Fifty Shades of Developing Grey Matter

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1. Addiction & the brain

2. Developing brain

3. Developing brain & alcohol

4. Summary & clinical implications
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

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

Cocaine

Meth

Alcohol

Heroin

Drug Abuser

Non-Drug Abuser
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!!!
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 than 18-year-olds. 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 because they’re 16. Visit Allstate.com/teen.
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

JUST DO IT.
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.

Source: Weintraub et al. (Submitted for Publication)
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 ≠ Low Brain Power
An Immature Brain ≠
Risky Judgment is Pervasive

Source: US News & World Report, 2005
1. Addiction & the brain

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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

First drug use (number of initiates)

- Infant
- Child
- Teen
- Adult
- Older Adult

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

![Graph showing prevalence of alcohol dependence by age group]
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>%</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>
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

Slide courtesy
Sion Kim Harris, Ph.D.
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 and motor impairment effects of intoxication.
3. Adolescent rats 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

Retention Rate %

<table>
<thead>
<tr>
<th></th>
<th>Verbal information</th>
<th>Nonverbal information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alc Dep</td>
<td>86</td>
<td>87</td>
</tr>
<tr>
<td>Non-Alc Dep</td>
<td>96</td>
<td>97</td>
</tr>
</tbody>
</table>

Source: Brown et al., 2000
MRI: Hippocampal Size

- Hippocampus encodes new info
- Left smaller in AUD teens (p < .01)
- But no relationship with cognitive functioning (due to less severe alcohol group than Brown et al. sample?)

10% smaller volume

Nagel, Schweinsburg, Pham, & Tapert, 2005
Teen Drinking & Brain Activation

Non-Drinkers

Heavy Drinkers

2 yrs drinking

5 yrs drinking

Age 16

Age 20

Slide courtesy of Susan Tapert, PhD.

Tapert et al., 2001, 2004
Are adolescents more susceptible than adults to drugs?

Implications of Brain Development for Drug Abuse Vulnerability

WHY?
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
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• Less than optimal..
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Dopamine D2 Receptors are Lower in Addiction

Cocaine

Meth

Alcohol

Heroin

Dopamine D2 Receptors are Lower in Addiction

control

addicted
1. Addiction & the brain

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4. Summary & clinical implications
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.
Summary

reward incentives
> perception of consequences
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!