



WEST VIRGINIA INTEGRATED BEHAVIORAL HEALTH CONFERENCE

Fifty Shades of Developing Grey Matter

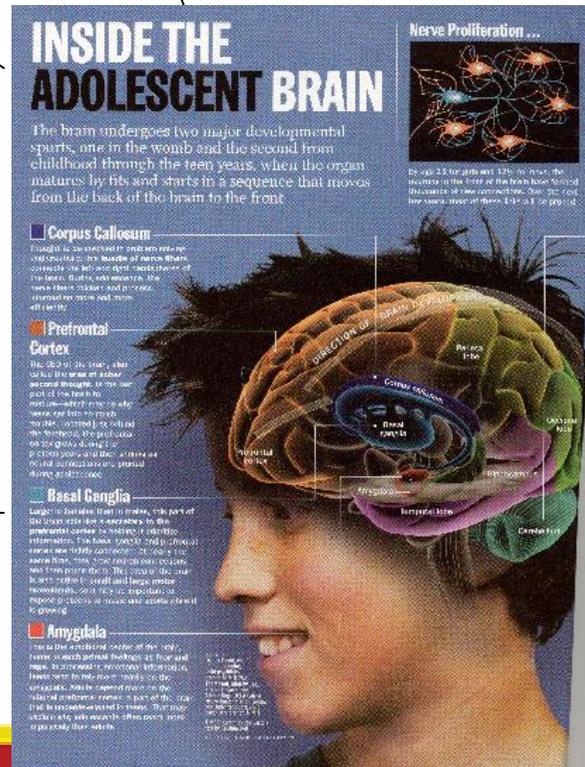
Ken Winters, Ph.D., Dept. of Psychiatry, University of Minnesota

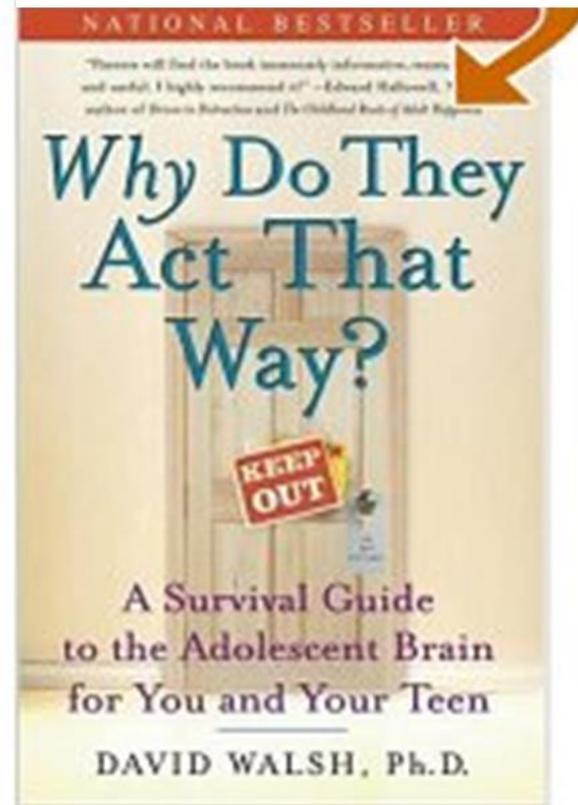
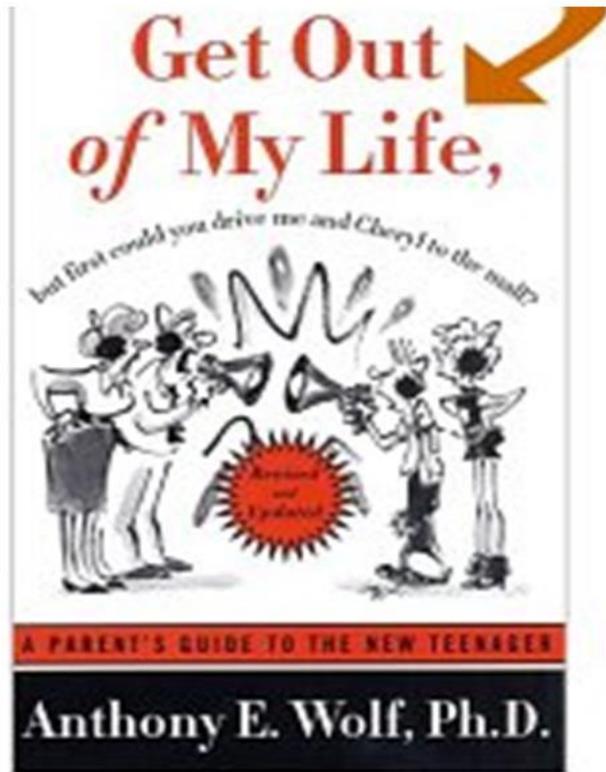
1. Addiction & the brain

4. Summary & clinical implications

3. Developing brain & alcohol

2. Developing brain

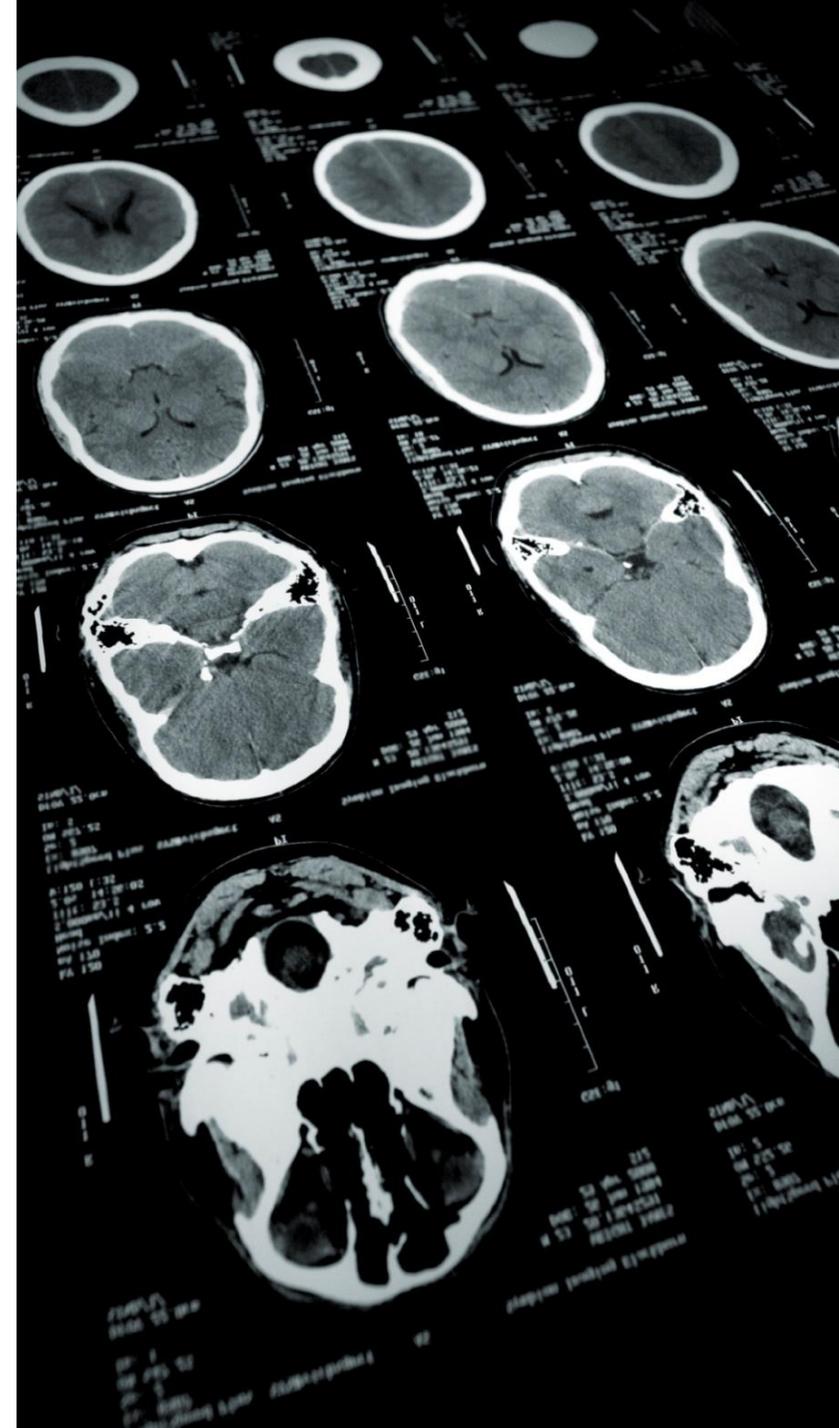




Emerging Science: Brain Imaging

New insights because:

- **1990's information explosion due to the development of brain imaging techniques (e.g., CT, PET and MRI).**

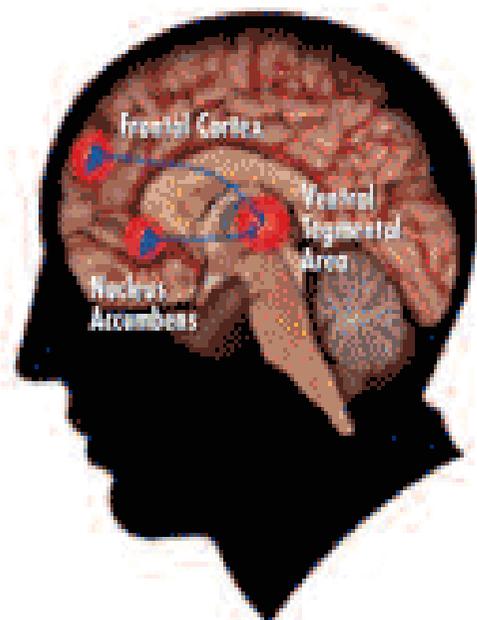


1. Addiction & the brain



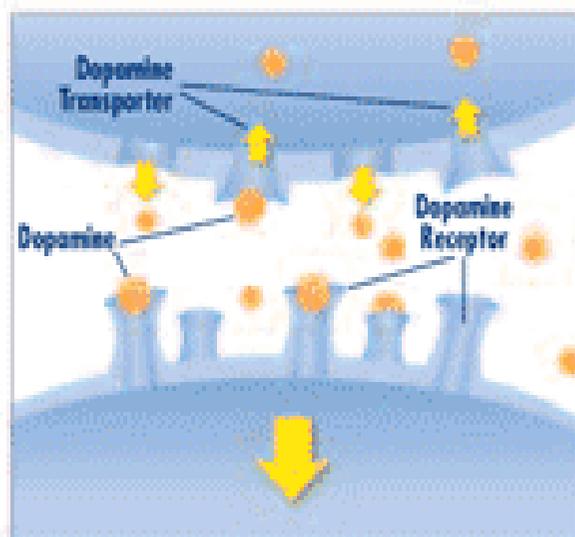
ALL DRUGS OF ABUSE TARGET THE BRAIN'S PLEASURE CENTER

Brain reward (dopamine) pathways



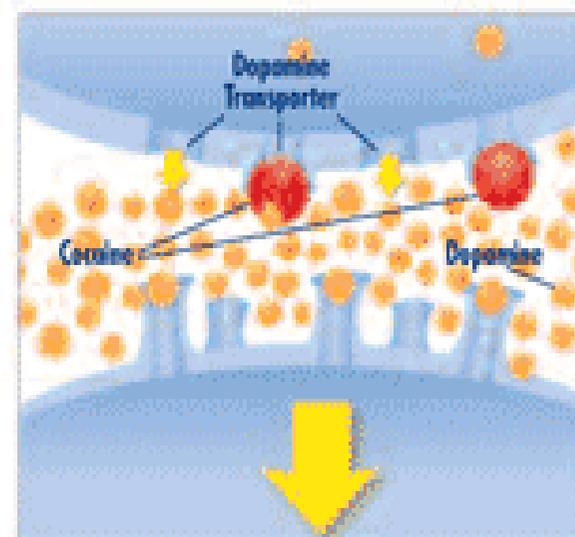
These brain circuits are important for natural rewards such as food, music, and art.

All drugs of abuse increase dopamine



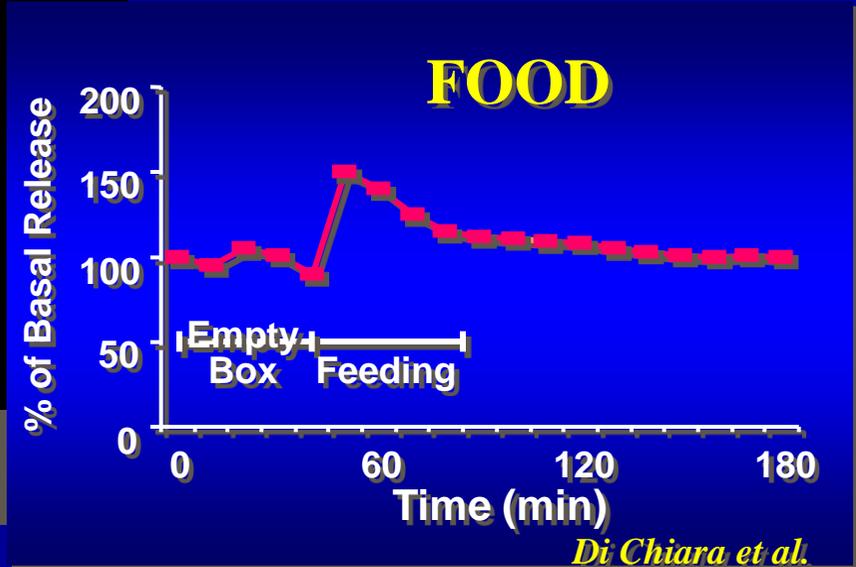
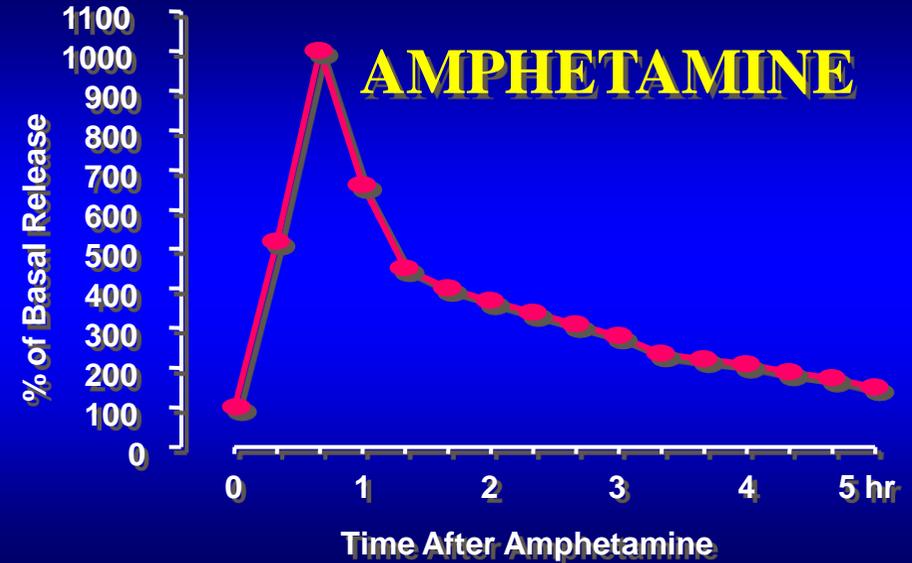
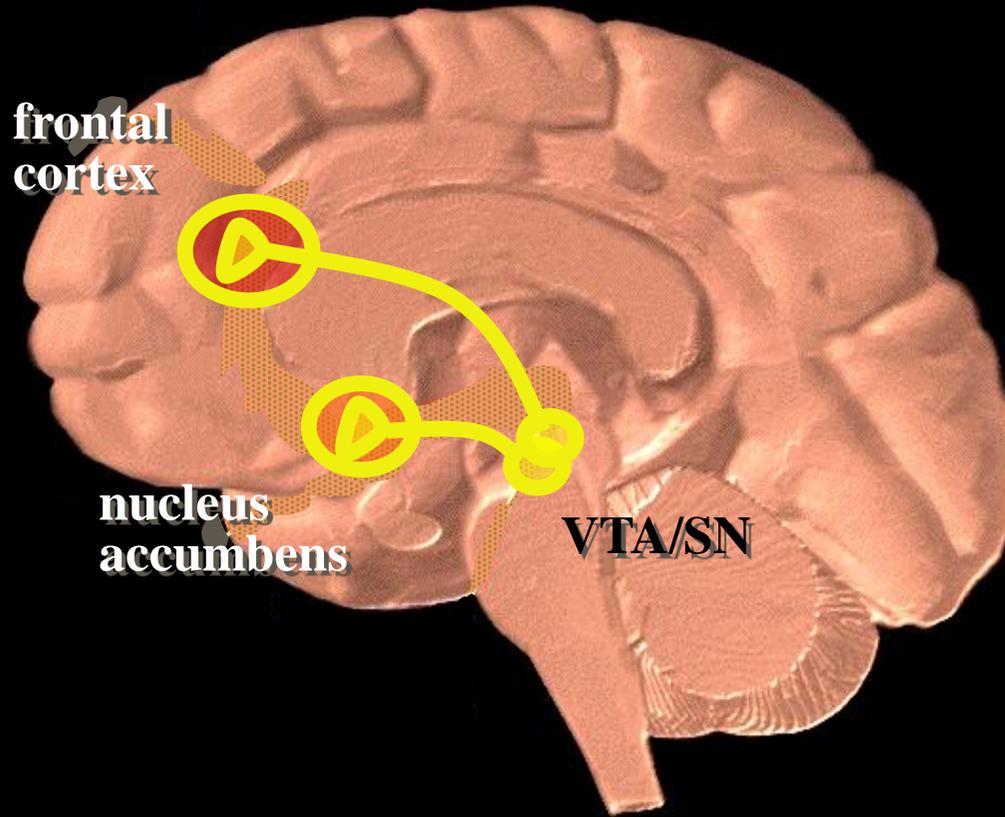
FOOD

Typically, dopamine increases in response to natural rewards such as food. When cocaine is taken, dopamine increases are exaggerated, and communication is altered.



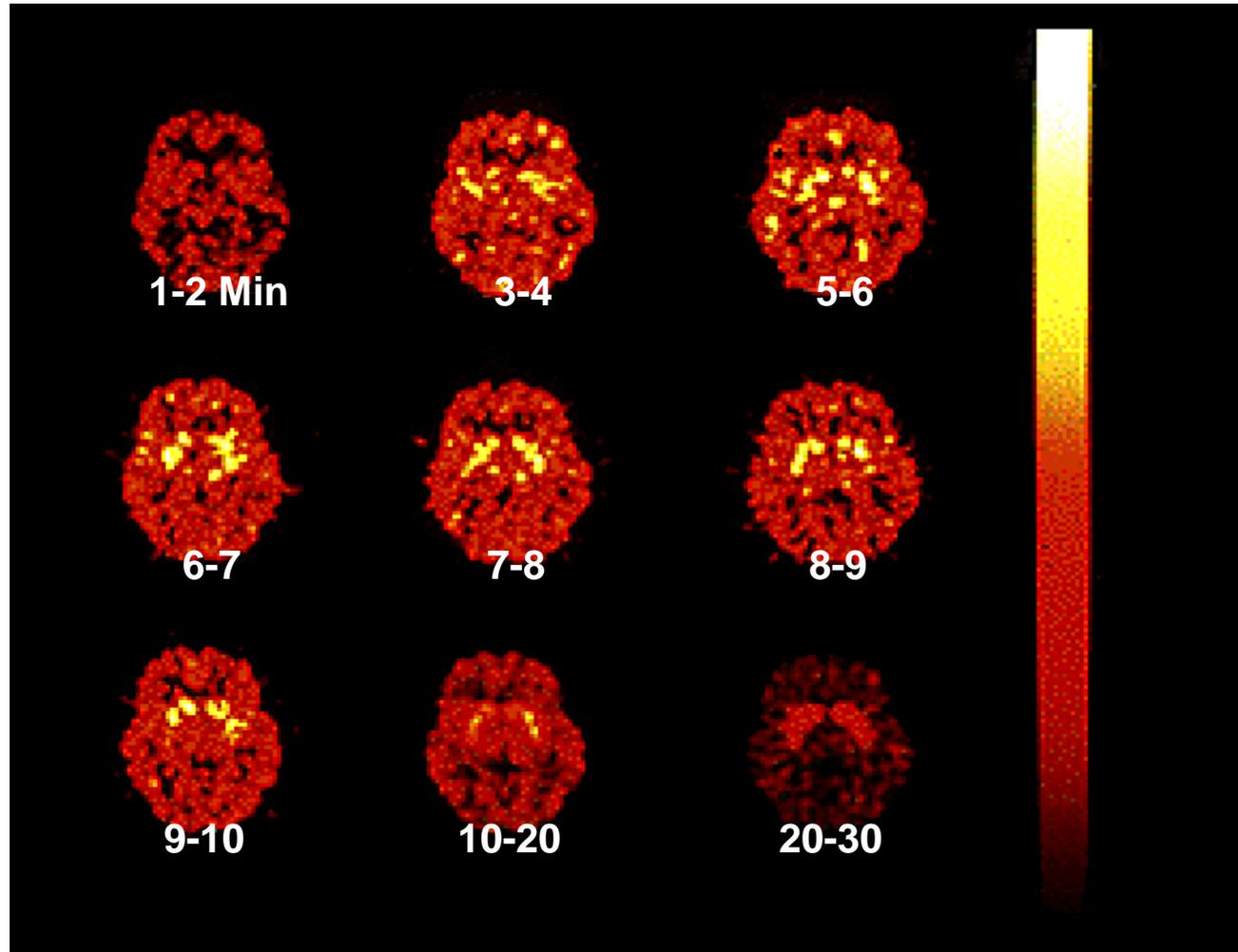
COCAINE

Dopamine Neurotransmission



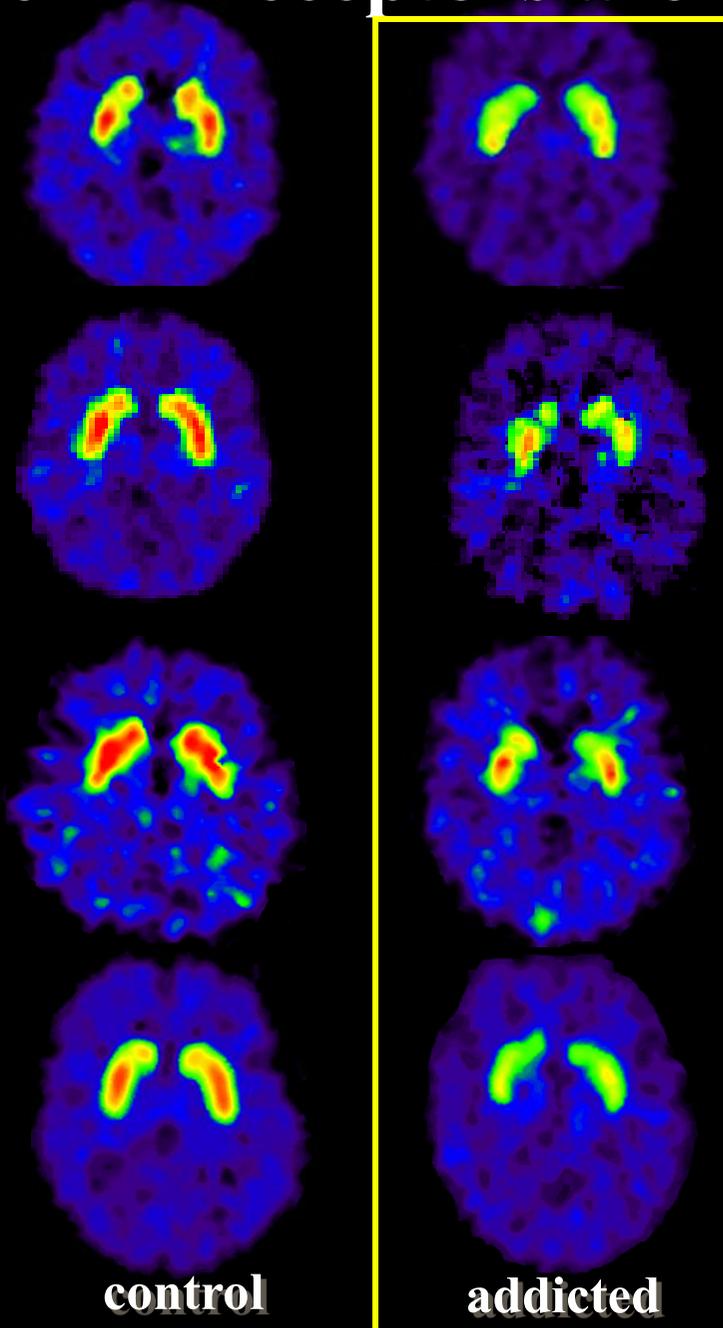
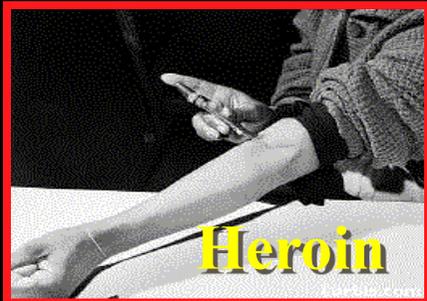
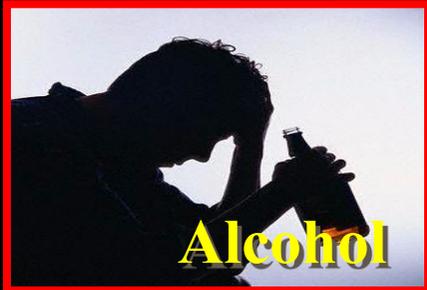
Your Brain on Cocaine

PET scan

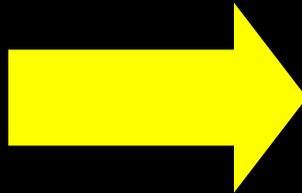


Yellow = cocaine is binding or attaching itself to areas of the brain

Dopamine D2 Receptors are Lower in Addiction



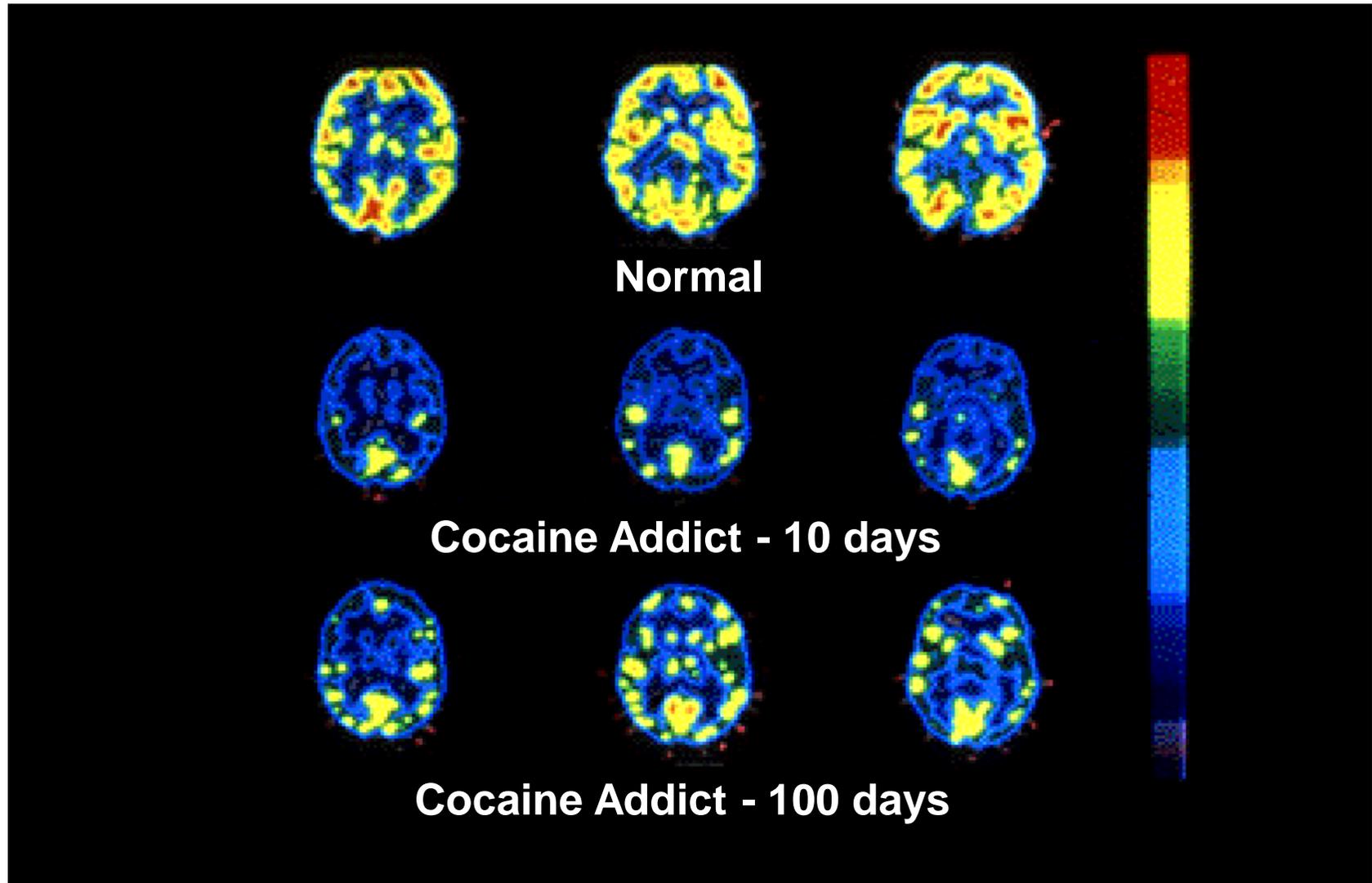
DA D2 Receptor Availability



What about recovery?

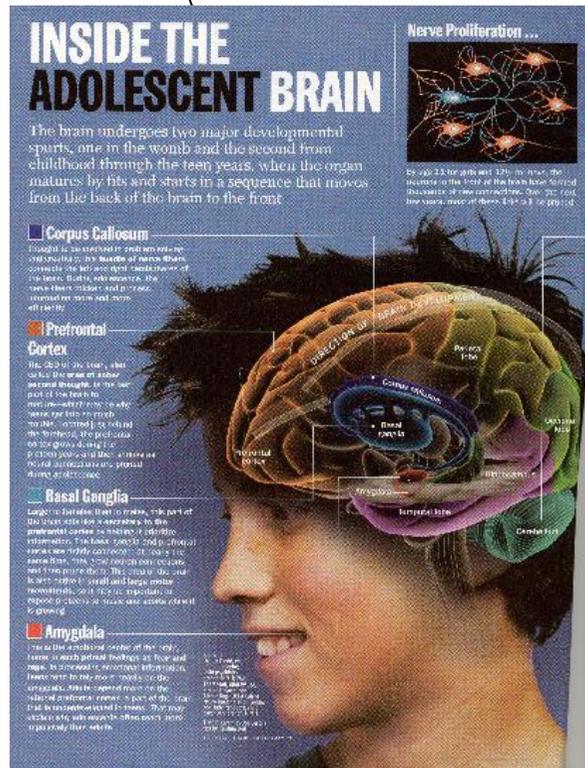


Your Brain After Cocaine



Yellow = normal brain functioning

1. Addiction & the brain



2. Developing brain



Cautions



- **Brain imaging studies are based on small samples**
 - **gender, ethnic and cultural differences may be significant.**

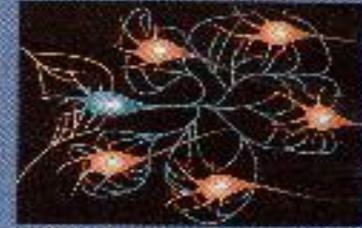


- **Adolescence is a period of profound brain maturation.**
- **We *thought* brain development was complete by adolescence**
- **We now know... maturation is not complete until about age 25!!!**

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 13 for girls and 17 for boys, the neurons in the front of the brain have formed the majority of new connections. Over the next five years, most of them will be pruned.

Corpus Callosum

Though it is so small in children and retracts to the bundle of nerves that connects the left and right hemispheres of the brain, the corpus callosum, the nerve fibers that connect the two halves of the brain, is so important that it is often called the "bridge of the brain."

Prefrontal Cortex

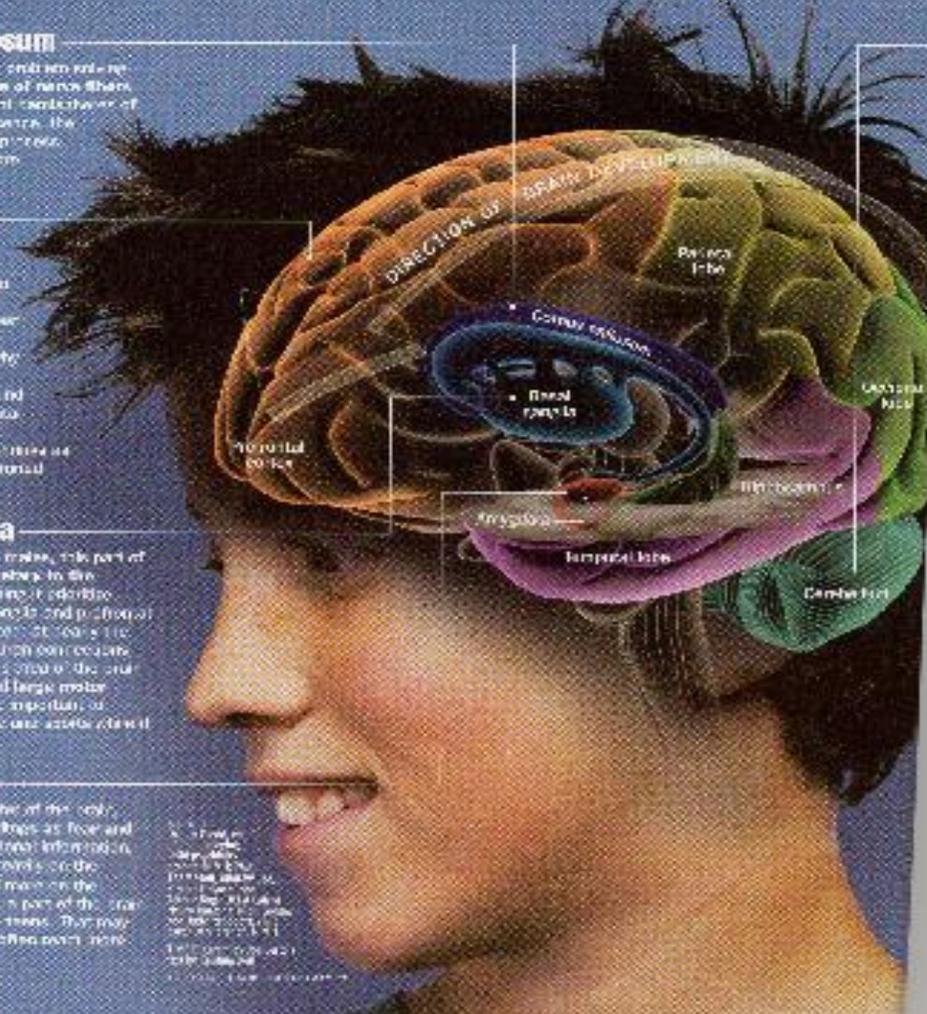
The CEO of the brain, also called the area of higher-level thought, is the part of the brain that is most sensitive to hormones. As the brain matures, the prefrontal cortex is the part of the brain that is most sensitive to hormones. As the brain matures, the prefrontal cortex is the part of the brain that is most sensitive to hormones.

Basal Ganglia

Larger in children than in adults, this part of the brain acts like a switchboard in the prefrontal cortex, helping it identify information. The basal ganglia and prefrontal cortex are highly connected. As the brain matures, the basal ganglia and prefrontal cortex are highly connected.

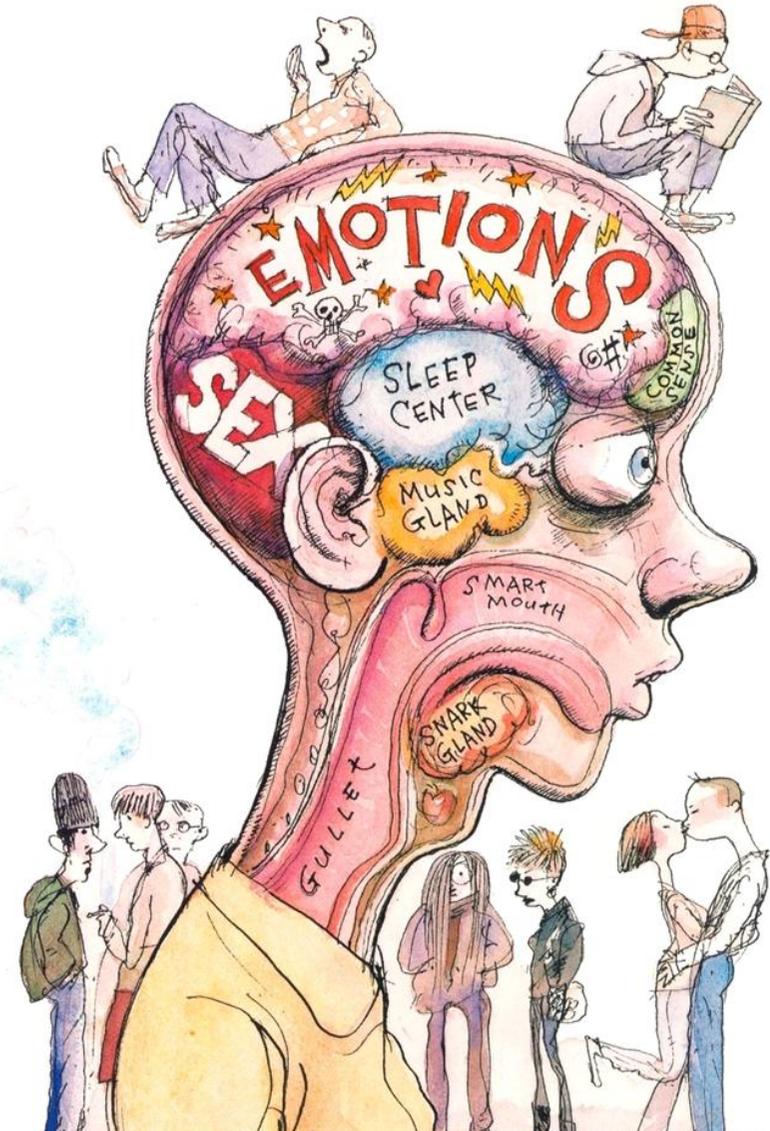
Amygdala

The so-called emotional center of the brain, the amygdala, is the part of the brain that is most sensitive to hormones. As the brain matures, the amygdala is the part of the brain that is most sensitive to hormones.



Important ages of majority and privileges

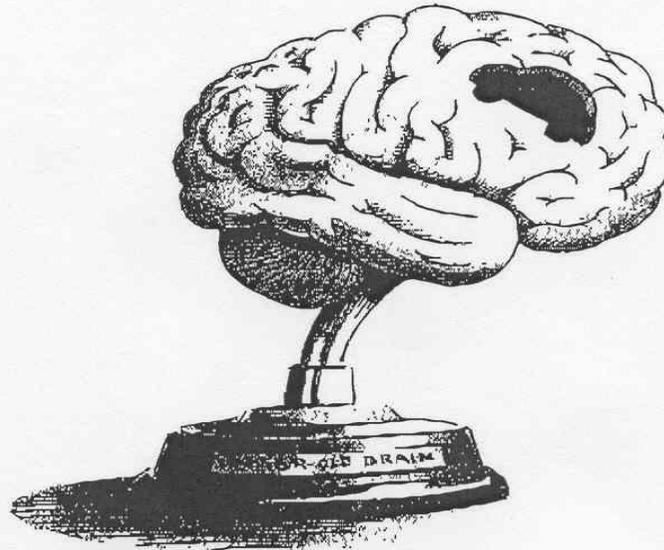
- 16** - emancipation
- driving
- 18** - gambling (usually age 21 when alcohol served)
- smoking (some at age 19)
- military
- 21** -drinking



Why do most 16-year-olds drive like they're *missing a part of their brain?*



BECAUSE THEY ARE.



EVEN BRIGHT, MATURE TEENAGERS SOMETIMES DO THINGS THAT ARE "STUPID."

But when that happens, it's not really their fault. It's because their brain hasn't finished developing. The underdeveloped area is called the dorsal lateral prefrontal cortex. It plays a critical role in decision making, problem solving and understanding future consequences of today's actions. Problem is, it won't be fully mature until they're into their 20s.

It's one reason 16-year-old drivers have crash rates three times higher than 17-year-olds and five times higher

crashes. These laws restrict the more dangerous kinds of driving teens do, such as nighttime driving and driving with teen passengers. Since North Carolina implemented one of the most comprehensive GDL laws in the country, it has seen a 25% decline in crashes involving 16-year-olds.

To find out what the GDL laws are in your state, visit Allstate.com/teen. Help enforce them—and if they aren't strong enough, ask your legislator to strengthen them.

Let's help our teenagers not miss out on tomorrow just

**Allstate ad, *NY Times*,
May, 2007**

An Immature Brain = Less Brakes on the “Go” System

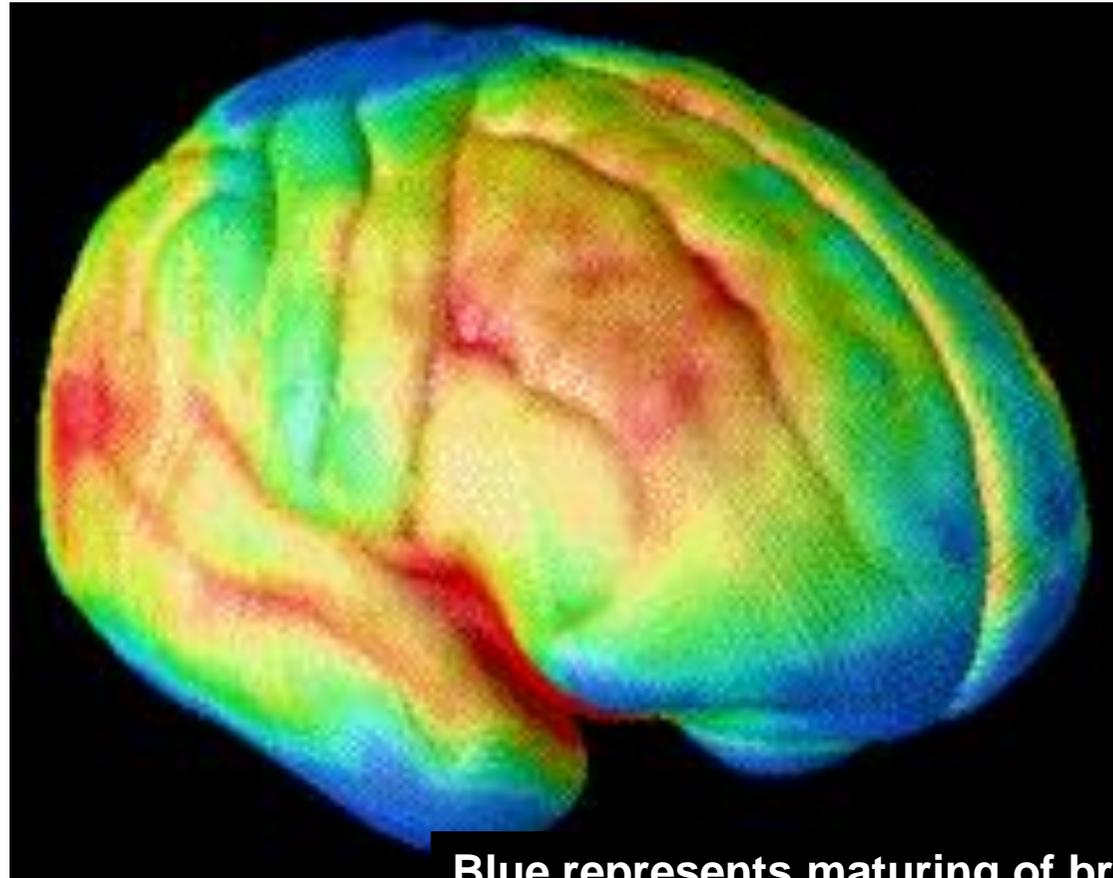


Maturation Occurs from Back to Front of the Brain

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

Earlier:
Motor Coordination
Emotion
Motivation

Later:
Judgment

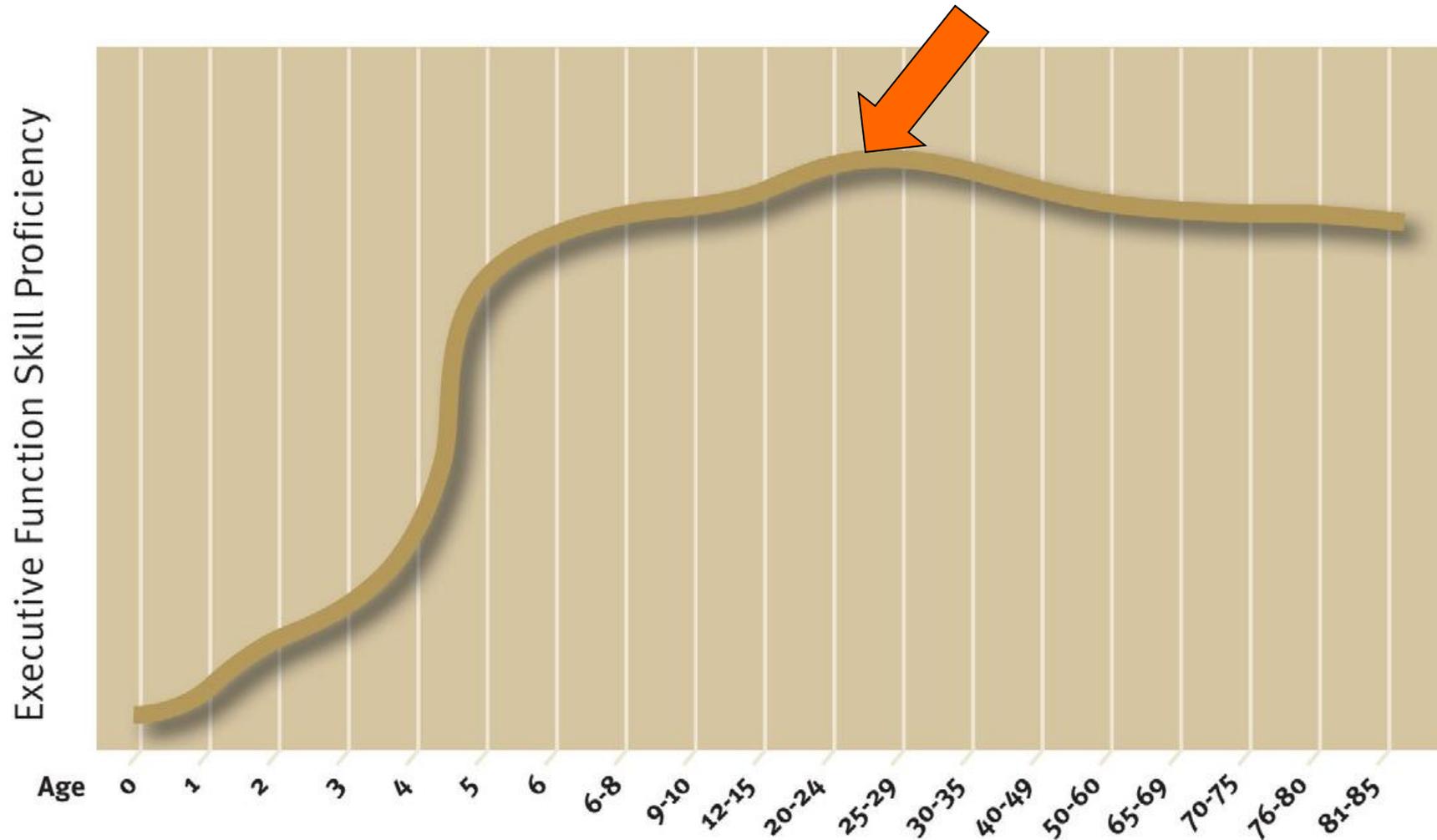


Blue represents maturing of brain areas

Limbic or Go System



Executive Function Skills Build Into the Early Adult Years



Source: Weintraub et al. (Submitted for Publication)

Tests measuring different forms of executive function skills indicate that they begin to develop shortly after birth, with ages 3 to 5 a window of opportunity for dramatic growth in these skills. Development continues throughout adolescence and early adulthood.

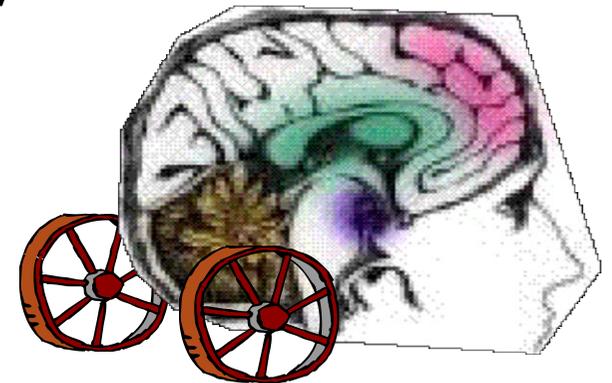
Construction Ahead



- When the pruning is complete, the brain is faster and more efficient.



- **But...** during the pruning process, the brain is not functioning at full capacity.

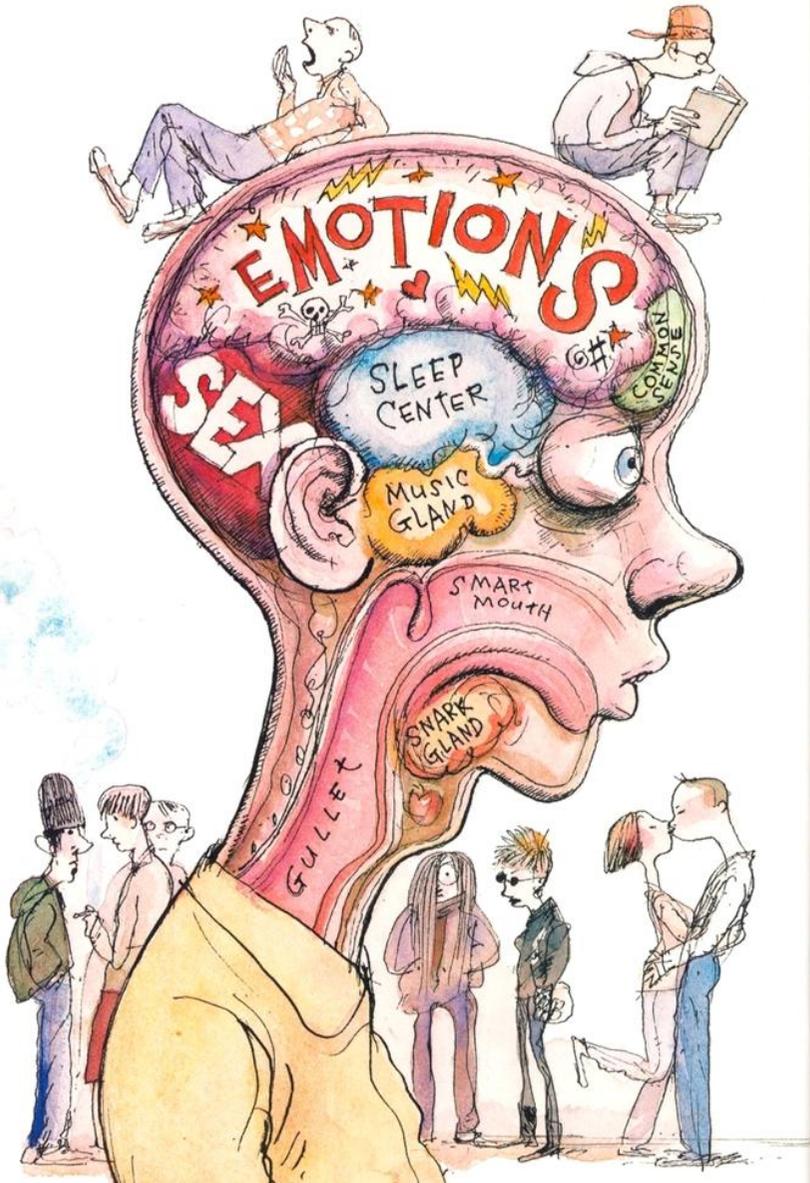


Implications of Brain Development for Adolescent Behavior

- **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 emotional arousal**
 - 6. consideration of negative conseq.**
- **Greater tendency to...**
 - 7. be attentive to social information**
 - 8. take risks and show impulsiveness**

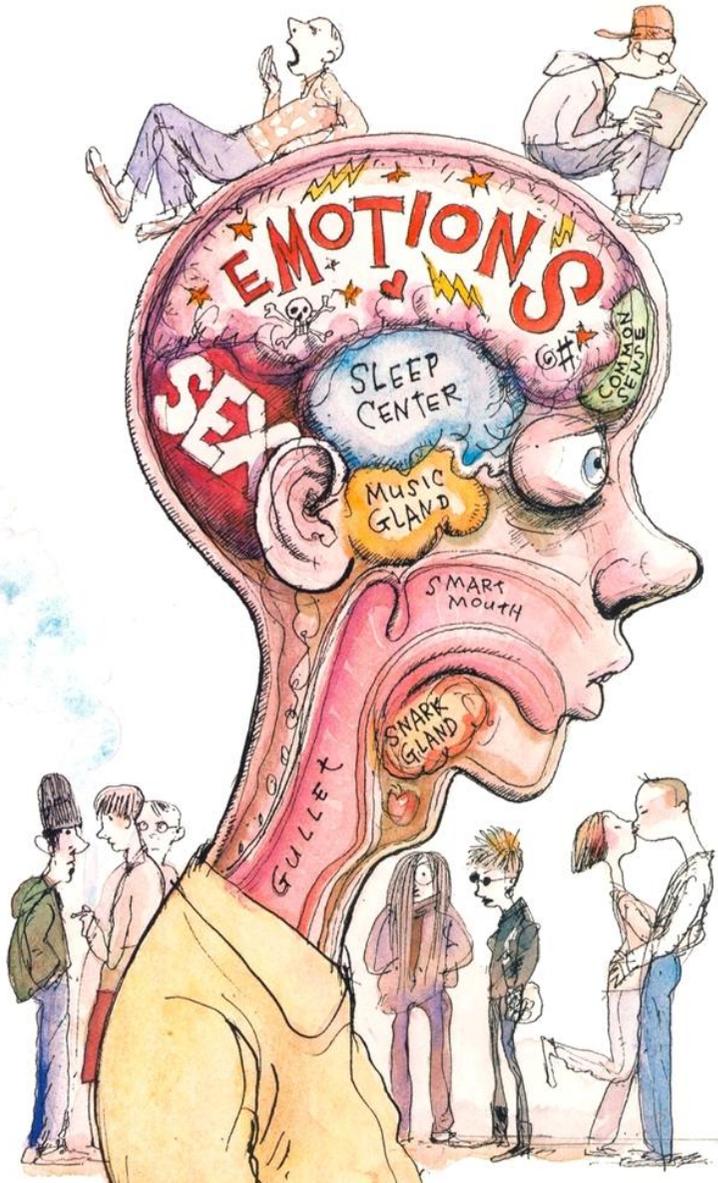


An Immature Brain \neq Low Brain Power

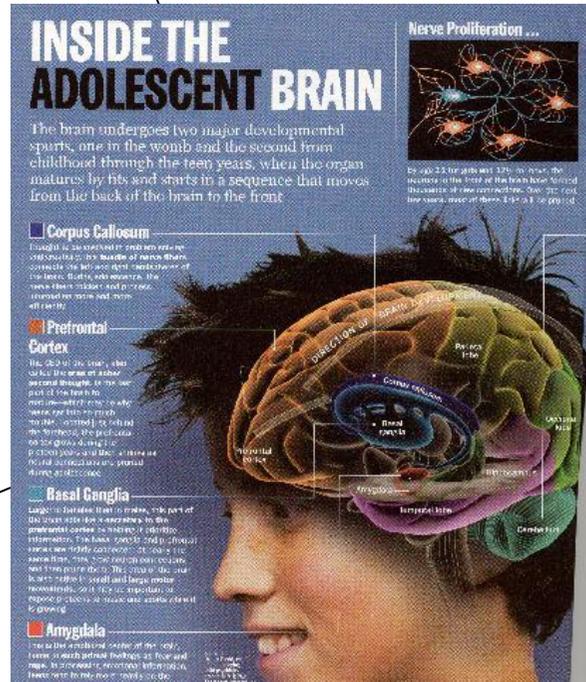


An Immature Brain ≠

Risky Judgment is Pervasive



1. Addiction & the brain

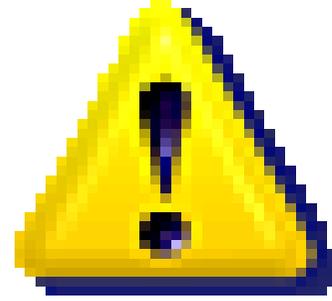


2. Developing brain

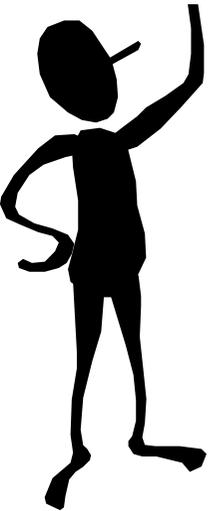
3. Developing brain & alcohol



Implications of Brain Development for Drug Abuse Vulnerability



Are adolescents more susceptible than adults to alcohol?



4 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.**



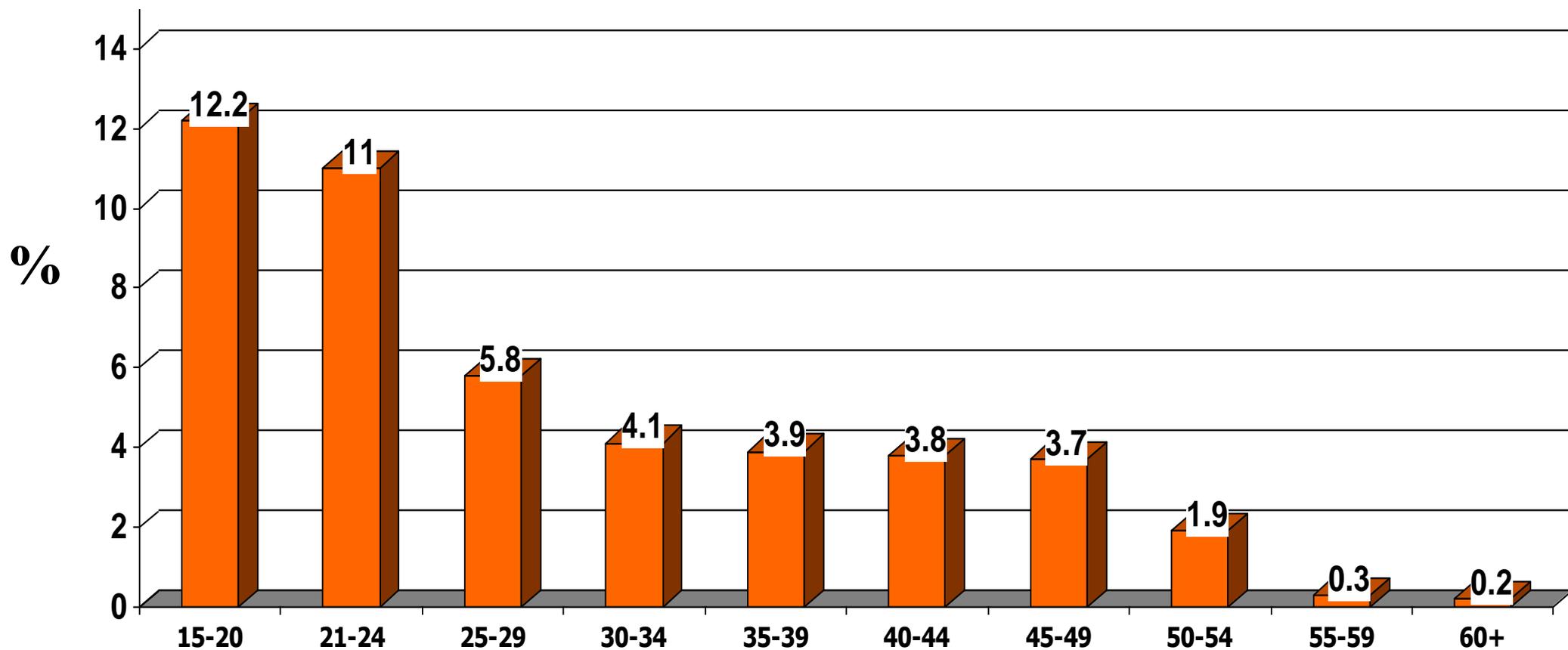
1. Evidence from epidemiological studies

Drug abuse starts early and peaks in teen years



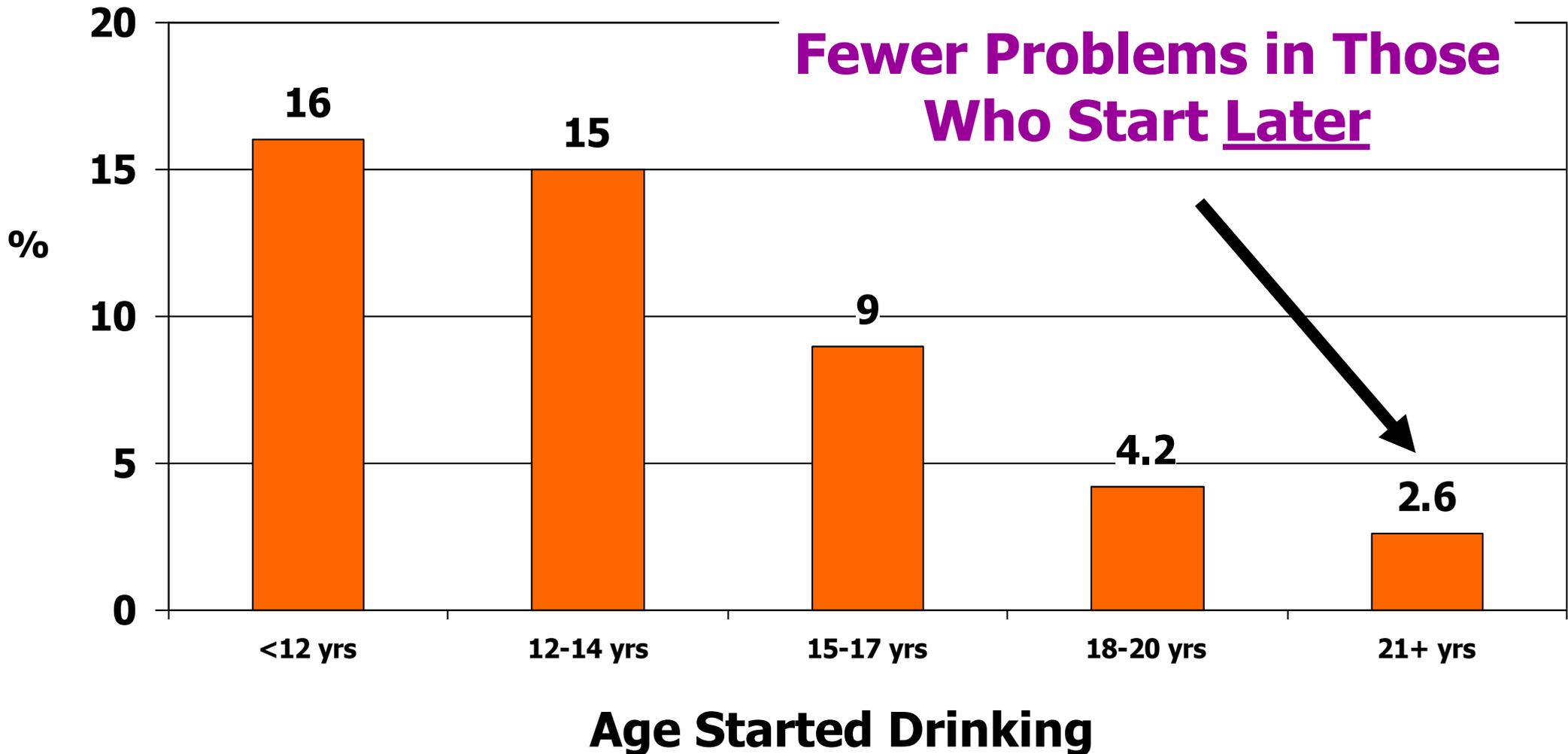
Prevalence of Past-Year DSM-IV Alcohol Dependence: United States, 2001-2002

(Grant, B.F., et al., *Drug and Alcohol Dependence*, 74, 223-234, 2004)

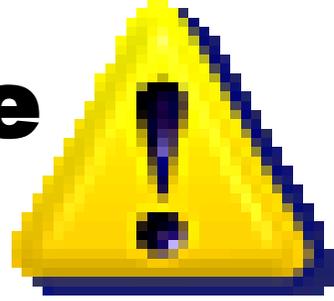


Percentages of Past Year Alcohol Use Disorder (Abuse or Dependence) Among Adults Aged 21 or Older, by Age of First Use (SAMHSA, 2005)

Fewer Problems in Those Who Start Later



Are adolescents more susceptible to alcohol than adults?



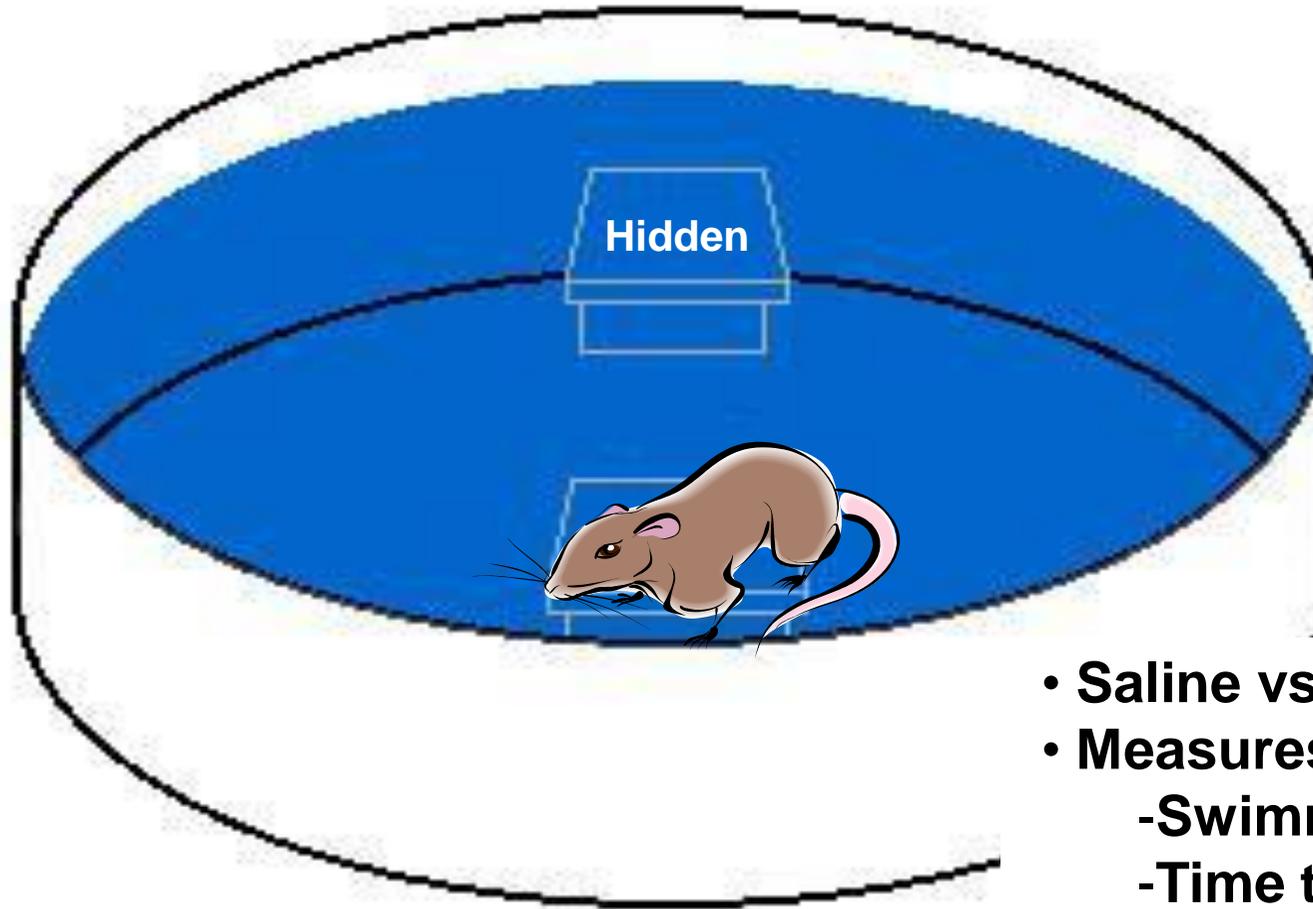
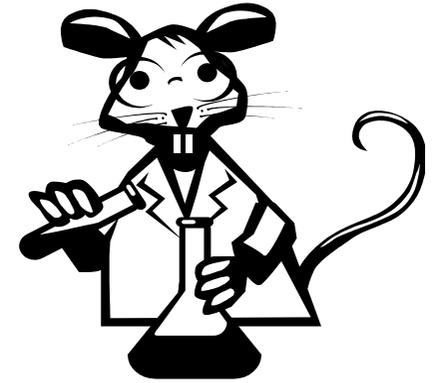
1. Epidemiological data

2. Adolescent rats are less sensitive to the sedative and motor impairment effects of intoxication.

3. Adolescent rats are more sensitive to the social disinhibition effects of alcohol.

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

The Water Maze Test



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

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



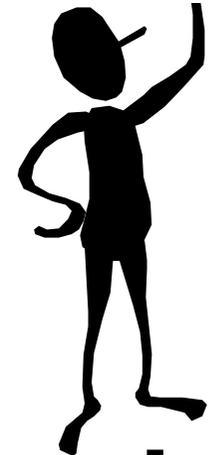
Sure!



Are adolescents more susceptible to alcohol than adults?



1. Epidemiological evidence
2. Adolescent rats are less sensitive to the sedative motor impairment effects of intoxication.
3. Adolescents are more sensitive to the social disinhibition effects of alcohol.



4. Alcohol may produce greater cognitive disruptions in adolescents.

Animal Data: Alcohol's Effects on Memory

4. Adolescent rats more sensitive to..

- **disruption in memory**
- **impairment of neurotransmission in hippocampus and cortex**



Human Data: Alcohol's Effects on Memory

4. Adolescents with a history of alcohol use disorder....

Poorer memory performance

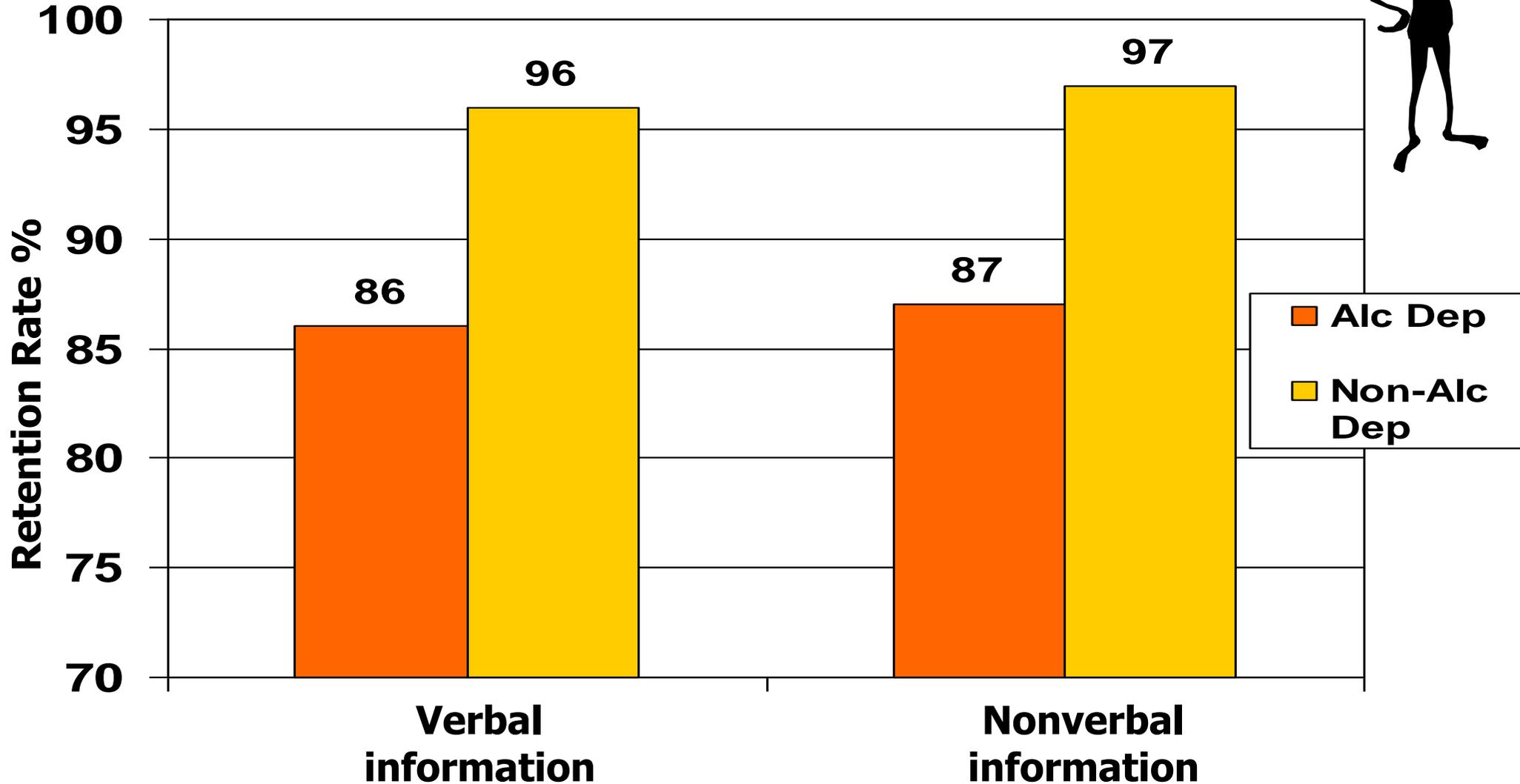


Hippocampus volume (10%)

Hippocampus converts information to memory

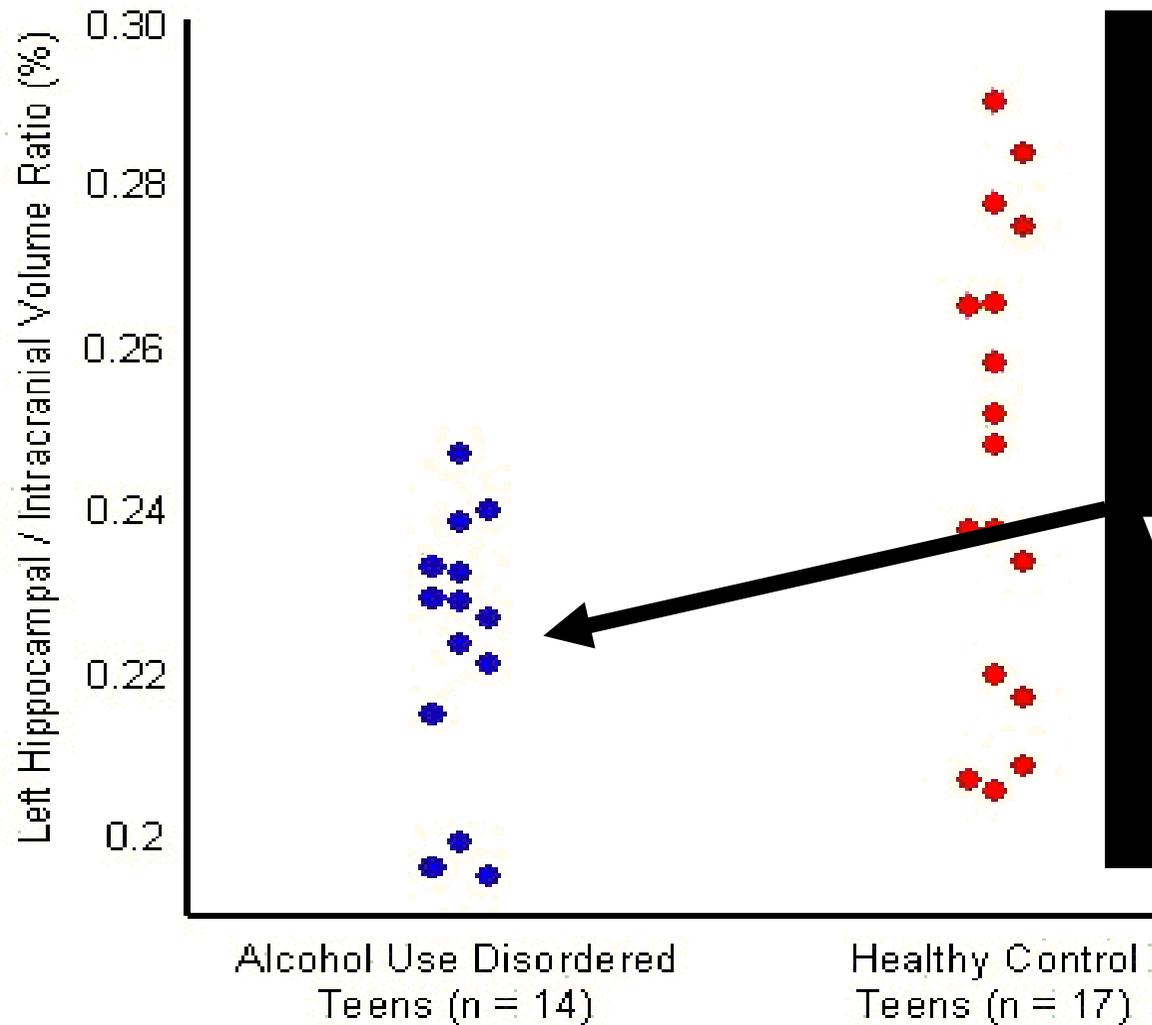


Human Data: Alcohol's Effects



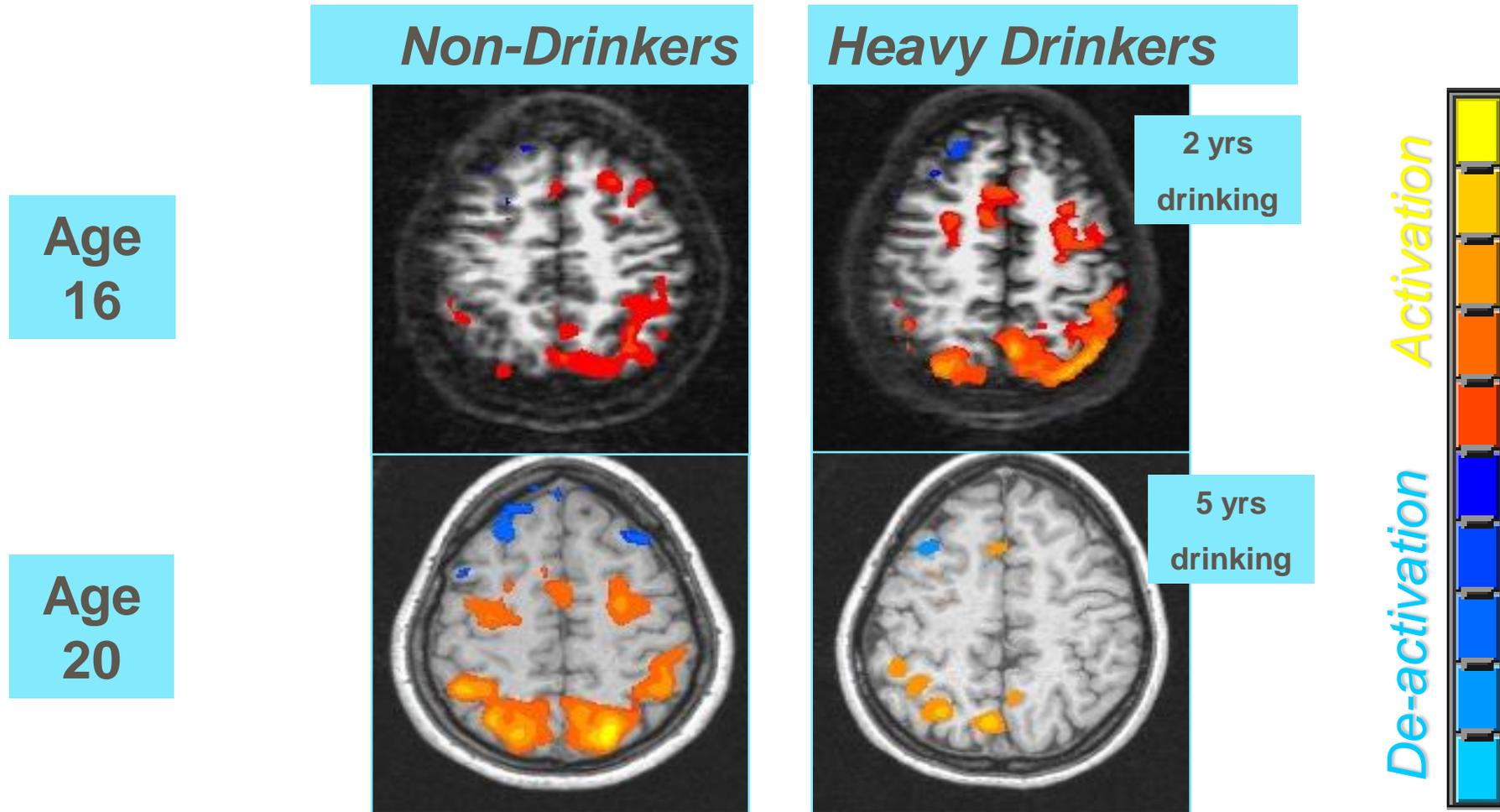
Source: Brown et al., 2000

MRI: Hippocampal Size



10% smaller volume

Teen Drinking & Brain Activation



WHY?

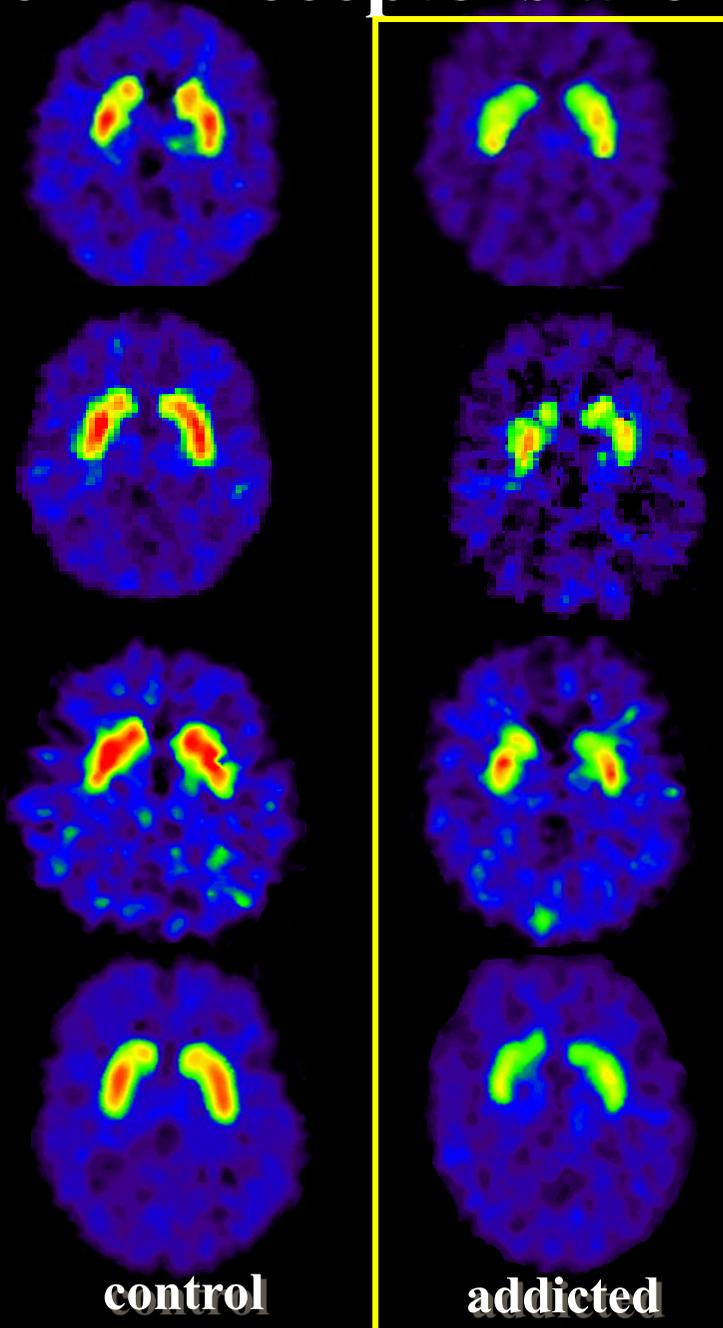
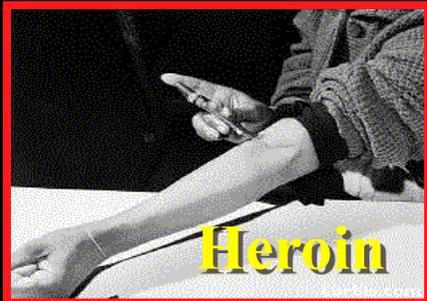
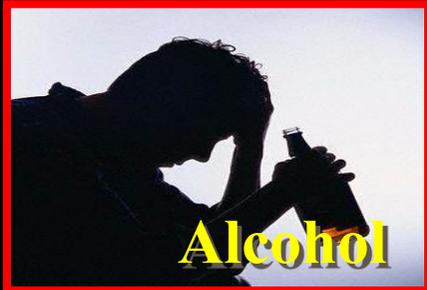


Implications of Brain Development for Adolescent Behavior

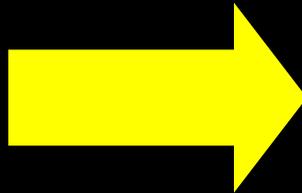
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Dopamine D2 Receptors are Lower in Addiction



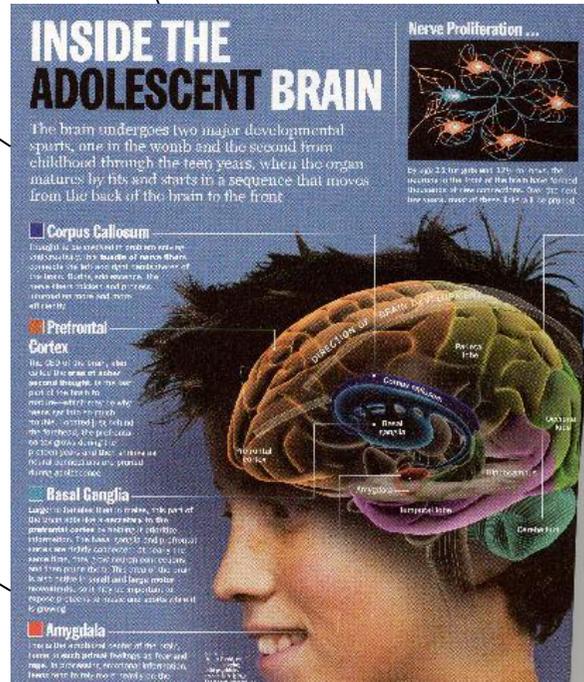
DA D2 Receptor Availability



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4. Summary & clinical implications

3. Developing brain & alcohol



2. Developing brain



Summary

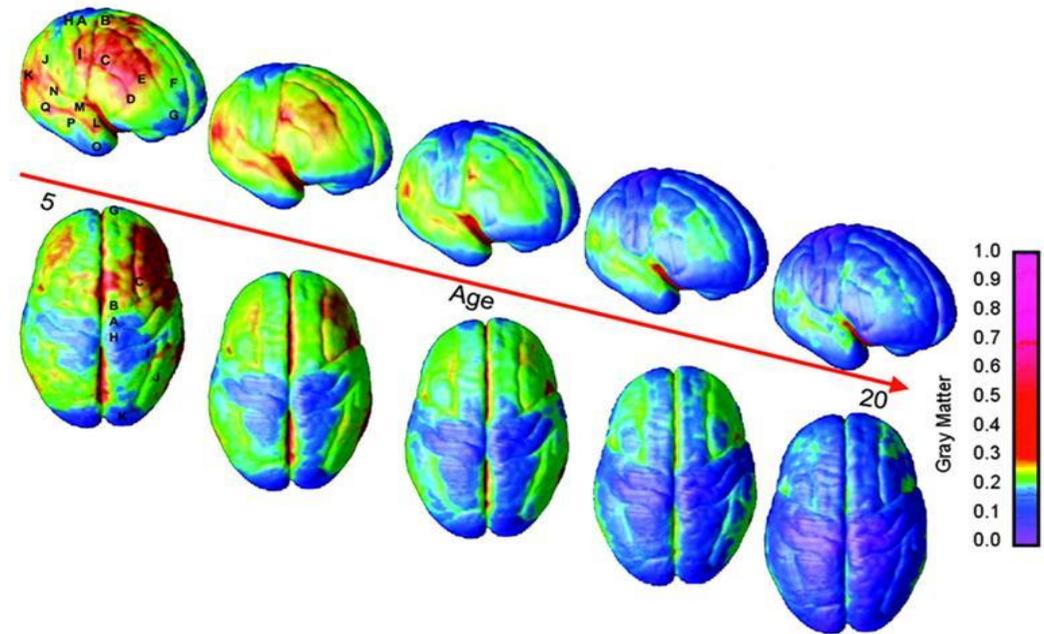
- **Adolescence is an extended period of transition from reliance on adults to independence**
- **Normal adolescence is characterized by....**
 - **increase in conflicts with family members**
 - **desire to be with one's friends**
 - **resistance to messages from authority**
 - **irritability**
 - **risk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



Summary

- The brain undergoes a considerable amount of development during the teen years.
- The last area to mature is the prefrontal cortex region; involved in planning, decision making and impulse control.

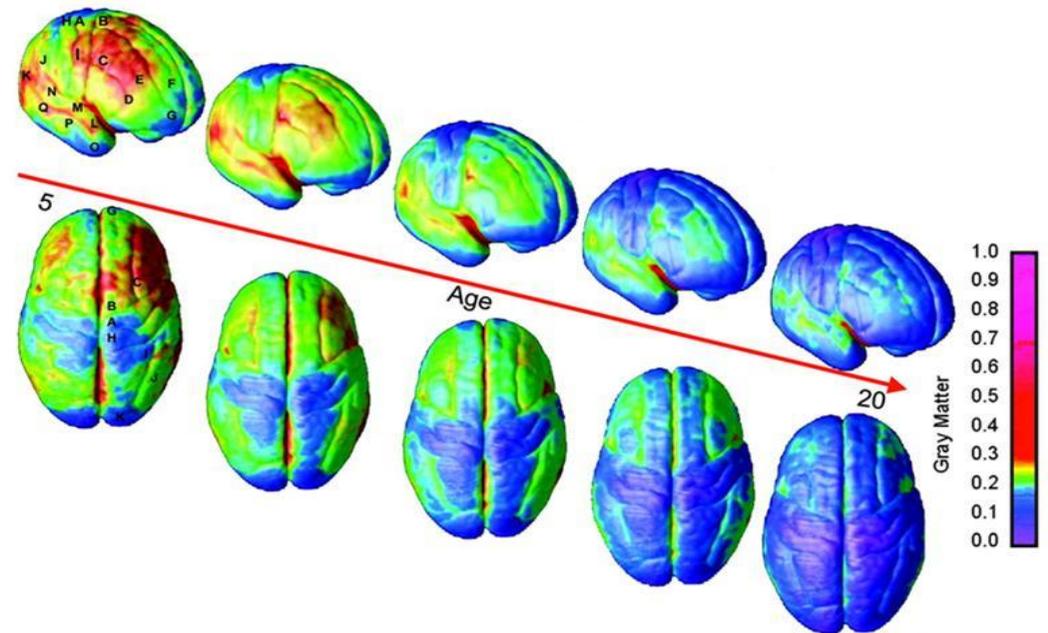
Gray Matter Maturation
(Gogtay et al., 2004)



Summary

**reward incentives
> perception of
consequences**

Gray Matter Maturation
(Gogtay et al., 2004)



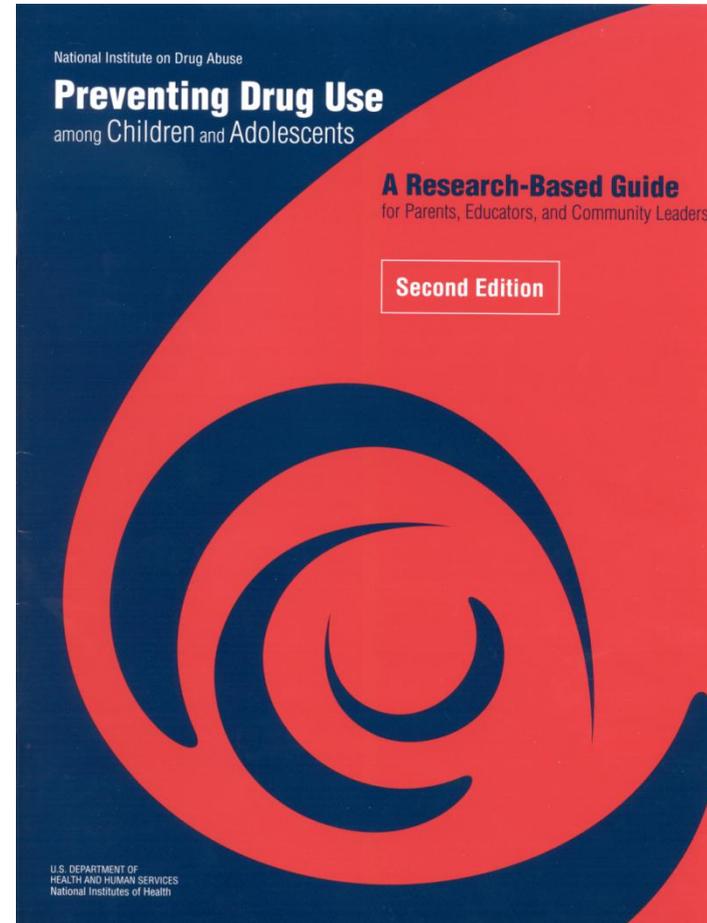
Summary

- **Several lines of evidence suggesting that adolescence is a period of vulnerability to the effects of drugs, as well as to several behavioral and mental disorders.**



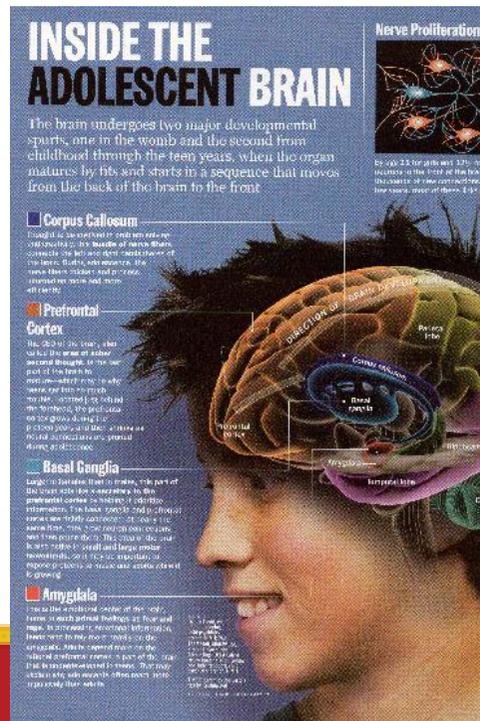
Brain Development: Reinforcing Need for Prevention and Treatment

- **Prevention and treatment programs for youth are vital.**



Brain Development: Opportunities for Prevention and Treatment

- Discuss the implications of brain development and decision making with both parents and youth.



Working with Parents

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 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.



Brain Development: Implications for Prevention and Treatment

Use CBT and Motivational Interviewing approaches to teach important skills associated with self-control

impulse control

“second” thought processes

social decision making

dealing with risk situations

taking healthy risks



New 12-Step Program for Adolescents ?

12-Steps of Self-Regulation

- 1. impulse control**
- 2. "second thought" processes**
- 3. social decision making**
- 4. dealing with risk situations**
- 5. taking healthy risks**
- 6. attention regulation**
- 7. anger control**
- 8. modulating reward incentives**
- 9. choosing options**
- 10. considering consequences**
- 11. minimizing arousal**
- 12. dealing with peer influences**

THANK YOU!

