Adolescent Brain Development

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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
Secrets of the Teen Brain

Research is revolutionizing our view of the adolescent mind—and explaining its mystifying ways
New data

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

Structures of Significance

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

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

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

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

Motor vehicle crash deaths per 100,000 people by age and gender, 2005

IIHS
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

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

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?

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 sex.

Drugs of abuse increase dopamine

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

NIDA
Brain Shape Linked to Cocaine Addiction

By DOUGLAS QUENNAU
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.

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...
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

Mental Illness

Loss Rate Maps

<table>
<thead>
<tr>
<th>Healthy Adolescents</th>
<th>Schizophrenia Subjects</th>
</tr>
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<tbody>
<tr>
<td>BOYS</td>
<td></td>
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<tr>
<td>GIRLS</td>
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<td>POOLED</td>
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Time-Lapse Maps

**SCHIZOPHRENIA**
- EARLY DEFICIT
- 5 YEARS LATER (SAME SUBJECTS)

**ALZHEIMER'S DISEASE**
- EARLY DEFICIT
- 1.5 YEARS LATER (SAME SUBJECTS)

Marker for Neuronal Damage Resolves a Year after Methamphetamine

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 abinent 1 to 6 months, 17 who had been abinent 1 to 5 years, and 30 individuals who had never used the drug. As in the team’s prior studies (see “Brain Recovery in Meth Abusers”): and

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Volume 24, Number 1
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:**

- **National Institute of Drug Abuse:**
  http://www.drugabuse.gov/

- **Society for Adolescent Health and Medicine:**
  www.adolescenthealth.org