

Marijuana and the Teen Brain



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**“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

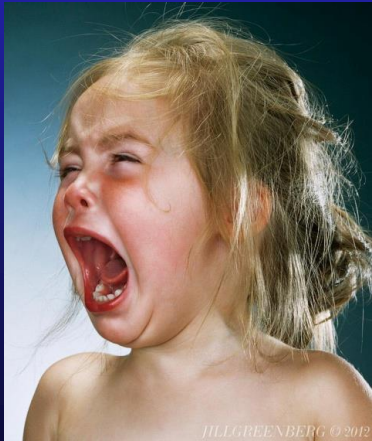
Repeated use has consequences, especially for the developing brain

The Brain & Behavior

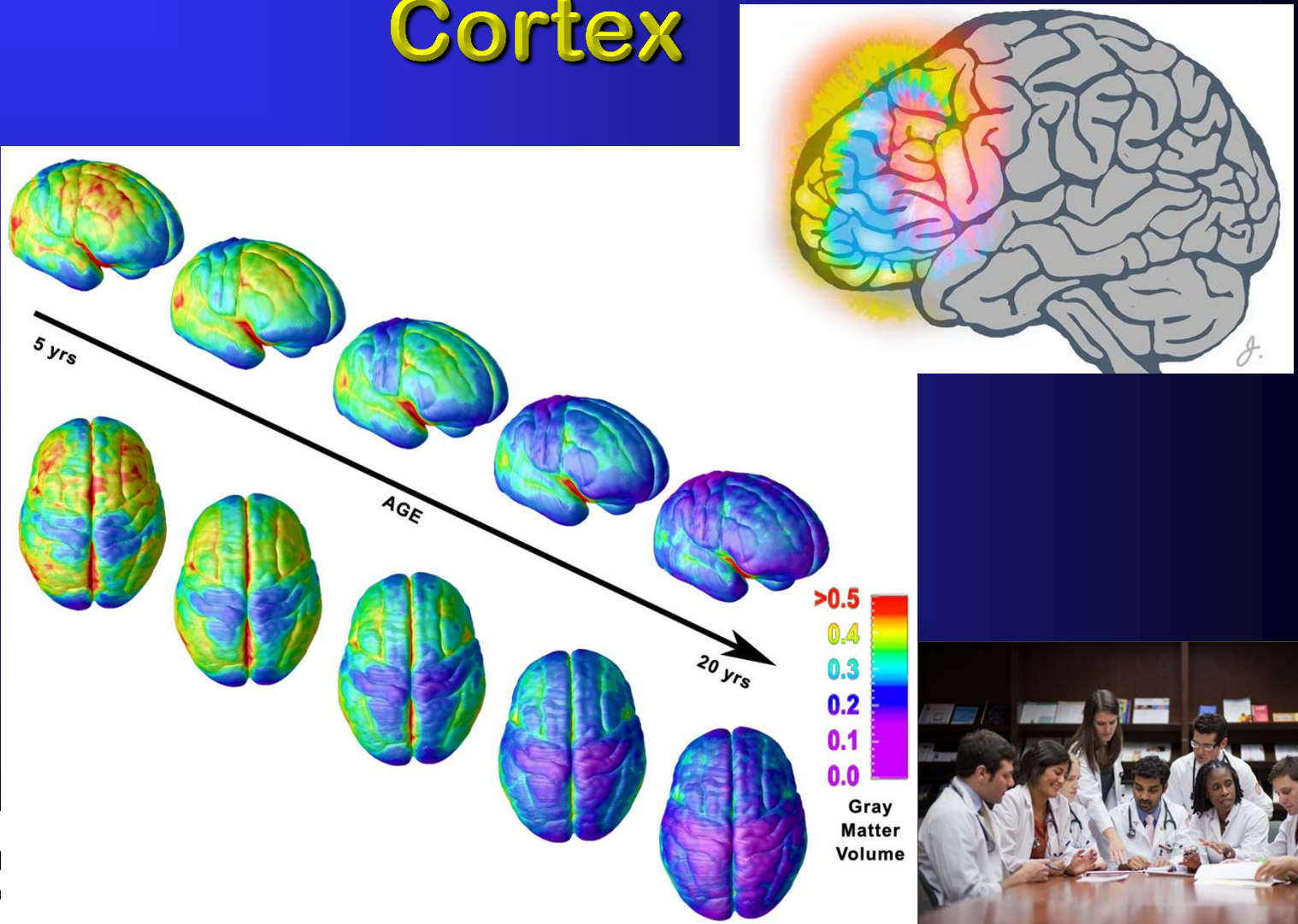
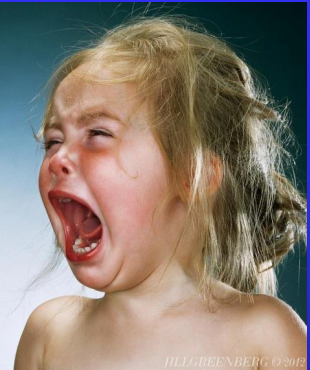
- The brain controls behavior
 - ◆ Some actions are automatic
 - ◆ Some actions are intentional
- The increasing control over our behavior as we become adults is due to the maturation of our brains
- Adolescence is a critical period for brain development
- Environmental factors play a crucial role

Adolescence Is Long Because Brain Maturation Takes a Long Time

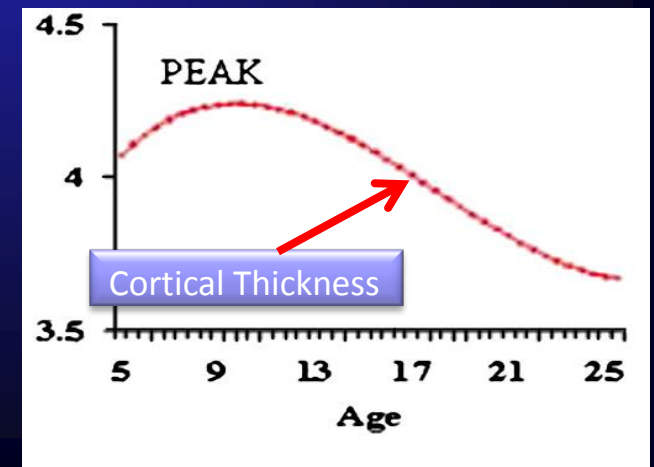
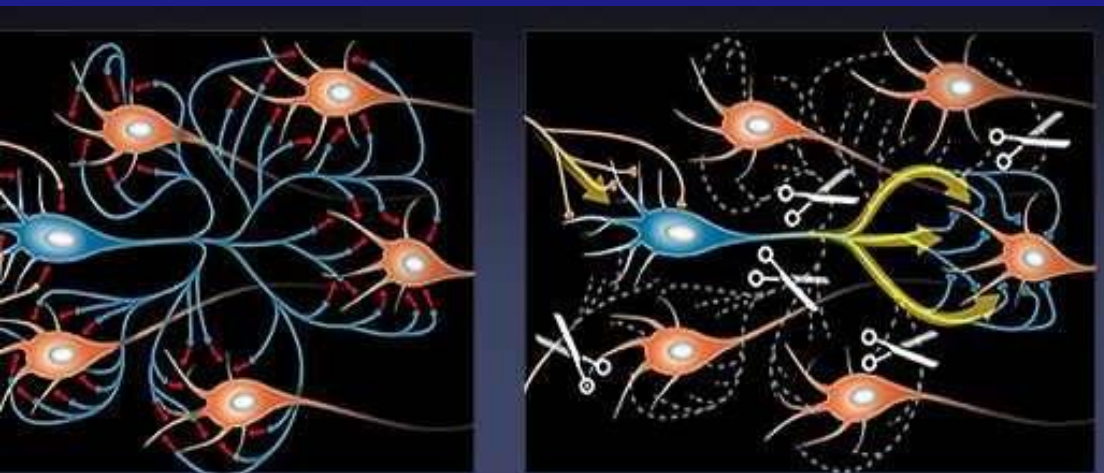
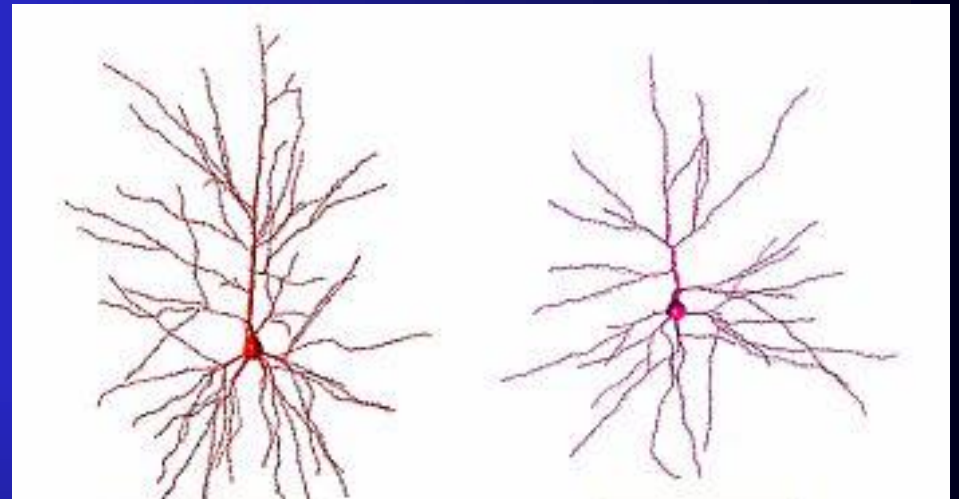
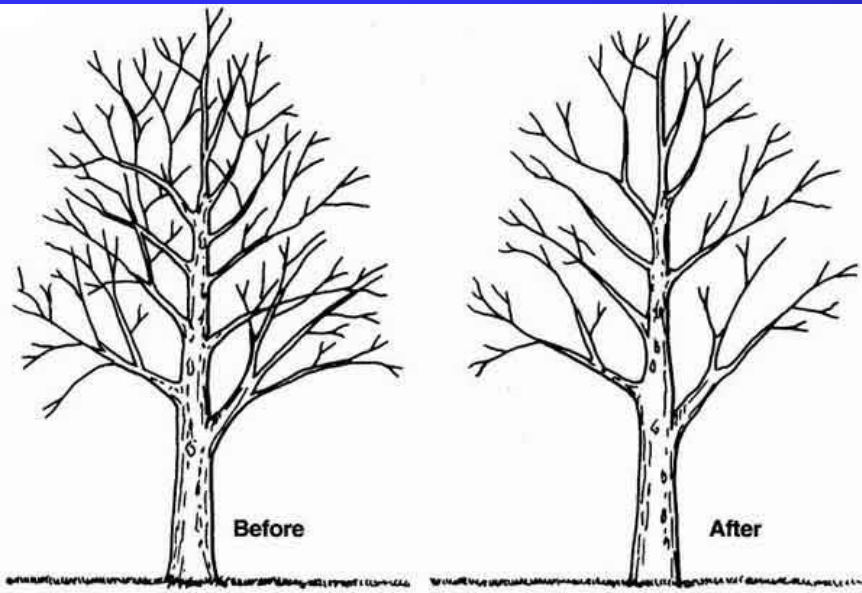
- In childhood, behavior is driven by needs and emotions
- Adult behavior can be driven by rational thought
- The development of this ability takes ~25 years



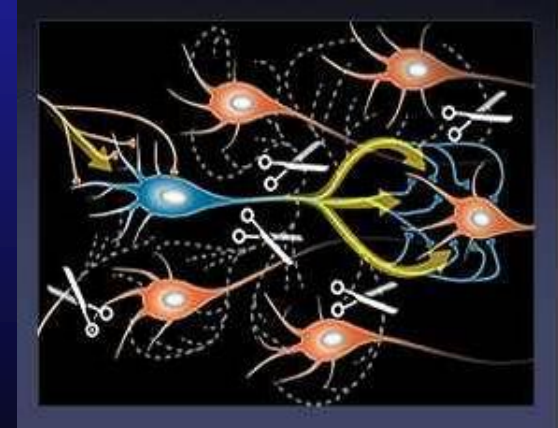
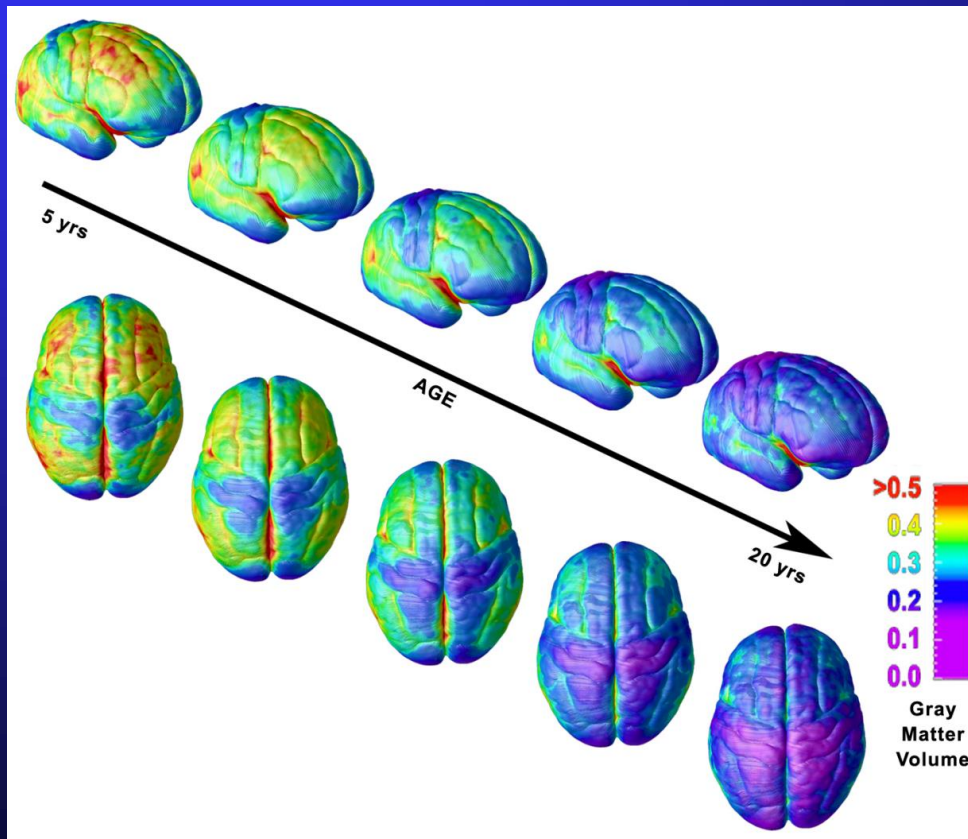
Control of Emotions Depends on Maturation of Prefrontal Cortex



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?

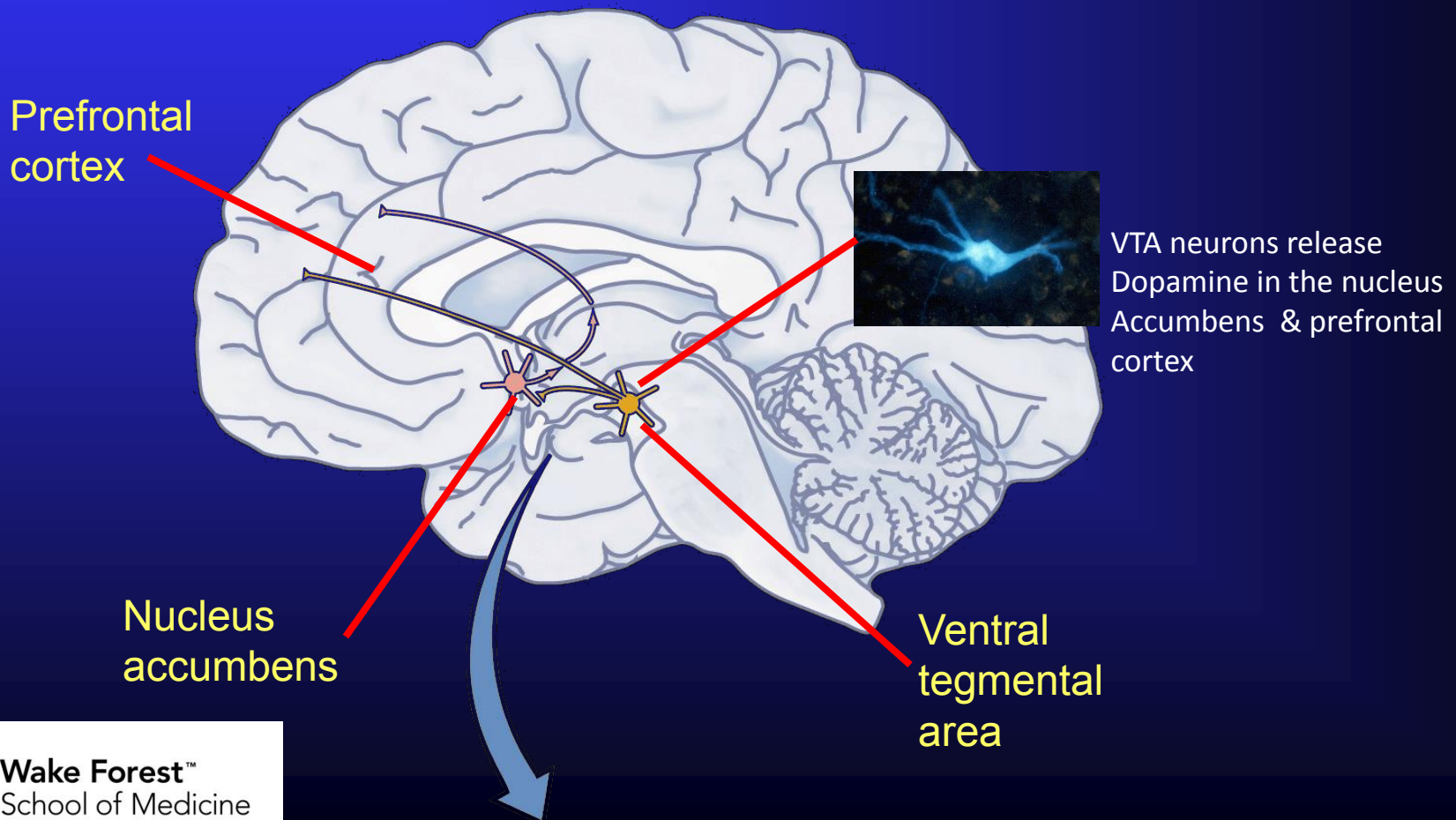
- Risky Behavior stimulates the Reward Circuit
 - ◆ Feels good now
- Avoiding risks for potential long-term benefit is boring
- Being able to put off pleasure for long-term benefit comes with brain maturation

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

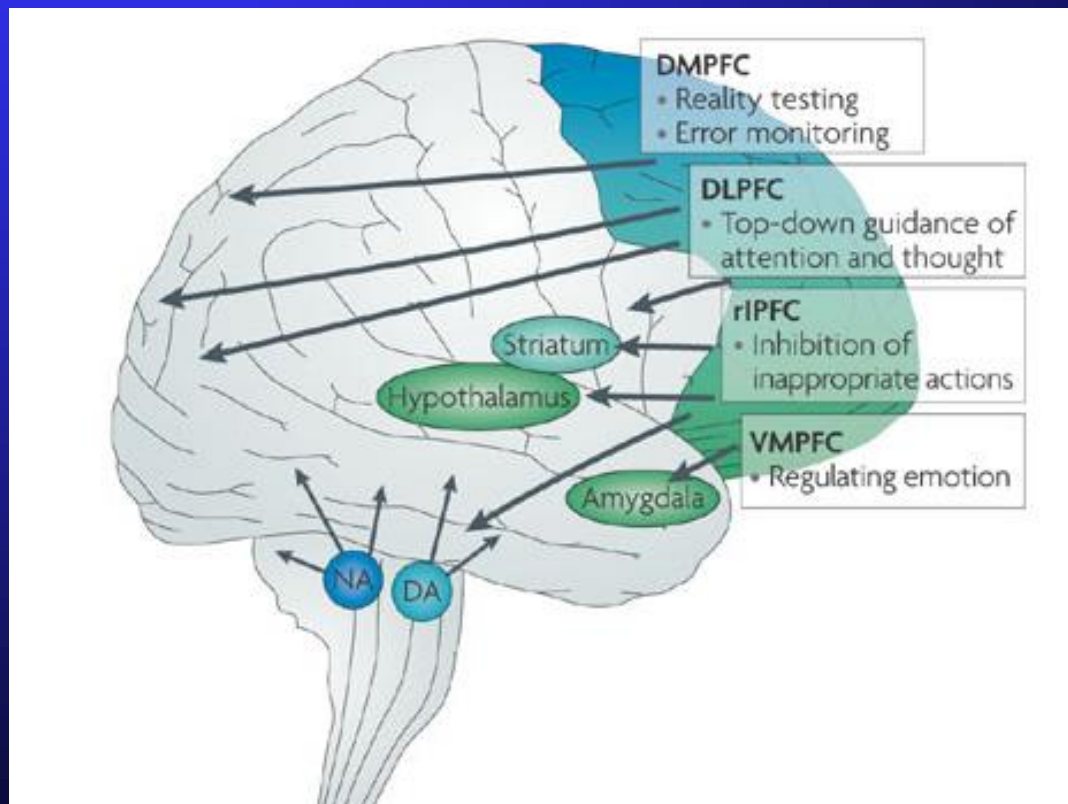


Activation of the Reward Pathway Makes Us Feel Good!

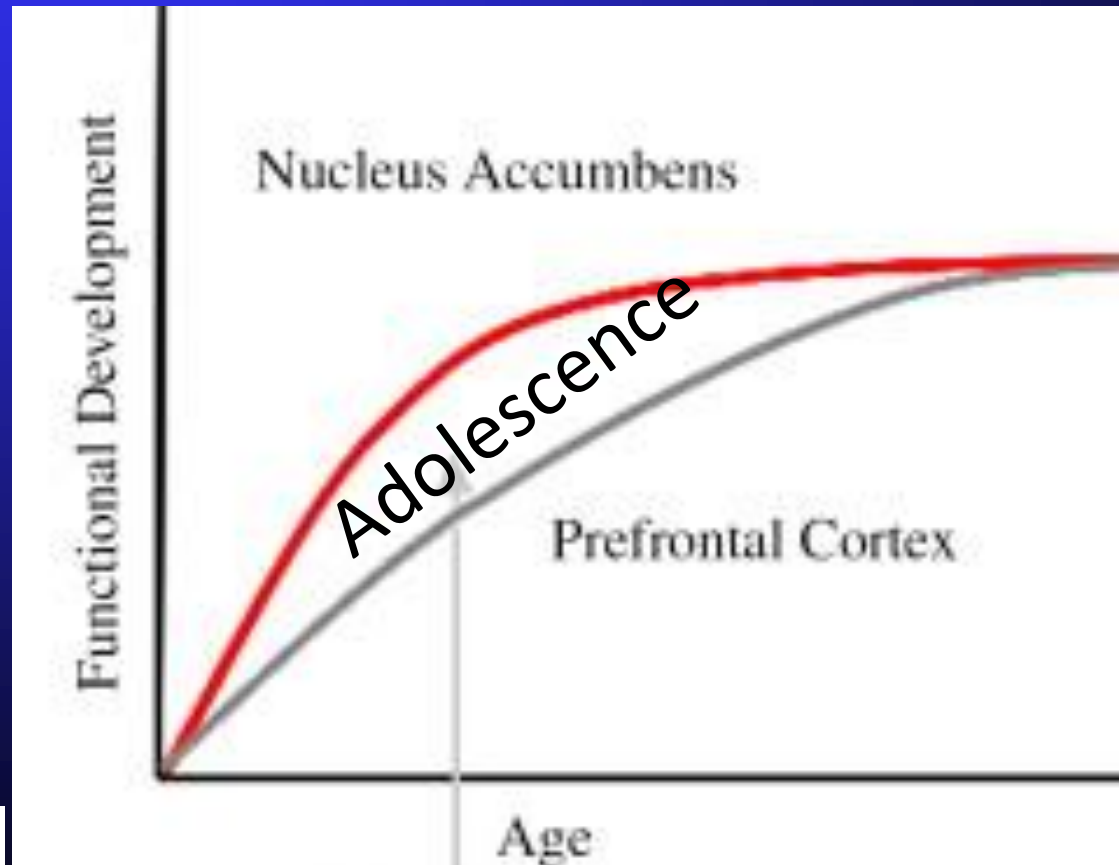


Activation of the Prefrontal Cortex Is Booooring

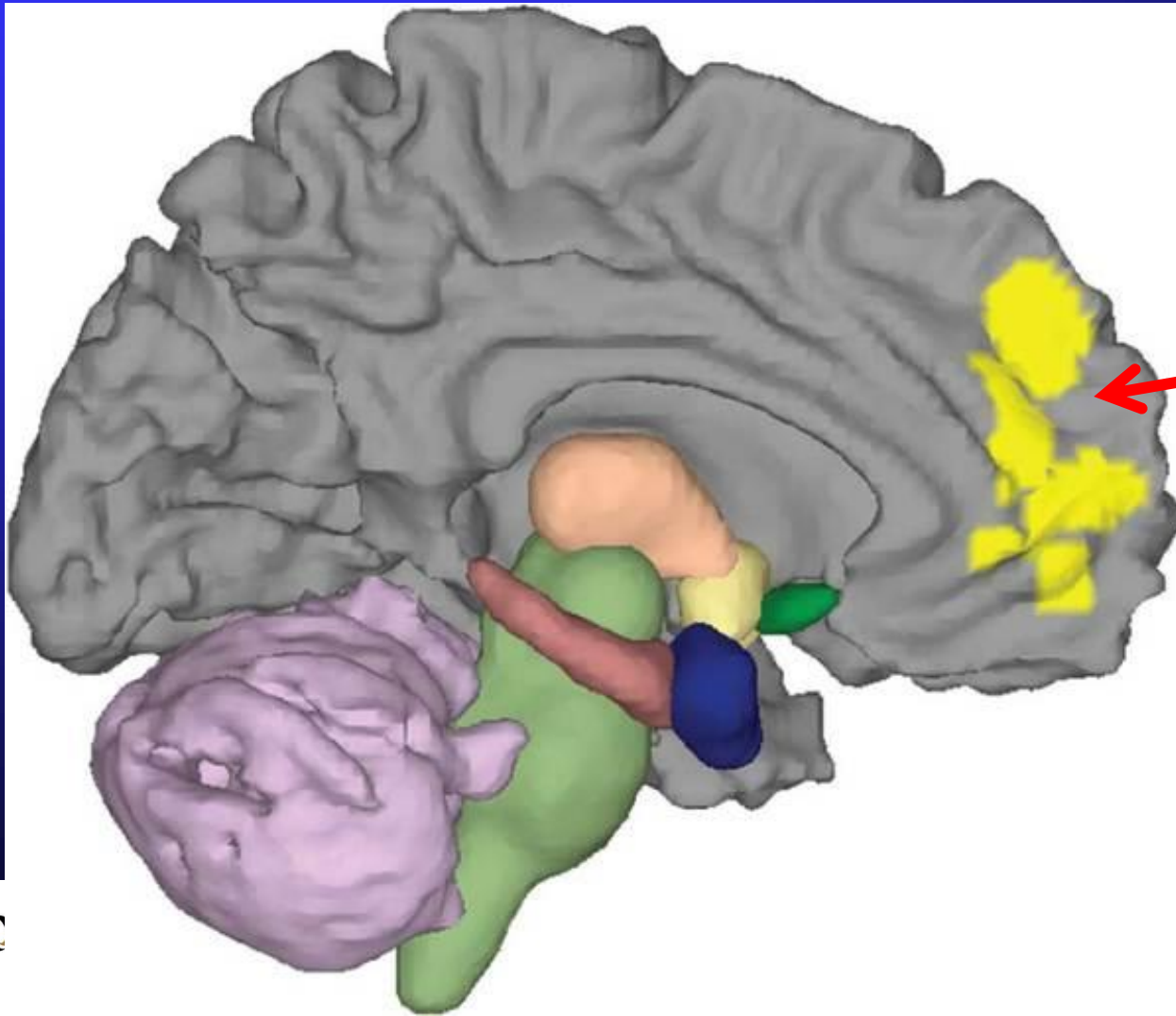
“Are you sure you want to do that?”



Adolescence: A Mismatch Between the Immediacy of Intense Emotion & the Effort of Rational Decision-making



Prefrontal Areas More Used by Adults in Decision-making



Emotional
Regulation

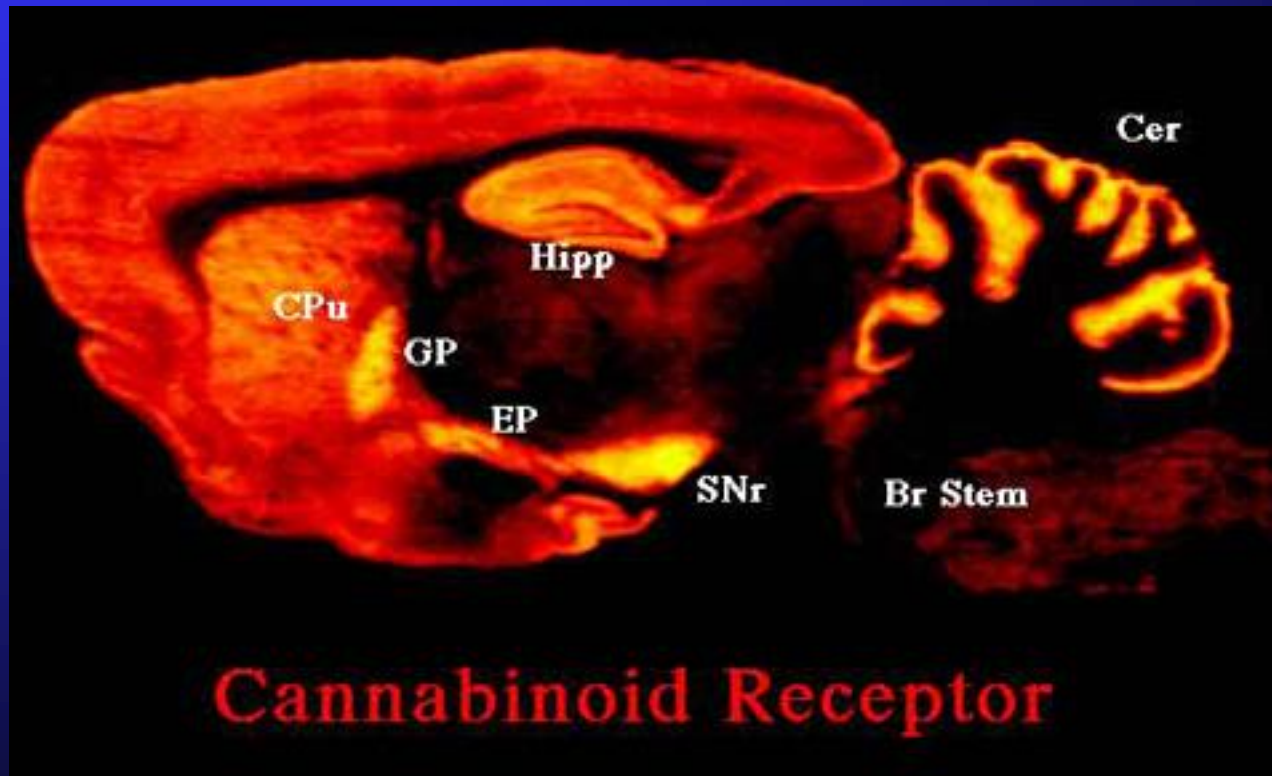
Quiz:

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



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

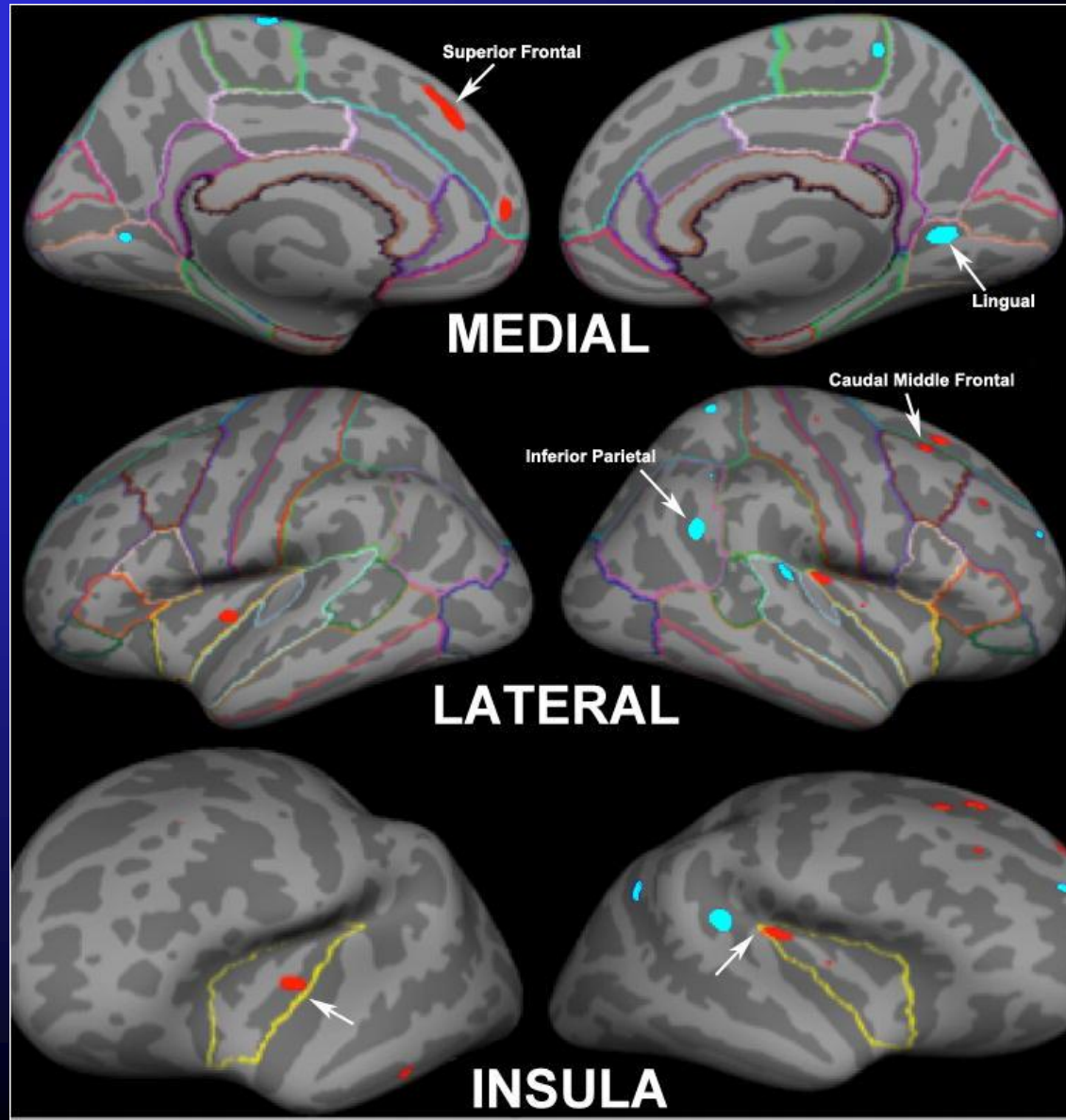
The Brain is Uniquely Vulnerable During Adolescence

- Early Use is associated with the most significant impairments

Persistent cannabis users show neuropsychological decline from childhood to midlife

Madeline H. Meier et al Proceedings of the National Academy of Sciences 109: E2657–E2664, 2012

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