A Window into the Teen Brain: Understanding the Effects of Substance Use

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Technical Information

This webinar is being recorded and archived, and will be available to all webinar participants. Please contact the webinar facilitator if you have any concerns or questions.

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For training use only.

Agenda

• Presentation by Dr. Marisa Silveri on adolescent brain development and the impact of substance use
• Questions and answers
• Wrap-up
Objectives

Participants will be able to:

- Describe the developmental changes in the brain during adolescence
- Identify the effects of alcohol, marijuana and other drug use on adolescent brain function
- Discuss ways that information about adolescent brain development can be used in planning prevention interventions in their communities

Presenter

Marisa Silveri

Director, Neurodevelopmental Laboratory on Addictions and Mental Health, McLean Hospital

Department of Psychiatry, Harvard Medical School
Understanding the Teen Brain

New Experiences
Making Good Decisions
Becoming Independent
FREEDOM!

A Window into the Teen Brain

Magnetic Resonance Imaging (MRI)
The Developing Brain

- Brain size and weight increases dramatically until age 5
- Brain size plateaus, with no further changes in brain volume
- Teen years: brain undergoes major, rapid remodeling

Brain Cells Under Construction

- Improving speed and efficiency of neuron communication: myelination
- Removing inefficient and unneeded neurons: pruning
Same Size, Different Brain

Teen Brain → Adult Brain

- Gray Matter
- Neuronal Pruning
- White Matter
- Myelination Connectivity

When is the Brain Adult?

“Neurobiological” adulthood occurs in the mid 20s

Gogtay et al., 2004
Teen Years: Frontal Lobe

Biggest Teen Cognitive Changes

Cognitive Control

GO  GO  GO  NO GO!
Brain works harder to hold back during “NO GO”

This is the frontal lobe

Greater frontal lobe activity with age

Brain Activity: Adults > Adolescents

Teens respond faster
Adults have better accuracy

Cognitive Control

Name Colors | Read Words | Name Ink Color
-------------|------------|------------------
blue red green red | green red blue red | red blue green red

Must inhibit automatic tendency to read

This is the “Stroop Effect”
Why was that so hard?

Most people can read words even when the letters are mixed. The brain is excellent at language and reading.

**READING - AUTOMATIC**

**NAMING COLORS - LESS AUTOMATIC**

Brain has to work harder to hold back
This is the frontal lobe working
 Gets better with age

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Biggest Teen Cognitive Changes

Brain works harder to hold back the automatic want to read

![Brain Activity: Increases with Age](image)

This is the frontal lobe working.

red  blue  green  red
Faced with Tough Choices?

What Should I Do After Class?
You Have a Math Test Tomorrow

Quick Response
Hang Out with Friends

Think It Out for a Minute
Study for Tomorrow’s Test

Fail Test
Get an A on the Test

WHAT WERE YOU THINKING??????

Faced with Tough Choices?

What Should I Do After Class?
You Have a Math Test Tomorrow

Quick Response
Amygdala
Hang Out with Friends

WHAT WERE YOU THINKING??????
Thinking about the information you just heard about the developing teen brain…

• Have you heard this information before?
• What did you find most compelling?
• Most surprising?
Earlier the Start, Worse the Problem

Drinking before age 13: 41% will be abuse alcohol or be dependent at some point

Wait until 16: down to 31%
Wait until 18: down to 17%
Wait until 21: down to 10%
Wait until the legal age to drink, DELAY

Brain needs to develop decision-making machinery

*If teens have started, the quicker they stop, the better chance the brain can get back on track*

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Alcohol & Drugs: Brain Effects

Short-term effects of alcohol and marijuana:

- Problems with memory, learning and judgment
- Trouble with thinking and problem solving
- Loss of motor coordination
- Increased heart rate
- Distorted perception (sights, sounds, time, touch)
- Effects can be unpredictable, especially when caffeine is mixed with alcohol or other drugs are mixed with marijuana
- Athletes: performance is off; timing, movements, and coordination are affected by alcohol and marijuana
Teen Alcohol Use and Memory

Teens who consistently use alcohol do worse on memory tasks by 10%, and show less brain activity during memory tasks.

Teen Non-Drinker

Teen Drinker

Identify when targets appear in same location

Brain activates when repeat target appears in repeat location

Teen Alcohol Use and Memory

Binge Drinking and White Matter

Infrequent exposure to large doses of alcohol, binge drinking, during youth may compromise white matter development.

Binge Drinking and White Matter

McQueeny et al., 2009
NIDA - McQueeny et al., 2009
Role of Familial Alcoholism

Teenagers with a family history of alcoholism activate more frontal lobe regions during response inhibition prior to the initiation of alcohol use.

Brain Activity: FH+ Teens > FH- Teens

Role of Familial Alcoholism

- 40 adolescents, ages 15-19; 19 marijuana, 21 non-users
- In marijuana group:
  - Age of weekly use: 15.6
  - # days of use in the last month: 16

Marijuana: Brain Effects

- 1,037 individuals followed from birth to age 38
- Cannabis use ascertained at ages 18, 21, 26, 32, and 38
- Neuropsychological testing was conducted at age 13, and again at age 38
- More persistent use was associated with greater decline, and stopping use did not fully restore functioning
- 40 adolescents, ages 15-19; 19 marijuana, 21 non-users
- In marijuana group:
Marijuana: Brain Effects

Less Brain Activity during Memory Test

More Brain Activity while at rest

Marijuana User vs. Non-User

NIDA - Schweinsburg et al., 2008

Marijuana: Brain Effects

Greater recruitment of frontal lobe and other neural circuits to perform response inhibition task.
### Prescription Drugs: Brain Effects

- Twenty-two percent (22%) of first time illicit drug users start with controlled medications (e.g. Vicodin®, OxyContin®, Adderall®), second to marijuana initiation.

- **The rise in prescription drug abuse appears highly related to access via friends and family.**

- Adolescents who were prescribed opioids or who used nonmedically had more substance abuse and psychological symptoms than youth who had never received a prescription for an opioid analgesic.

- **Adolescents being prescribed opioids should be assessed for substance use, with recognition that girls may be at higher risk than boys for nonmedical use.**

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### Prescription Drugs: Brain Effects

- There is very limited data available on the effects of prescription drugs on the human adolescent brain.

- One study conducted in animals showed that adolescents exhibit greater sensitivity than adults to the rewarding effects of oxycodone, which was indicated as an increased release of dopamine at the lowest dose tested.

- **Greater sensitivity could lead to greater use.**
Prescription Drugs: Brain Effects

- Heroin acutely reduced left amygdala response to fearful faces. Amygdala activity was related to anxiety, stress hormones, and heroin craving.

- Drug users claim to use oxycodone to dampen physical and emotional pain.
- Oxycodone attenuates connectivity of the frontal lobe with other important brain areas, which may impair the perception and appraisal of internal pain states.
- Alterations in these neural pathways may underlie the pathophysiology of drug abuse.

All About the Science

- The adolescent brain is rapidly developing from age 8 up to age 22. During this time, the frontal lobe is undergoing necessary reconstruction to improve cognitive abilities.
- Despite the legalities surrounding marijuana use, marijuana and other drugs unequivocally impair brain function in youth in ways that are more pronounced than in adults, because the brain is developing.
- Alcohol also impairs the functioning of the teen brain in ways that can cause brain changes that can last for several weeks, even when not intoxicated.
- Science says: Don’t do it
- And if teens have already started, encourage them to stop so their brains can recover and resume remodeling and fine-tuning
Google News Alert
“adolescent”, “adolescence”, “teen”, “teenager”

“Some parents and communities allow underage drinking. Everybody’s doing it. At least that’s the excuse given to allow teenagers to drink alcohol. But what we are doing is fueling the continuous problem of underage drinking.

It’s a problem that has meant serious consequences for decades for youth — locally and nationally.”

Google News Alert
“adolescent”, “adolescence”, “teen”, “teenager”

Posted by scooter at 4:13PM on Monday, 3/31/08

I had three close high school friends whose "cool" parents let them and others drink at home.

The ol' "it's better to know where they're at" motto.

Two of those kids are now raging alcoholics, and the third is dead (yes, alcohol related).

It's better to tell kids that drinking is a choice to be made when you turn 21. Until then, let "youth" be the only thing impairing judgment.
In Their Own Words

Vermont Alcohol Trends

Past Month Alcohol Use by Grade Level and Gender

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Past Month Binge Drinking by Grade Level and Gender

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Source: 2015, Vermont Youth Risk Behavior Survey
Almost half (45%) of those who reported use in the past 30-days, used marijuana 10 or more times!

And males reported using marijuana more frequently than females!

Source: 2015, Vermont Youth Risk Behavior Survey
Checking in….

In what ways can you envision using this information in your work?

Vermont Prevention Model

Vermont Prevention Model

Policies and Systems
Local, state, and federal policies and laws, economic and cultural influences, media

Community
Physical, social and cultural environment

Organizations
Schools, worksites, faith-based organizations, etc.

Relationships
Family, peers, social networks, associations

Individual
Knowledge, attitudes, beliefs

Examples of Actions We Can Take

- Educate youth and adults about the effects of alcohol and other drugs on the teen brain
- Help parents develop skills to talk to their children about underage drinking and drug use
- Limit social and retail access to alcohol and other substances
- Promote positive community norms around youth substance use

Questions?
# References


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If you have questions or comments, please don’t hesitate to contact:

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