BINGES, BLUNTS AND BRAIN DEVELOPMENT

Why delaying the onset of alcohol and other drug use during adolescence is so important

Aaron White, PhD
Division of Epidemiology and Prevention Research
National Institute on Alcohol Abuse and Alcoholism
National Institutes of Health
Alcohol and other drug use tends to begin during the teen years – But why?


Key questions

• WHY does alcohol/other drug use tend to begin in adolescence?
• WHERE in the brain does alcohol produce its effects?
• WHAT are the short- and long-term risks?
• HOW can we delay the onset of use to allow the brain time to mature?
Adolescent brain changes underlie many typical teen behaviors

“Teenage brains. Beautiful brains. Moody. Impulsive. Maddening. Why do teenagers act the way they do? Viewed through the eyes of evolution, their most exasperating traits may be the key to success as adults.”

David Dobbs
National Geographic
October, 2011

Overall size of brain changes little during adolescence

- Brain reaches adult size before age 10 and size changes little during the second decade of life
- *However*, there are widespread changes in wiring and in levels of gray matter and white matter


Frontal lobe changes during adolescence

- Planning, decision-making, impulse control, memory, language, processing social cues
- Gray matter goes down, white matter goes up, overall size stays about the same

Ball W et al with the Brain Development Cooperative Group (2012). Total and regional brain volumes in a population-based normative sample from 4 to 18 years: the NIH MRI Study of Normal Brain Development. Cerebral Cortex, 22(1):1-12.

Subcortical drive contributes to risk taking

Strong emotional drive during adolescence combined with still developing executive circuits leads to risk taking

"According to the model, the adolescent is biased by functionally mature subcortical relative to less mature cortical circuitry" Casey and Jones, 2010

Adolescence is risky business

Alcohol and drug use often begins here

Past month use of alcohol decreasing among 8th, 10th and 12th graders in US

Binge drinking is decreasing among 8th, 10th and 12th graders in US

Binge = 5+ drinks at a time at least once in a two week period

Significant decline for all grade levels


Trends in marijuana use for teens and young adults from 1971 to 2013

Source: NSDUH 2014 – www.samhsa.gov/data
Roughly 2 to 4 fold increase in average THC content over the last few decades

Acute intoxication impairs executive function and disrupts frontal lobe activity

Alcohol increased reaction time and false alarm errors in a dose-dependent manner in a Go/No-Go task (N = 51, mean age 24.5). FMRI analyses showed alcohol decreased activity in anterior cingulate, lateral prefrontal cortex, insula and parietal lobe regions during false alarm responses to No-Go stimuli.

Heavy drinking during adolescence associated with reduced frontal lobe volume

Prefrontal cortex:


---

Use of alcohol goes up, cognitive functioning goes down

As the number of drinks consumed per day goes up performance on tests of attention, executive function and memory go down. More days smoking marijuana per month equals poorer memory.

SUBJECTS: 48 adolescents (ages 12 to 18), recruited in 3 groups: a healthy control group (HC, n = 15), a group diagnosed with substance abuse or dependence (SUD, n = 19), and a group with a family history positive for alcohol use disorder (AUD) but no personal substance use disorder (FHP, n = 14).

RESULTS: More DPDD predicted poorer performance on Attention and Executive Function composites, and more frequent use of marijuana was associated with poorer Memory performance. In separate analyses, adolescents in the SUD group had lower scores on Attention, Memory, and Processing Speed composites, and FHP adolescents had poorer Visuospatial Ability.

Marijuana use during adolescence produces lingering deficits in important cognitive skills

- Medina et al (2007) assessed cognitive skills in 31 adolescent marijuana users and 34 controls after at least 3 weeks of abstinence
- The observed impairments in:
  - Attention
  - Verbal story memory
  - Speed of responding
- More lifetime use associated with worse performance


Differences in brain activation during a memory task in marijuana abusing teens after 1 month of abstinence

Orange indicates brain areas in which abstinent previous MJ abusing teens showed less brain activity than controls during a spatial working memory task; blue indicates areas in which MJ teens showed greater response than controls during the spatial working memory task (Source: Schweinsburg et al., 2008)
Studies of neurocognitive performance in adolescent marijuana users


<table>
<thead>
<tr>
<th>Study</th>
<th>Age (years)</th>
<th>Marijuana Users</th>
<th>Non-Using Controls</th>
<th>Other Groups</th>
<th>Length of Abstinence</th>
<th>Impairments in Marijuana Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacobson et al., 2007 [46]</td>
<td>15.3 ± 1.1</td>
<td>10</td>
<td>none</td>
<td>16 male students</td>
<td>15 days</td>
<td>Reduced verbal memory, reduced working memory, verbal matching to sample (VMST) of alcoholization</td>
</tr>
<tr>
<td>Medica et al., 2009 [47]</td>
<td>16.2 ± 1.0</td>
<td>11</td>
<td>34</td>
<td>none</td>
<td>20 days</td>
<td>Unknown</td>
</tr>
<tr>
<td>Medica et al., 2008 [48]</td>
<td>16 ± 0.7</td>
<td>11</td>
<td>36</td>
<td>none</td>
<td>28 days</td>
<td>Unknown</td>
</tr>
<tr>
<td>Dipoto et al., 2007 [49]</td>
<td>18.1 ± 0.7</td>
<td>10</td>
<td>27</td>
<td>none</td>
<td>28 days</td>
<td>Reduced verbal memory, reduced working memory (VMST) of alcoholization</td>
</tr>
<tr>
<td>Schweinsburg et al., 2010 [50]</td>
<td>18.1 ± 0.7</td>
<td>13</td>
<td>17</td>
<td>none</td>
<td>26 days</td>
<td>Spatial working memory (VMST) of alcoholization</td>
</tr>
<tr>
<td>Pedra et al., 2006 [51]</td>
<td>18.1 ± 0.8</td>
<td>17</td>
<td>17</td>
<td>none</td>
<td>28 days</td>
<td>Reduced verbal memory, reduced working memory (VMST) of alcoholization</td>
</tr>
<tr>
<td>Jacobson et al., 2009 [52]</td>
<td>17.4 ± 1.9</td>
<td>17</td>
<td>7</td>
<td>7 male students</td>
<td>1.5 months</td>
<td>Reduced verbal memory, reduced working memory (VMST) of alcoholization</td>
</tr>
<tr>
<td>Schmidt et al., 1993 [53]</td>
<td>Range: 14 – 16</td>
<td>10</td>
<td>9</td>
<td>Male college students</td>
<td>6 months</td>
<td>Reduced verbal memory, reduced working memory (VMST) of alcoholization</td>
</tr>
<tr>
<td>Fried et al., 2005 [54]</td>
<td>17.6 ± 0.8</td>
<td>10</td>
<td>29</td>
<td>18 high users</td>
<td>1.4 day</td>
<td>Unknown</td>
</tr>
<tr>
<td>17 ± 0.1</td>
<td>16</td>
<td>30</td>
<td>18 high users</td>
<td>3 months</td>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>

Alcohol suppresses activity in the amygdala – makes it harder to recognize danger

- The amygdala is involved in forming emotional responses, particularly negative, to stimuli (i.e., fear and anxiety)
- The amygdala is hyper-reactive in adolescents, perhaps making alcohol more reinforcing because it dampens fear and anxiety

Impaired frontal lobes and amygdala lead to risky decision making

Hippocampus creates autobiographical memories and is suppressed by alcohol

Example of a blackout

Alcohol-induced memory blackouts are common among recent HS grads and college students

Prevalence of blackouts in a sample of U.S. college students (n = 772)
(White et al., 2002)

- 51% LIFETIME
- 40% YEAR
- 9% 2 WKS

Similarly, 12% of college bound recent high school graduates blacked out in a 2-week period over the summer before freshman year (White and Swartzwelder, 2009)