

# This is Your Brain on Adolescence

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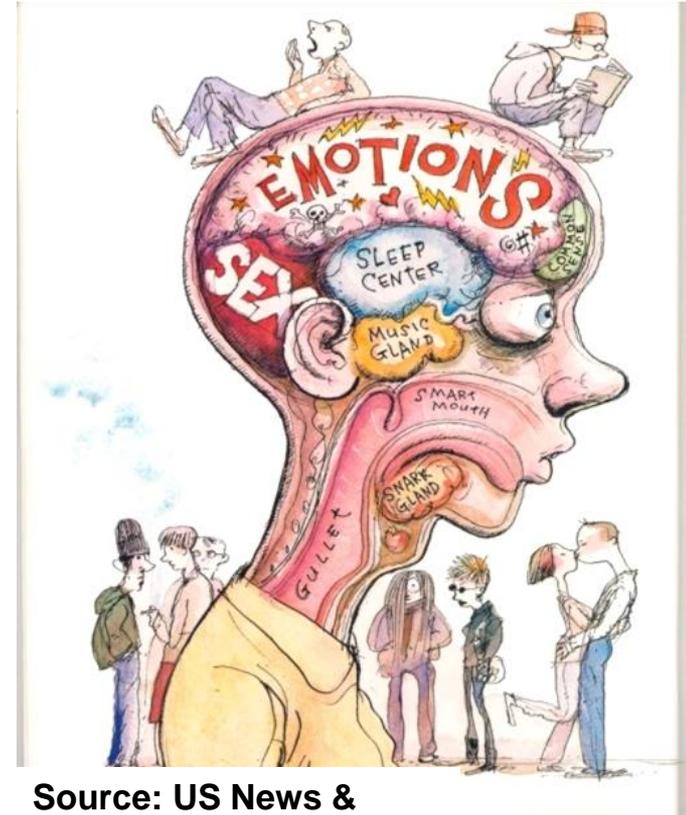
&

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International Society of Substance Use  
Professionals

Webinar, February 20, 2020



Source: US News &  
World Report, 2005

# **Professional Disclosures**

**None to report**

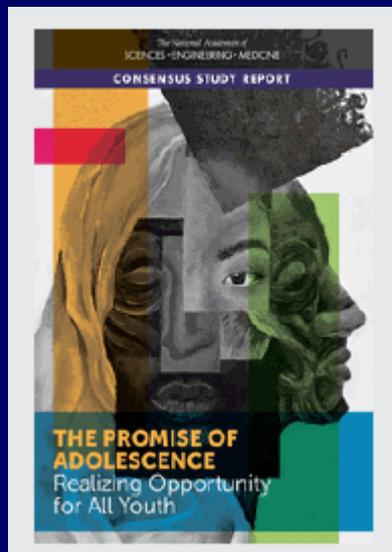
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MEDICINE

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# Website

- <https://www.unicef-irc.org/adolescent-brain>

**ADOLESCENT BRAINS ARE SENSITIVE TO STRESSORS**

**BIOLOGICAL**  
ADOLESCENTS EXPERIENCE PHYSICAL CHALLENGES TO NEUROBIOLOGICAL DEVELOPMENT

**POPULATION**  
ADOLESCENTS CAN BE MOST SUSCEPTIBLE TO STRESSORS DURING THIS PERIOD

**SOCIAL**  
ADOLESCENTS FACE OPPORTUNITIES TO DEVELOP POSITIVE TRAJECTORIES AND AVOID NEGATIVE ONES

**PROMPT RESPONSE**

**SUPPORTING ADOLESCENTS TO COPE WITH STRESS IS A UNIQUE OPPORTUNITY FOR HEALTH AND WELL-BEING**

**STRESS MANAGEMENT**

**DOWNLOAD**  
"THE ADOLESCENT BRAIN: A SECOND WINDOW OF OPPORTUNITY"  
[WWW.UNICEF-IRC.ORG/ADOLESCENT-BRAIN](http://WWW.UNICEF-IRC.ORG/ADOLESCENT-BRAIN)

**THE ADOLESCENT BRAIN: A SECOND WINDOW OF OPPORTUNITY**

**EARLY ADOLESCENCE IS A TIME OF RAPID LEARNING AND BRAIN DEVELOPMENT**

**A PERIOD OF VULNERABILITY AND OPPORTUNITY**

THESE INCLUDE INCREASES IN SENSATION-SEEKING, MOTIVATION FOR SOCIAL RELATIONS AND SENSITIVITY TO SOCIAL EVALUATION.

PUBERTY INITIATES INTENSE LEARNING & BRAIN DEVELOPMENT, WHICH LEAD TO STRUCTURAL REMODELING AND NEURAL RE-CONFIGURATION OF KEY BRAIN SYSTEMS. IT'S A CRUCIAL TIME TO INVEST IN ADOLESCENTS.

**WINDOWS OF OPPORTUNITY**

FIRST: 0-3  
SECOND: 9-14

**LEARNING AND BRAIN DEVELOPMENT**

**DOWNLOAD**  
"THE ADOLESCENT BRAIN: A SECOND WINDOW OF OPPORTUNITY"  
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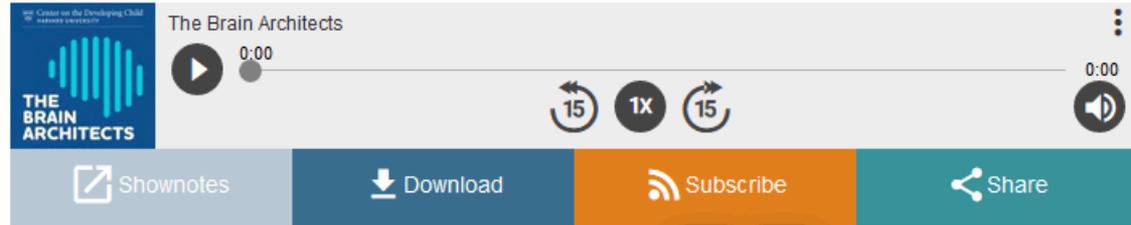
**POSITIVE AND NEGATIVE SPIRALS DURING ADOLESCENT BRAIN DEVELOPMENT**

THE ADOLESCENT BRAIN NEEDS SUPPORT TO CREATE POSITIVE SPIRALS, AVOIDING NEGATIVE TRAJECTORIES

**DOWNLOAD**  
"THE ADOLESCENT BRAIN: A SECOND WINDOW OF OPPORTUNITY"  
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# Podcast Series

- Harvard's Center on the Developing Child on the new podcast series, *The Brain Architects*



- “Learn the science behind how brains are built and what it means how to build a strong brain.”
- <https://developingchild.harvard.edu/science/key-concepts/brain-architecture/>

# YouTube Video

<https://youtu.be/6zVS8HIPUng>  
Sarah-Jayne Blakemore's Ted Talk:  
*The mysterious workings of the  
adolescent brain*



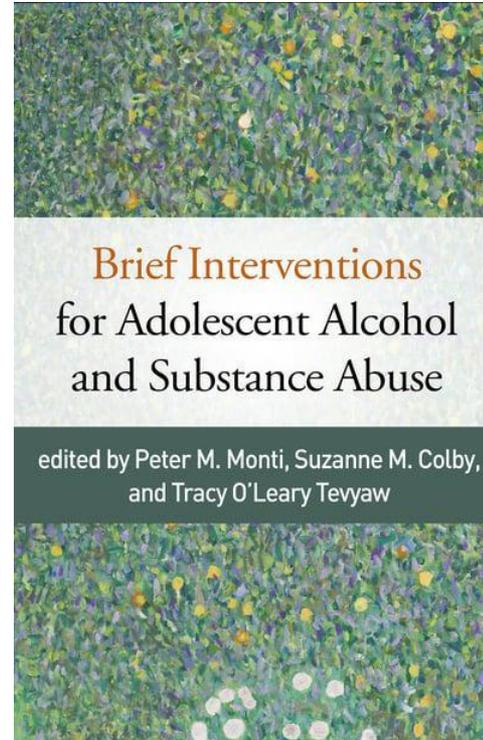
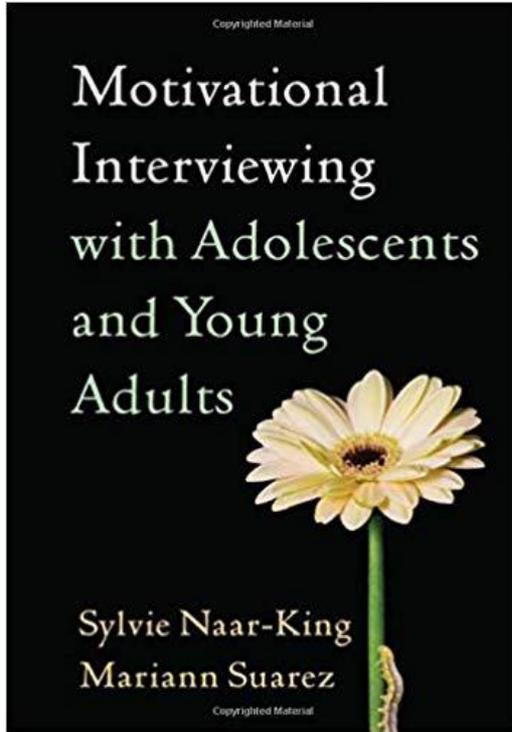
# **Publication on the Intersection of Brain Development and Treatment**

**Wetherill, R., & Tapert, S. F. (2013). Adolescent brain development, substance use, and psychotherapeutic change. *Psychology of Addictive Behaviors*, 27(2), 393–402.**

**<https://doi.org/10.1037/a0029111>**

# Recent “Treatment” Publications

(that integrate teen brain development)



# Teen Brain Development Quiz



- 1. There are several health indices suggesting that teenagers take less risk than in years past. T or F ?**
- 2. What lifestyle choices during adolescence promote good brain development?**
- 3. Which is more harmful to the developing brain?**
  - a. Chronic, heavy use of marijuana?**
  - b. Chronic, heavy drinking?**

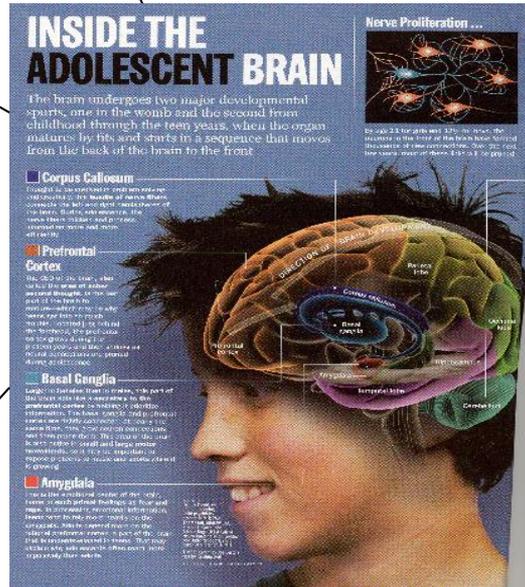


# I. Overview of brain development

## IV. Summary

## III. Youth Serving Workers

## II. Developing brain: drug use, mental health, early experiences



# Possible Sources of Confounds when Interpreting Studies on Brain Development and Health



1. Confirmation bias
2. Small sample sizes
3. Too small a time window
4. Community-level vs. individual-level data
5. Direct links between brain functions and structures and human behavior are problematic



# Possible Sources of Confounds when Interpreting Studies on Brain Development and Health



- One more introductory note about this talk: My “spotlight” on brain development and its impact on adolescent behavior and health does not diminish the impact of environment and social determinants on adolescent behavior.
- I will be integrating into today’s discussion the important role of non-biological influences.



# Major Points from My Talk



- 1. The maturation of the adolescent brain likely contributes to behaviors that are characteristic of this developmental period.**
- 2. This maturation also informs our understanding of risk for substance use disorders and other behavioral disorders.**
- 3. Youth serving workers & educators can leverage teen brain science when working with adolescents and parents.**

# Major Points from My Talk



1. The maturation of the adolescent brain likely contributes to behaviors that are characteristic of this developmental period.
2. This maturation also informs our understanding of risk for substance use disorders and other behavioral disorders.

## 3. Youth serving workers & educators can leverage teen brain science when working with adolescents and parents.

- i. teaching youth about brain development
- ii. use evidenced-based prevention programs
- iii. treat teen behavioral disorders as early as possible
- iv. use evidence-based treatment programs
- v. increase youth "cannabis and vaping IQ"
- vi. educate parents



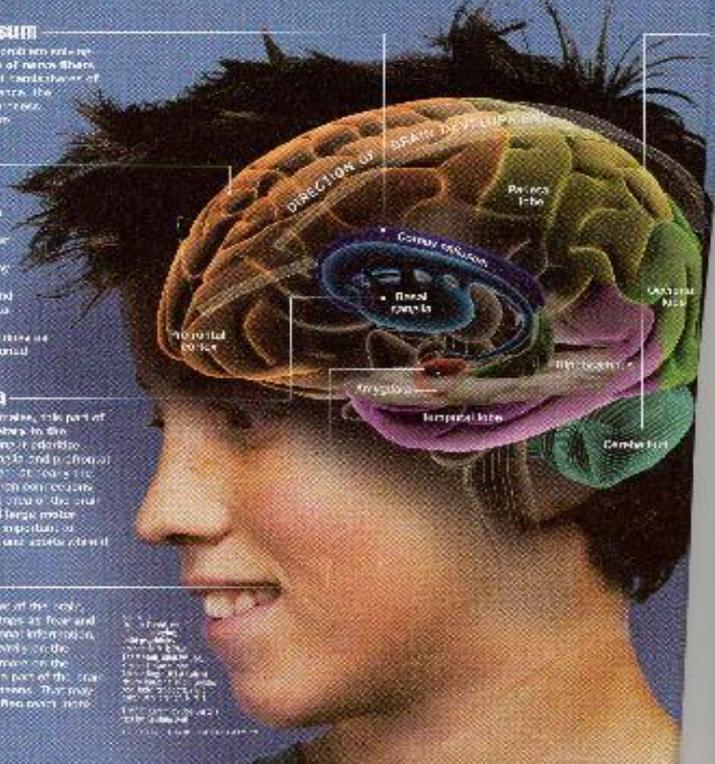
- Based on research by neuroscientists, brain maturation continues through adolescence, until approx. age 25

# INSIDE THE ADOLESCENT BRAIN

The brain undergoes two major developmental spurts, one in the womb and the second from childhood through the teen years, when the organ matures by fits and starts in a sequence that moves from the back of the brain to the front.



**Nerve Proliferation ...**  
By age 25, for all but 1% of them, the neurons in the front of the brain have formed the axons of new connections. One 3D model shows a mass of them. It is 1.5 cm high.



**Corpus Callosum**  
Thought is an electrical signal that travels through the bundles of nerve fibers that connect the left and right hemispheres of the brain. During adolescence, the nerve fibers thicken and become more numerous, and they will rarely.

**Prefrontal Cortex**  
The CEO of the brain, also called the seat of higher-order thought, is the last part of the brain to mature. It is the seat of the brain's executive functions, including the ability to plan, to solve problems, to control impulses, and to regulate emotions. It is the last part of the brain to mature, and it is the last part of the brain to be fully developed.

**Basal Ganglia**  
Largest in the brain, it is the seat of the brain's motor system. It is the seat of the brain's motor system, and it is the seat of the brain's motor system. It is the seat of the brain's motor system, and it is the seat of the brain's motor system.

**Amygdala**  
One of the most important parts of the brain, it is the seat of the brain's emotional system. It is the seat of the brain's emotional system, and it is the seat of the brain's emotional system.

**Other Labels:** DIRECTOR OF BRAIN DEVELOPMENT, Prefrontal Cortex, Corpus Callosum, Basal Ganglia, Amygdala, Hippocampus, Temporal Lobe, Cerebellum, Corpus Callosum, Prefrontal Cortex, Amygdala, Hippocampus, Temporal Lobe, Cerebellum.

# **A Developing Brain = Less Brakes on the “Go” System**

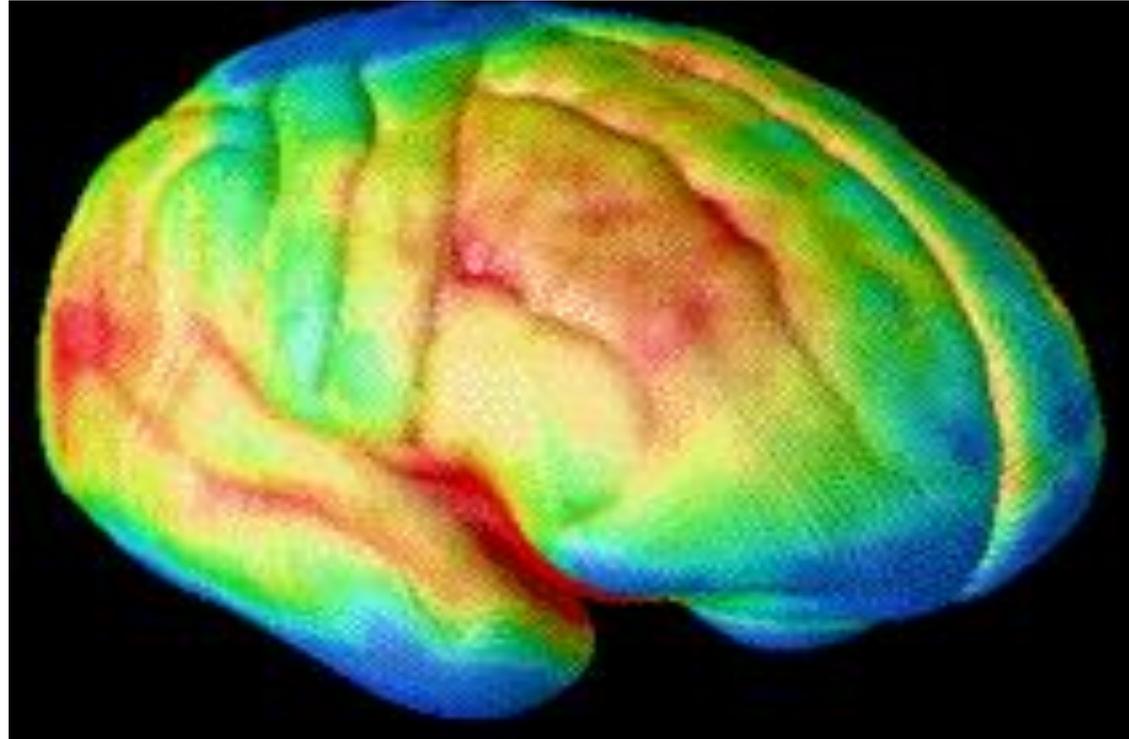


# Maturation Occurs from Back to Front of the Brain and Inside to Outside

Images of Brain Development in Healthy Youth  
(Ages 5 – 20)

**Frontal: later  
(judgment)**

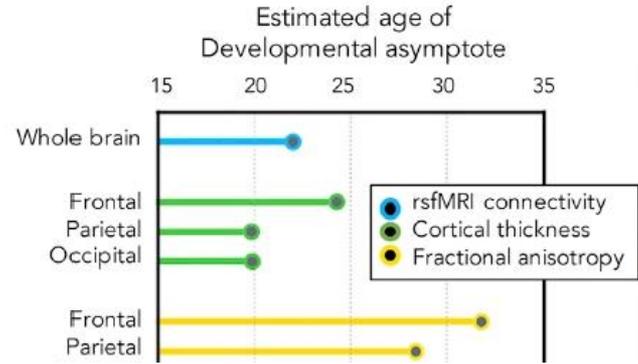
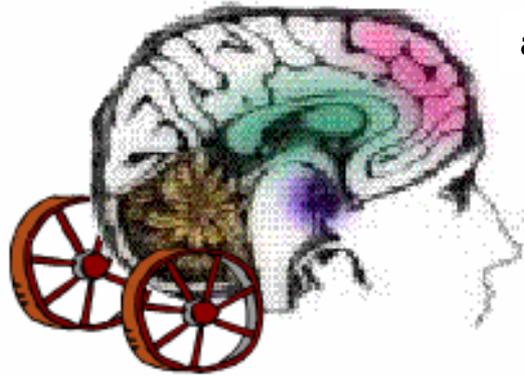
**Limbic: earlier  
(emotion, motivation)**



**Blue represents maturing of brain areas**

*Source: PHAS USA 2004 May 25; 101(21): 8174-8179. Epub 2004 May 17.*

- **During adolescent brain development, the brain is not functioning at full and optimal capacity.**



adapted from Somerville, 2016

# Implications of Brain Development for Adolescent Behavior

(Winters et al., 1995)



- **Preference for ....**
  1. **physical activity**
  2. **high excitement and rewarding activities**
  3. **activities with peers that trigger high intensity/arousal**
  4. **novelty**
- **Less than optimal..**
  5. **control of emotions**
  6. **consideration of negative consequences**
- **Greater tendency to...**
  7. **be overly attentive to social information**
  8. **take risks**

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**Contributors for  
unhealthy or unwise risk?**

# Implications of Brain Development for Adolescent Behavior

(Winters et al., 1995)



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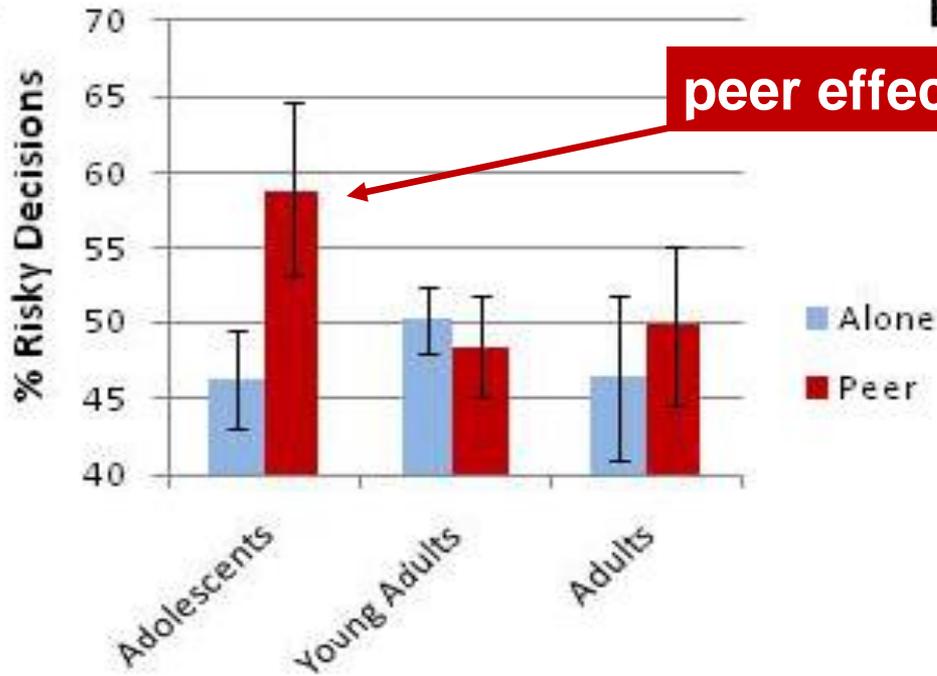
**Contributors for healthy  
or personal growth?**

# **Risk-Taking – Context Matters!**

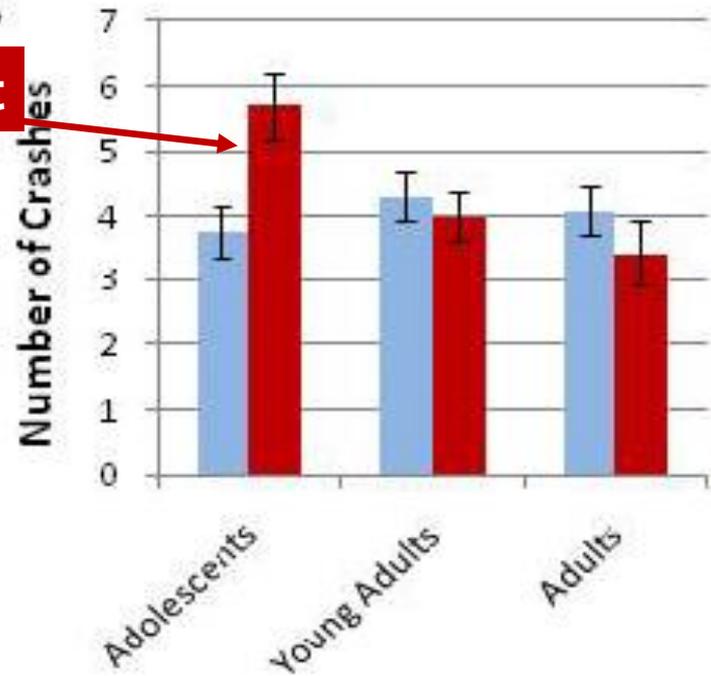
- **Based on science of brain development, a modern view of risk taking in adolescence is...**
  - **evolutionarily adaptive**
  - **normative; important to development**
  - **significant individual differences**
  - **is due primarily to emotional and contextual, not cognitive, factors**

# Impact of Peer Presence on Risky Driving in Simulated Context

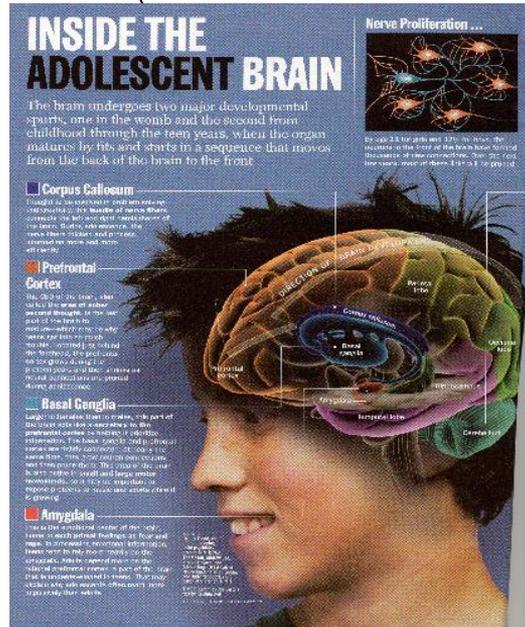
A



B



# I. Brain development



# II. Developing brain: drug use, mental health, early experiences

# i. Developing brain and drugs

## INSIDE THE ADOLESCENT BRAIN

The brain undergoes two major developmental spurts, one in the womb and the second from childhood through the teen years, when the organ matures by fits and starts in a sequence that moves from the back of the brain to the front.

### Nerve Proliferation ...



By age 23, the brain has 12% to 15% more neurons in the front of the brain than formed throughout the course of new neurogenesis. Over the next few years, most of these cells will be pruned.

### ■ Corpus Callosum

Thought to be involved in emotion and memory, the corpus callosum, the bundle of nerve fibers connecting the left and right hemispheres of the brain, thins and narrows, the nerve fibers mature and pruned, around age 16 and more all the way.

### ■ Prefrontal Cortex

The CEO of the brain, what makes the area of other second thought, is the last part of the brain to mature, which may be why teenagers are so much more likely to get into trouble. The prefrontal cortex continues to develop through the mid-20s and then, a time when frontal structures are pruned during adolescence.

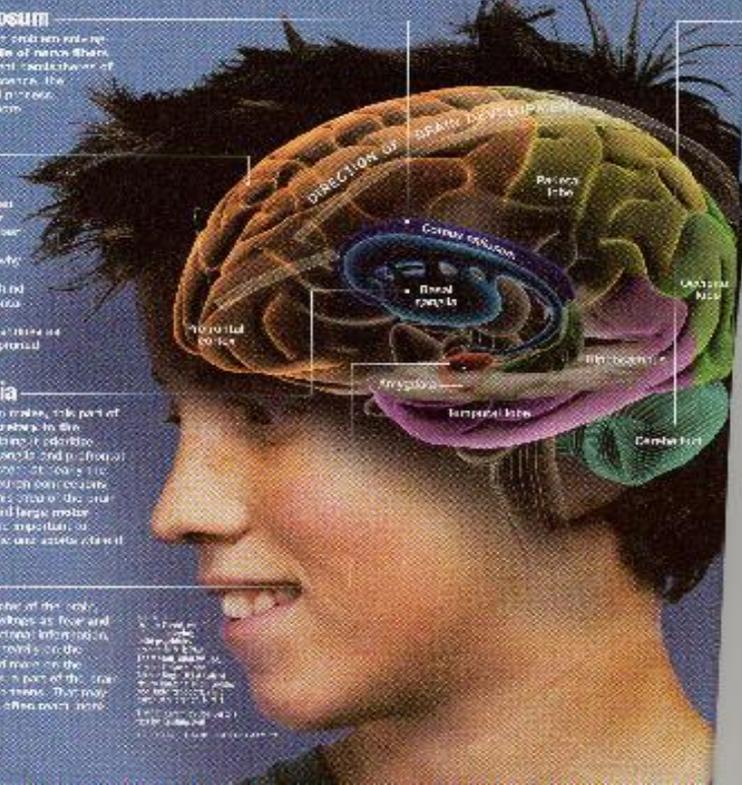
### ■ Basal Ganglia

Larger in females than in males, this part of the brain acts like a switchboard in the prefrontal cortex, to receive and distribute information. The basal ganglia and prefrontal cortex are highly connected. At least the same time, they do the rough work, creating and maintaining them. The structure of the basal ganglia, small and large motor neurons, so it's the accumulation of response blocks at these sites that is critical to growth.

### ■ Amygdala

It's the emotional center of the body, home to such primal feelings as love and rage. It processes or receives information, feeds into the motor cortex on the cerebral cortex, which is spread across the lateral cerebral cortex, a part of the brain that is responsible for thought. They may also be involved with emotions, often being more responsible than others.

Source:   
N. S. Grayson,   
"The Adolescent   
Brain,"   
Journal of   
Neuroscience,   
2004, 24(18):   
4403-4411.   
© 2004 Society   
for Neuroscience   
0270-6474/04/244403-09\$15.00/0

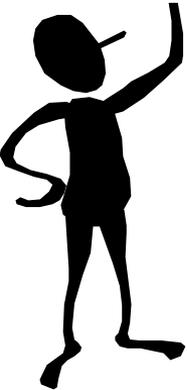


# **Implications of Brain Development for Drug Abuse Vulnerability**

**Are adolescents more susceptible than adults to drugs?**

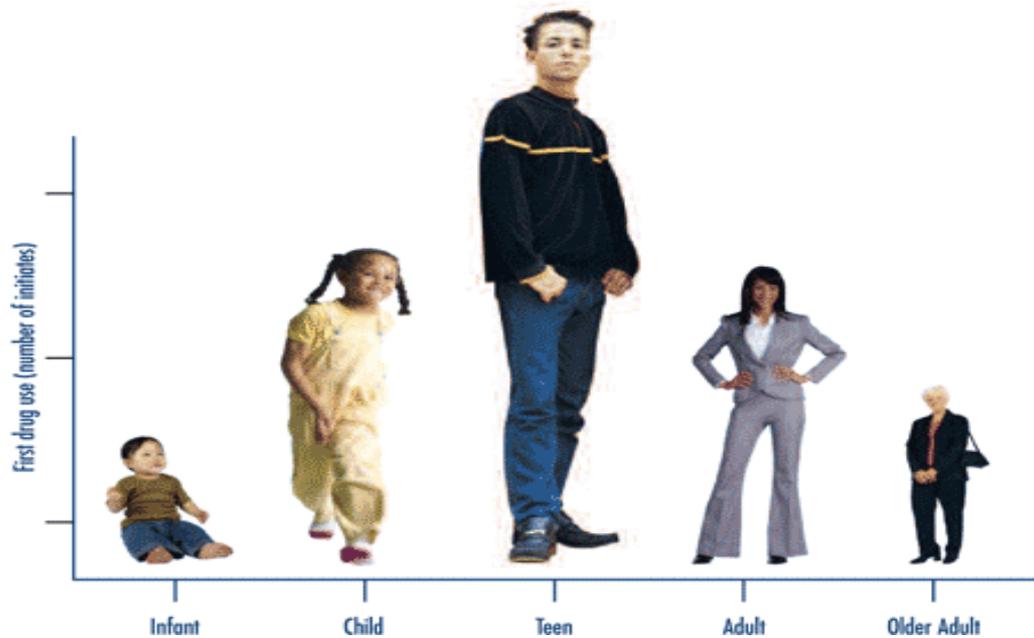
**Several lines of evidence  
(acknowledgement to Linda Spear, Ph.D.)**

**Unethical to give human adolescents alcohol in the laboratory;  
much of the best evidence comes from adolescent rat studies.**

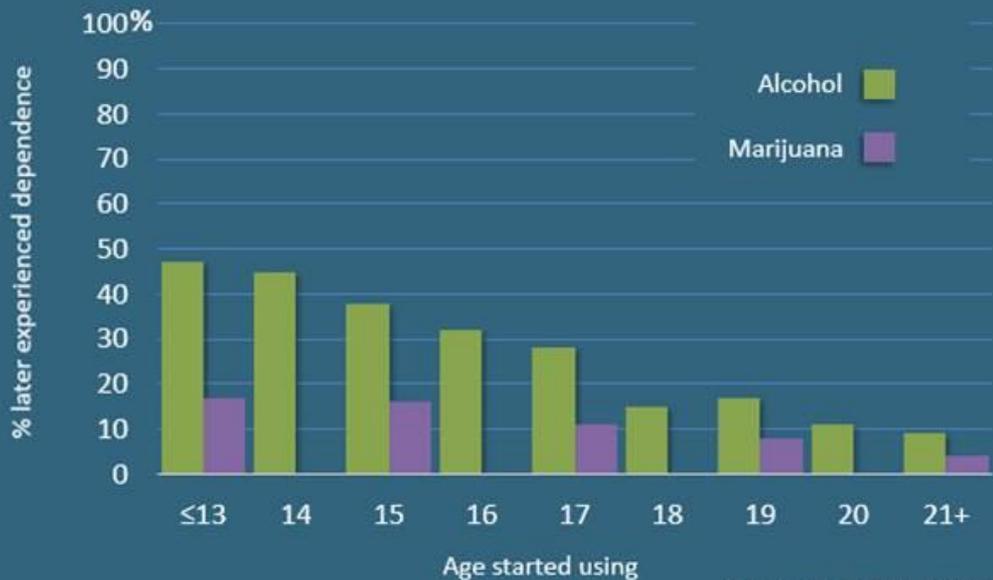


# Evidence from epidemiological studies

Drug use starts early and peaks in the teen years



## Age at substance use onset and later addiction



# Implications of Brain Development for Drug Abuse Vulnerability

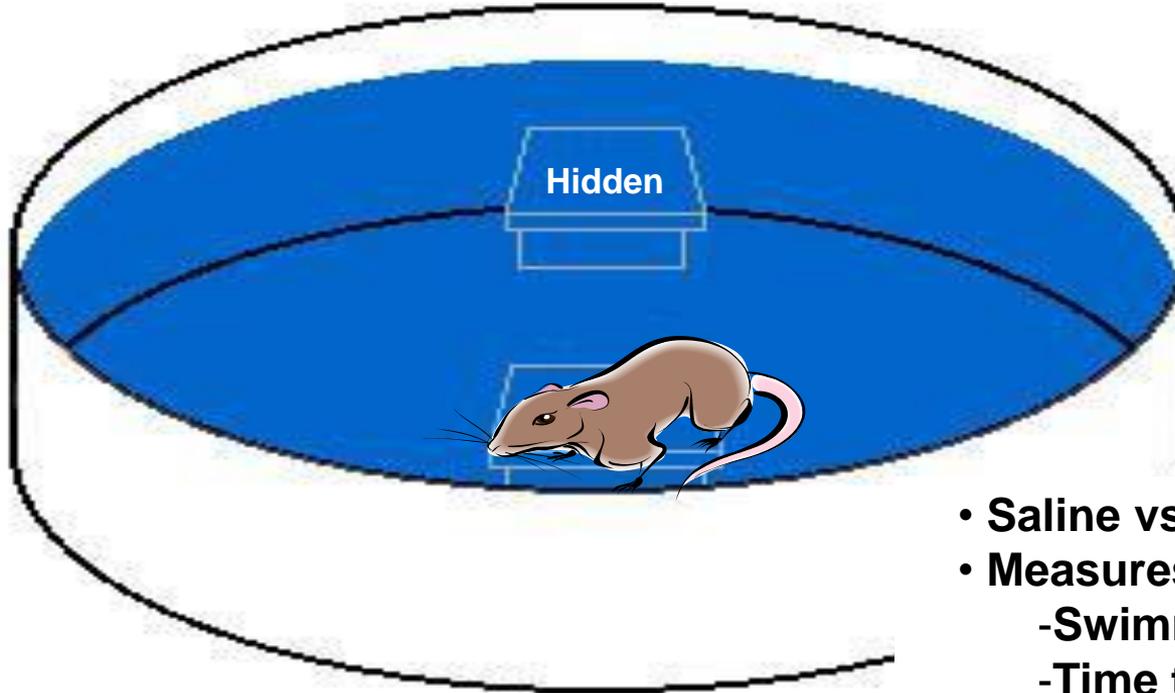
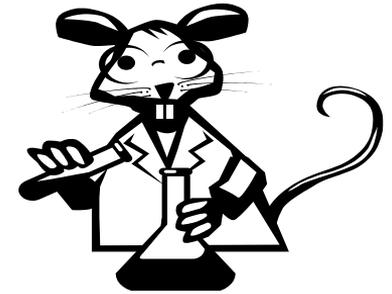
# Alcohol



# Are adolescents more susceptible to alcohol than adults?

1. Adolescent mice are less sensitive to the sedative and motor impairment effects of intoxication.
2. Adolescent rats are more sensitive to the social disinhibition effects of alcohol.

# The Water Maze Test



- Saline vs alcohol
- Measures
  - Swimming speed
  - Time to find platform

# Are adolescents more susceptible to alcohol than adults?

1. Adolescent mice are less sensitive to the sedative and motor impairment effects of intoxication.
2. Adolescent mice are more sensitive to the social disinhibition effects of alcohol.

**#2** and **#3** : May contribute to **binge drinking** and increased risk to **alcohol dependence**.

**Wanna look  
for some cheese  
with me?**

**Sure!**





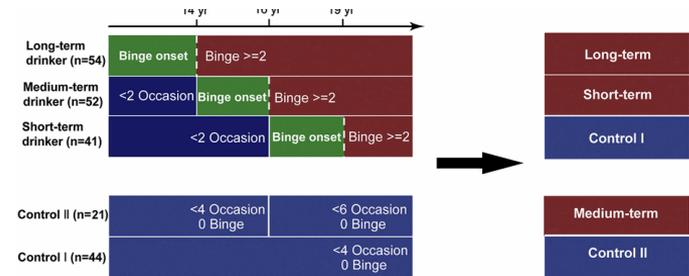
# Impact of Binge Drinking

Adolescent binge drinking disrupts normal trajectories of brain functional organization and personality maturation

Ruan et al., 2019



- Longitudinal design; assessed at ages 14, 16 and 19
- Accumulating effect of binge drinking....
  - Neuroimaging data: disruption in the maturation of frontal connectivity (caution: small sample with neuroimaging data at baseline)
  - Personality data: slower developmental improvement of impulse control



**Implications of Brain Development for Drug Abuse Vulnerability**

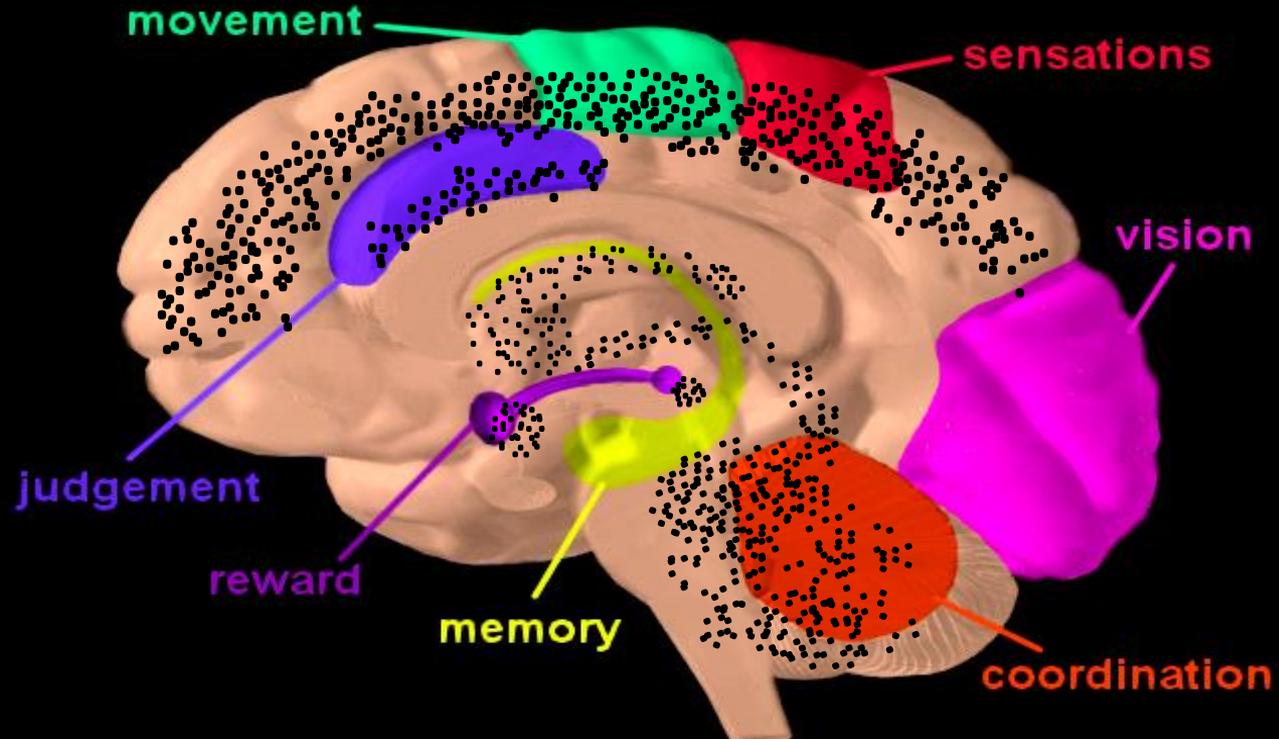
# Marijuana



# Marijuana Binds Cannabinoid Receptors Located Throughout the Brain

(source NIDA)

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



Slide courtesy of Maureen Boyle, PhD

# **Eight Adverse Health Effects of Chronic Cannabis Use (Volkow et al., 2014)**

## **“Low Level of Confidence”**

- Lung cancer

## **“Medium Level of Confidence”**

- Altered brain development
- Progression to use of other drugs
- Increased risk of schizophrenia, depression and anxiety disorders (in persons with a predisposition to such disorders)

## **“High Level of Confidence”**

- Addiction
- Motor vehicle accidents
- Diminished life achievement (including cognitive impairment and poor educational outcome)
- Symptoms of chronic bronchitis



# Some Adverse Health Effects of Chronic Cannabis Use More Pronounced with Youth Onset (Volkow et al., 2014)

## “Low Level of Confidence”

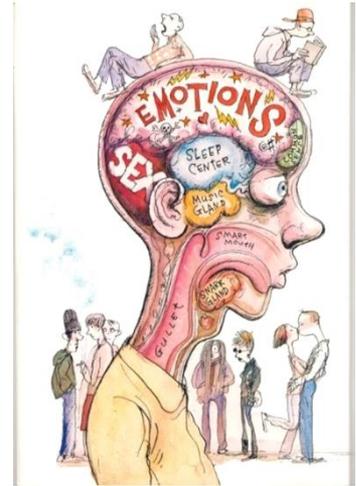
- Lung cancer

## “Medium Level of Confidence”

- Altered brain development
- Progression to use of other drugs
- Increased risk of chronic psychosis disorders (including schizophrenia and depression) in persons with a predisposition to such disorders

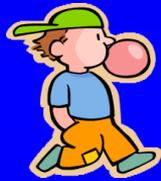
## “High Level of Confidence”

- Addiction
- Motor vehicle accidents
- Diminished life satisfaction and achievement (including cognitive impairment and poor educational outcome)
- Symptoms of chronic bronchitis



Source: US News & World Report, 2005

# The Dunedin Study (New Zealand) (N=1,037)



**13 yrs**  
(Pre-initiation)

1



**18 yrs**

2

**21 yrs**

3



**32 yrs**

4

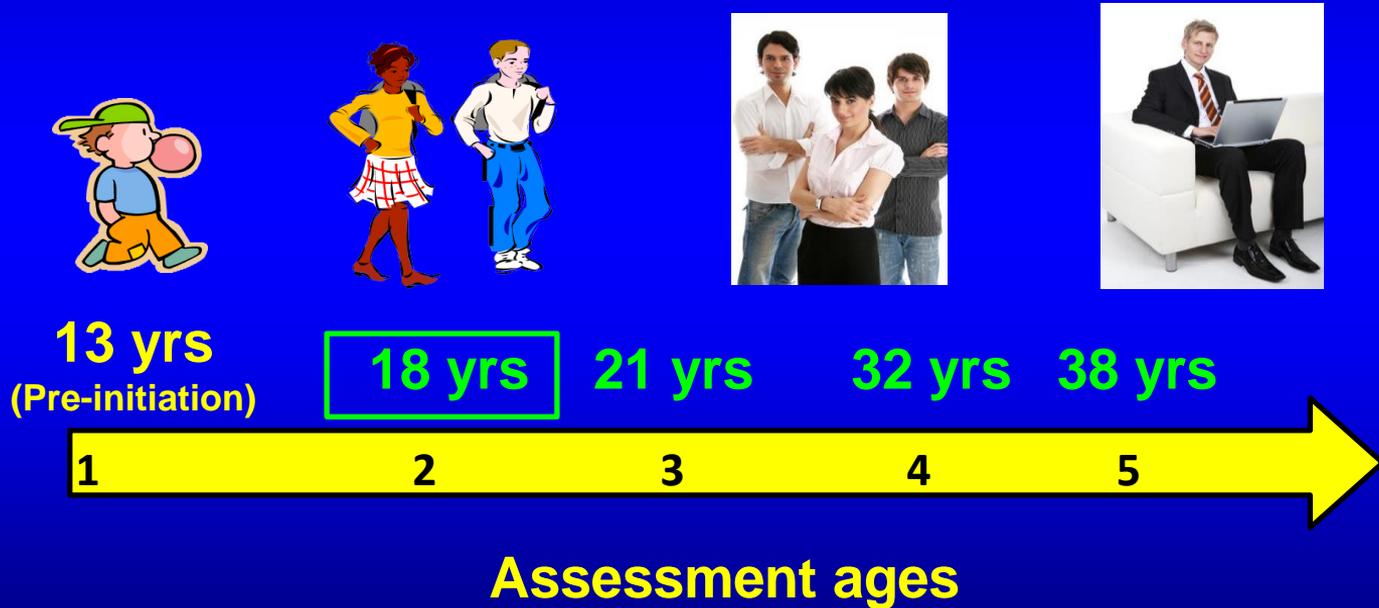


**38 yrs**

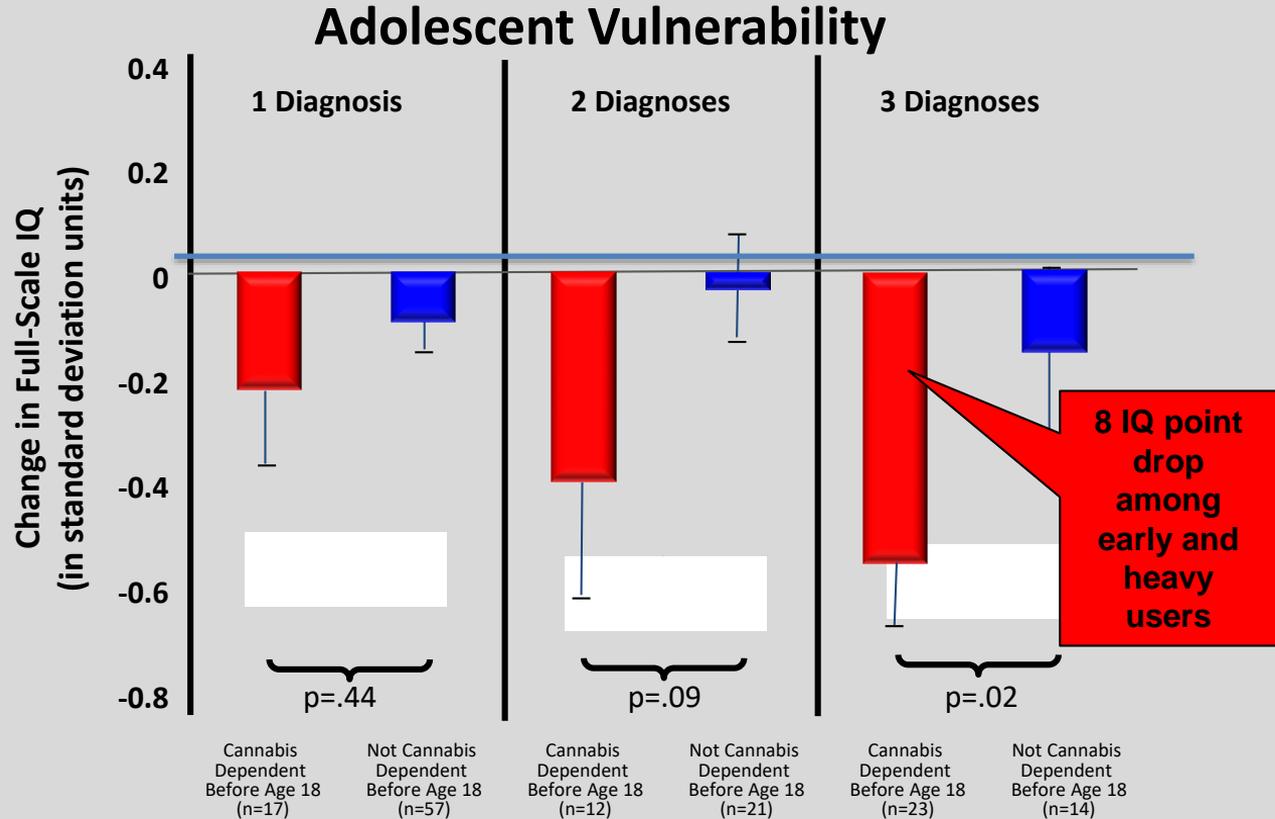
5

**Assessment ages**

# The Dunedin Study (New Zealand) (N=1,037)

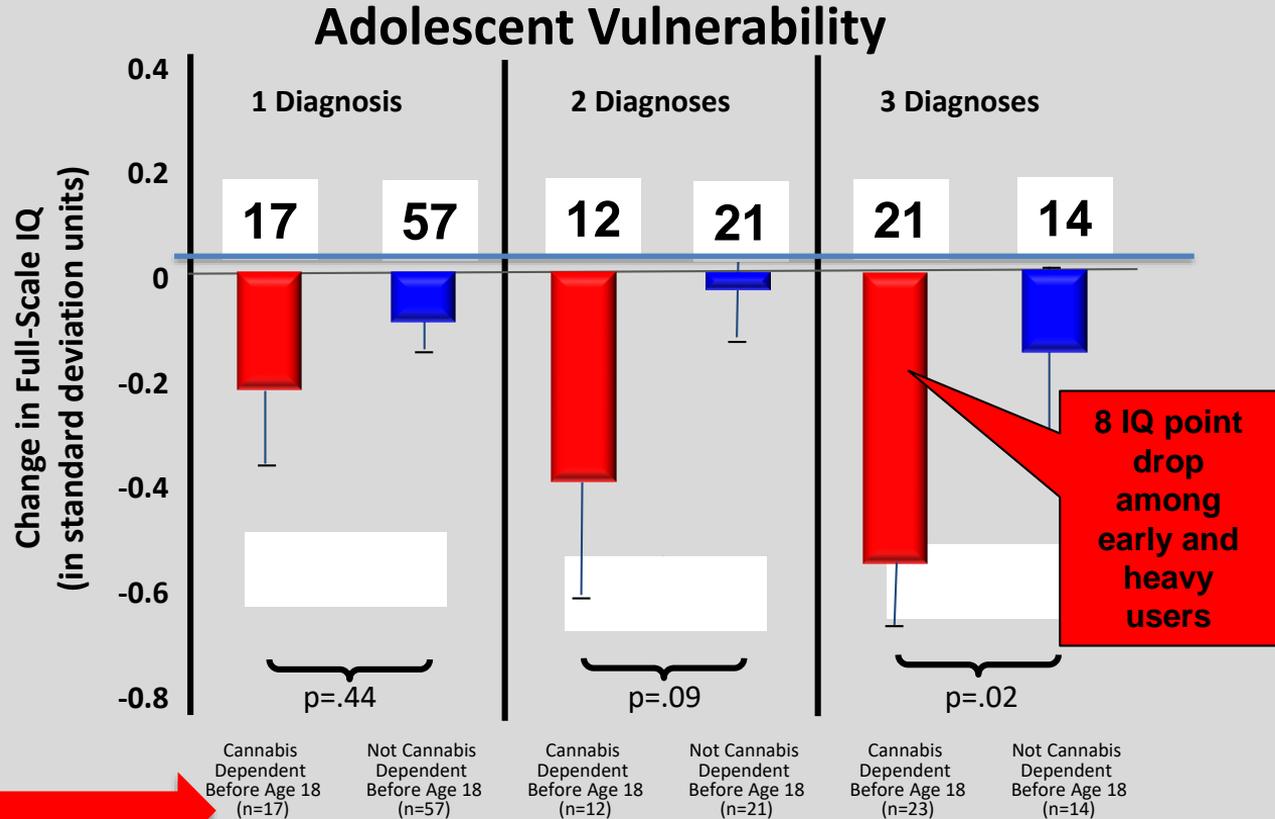


# Marijuana and Cognitive Development



Source: Meier MH et al., PNAS Early Edition 2012

# Sample Sizes Far from Ideal!!



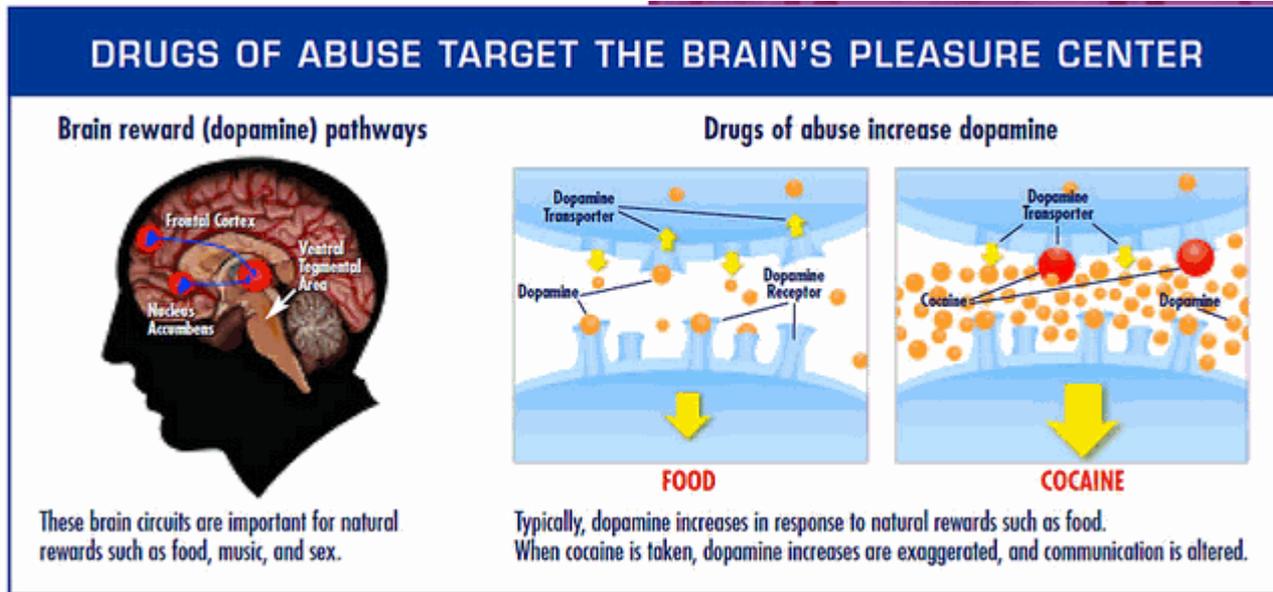
Source: Meier MH et al., PNAS Early Edition 2012

**WHY?**

# **1. Could there be inherent risk factors of brain development that contribute to drug use?**

- **Preference for ....**
  1. **physical activity**
  2. **high excitement and rewarding activities**
  3. **activities with peers that trigger high intensity/arousal**
  4. **novelty**
- **Less than optimal..**
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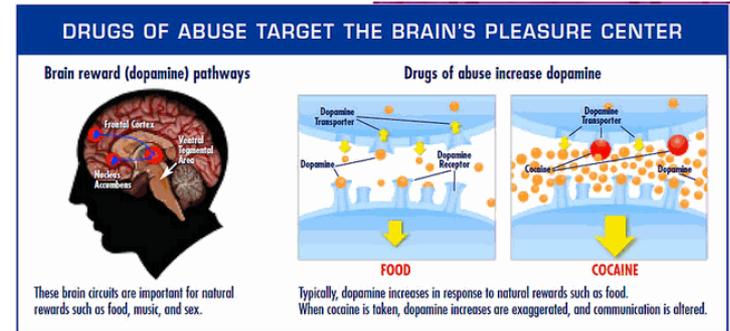
## 2. Adolescent pleasure centers in the brain may be more sensitive to the acute effects of drugs than pleasure centers in the adult brain.



*Courtesy National Institute on Drug Abuse, National Institute of Health*

## 2. Adolescent pleasure centers in the brain may be more sensitive to the acute effects of drugs than pleasure centers in the adult brain. (Chambers, Taylor and Potenza, 2003)

- Evidence that dopamine activity is more “robust” during adolescence.
- If dopamine production is more pronounced or “robust” during adolescence, risk of drug abuse could be heightened
  - > sensitivity to initial drug effects
  - > motivation to continue use
  - > difficulty to reduce use



*Courtesy National Institute on Drug Abuse, National Institute of Health*

### 3. Early Use May Create a Biological Priming or Gateway Effect

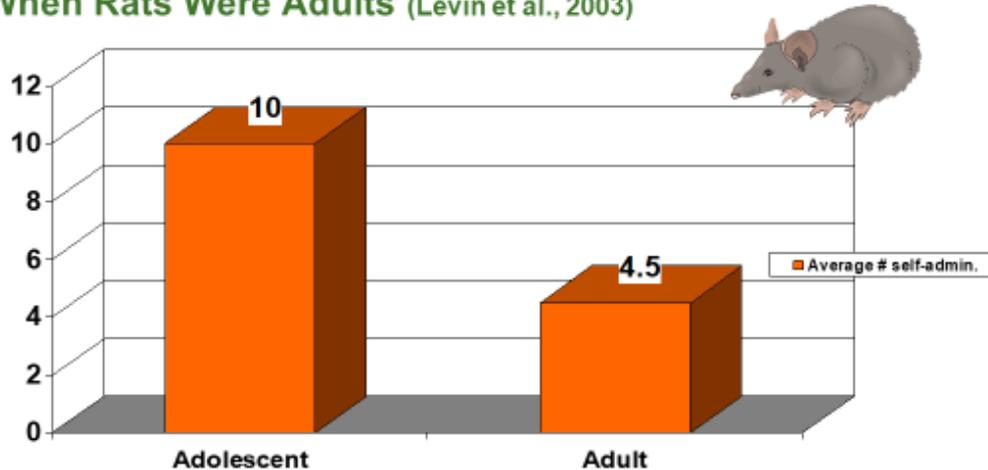
#### Nicotine Gateway Effects on Adolescent Substance Use

Michelle Ren, MS\*  
Shahrdad Lotfipour, PhD†

\*University of California, Irvine, Department of Pharmaceutical Sciences, Irvine, California  
†University of California, Irvine, Department of Emergency Medicine and Pharmaceutical Sciences, Irvine, California

Section Editor: Tony Zitek MD

#### Average Number of Self-Administered Doses of Nicotine When Rats Were Adults (Levin et al., 2003)



Age of Rates When First Exposed to Nicotine. All Data Collected When Rats were Adults.

- Literature suggests: Disruption of nicotinic acetylcholine receptors (nAChR) development with early nicotine use may alter the release of reward-related neurotransmitters, and thus increase the likelihood of future drug seeking behaviors, including drugs other than nicotine.
- There is a “large collection of clinical and preclinical evidence that adolescent nicotine exposure influences long-term molecular, biochemical, and functional changes in the brain that encourage subsequent drug abuse.”

## ii. Brain development and behavioral disorders

# INSIDE THE ADOLESCENT BRAIN

The brain undergoes two major developmental spurts, one in the womb and the second from childhood through the teen years, when the organ matures by fits and starts in a sequence that moves from the back of the brain to the front.

### ■ Corpus Callosum

Thought to be involved in emotion and memory, the corpus callosum is a bundle of nerve fibers connecting the left and right hemispheres of the brain. It acts, for example, to help the brain make and process sound or recognize faces all at once.

### ■ Prefrontal Cortex

The CEO of the brain, what you'd call the area of higher-level thought, is the part of the brain that matures last. It's the area that helps you think, make decisions, and control your impulses. It's also the area that helps you learn from your mistakes and control your emotions.

### ■ Basal Ganglia

Larger in children than in adults, this part of the brain acts like a switchboard in the prefrontal cortex, helping it sort out information. The basal ganglia and prefrontal cortex are highly connected. As the brain matures, the basal ganglia become smaller and more specialized. This is because the brain has to learn to control its impulses and respond to the world around it.

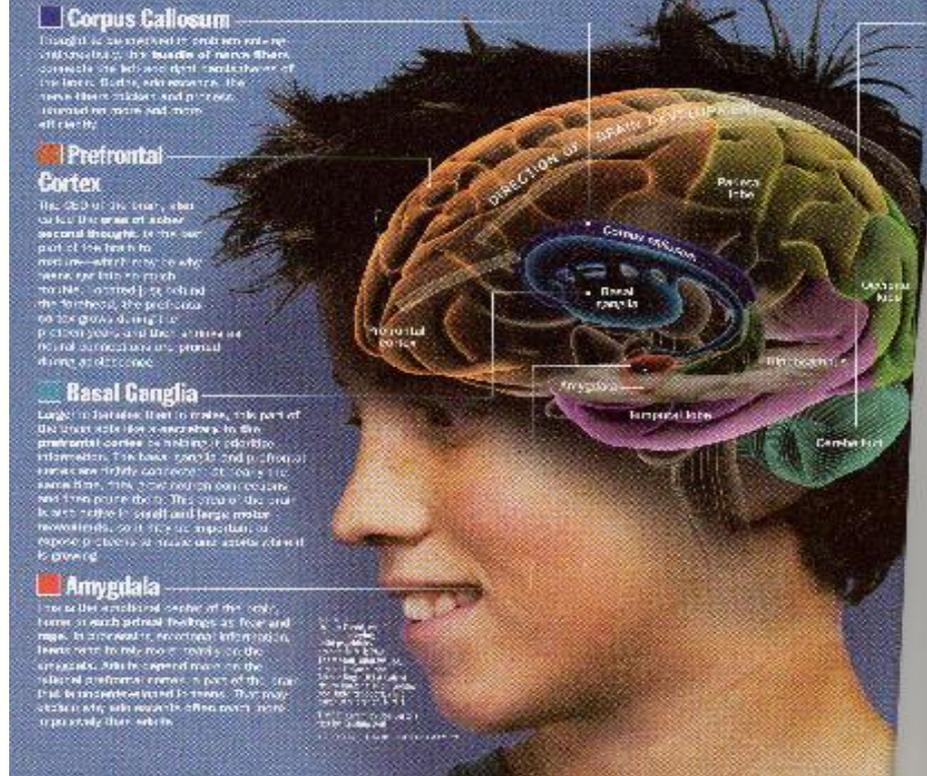
### ■ Amygdala

It's the emotional center of the brain, the part that helps you feel fear and anger. It's also the part that helps you learn from your mistakes. The amygdala is highly connected to the prefrontal cortex, which helps you control your emotions. The amygdala is also the part of the brain that helps you learn from your mistakes. The amygdala is also the part of the brain that helps you learn from your mistakes.

### Nerve Proliferation ...



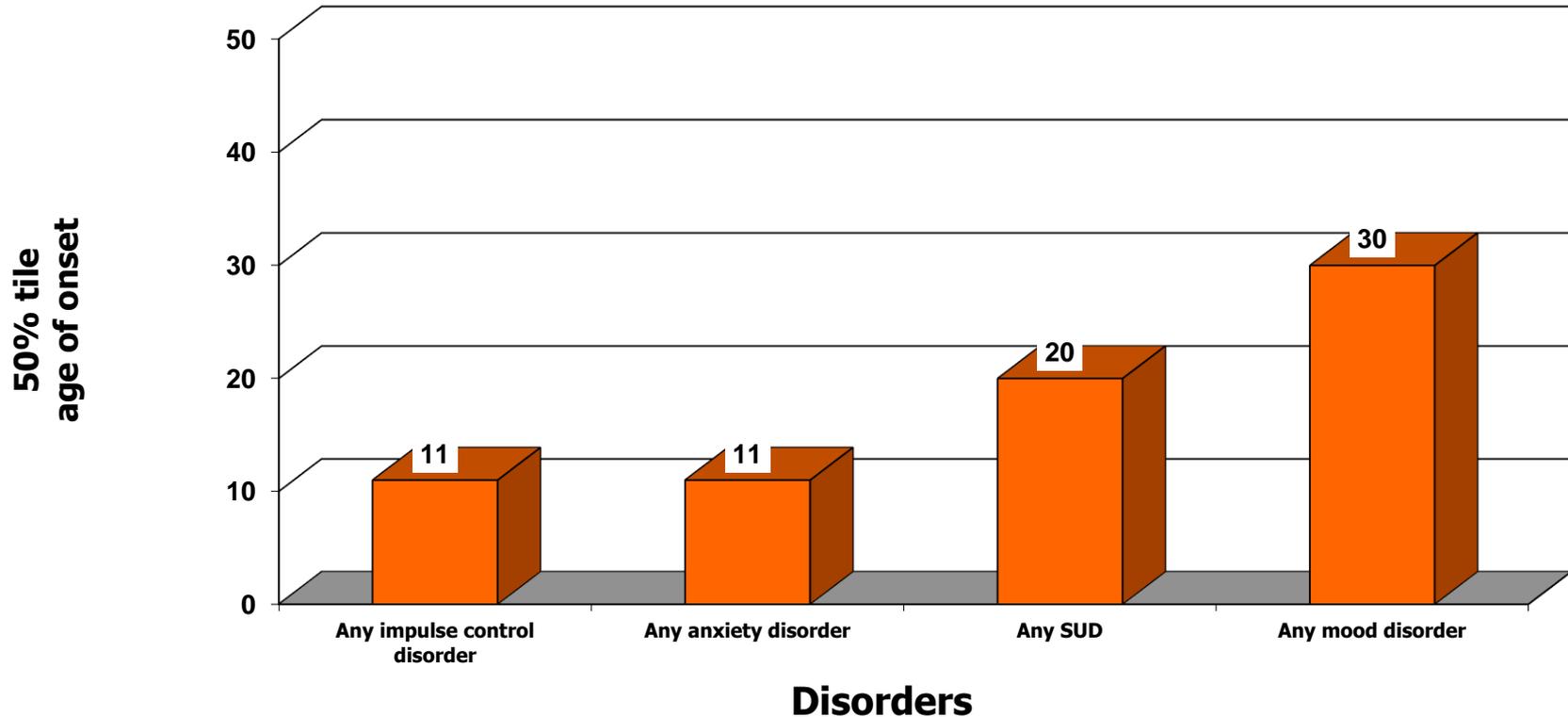
By age 25, the brain has 100 billion neurons. The neurons in the front of the brain have formed the basis of new connections. Over the next few years, most of these links will be pruned.



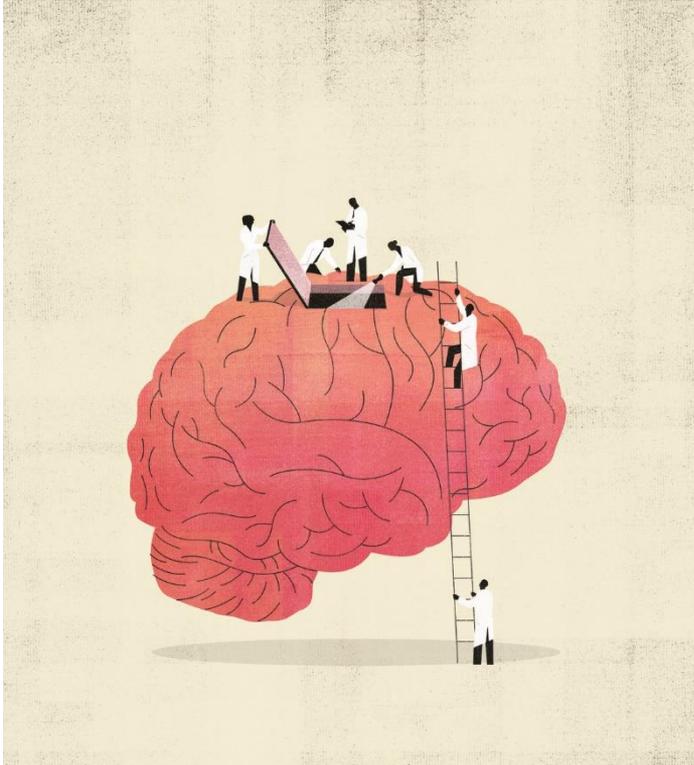
# **Adolescence and Behavioral Disorders**

- **Alterations in neurodevelopment have been linked to several adolescent-onset mental and behavioral disorders (Charney et al., 2013):**
  - **ADHD**
  - **Affective Disorders**
  - **Anxiety Disorders**
  - **Autism**
  - **Obsessive-Compulsive Disorders**
  - **PTSD**
  - **Schizophrenia**

# Ages at the 50 Percentile of the Age-at-Onset Distribution for Major Disorders (Kessler et al., 2005)



# Adolescent Use of *Marijuana* and Behavioral Disorders



## Miller's Review of the Marijuana and Mental Health Connection

| Disorder             | Cross-Sectional Data | Longitudinal Data |
|----------------------|----------------------|-------------------|
| Schizophrenia        | ++                   | ++                |
| Bipolar              | +                    |                   |
| Anxiety Disorders    | +                    | +                 |
| Depressive Disorders | +                    | +                 |
| Risk of Suicide      | +                    |                   |

Key: ++ = several studies; + a few studies

Yellow box = risk greater when MJ use onset during youth.

Miller, C. L. (in press). The impact of marijuana on mental health. In K. Sabet & K.C. Winters, *Contemporary health issues on marijuana*. NY: Oxford Press.

# The contribution of cannabis use to variation in the incidence of psychotic disorder across Europe (EU-GEI): a multicentre case-control study

Marta Di Forti, PhD   • Diego Quattrone, MD • Tom P Freeman, PhD • Giada Tripoli, MSc •  
Charlotte Gayer-Anderson, PhD • Harriet Quigley, MD • et al. [Show all authors](#) •

- **901 patients with first episode psychosis across 11 clinic sites in Europe**
- **Compared 1237 population controls from those same sites**
- **Cannabis use was associated with increased odds of psychotic disorder compared with never users**
  - **Daily use of low potency cannabis = adjusted odds ratio, 3.2 (95% CI 2.2 – 4.1)**
  - **Daily use of high potency cannabis = adjusted odds ratio, 4.8 (95% CI 2.5 – 6.3)**

Source: Lancet Psychiatry, 2019

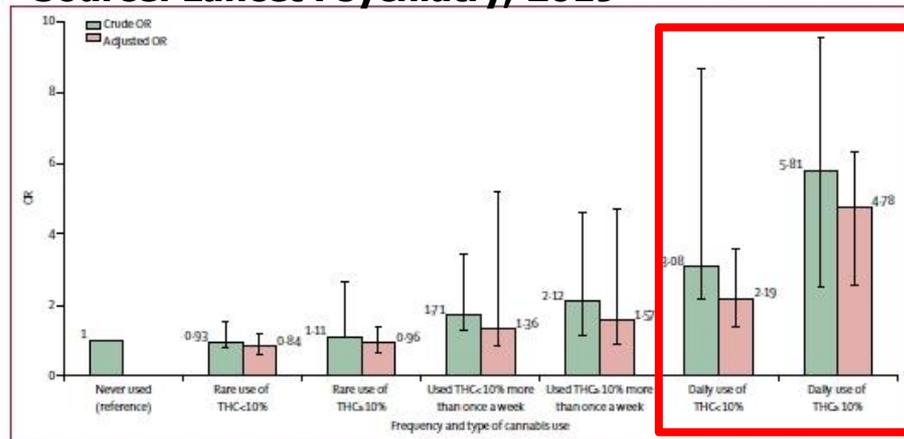
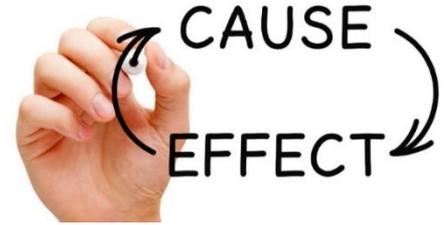


Figure 1: Crude and fully adjusted ORs of psychotic disorders for the combined measure of frequency plus type of cannabis use in the whole sample. Crude ORs are adjusted only for age, gender and ethnicity and fully adjusted ORs are additionally adjusted for level of education, employment status, and use of tobacco, stimulants, ketamine, legal highs, and hallucinogenics. Error bars represent 95% CIs. OR—odds ratio.

## Cautionary Notes

- **Reverse causation (self-medication).**
- **Early drug use may be a marker of underlying genetic risk and not causative, or only partially causative.**



### iii. Impact of early experiences on the developing brain and subsequent health and well-being

## INSIDE THE ADOLESCENT BRAIN

The brain undergoes two major developmental spurts, one in the womb and the second from childhood through the teen years, when the organ matures by fits and starts in a sequence that moves from the back of the brain to the front.

### ■ Corpus Callosum

Thought to be involved in emotion and memory, the corpus callosum is a bundle of nerve fibers connecting the left and right hemispheres of the brain. It acts as a highway, allowing information to travel between the two halves of the brain.

### ■ Prefrontal Cortex

The CEO of the brain, also called the area of higher thought, is the part of the brain that helps you think, plan, and make decisions. It's the part of the brain that helps you control your impulses and manage your emotions.

### ■ Basal Ganglia

Larger in females than in males, this part of the brain acts like a switchboard, relaying information from the back of the brain to the front. It's involved in movement, learning, and emotion.

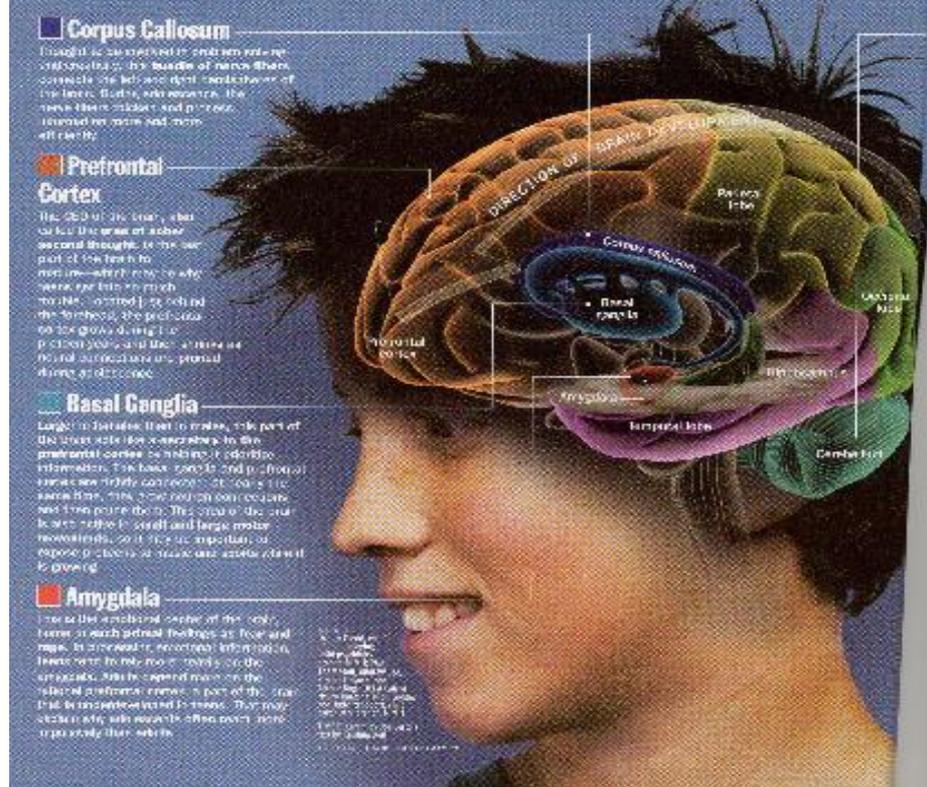
### ■ Amygdala

It's the emotional center of the brain, home to such primal feelings as fear and rage. It's involved in processing information from the senses and is a key player in the brain's reward system. It's also involved in the brain's response to stress.

### Nerve Proliferation ...



By age 25, the brain has 100 billion neurons. In the first 10 years of life, the brain loses 100 billion neurons. Over the next 10 years, most of these 100 billion are replaced.

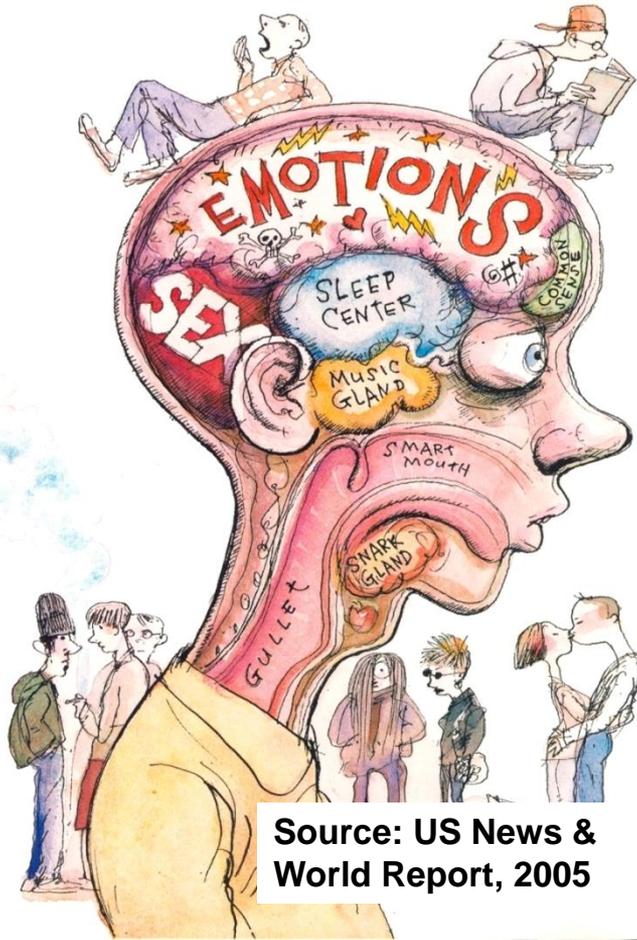


# A Developing Brain

## > Impact from Environment?

- “Exposure to both positive and negative elements before adolescence can imprint on the final adult topography in a manner that differs from exposure to the same elements after adolescence.”

(Anderson, 2003, *Neuroscience & Biobehavioral Reviews*)



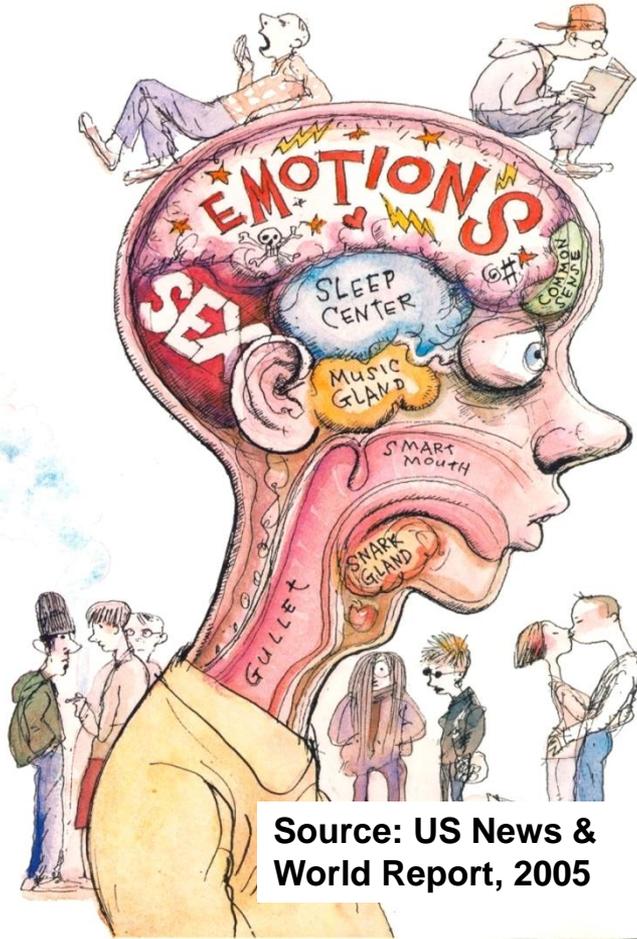
Source: US News &  
World Report, 2005

# A Developing Brain

## > Impact from Environment?

<https://developingchild.harvard.edu/science/deep-dives/mental-health/>

- “The interaction between genetic predispositions and sustained, stress-inducing experiences early in life can lay an unstable foundation for mental health that endures well into the adult years.”



Source: US News &  
World Report, 2005



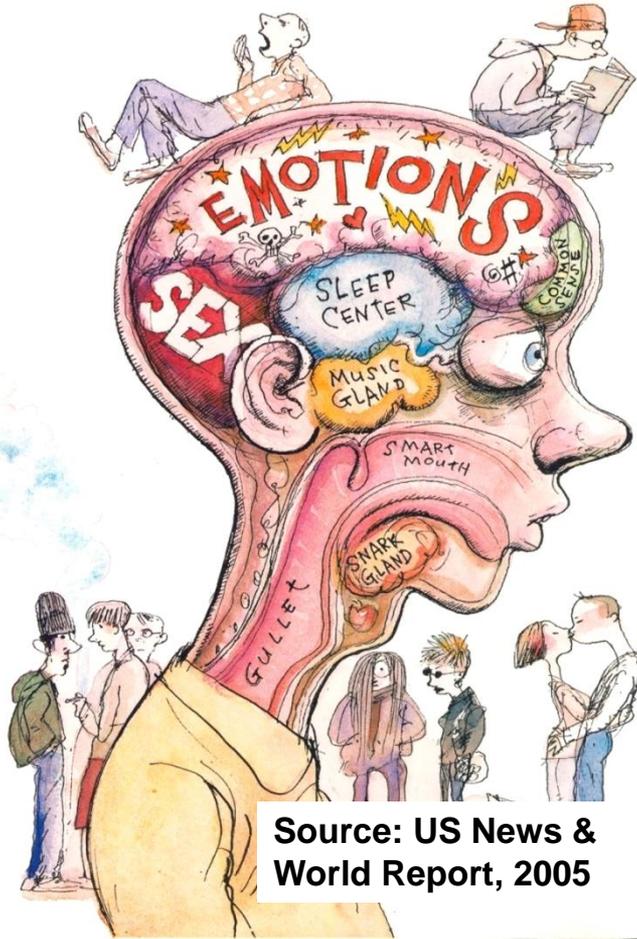
# A Developing Brain

## > Impact from Environment?

<https://developingchild.harvard.edu/science/deep-dives/mental-health/>

## Rays of Hope!

- **“Some individuals demonstrate remarkable capacities to overcome the severe challenges of early, persistent maltreatment, trauma, and emotional harm.”**
- **“Most potential mental health problems will not become mental health problems if we respond to them early.”**



Source: US News &  
World Report, 2005

# Early experiences can alter brain development in positive ways



<https://www.cdc.gov/ncbddd/childdevelopment/early-brain-development.html>

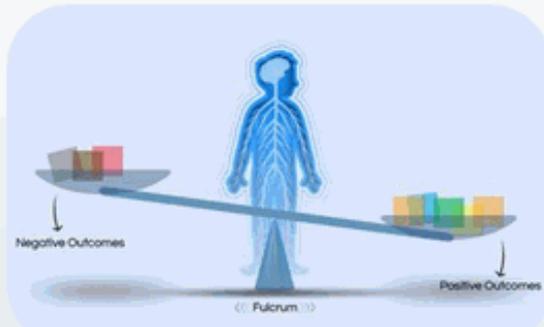
**“Nurturing and responsive care for the child’s body and mind is the key to supporting healthy brain development.”**

# Early experiences can alter brain development in positive ways



Center on the Developing Child  
HARVARD UNIVERSITY

<https://developingchild.harvard.edu/>



The science of early childhood is a source of new ideas that could be used to develop more effective policies & services focused on the early years of life.

[Browse Key Concepts](#) | [Browse Deep Dives](#)

# Early experiences can alter brain development in positive ways



Preschool is a sensitive period for the influence of maternal support on the trajectory of hippocampal development

Joan L. Luby<sup>a,1</sup>, Andy Belden<sup>a</sup>, Michael P. Harms<sup>a</sup>, Rebecca Tillman<sup>a</sup>, and Deanna M. Barch<sup>a,b,c</sup>

<sup>a</sup>Department of Psychiatry, Washington University in St. Louis, St. Louis, MO 63110; <sup>b</sup>Department of Psychological & Brain Sciences, Washington University in St. Louis, St. Louis, MO 63130; and <sup>c</sup>Department of Radiology, Washington University in St. Louis, St. Louis, MO 63110

**More parental support = more hippocampus volume**

**More hippocampus volume = better memory & emotional regulation**



**Early experiences can alter brain development in negative ways**

## **WHAT ARE ACES?**

**AND HOW DO THEY RELATE TO TOXIC STRESS?**

**SAMHSA**

Substance Abuse and Mental Health  
Services Administration



- **The impact of child traumatic stress can last well beyond childhood. Associated with...**
  - **learning problems**
  - **mental illness; diminished level of functioning**
  - **increased use of a health services, including mental health services**

**Early experiences can alter brain development in negative ways**



## **Infant Stress Affects Teen Brain (Davidson et al., 2012; *Nature Neuroscience*)**

- **For *some* girls, stressful experiences in the first year of life was associated with.....**
  - 1. altered hormonal changes; and**
  - 2. abnormal development of connections between regions of the brain that control fear and stress responses**

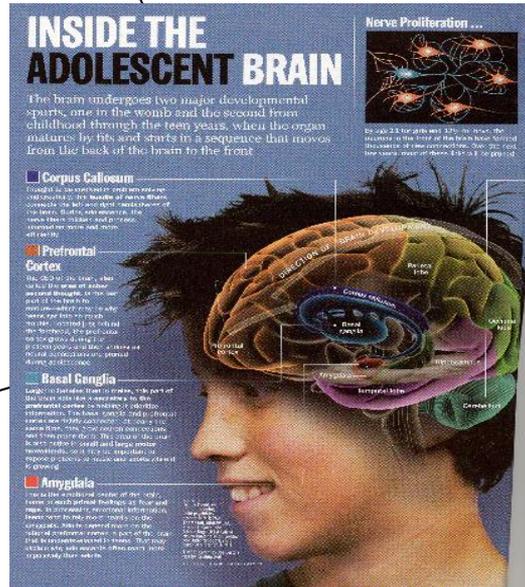
# Early experiences can alter brain development in negative ways



- **Children deprived of parents early in life (orphans), compared to children with parents, revealed....**
  - **increased gastrointestinal symptoms**
  - **pattern of gut microbiomes linked to..**
    - **concurrent and future anxiety**
    - **prefrontal cortex activation to emotional faces**



# I. Brain development

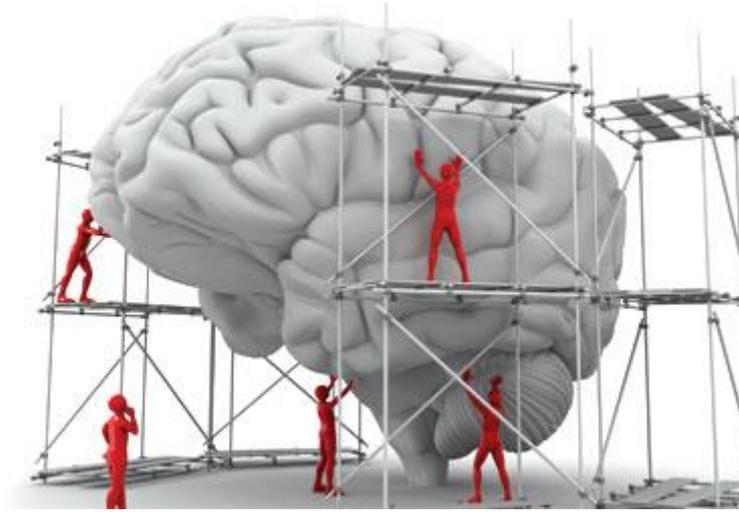


# II. Developing brain, drug use and mental health

# III. Youth Serving Workers

# Brain Development: Implications for Youth Serving Workers & Educators

- i. **Teach youth about brain development and its importance to health and personal growth**



# Implications of Brain Development for Adolescent Behavior



- **Preference for ....**
  1. **physical activity**
  2. **high excitement and rewarding activities**
  3. **activities with peers that trigger high intensity/arousal**
  4. **novelty**
- **Less than optimal..**
  5. **control of emotions**
  6. **consideration of negative consequences**
- **Greater tendency to...**
  7. **be overly attentive to social information**
  8. **take risks**

# Brain Development: Implications for Youth Serving Workers & Educators

- **Teach “adaptive” decision making**
  - **taking risks that promote “personal-growth”**
  - **“on second thought” skills**
  - **how to avoid peer pressure to engage in delinquency**

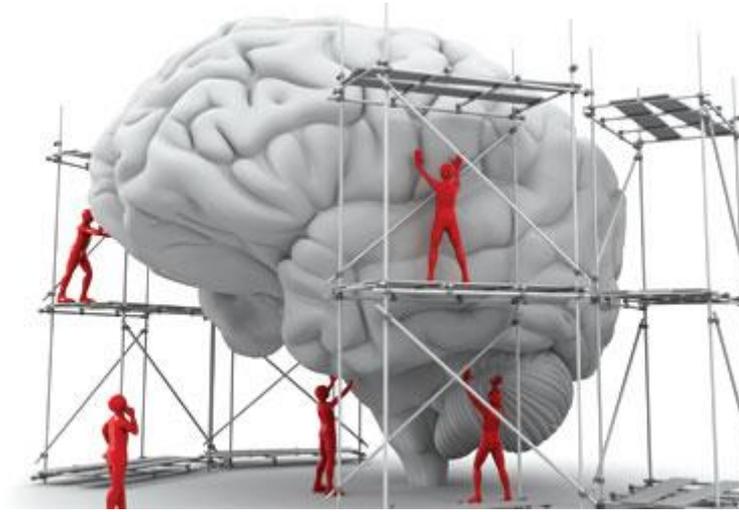


# **Brain Development: Implications for Youth Serving Workers & Educators**

- i. Interested in a “teen brain” resource to help teach youth about brain development?**

**send me an e-mail:**

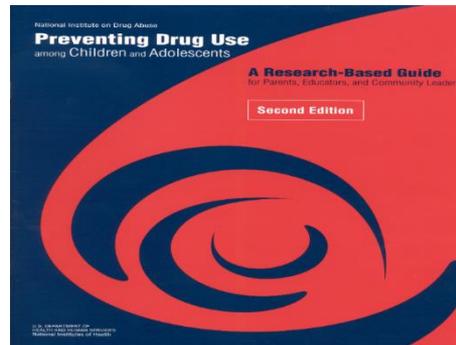
**winte001@umn.edu**



# Brain Development: Implications for Youth Serving Workers & Educators

## ii. Use evidenced-based *prevention* programs

- Keys to effective prevention are in the research literature
  1. National Institute on Drug Abuse  
<https://www.drugabuse.gov>
  2. Cochran literature review  
<https://www.cochranelibrary.com/cdsr/about-cdsr>
  3. ISSUP's prevention curriculum  
<https://www.issup.net/training/universal-prevention-curriculum>



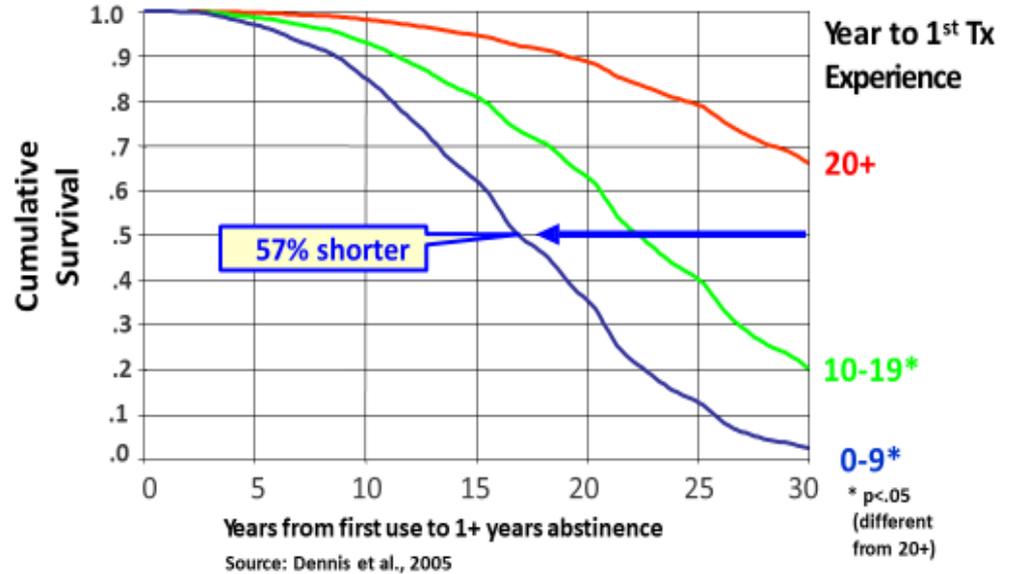
Trusted evidence.  
Informed decisions.  
Better health.



# Brain Development: Implications for Service Providers

iii. Earlier the *treatment*, the better

“Careers” are Shorter the Sooner People Access Treatment



# Brain Development: Implications for Service Providers

## iv. Use evidenced-based *treatment*

Treatment: Recent literature summary and meta-analysis (Hogue et al., 2018; **NIDA, 2014**; Tanner-Smith et al., 2012)

Treatment “as usual” is no better than prevention education only or no treatment.

A wide range of more recent evidenced-based treatment do significantly better.

**MET, CBT and family therapy**



# Brain Development: Implications for Youth Serving Workers & Educators

## v. Increase the “cannabis and vaping IQ” of adolescents



- Sources of exercises and quizzes

- Cannabis:

- [www.dfaf.org](http://www.dfaf.org) (*Busting the Top Ten Myths of Marijuana*)

- Vaping:

- Google “CDC educating kids on vaping”  
<https://www.cdc.gov/tobacco/features/back-to-school/e-cigarettes-talk-to-youth-about-risks/index.html>

# Brain Development: Implications for Service Providers & Educators

## vi. Teach parents about brain development

**P** = Promote activities that capitalize on the strengths of the developing brain.

**A** = Assist children with challenges that require planning.

**R** = Reinforce their seeking advice from adults; teach decision making.

**E** = Encourage a lifestyle that promotes good brain development.

**N** = Never underestimate the impact of a parent being a good role model.

**T** = Tolerate the “oops” behaviors due to an immature brain.



# Parent Resources

1.

 **Mentor**  
International

**DRUG PREVENTION  
FOR PARENTS**

MENTOR INTERNATIONAL'S SELECTION OF SUBSTANCE  
ABUSE PREVENTION RESOURCES FOR PARENTS

2.



THE PARTNERSHIP™  
**AT DRUGFREE.ORG**

3. **Prevent\_Intervene\_Get  
Treatment\_Recover**

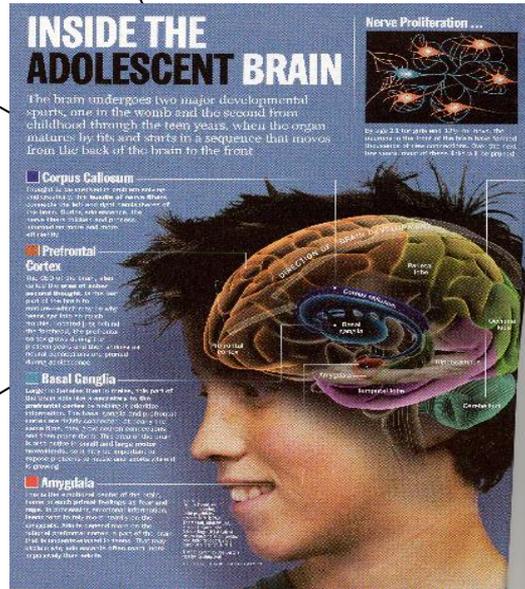
**[www.drugfree.org](http://www.drugfree.org)**

# I. Brain development

## IV. Summary

## III. Youth Serving Workers

## II. Developing brain, drugs and mental health



# Summary

- **Adolescence is an extended period of transition from reliance on adults to independence**
- **Normal adolescence is characterized by....**
  - **increase in conflicts with family members**
  - **desire to be with one's friends**
  - **resistance to messages from authority**
  - **irritability**
  - **risk taking**
  - **proclamations of sheer boredom**



# Summary

**reward incentives >  
perception of  
consequences**

JUST DO IT.



# Summary

- **Several lines of evidence suggesting that adolescence is a period of vulnerability to the effects of drugs, and a period linked to the onset of some mental disorders.**
- **It is also a time when personal growth can be shaped in ways that are unique to adolescence**



# Summary

- **Employ teen-brain friendly and evidence-based prevention and treatment**
  - **Prevention: decrease risk, increase protective factors**
  - **Treatment: employ these techniques**
    - **Motivational interviewing**
    - **CBT**
    - **Family therapy**
  - **Teach parents to strengthen parenting with brain development science**



# Teen Brain Development Quiz



1. There are several health indices suggesting that teenagers take less risk than in years past.  
**True (increased rate of “abstaining” from all substances; lower rate of teenage pregnancies and certain delinquency behaviors)**
  
2. What lifestyle choices during adolescence promote good brain development?
  - i. no drug use
  - ii. healthy lifestyle (good diet, exercise, sufficient sleep; active social life)
  
3. Which is more harmful to the developing brain?
  - a. Chronic, heavy use of marijuana?
  - b. Chronic, heavy drinking?**Good question!!**



# THANK YOU

winte001@umn.edu

## Questions and Discussion

