This is Your Brain on Adolescence
Navigating the Teen Years

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www.psychiatry.umn.edu/research/casar/home.html
1. Addiction as brain disease

2. Brain development

3. Developing brain & drug risk

4. Summary & applications
When talks get too technical, the audience can look like this!
1. Addiction as brain disease
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

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

Frontal cortex

Nucleus accumbens

VTA/SN

Di Chiara et al.
Dopamine D2 Receptors are Lower in Addiction

- Cocaine
- Meth
- Alcohol
- Heroin

Reward Circuits

Control

Addicted
What about recovery?
Your Brain After Cocaine

Normal

Cocaine Addict - 10 days

Cocaine Addict - 100 days

Yellow = normal brain functioning
1. Addiction as brain disease

2. Brain development
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!!!
Important ages of majority and privileges

What one “privilege” in our culture does not become fully available until the age of 25?
An Immature Brain =
Less Brakes on the “Go” System
Brain Development

- Volume
- Metabolism
- Myelination
- Blood Flow
- Receptors
- Synaptic Refinement

Prenatal

Post-birth Age

Adolescence

Tapert & Schweinsburg (2005)
Maturation Occurs from Back to Front of the Brain
Images of Brain Development in Healthy Youth
(Ages 5 – 20)

Earlier:
Motor and Sensation
Emotion
Motivation

Later:
Judgment

Blue represents maturing of brain areas

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
Risk-Taking

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

Source: US News & World Report, 2005
A Developing Brain ≠
Risky Judgment is Pervasive

Source: US News &
World Report, 2005
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Implications of Brain Development for Drug Abuse Vulnerability

Adolescents may be more susceptible than adults to drugs

(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
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

<table>
<thead>
<tr>
<th>Age Started Drinking</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 yrs</td>
<td>16</td>
</tr>
<tr>
<td>12-14 yrs</td>
<td>15</td>
</tr>
<tr>
<td>15-17 yrs</td>
<td>9</td>
</tr>
<tr>
<td>18-20 yrs</td>
<td>4.2</td>
</tr>
<tr>
<td>21+ yrs</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Adolescents may have different sensitivity to alcohol than adults?

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

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

Slide courtesy
Sion Kim Harris, Ph.D.
Adolescents may have different sensitivity to alcohol than adults?

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

Adolescent rats are more sensitive to the social disinhibition effects of alcohol.
Wanna look for some cheese with me?

Sure!
Human Data: Drug’s Effects on Memory
Human Data: Alcohol’s Effects

Retention Rate %

Verbal information
- Alc Dep: 86
- Non-Alc Dep: 96

Nonverbal information
- Alc Dep: 87
- Non-Alc Dep: 97

Source: Brown et al., 2000
Marijuana: IQ Changes Among Diagnosed Users

Fig. 2. Adolescent vulnerability. Shown is change in full-scale IQ (in SD units) from childhood to adulthood among study members with 1, 2, or 3+ diagnoses of cannabis dependence as a function of age of onset of cannabis dependence. Individuals with adolescent-onset cannabis dependence (black bars) experienced greater IQ decline than individuals with adult-onset cannabis dependence (gray bars). IQ decline of approximately −0.55 SD units among individuals with adolescent-onset cannabis dependence in the 3+ group represents a decline of 8 IQ points. Error bars = SEs.
Support for Marijuana Legalization in the United States Has Reached Unprecedented Levels

Views of Legalizing Marijuana: 1969-2013

% saying marijuana should be...

(Chart showing percentages for illegal and legal perspectives over the years from 1969 to 2013.)

PEW RESEARCH CENTER March 13-17, 2013.
Average THC and Cannabidiol (CBD) Levels in the US: 1960 - 2011

THC: Psychoactive Ingredient

CBD: Non Psychoactive (Medicinal) Ingredient

Source: Mehmedic et al., 2010
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Review

- 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
  - proclamations of sheer boredom
  - risk taking
  - reward incentive-biased decision making
Review

- 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.
Review

Gray Matter Maturation, Age 4-21
Gogtay et al., 2004

reward incentives > perception of consequences
Brain Development: Reinforcing Need for Prevention and Treatment

• Youth is a particularly vulnerable period for developing a substance use disorder.

• Prevention and treatment programs are vital.
Brain Development: Opportunities for Prevention and Treatment

• Discuss with teenagers the science of the neurobiology of addiction
ALL DRUGS OF ABUSE TARGET THE BRAIN’S PLEASURE CENTER

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Brain Development: Opportunities for Prevention and Treatment

• Discuss the implications of using substances when the brain is still developing.
Human Data: Alcohol’s Effects on Memory
Brain Development: Implications for Prevention and Treatment

• Teach important **skills** associated with self-control
  • **impulse control**
  • “**second”** thought processes
  • **social decision making**
  • **dealing with risk situations**
  • **taking healthy risks**
Teen-Friendly Treatment Strategies

• Apply two major treatment approaches seem accommodating to the teen brain:

  • Cognitive – Behavioral Therapy (CBT)

  • Motivational Interviewing
Characteristics of CBT

• Focus on immediate, relevant and specific problems

• Solutions are realistic, concrete, specific
Characteristics of Motivational Interviewing

• De-emphasize labels
• Emphasis on personal choice and responsibility
• Therapist focuses on eliciting the client's own concerns
• Resistance is met with reflection and non-argumentation
• Treatment goals are negotiated; client’s involvement is seen as vital
Could we have some day a 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
Classroom Resources

• There are now some age-appropriate resources to educate youth about their developing brain.

• Resource from BSCS
  *Drug Abuse, Addiction and the Adolescent Brain*
  (www.BSCS.org)

• Hazelden has published an 8-lesson multi media resource: *Drugs and the Developing Brain*
  (www.hazelden.org)
Parent Resources

'I attend as many parenting classes as I can - anything to get away from my children'
Prevention Smart Parents

www.prevention-smart.org
THANK YOU!

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