Effects of Alcohol and Marijuana on Teen Brain Development

Lindsay M. Squeglia, Ph.D.
Medical University of South Carolina
September 19, 2017
NCPA, Myrtle Beach, SC

Past Month Substance Use

- Alcohol
- Been Drunk
- Marijuana
- Cigarettes
- Amphetamine (Rx)
- Hallucinogens
- Cocaine
- Ecstasy
- Inhalants
- Heroin

Monitoring the Future, 2015
Earlier Onset = More Problems

The odds of developing alcohol dependence ↓ by 14% with each increasing year of age at first use

Genetics Play a Role...To a Point

Grant & Dawson, 1997, Journal of Substance Abuse; Dawson et al., 2008, ACER
Youth Drink ½ as often, but 2xs as much!

<table>
<thead>
<tr>
<th>Drinking days/month</th>
<th>Usual # drinks/occasion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth</td>
<td>Adults</td>
</tr>
<tr>
<td>4.6</td>
<td>4.7</td>
</tr>
<tr>
<td>9.1</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Binge = 4+/5+ drinks on an occasion

20% of high school seniors binge drank in the past 2 weeks!

Binge Drinking Peaks in Young Adulthood

% binge drinking in the past 30 days

2014 National Survey on Drug Use and Health
Alcohol’s Acute Effect on Youth

- ↓ Negative effects
  - Hangover
  - Motor impairments
- ↑ Positive effects
  - Rewarding effects
  - Social facilitation

Spear et al., 2014, 2015

Marijuana Use ↑ during Adolescence

% of teens using in past month

Alcohol + Marijuana are used TOGETHER!

Monitoring the Future, 2017
Effects of Alcohol and Marijuana on Teen Brain Development

Lindsay M. Squeglia, PhD

Saturday, September 16, 2017
Child Session

Perception of Harm

Monitoring the Future, 2017

Substance Use Treatment

SAMSHA 2015

Only 8% of population who needs treatment gets treatment!
Current Adolescent Substance Use Treatments

- Most do not receive evidence-based care
- 1 FDA-approved medication for adolescents: Buprenorphine (approved down to age 16)=Opioid Use Disorder
- Majority of evidence-based interventions are psychosocial
- Effect sizes = small to modest
- Up to 86% of youth return to alcohol or drug use within 12 months of treatment

Brown et al., 1996; Winters et al., 2000; Jensen et al., 2011; Tripodi et al., 2010; Tanner-Smith et al., 2012; Waldron & Turner, 2008; Sussman et al., 2006

The Developing Brain

Gogtay et al., 2004

The brain develops until age ~25
Brain Basics: Gray Matter

Adolescence = ↓ gray matter = synaptic pruning
Brain Basics: White Matter

Adolescence = ↑ white matter = myelination

Reward Regions Develop before Cognitive Control Regions

Somerville & Casey, 2010; van Duijvenvoorde et al., 2016; Mills et al., 2014; Baker et al., 2015
Effects of Alcohol and Marijuana on Teen Brain Development  
Lindsay M. Squeglia, PhD  
Saturday, September 16, 2017  
Child Session

**Gender Differences**

![Gender Differences Graph](image)

- Male brain develops 1-2 years after the female brain!

Giedd et al., 1999, 2004

---

**Important Predictors of Drinking by age 18**

<table>
<thead>
<tr>
<th>Demographics:</th>
<th>Male</th>
<th>High parent income/education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviors:</td>
<td>Dating</td>
<td>Conduct disorder sx</td>
</tr>
<tr>
<td>Expectancies:</td>
<td>+Alcohol expectancies</td>
<td>+Alcohol social facilitation expectancies</td>
</tr>
<tr>
<td>Neuropsych scores:</td>
<td>More impulsive responding</td>
<td>Poorer cognitive control</td>
</tr>
<tr>
<td>Gray Matter:</td>
<td>Thinner gray matter</td>
<td></td>
</tr>
<tr>
<td>Brain activation to working memory:</td>
<td>Less brain activation</td>
<td></td>
</tr>
</tbody>
</table>

Squeglia, Ball, et al., 2016, *American Journal of Psychiatry*
**Regions Predicting Alcohol Initiation by Age 18:**

- **YELLOW**
  Thinner gray matter

- **BLUE=BOLD**
  Less brain activation during working memory

- **GREEN=both**
  Thinner gray matter and less BOLD response

Squeglia, Ball, et al., 2016, *American Journal of Psychiatry*

---

**Substance Use and Neurocognition**

![Graph showing cognitive performance in various domains](image)

Nguyen-Louie et al., 2015, *JSAD*
MRI

- Non-invasive
- Safe
- Structural MRI: measures brain structure
- Functional MRI: measures brain activity

**Brain Structure and Youth Drinking**

- Substance Use = Greater ↓ Gray Matter, Less ↑ White Matter

Squeglia, Tapert, et al., 2015, *American Journal of Psychiatry*
Effects of Alcohol and Marijuana on Teen Brain Development
Lindsay M. Squeglia, PhD
Saturday, September 16, 2017
Child Session

Minimal Gender Differences

Squeglia, Tapert, et al., 2015, *American Journal of Psychiatry*

Brain Function and Substance Use

Brain Structure and Youth Substance Use

Bava, Jacobus, Thayer, & Tapert, 2013, ACER

Recovery?
Will cognition improve with abstinence?

Controls
Heavy Drinkers
Week:
Recovery of Spatial Skills

Winward, et al., 2014, *JINS*

Distress Tolerance: PASAT-D

Winward, et al., 2014, *ACER*
Mood Changes

- ↓ Negative mood
- ↓ Depression
- ↓ Anxiety

Winward, et al., 2014, ACER

Adolescent Immaturity Persists?

Varlinskaya, Truxell, & Spear, 2014, Alcohol
Substance-Using Youth

- **Before** substance use
  - Demo/Behavioral: Male, ↑ SES, early dating, ↑ + expectancies, ↑ + contexts
  - Neuropsychological: ↓ cognitive control
  - Structural: Less gray matter
  - Functional: ↓

- **After** substance use
  - Neuropsychological: ↓ visuospatial functioning, attention, memory, processing speed
  - Structural: Greater ↓ gray matter, less ↑ white matter
  - Functional: ↑ compensatory brain activation during early drinking

Parents Should:

- Talk to youth!

Adolescents whose parents talk to them about alcohol use are **42% less likely** to drink than teens who parents do not.
Parents Should Not:

- Take the permissive approach
- Think effects are only temporary!

Kaynak et al., 2014; *Journal of Studies on Alcohol and Drugs*

Summary

- Substance use disorder is a **developmental disorder**
- Neural differences exist BEFORE and AFTER youth start to use alcohol and marijuana
- There is SOME recovery with abstinence
- Talk to youth, delay drinking/drug use age
Research Objectives

- Describe individual developmental trajectories (e.g., brain, cognitive, emotional, academic), and the factors that can affect them.
- Develop national standards of healthy brain development.
- Investigate the roles and interaction of genes and the environment on development.
- Study how physical activity, sleep, screen time, sports injuries, and other experiences affect brain development.
- Examine the factors that influence the onset, course, and severity of mental illnesses.
- Understand the relationship between mental health and substance use.
- Study how use of different substances (caffeine, nicotine, alcohol, marijuana) affects developmental outcomes, and vice versa.
Further Questions?

Lindsay Squeglia

- Email: squegli@musc.edu
- Office phone: 843-792-5451
Considerations

- Heterogeneity in patterns of substance use
- Co-use of other drugs; understand less frequently used drugs
- More diverse samples needed
- Interactive effect w/:
  - ADHD, depression, anxiety
  - Genetics
  - Sleep habits
  - Age of initiation

Teen Alcohol Use is an Important Public Health Issue!

Excessive drinking leads to:

- ↑ mortality (shortened lives by ~30 years)
- $224 billion in costs ($1.90 per drink)
- Earlier sexual activity, risk for STDs
- Violent behaviors
- Academic difficulties, school drop out

Alcoholism is a **developmental disorder**

*Centers for Disease Control, http://www.cdc.gov/alcohol/fact-sheets/alcohol-use.htm*