

Adolescent binge drinking can damage spatial working memory

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Binge or "heavy episodic" drinking is prevalent during adolescence, raising concerns about alcohol's effects on crucial neuromaturational processes during this developmental period. Heavy alcohol use has been associated with decrements in cognitive functioning in both adult and adolescent populations, particularly on tasks of spatial working memory (SWM). This study examined gender-specific influences of binge drinking on SWM, finding that female teens may be particularly vulnerable to the negative effects of heavy alcohol use.

Results will be published in the October 2011 issue of *Alcoholism: Clinical & Experimental Research* and are currently available at Early View.

"Even though adolescents might physically appear grown up, their brains are continuing to significantly develop and mature, particularly in frontal brain regions that are associated with higher-level thoughts, like planning and organization," said Susan F. Tapert, acting chief of psychology at the VA San Diego Healthcare System as well as professor of psychiatry at the University of California, San Diego. "Heavy [alcohol](#) use could interrupt normal brain cell growth during adolescence, particularly in these frontal brain regions, which could interfere with teens' ability to perform in school and sports, and could have long-lasting effects, even months after the teen uses."

Tapert, who is also the corresponding author for this study, explained that "[working memory](#)" is a term that refers to using and working with

information that is held in your mind, such as adding numbers in your head. "Working memory is critical to logical thinking and reasoning," she said.

Spatial working memory is the ability to perceive the space around you, she added, and then remember and work with this information. "We chose to examine spatial working memory because previous studies have shown it is impaired in [adults](#) and adolescents who heavily drink alcohol," she said. "Deficits on tasks of spatial working memory could relate to difficulties with driving, figural reasoning (like geometry class), sports (remembering and enacting complex plays), using a map, or remembering how to get to places."

Tapert and her colleagues recruited 95 participants from San Diego-area public schools as part of ongoing longitudinal studies: 40 binge drinking (27 males, 13 females) and 55 control (31 males, 24 females) adolescents 16 to 19 years of age. All of the [adolescents](#) completed neuropsychological testing, substance use interviews, and a SWM task during functional magnetic resonance imaging (fMRI).

"Our study found that female teenage heavy drinkers had less brain activation in several brain regions than female non-drinking teens when doing the same spatial task," said Tapert. "These differences in brain activity were linked to worse performance on other measures of attention and working memory ability. Male binge drinkers showed some but less abnormality as compared to male non-drinkers. This suggests that female teens may be particularly vulnerable to the negative effects of heavy alcohol use."

"These findings remind us that adolescent boys and girls are biologically different and represent distinctive groups that require separate and parallel study," noted Edith V. Sullivan, a professor in the department of psychiatry and behavioral sciences at Stanford University School of

Medicine. "Adding alcohol to the mix of the developing brain and its multifaceted functions likely complicates the normal developmental trajectory, which is already sexually dimorphic."

Tapert agreed there is a need to examine gender differences associated with alcohol use, particularly during adolescence, as alcohol seems to have a differential effect on the brain. "Females' brains develop one to two years earlier than males, so alcohol use during a different developmental stage – despite the same age – could account for the gender differences," she said. "Hormonal levels and alcohol-induced fluctuations in hormones could also account for the gender differences. Finally, the same amount of alcohol could more negatively affect females since females tend to have slower rates of metabolism, higher body fat ratios, and lower body weight. This is similar to what generally has been found in adult alcoholics: while both men and women are adversely affected, women are often more vulnerable than men to deleterious effects on the brain."

These findings reflect "relatively normal healthy teens" who engage in social drinking, added Tapert, such as having four to five drinks at a party on the weekend but not using for weeks afterwards. "The teens we examined have relatively limited experience with alcohol, are drinking at levels that are widespread for kids their age – almost a quarter of all seniors admit to binge drinking in the preceding two weeks – have no diagnosable alcohol or drug disorder, do not use other drugs, and do not have any mental health disorders," said Tapert.

"And yet [binge-drinking](#) is a dangerous activity for all youth," observed Sullivan. "Long after a young person – middle school to college – enjoys acute recovery from a hang-over, this study shows that risk to cognitive and brain functions endures. The effects on the developing brain are only now being identified. 'Why tamper with normal developmental trajectories that will likely set the stage for cognitive and motor abilities

for the rest of one's life?"

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