
    – Teens nabbed with marijuana will be required to attend drug counseling and complete community service hours
    – Adults caught smoking in public would face a $100 fine
    – Anyone 18 or over who’s caught with more than 1 ounce of marijuana can be fined $500, go to jail for up to six months or both

• Q: What about work? Will workers be able to get in trouble for having marijuana in their system even if it’s legal?
  • A: They might. The initiative states that both public and private employers would still have a right to maintain a “drug and alcohol free workplace.” That means businesses would still be able to make hiring and firing decisions based on marijuana use, just as they can now.

• Q: Won’t this generate a lot of new tax revenue?
  • A: The measure would tax marijuana sales at 15 percent and cultivation at $9.25 per ounce for dry flowers or $2.75 per ounce for leaves. The Legislative Analyst’s Office anticipates revenue from those taxes could top $1 billion annually.
Potential Mechanisms of Benefit of Adult Legalization of MJ

• Parental Incarceration / ACE
  – 50% of the U.S. prison inmate population is being held for drug offenses (98,500)
  – In 2012/2013, 27.6% of drug offenders were locked up for crimes related to marijuana (27,000)
  – BUT only 0.7% of all state inmates were behind bars for just marijuana possession, with many of convicts pleading down from more serious crimes)
  – Only 0.1 percent of all state prisoners were marijuana-possession offenders with no prior sentences

• Reducing parental deaths by lowering lethal opioid overdoses
  – Medical cannabis laws are associated with significantly lower (25% reduction) state-level opioid overdose mortality rates

• By generating tax revenue. CA State Board of Equalization estimate that will generate $1.4 billion per year increase in state revenues were it to legalize marijuana. This will provide an estimated $600 million per year to
Potential Mechanisms of Benefit of Adult Legalization of MJ

• By generating tax revenue (estimated to be $1.4 billion per year)
• This will provide an estimated $600 million per year to the Youth Education, Prevention, Early Intervention, and Treatment Account
  – Construction of community-based youth treatment facilities
  – Prevention and early intervention services
  – Collaboration between CDPH, DHCS and CDE
    • Grants to programs for outreach, education and treatment
    • For homeless youth and out-of-school youth with substance use disorders

http://www.addictionpro.com/article/pot-profits
Resources for MJ Addiction in OC

• OC Links (855-OC LINKS)
• California Youth Services
  http://www.calyouthservices.org/
• Touchstones – Orange Orange, CA 92856
  www.socialmodel.com
• Hoag ASPIRE program (After-School Program Interventions and Resiliency Education)
• Center for Discovery – Newport Beach
• Callers can be potential participants, family members, friends, service providers or individuals seeking out resources

• OC Links is available Monday through Friday between the hours of 8am – 6pm

• To chat live visit: http://ochealthinfo.com/oclinks
## Presidential Candidate MJ Positions

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<tr>
<th>Candidate</th>
<th>+ Medical MJ</th>
<th>+ Legalization</th>
<th>+ Changing Schedule</th>
<th>National vs. State Decision</th>
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<td>Johnson</td>
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<td>YES</td>
<td>YES</td>
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https://www.mpp.org/2016-presidential-candidates/
Synthetic Cannabinoids

- K2, Spice, Black Mamba, Crazy Monkey, Crazy Clown, Dead Man Walking, Funky Monkey, Sexy Monkey, SinX, TenX, Twilight, 3X
  “Not for human consumption”
  Sold thru Internet or head shops
- Bind to CB1, CB2 receptors and sometimes to NMDA receptors
- Case reports of seizures, renal failure, psychosis, anxiety

Rosenbaum et al. (2012), *J Med Toxicol* 8:15-32
Take-Home Points

1. The teen years are a time of tremendous opportunity and risk for the brain

2. The endocannabinoid system is important for maintaining brain health and proper development

3. THC interferes with brain functioning

4. Regular marijuana use in adolescence may have lasting effects on memory and IQ

5. The risk of serious mental illness is 2-7 times greater for those starting marijuana use during adolescence
Resources

• National Institute on Drug Abuse  
  http://www.drugabuse.gov/drugs-abuse/marijuana

• Leslie Green, LICSW, Clinical Social Worker, Shannon Mountain-Ray, LICSW; Boston Children’s Hospital. Marijuana and the Teen Brain: What parents need to known (PPT)

• Christian Thurstone, M.D. University of Colorado; Update on Marijuana  Chapter 4 American Academy of Pediatrics CME presentation