Marijuana and the Teen Brain

David P. Friedman, Ph.D.
“Marijuana’s greatest danger is if a bale of it falls on you.”

Washington Post, September 19, 1990

"But in terms of a direct physical threat to the body, it's probably true that marijuana's greatest danger is if a bale of it falls on you."
Things Have Changed

Published Research
- 7419 citations for marijuana
- 16,516 for cannabinoid
- 11,974 medicinal marijuana

Role of Endocannabinoids
- Brain development
- Neuronal communications
  - Memory
  - Movement
  - Appetite & weight control
  - Pain
  - Attention
- Birth of new neurons in adults
So, Marijuana Is Going to Be Legal

What’s the big deal?
One of the Biggest Risk Factors for Drug Use Is Availability

Repeated use has consequences, especially for the developing brain
The Brain & Behavior

- The brain controls behavior
  - Some actions are automatic
  - Some actions are intentional

- The increasing control over our behavior as we become adults is due to the maturation of our brains

- Adolescence is a critical period for brain development

- Environmental factors play a crucial role
Adolescence Is Long Because Brain Maturation Takes a Long Time

- In childhood, behavior is driven by needs and emotions
- Adult behavior can be driven by rational thought
- The development of this ability takes ~25 years
Control of Emotions Depends on Maturation of Prefrontal Cortex
What Actually Happens as the Brain Matures?
Control of Emotions Depends on Maturation of Prefrontal Cortex
Development of Rational Decision-making

- Age 12 – move from concrete “here-and-now” thinking to abstract thinking
  - visualization of outcomes
  - logical cause and effect analysis
- Age 15 - make sound decisions about hypothetical situations as well as adults
- Yet they take silly risks – what’s that about?
Why Are Teens So Reckless?

- Risky Behavior stimulates the Reward Circuit
  - Feels good now
- Avoiding risks for potential long-term benefit is boring
- Being able to put off pleasure for long-term benefit comes with brain maturation
Teen Brains Are Volatile

- Increased estrogen and testosterone provoke brain maturation
  - But, they lead to emotional volatility and impulsivity
- Reward circuit is “hot” during adolescence
  - Drugs, sex and Rock ‘n Roll
Activation of the Reward Pathway Makes Us Feel Good!

VTA neurons release Dopamine in the nucleus Accumbens & prefrontal cortex
Activation of the Prefrontal Cortex Is Booooring

“Are you sure you want to do that?”
Adolescence: A Mismatch Between the Immediacy of Intense Emotion & the Effort of Rational Decision-making
Prefrontal Areas More Used by Adults in Decision-making
Quiz:
Who First Figured Out When the Brain Is Fully Mature?

1. Neuroscientists — using brain imaging
2. DMV — lets you drive
3. Board of Elections — lets you vote
4. The Army — lets you enlist
5. State liquor control board — lets you drink
6. Actuaries at rental car companies — let you rent a car
So, What does all that have to do with marijuana laws?
Marijuana Affects Much of the Brain

Cannabinoid Receptor
Endogenous Cannabinoids Affect Fundamental Brain Processes

- Guide development of the nervous system
- Modulate communications between neurons
  - Strengthen or weaken connections
- Encourage new neuron formation
Chronic Marijuana Use Leads to Cognitive Impairments

- Impaired short-term memory
- Impaired episodic memory
- Impaired attention
- Impaired executive function
  - Difficulty with complex tasks
  - Impaired decision-making
  - Impaired learning
- Risk of psychosis in vulnerable individuals
The Brain is Uniquely Vulnerable During Adolescence

- Early Use is associated with the most significant impairments

Persistent cannabis users show neuropsychological decline from childhood to midlife

Marijuana Use Alters Cortical Thickness
Conclusions

- Adolescence is a critical period of brain development
  - Development is modified by the environment
- Adolescents are prone to risk taking
  - Delayed development of prefrontal cortex
- Marijuana use has profound effects on brain development
- Protecting adolescents from marijuana use is crucial