
McLane Children's
SCOTT&WHITE

# *Adolescent Brain Development*

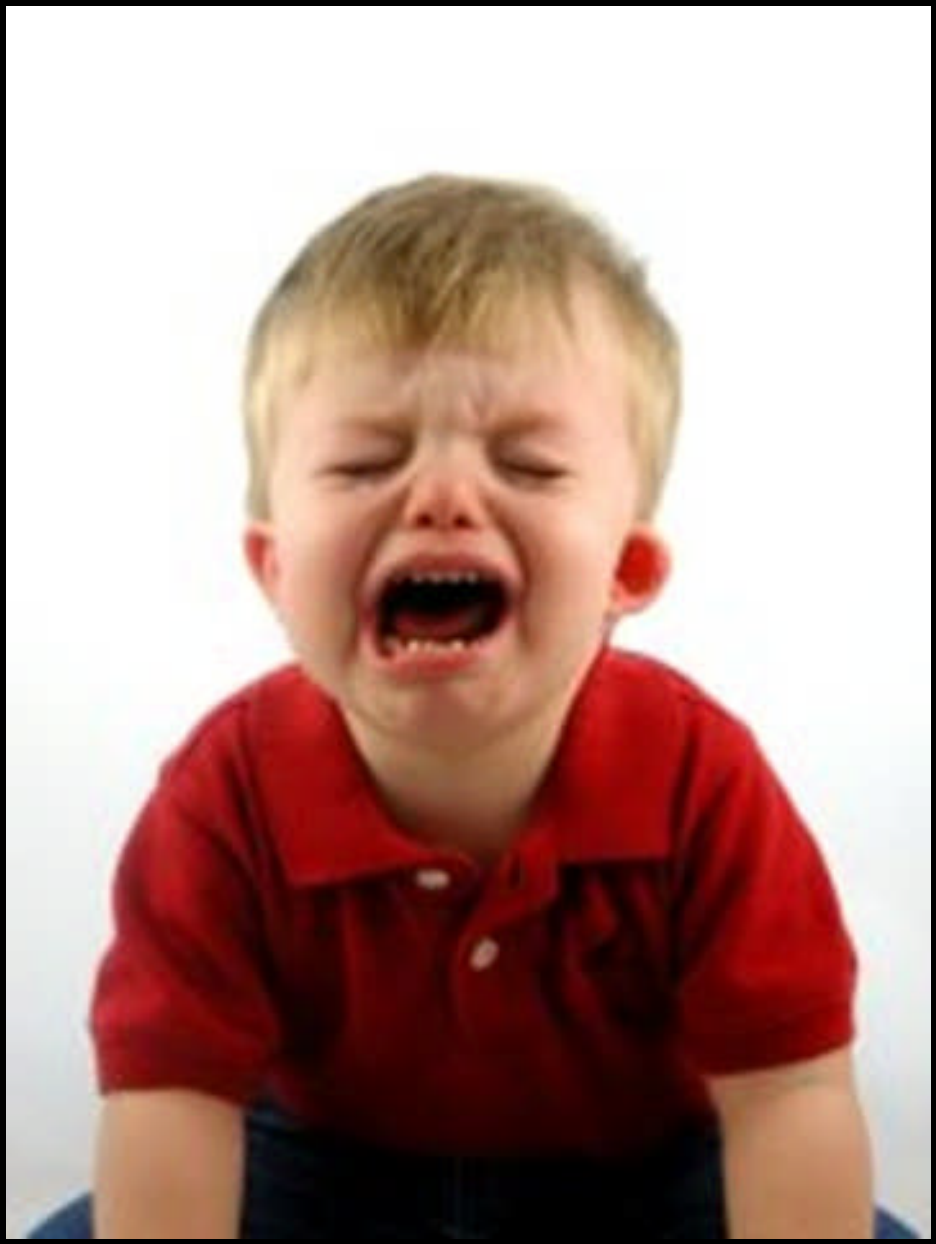
Meera Beharry, MD, FAAP
Adolescent Medicine Section Chief
McLane Children's Hospital
Scott & White

# *Objectives*

- Review current data re: Adolescent Brain development
- Describe findings of known and suspected pathology
- Discuss implications of data for work with youth

# *Brief Review of Adolescence*

- Transition from child to adult
- Physical maturation - puberty
- Social maturation
- Emotional maturation




MAY 10, 2004
TIME
TROY:
THE MAKING
OF AN EPIC
SECRETS
OF
THE
TEEN
BRAIN
Research is revolutionizing our
view of the adolescent mind—and
explaining its mystifying ways
www.time.com AOL Keyword: TIME

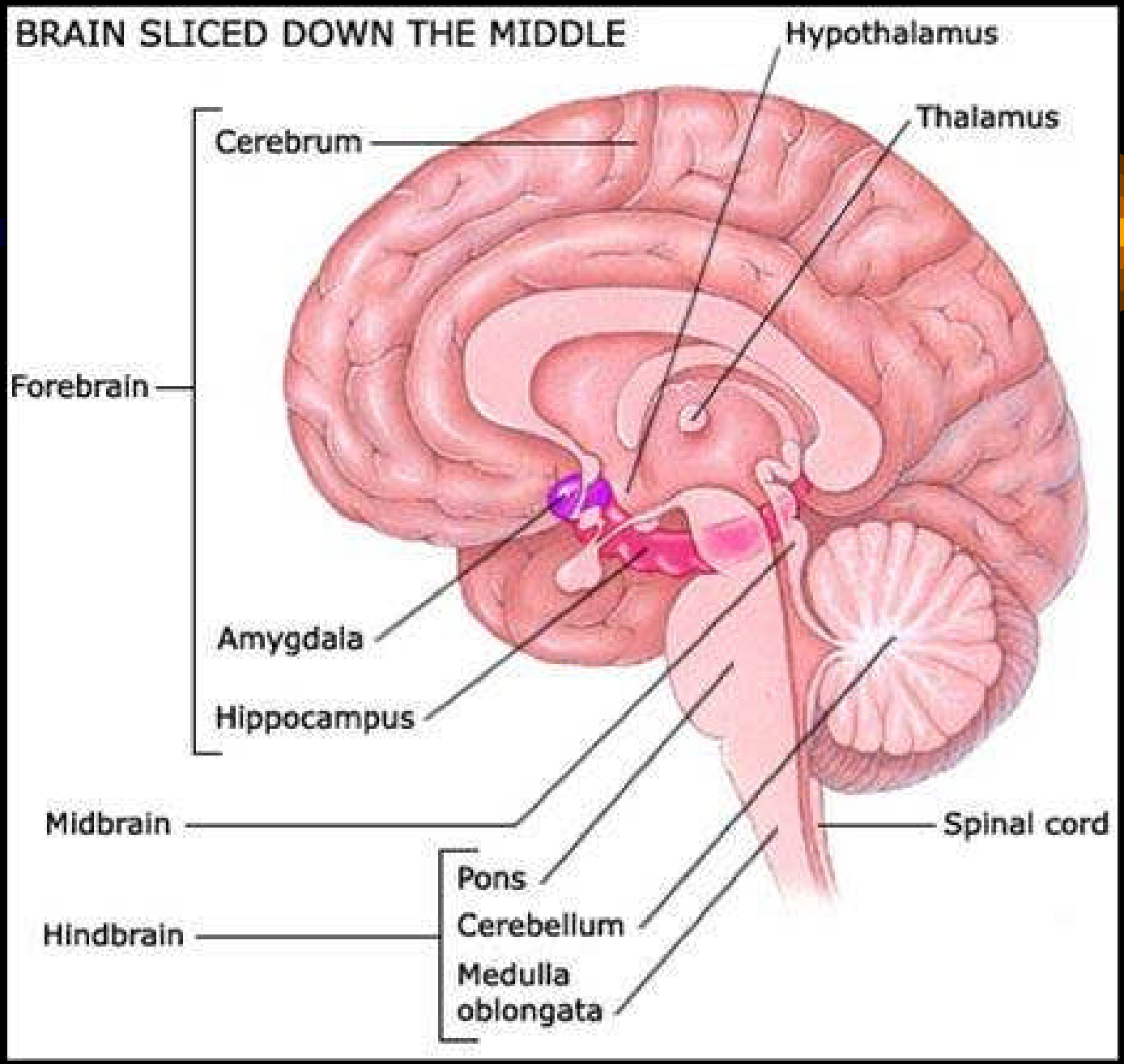
# *New data*

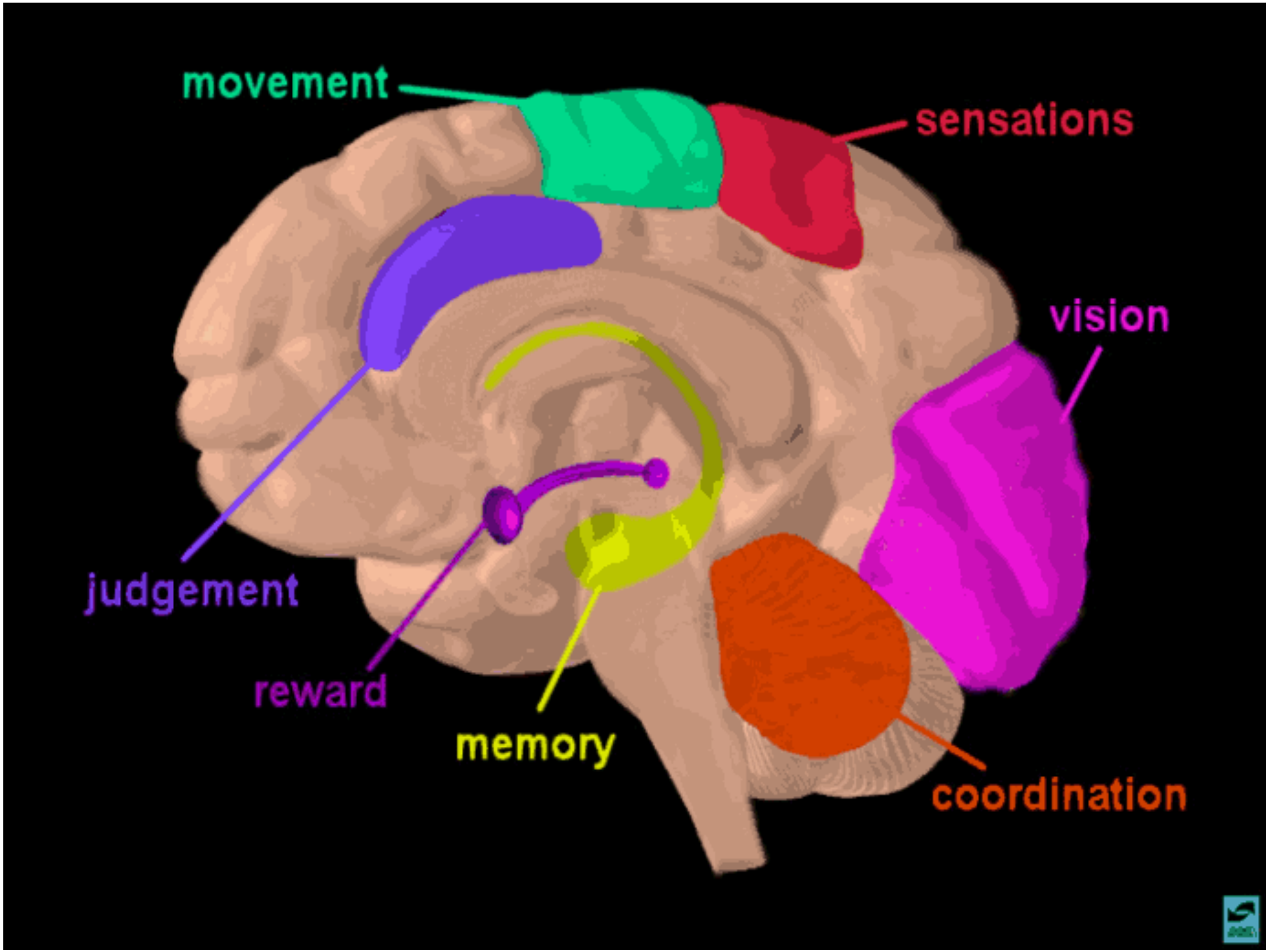
- Dr. Jay Giedd and MRI
- Brain develops until 25 years old

Giedd, J. The Teen Brain: Insights from Neuroimaging. Journal of Adolescent Health 42 (2008) 335-343.

# *Structures of Significance*

- Pre-frontal Cortex – Executive Function
- Amygdala – emotion and associated memory
- Nucleus accumbens – motivation/reward/punishment
- Cerebellum – co-ordination/balance


BRAIN SLICED DOWN THE MIDDLE
Hypothalamus
Thalamus
Cerebrum
Forebrain
Amygdala
Hippocampus
Midbrain
Spinal cord
Pons
Hindbrain
Cerebellum
Medulla
oblongata

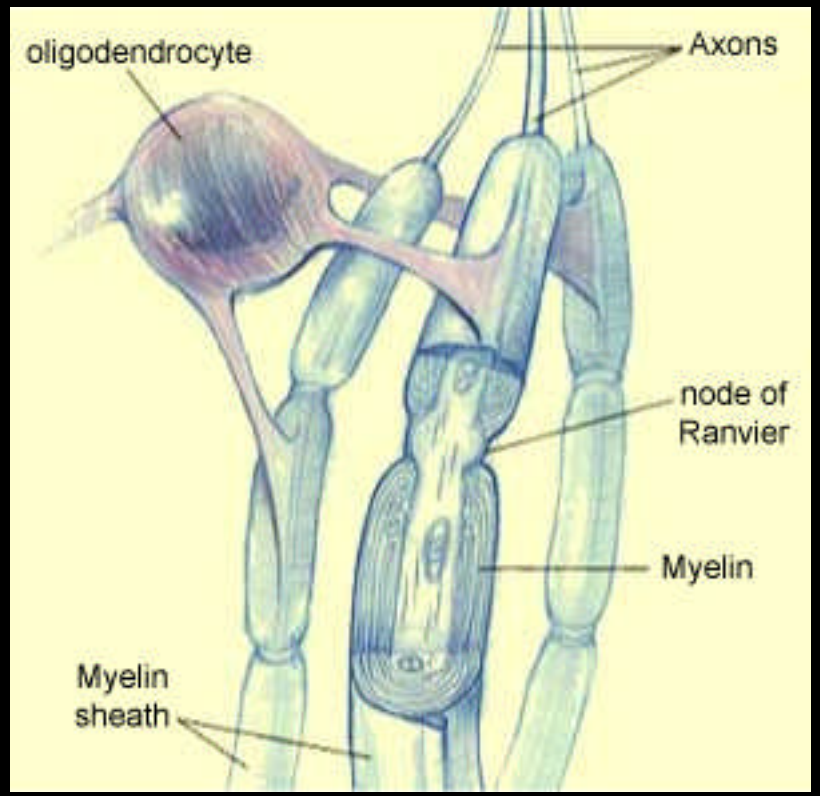

movement
sensations
vision
judgement
reward
memory
coordination

# *The Stress Response: Fight-Flight-or-Freeze*

- Physiology
  - H-P-A Axis, Catecholamines
  - Acute: Physical symptoms
  - Chronic: Multiple organ systems
- Brain and Behavior: “Lizard Brain”
  - Overwhelming emotions
  - Cognition: Rumination
  - Behaviors: Reactive, Impulsive
  - Triggers: Internal or external, Real or Perceived

Vo D. Am J Men’s Health. 2008;2(4):353

# *Myelin*




- Oligodendrocyte makes the myelin for axons in brain
- Node of Ranvier is left uncovered
- Saltatory conduction
- White matter

# *Gray Matter v. White Matter*

- Gray Matter
- White matter

# *Growth and Pruning*

# *Findings*

- Growth and Pruning
  - Second trimester of gestation
  - Late Adolescence
- Difference
  - In utero birth and pruning of new cells
  - Adolescent growth and pruning of new synapses

# *Process: Growth Spurt*

- Between age 6- 12 a growth spurt of synaptic elaboration-gray matter
- Brain growth is independent of body growth
- Girls peak = 10
- Boys = 14.5
- By the end of childhood the brain has 1,000,000,000,000,000 connections

Giedd, J. The Teen Brain: Insights from Neuroimaging. JAH 42 (2008) 335-343.

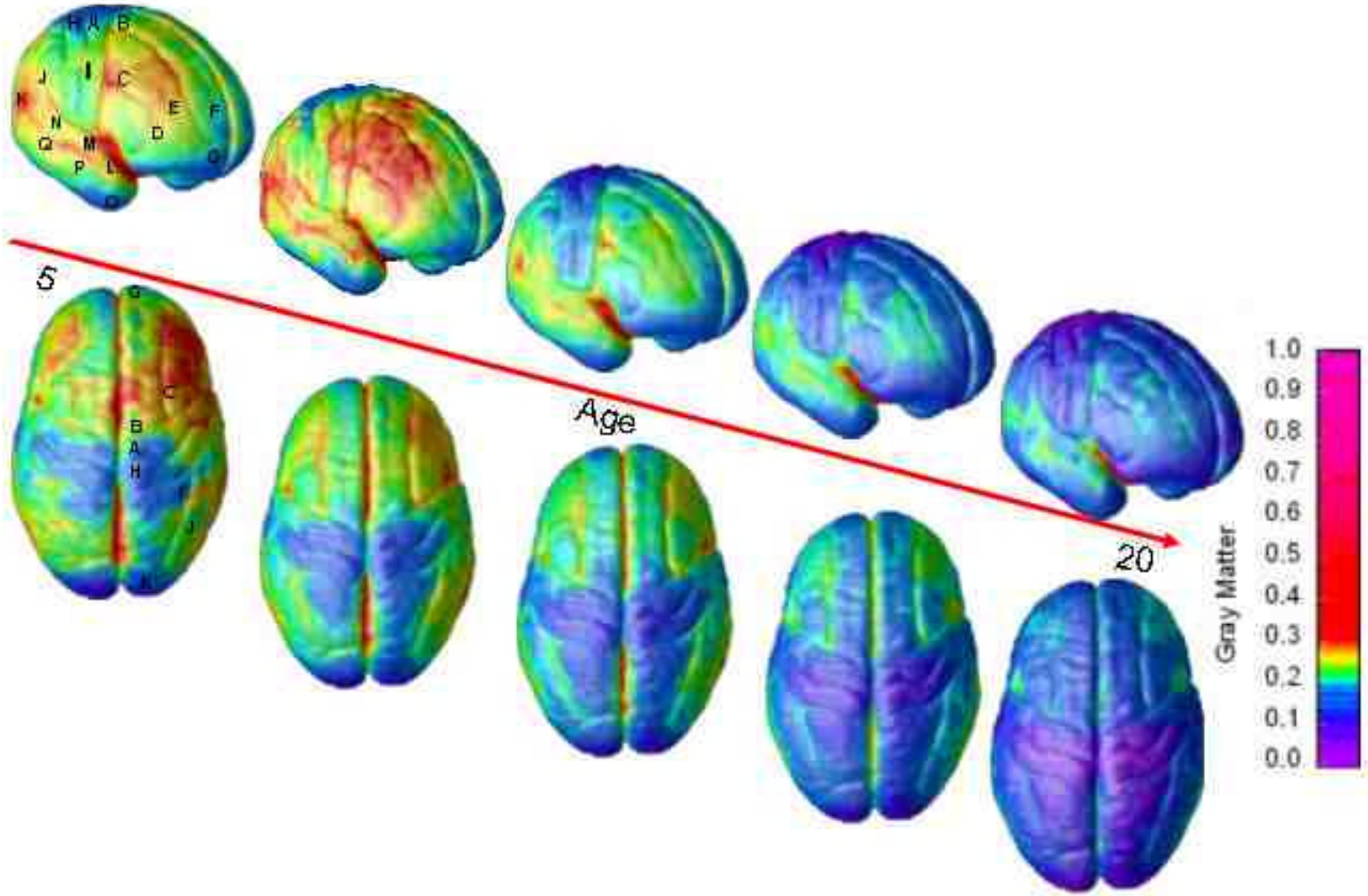
# *Process: Pruning*

- Puberty to 25 years old- unused gray matter dies
- White matter thickens- increasing transmission of information

# *Supporting Data*

- Dr. Nitin Gogtay brain mapping to show 17 years of brain development over a few seconds
- Results:
  - Pre-frontal cortex is last to develop
  - Increased density of dopamine connections in pre-frontal cortex  increases capacity to learn in response to reward

http://www.nimh.nih.gov/videos/press/prbrainmaturing.mpeg


5
Age
20
Gray Matter
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

# *Lizard Brain v. Wizard Brain*

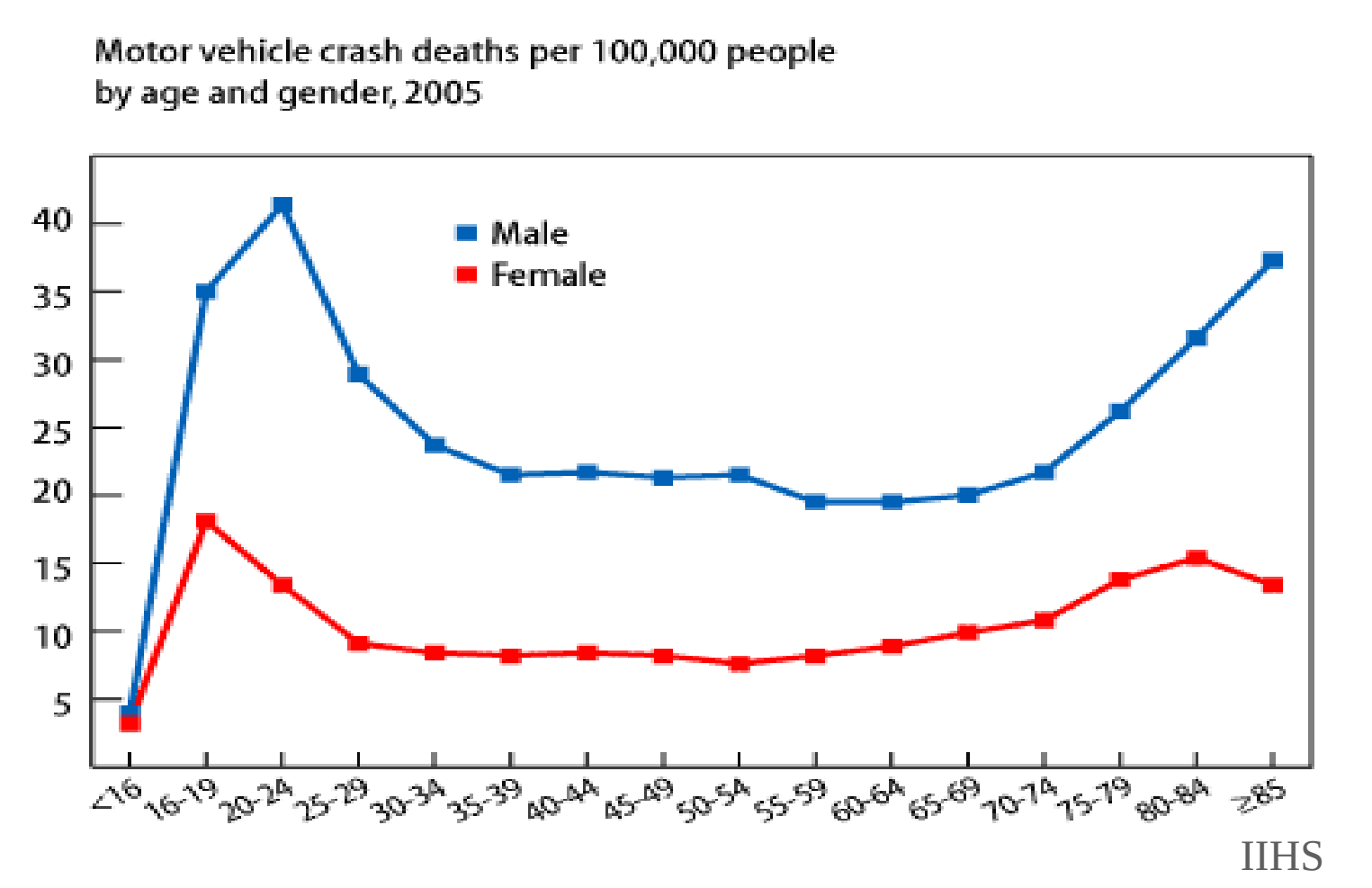
Limbic system:
amygdala/hippocampus

Pre-frontal cortex

# *Data Implications*

- Brain with great potential at the beginning of puberty
- Which synaptic pathways develop and strengthen depend on exposure and experience
- Late development of reasoning

# *Motor Vehicle Accidents*



# *Adolescents and Sleep*

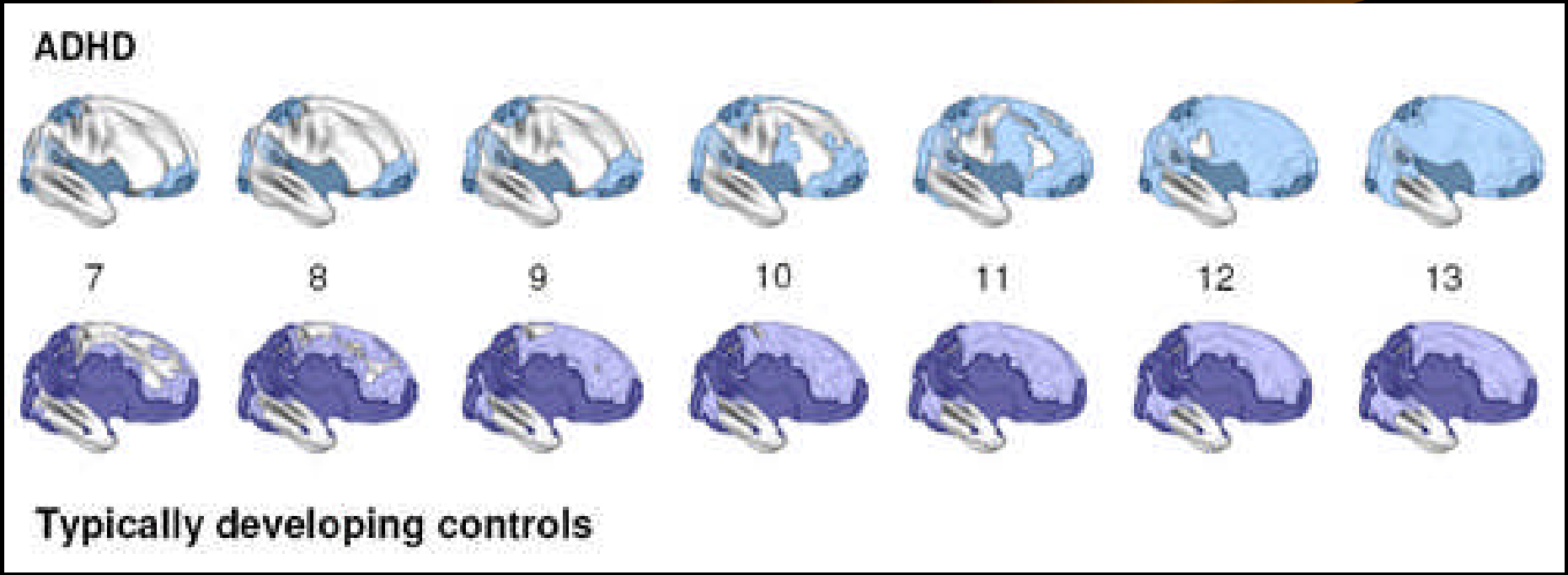
- Adolescents need 9.5 hours of sleep
- Most get 7
- Melatonin production continues later into the morning for teens compared to younger children

http://www.stanford.edu/~dement/adolescent.html
http://www.cehd.umn.edu/research/highlights/Sleep/

# *ADHD*

- Prevalence of 5-16%
- Must be differentiated from other causes of inattention and hyperactivity

# *ADHD v. normal*




http://www.nimh.nih.gov/videos/press/ADHDDelayRtSideWeb.mp4

# *Tips to help kids with ADHD*

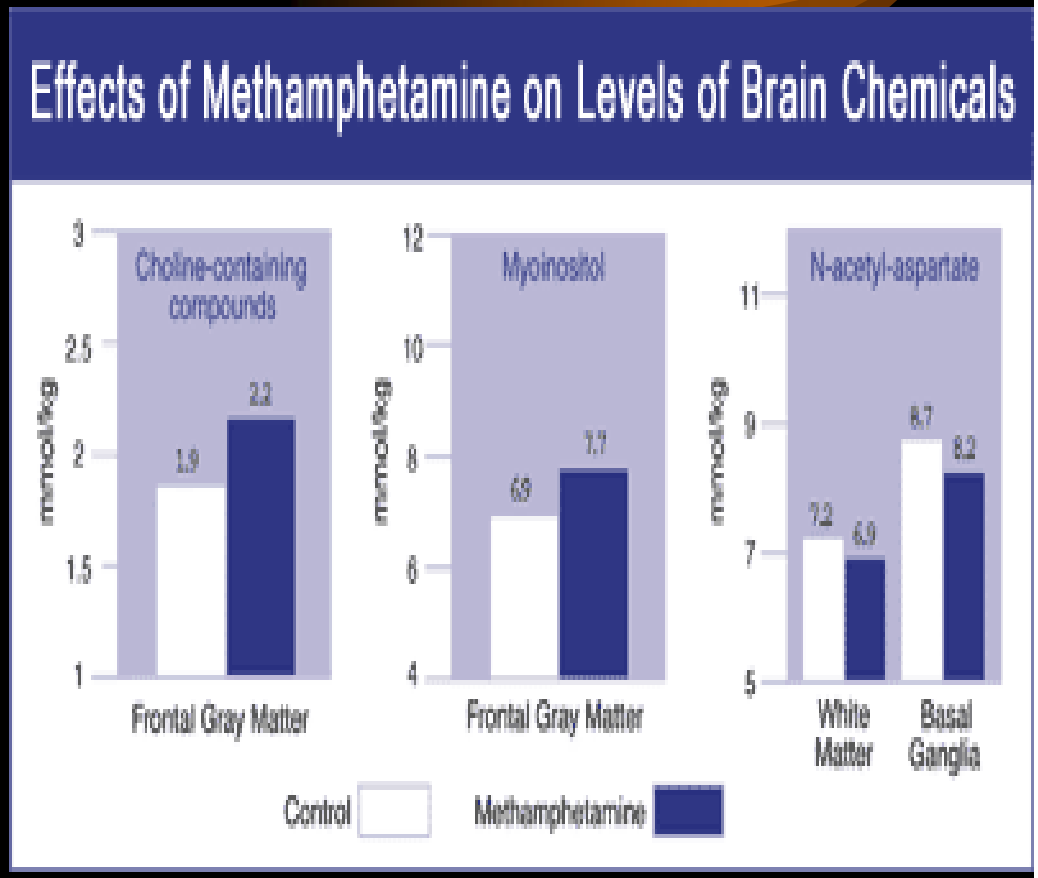
- **Schedule**. Keep the same routine every day, from wake-up time to bedtime. Include time for homework, outdoor play, and indoor activities. Keep the schedule on the refrigerator or on a bulletin board in the kitchen. Write changes on the schedule as far in advance as possible.

# *More Tips*

- **Organize everyday items.**
  - Have a place for everything, and keep everything in its place. Including clothing, backpacks, toys.
- **Use homework and notebook organizers.**
- **Be clear and consistent.**
- **Give praise or rewards when rules are followed.**
  - Children with ADHD often receive and expect criticism. Look for good behavior, and praise it.

# *Substance use*

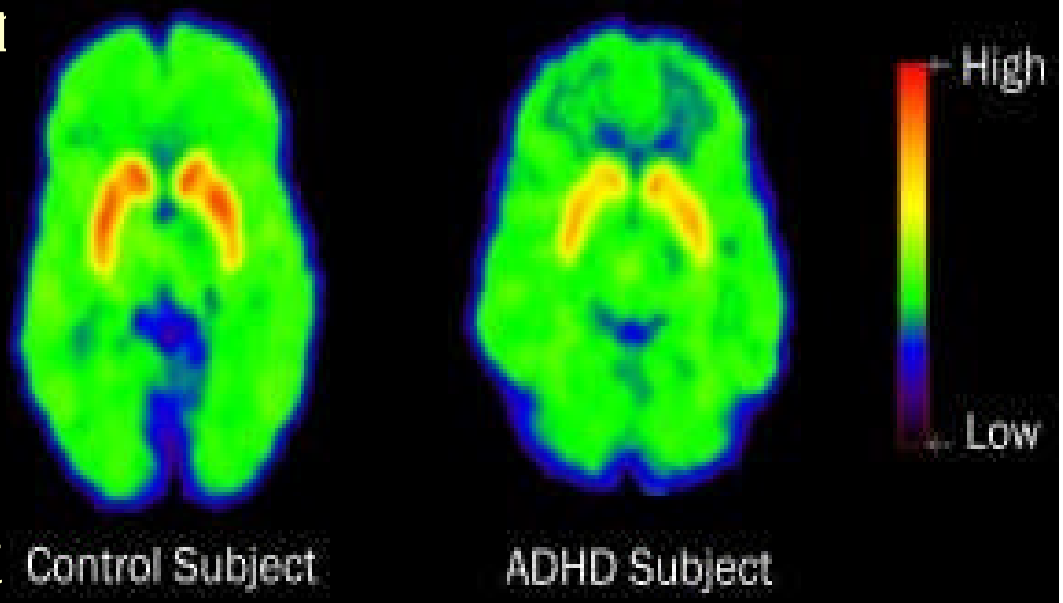
- Many substances that are commonly used by adolescents effect the dopaminergic pathway
- Adolescent brain may be particularly vulnerable to effects



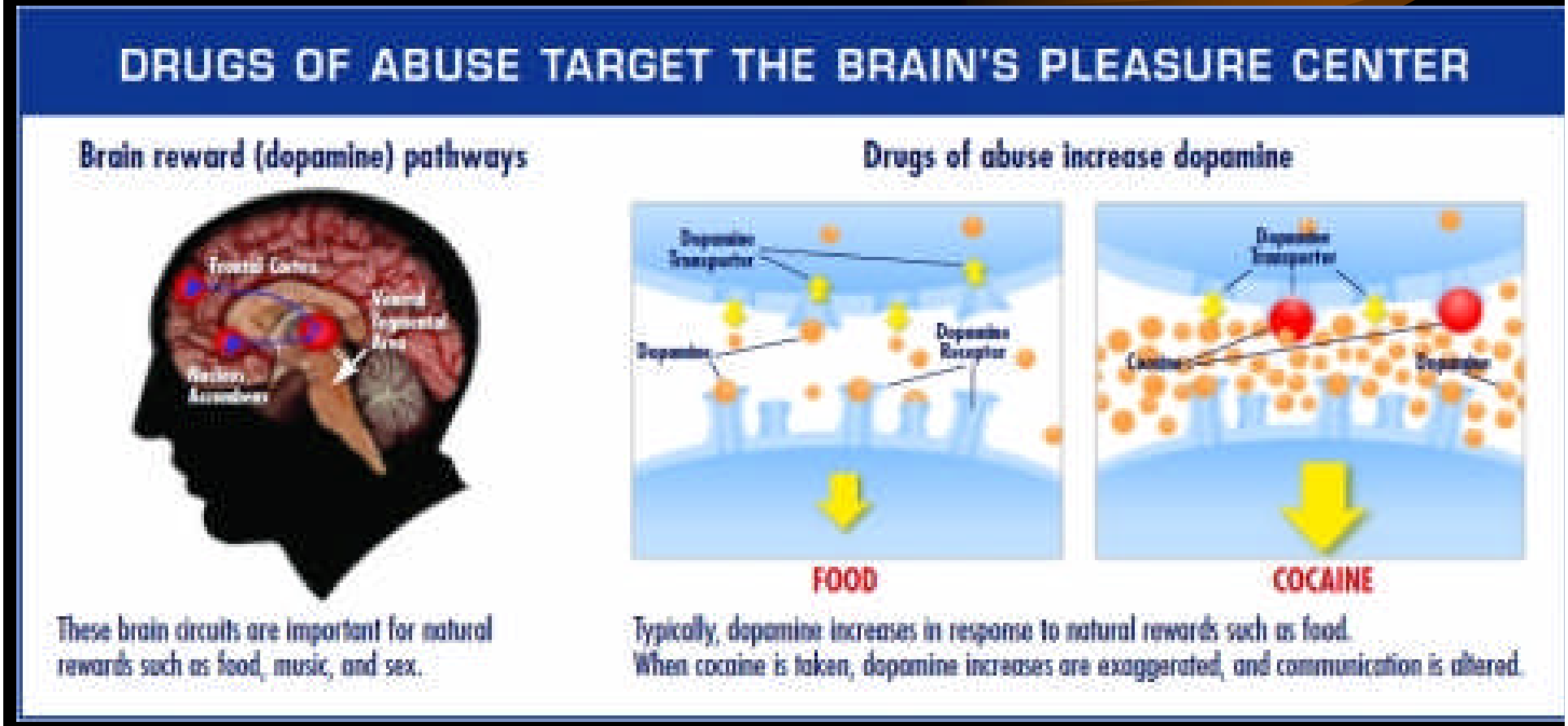

NIDA: http://www.drugabuse.gov/

# *So how do the meds help kids with ADHD?*

- Patients with ADHD have lower dopamine levels compared to kids without ADHD.
- Stimulant medications affect them differently.



# *What about other drugs?*




NIDA

# *Drug Use*

HOME PAGE | TODAY'S PAPER | VIDEO | MOST POPULAR | U.S. Edition

The New York Times

## Science

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

ENVIRONMENT | SPACE & COSMOS

OBSERVATORY

### Brain Shape Linked to Cocaine Addiction

By DOUGLAS QUENQUA
Published: February 4, 2013

Why are some people able to use cocaine without becoming addicted? A new study suggests the answer may lie in the shape of their brains.

**Related**

Observatory: Study Flags Duplicate Financing (February 5, 2013)

More Observatory Columns

**Connect With Us on Social Media**

Sporadic cocaine users tend to have a larger frontal lobe, a region associated with self-control, while cocaine addicts are more likely to have small frontal lobes, according to the study, which was published in the journal Biological Psychiatry.

The scientists, at the University of

FACEBOOK
TWITTER
GOOGLE+
SAVE
E-MAIL
SHARE
PRINT
REPRINTS

T POPULAR | TIMES TOPICS

## Research

TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

Go

**Inside Health**

Research | Fitness & Nutr

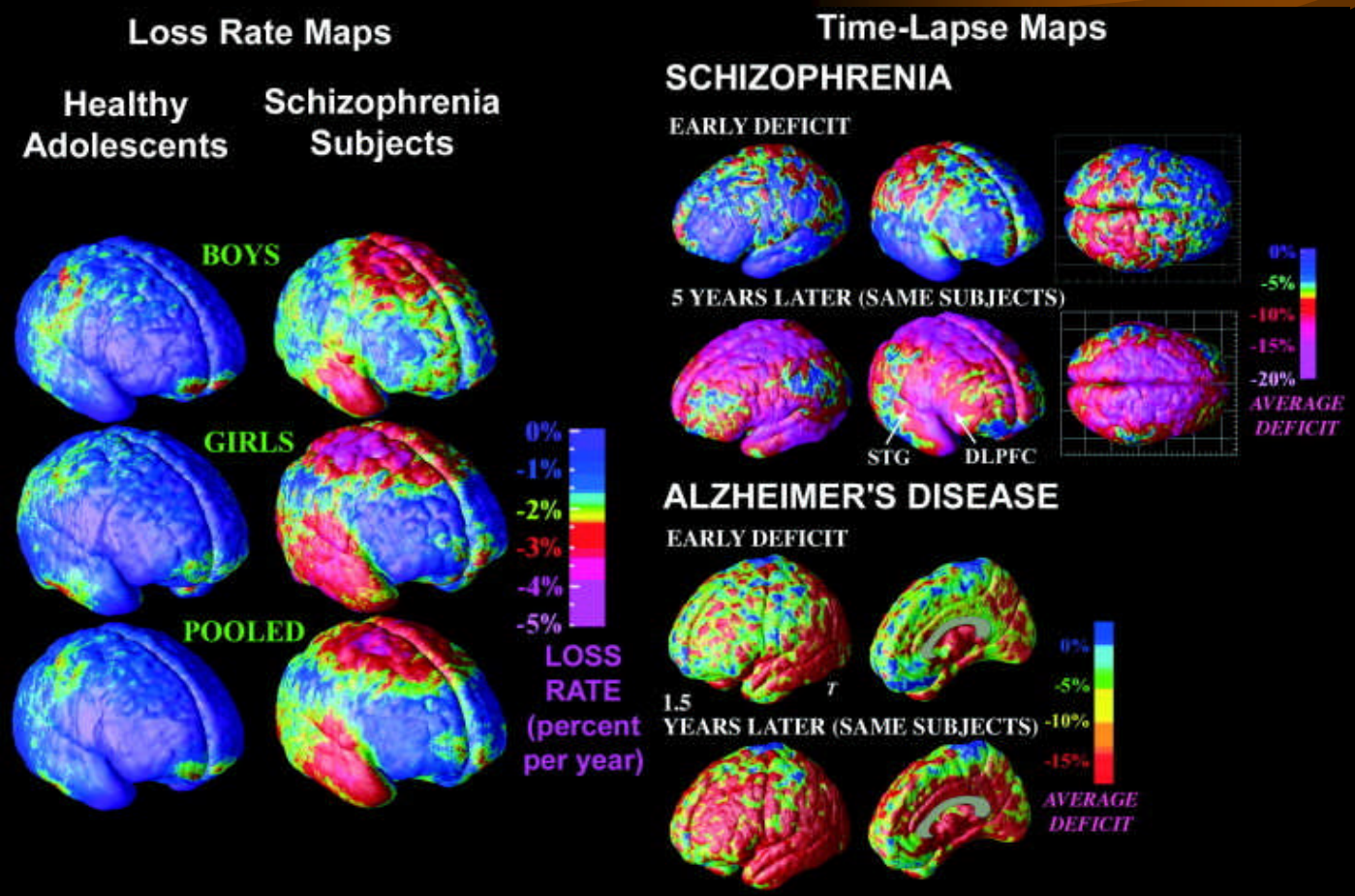
no Start Early Are at Greatest

# *Trauma: Adverse Childhood Events*

- Deficits in:
  - IQ
  - memory, working memory
  - attention
  - response inhibition
  - emotion discrimination
- Deficits in brain volume, gray and white matter of several regions, most notably, the frontal cortex

Carrion and Wong. Journal of Adolescent Health 51 (2012) S23–S28

# *Mental Illness*




Thompson et al. Structural MRI and Brain Development International Review of Neurobiology Volume 67, 2005, Pages 285–323

# Recovery

Researchers | Medical & Health Professionals | Patients & Families | Parents & Teachers | Students & Young Adults

National Institute on Drug Abuse
*The Science of Drug Abuse & Addiction*

Search

Connect with NIDA:

Drugs of Abuse | Related Topics | Publications | Funding | News & Events | About NIDA

Home » News & Events » NIDA Notes » Updates » **Marker for Neuronal Damage Resolves a Year after Methamphetamine**

## Marker for Neuronal Damage Resolves a Year after Methamphetamine

Print Share

NIDA Notes

**Sections**

- Featured Articles
- NIDA at Work
- Director's Perspective
- Research Briefs

**December 19, 2011**

Dr. Ruth Salo and colleagues at the University of California, Davis, extended previous findings that biochemical markers for nerve damage and viability persist in the brain through 6 months of abstinence from methamphetamine, but normalize after longer abstinence. In the new study, the researchers once again used proton magnetic resonance spectroscopy, imaging the brains of 30 former abusers of the stimulant who had been abstinent 1 to 6 months, 17 who had been abstinent 1 to 5 years, and 30 individuals who had never used the drug. As in the team's two prior studies (see "Brain Recovery in Meth Abusers"; and

**Subscribe to NIDA Notes**

Email: Go

**Past NIDA Notes Print Issues**

- Volume 24, Number 2
- Volume 24, Number 1

# *Data Implications*

- ABA recommends all states ban death penalty for minors
- Teenagers need parents/older adults to guide them
- Teenagers are greatly affected by their environment

# *Data Implications*

- Pediatricians may see patients up to age 25
- Reward focused
- New view of mental illness and addiction
- Perhaps learning how to reverse changes
- Many research opportunities in effects of chemicals on developing brain
  - Effects of programs?

# *More to come…..*

- Decade of the brain


- Part 2….

# *Take Home Points*

- Adolescent Brains are Works in Progress
- Lizard Brain to Wizard Brain
- Neurons that Fire Together, Wire together

# *Resources*

- World News: http://wn.com/Adolescent_brain#/videos
- National Institute of Mental Health: http://www.nimh.nih.gov/educational-resources/brain-basics/brain-basics.shtml
- http://www.nimh.nih.gov/health/topics/child-and-adolescent-mental-health/index.shtml
- National Institute of Drug Abuse: http://www.drugabuse.gov/
- Society for Adolescent Health and Medicine: www.adolescenthealth.org