KEEPING IT REAL – AND SAFE

by AARON M. WHITE, PH.D., Scientific Advisor to the Director, National Institute on Alcohol Abuse and Alcoholism.

[This content adapted from the author’s article in School Counselor Magazine, Nov./Dec. 2018.]

Alcohol remains the most commonly used drug among middle and high school students in the United States. Nearly one in 10 adolescents aged 12-17 drinks alcohol each month, and half of them (53.2 percent) engage in binge drinking, according to a 2017 Substance Abuse and Mental Health Services Administration (SAMHSA) survey.

Binge drinking, defined as four-plus drinks for females or five-plus drinks for males on one occasion, can produce blood alcohol concentrations in teens beyond 0.08 percent, the legal limit for driving after drinking. This level of intoxication increases the risk of injuries, memory blackouts, sexual assaults, fights and potentially dangerous interactions with other drugs, such as opioids.

Roughly one in nine students drop out of school by 12th grade. Compared with teens who stay in school, those who drop out are more likely to drink or use other drugs. Approximately one in three (31.8 percent) students who dropped out report recent binge drinking compared with 22.1 percent of 12th-grade students in school, according to a 2017 SAMHSA report.

Alcohol use becomes more likely as young people enter and progress through adolescence. Adolescence represents the developmental transition from dependence on adults to the relative autonomy of young adulthood. As teens begin to socialize with peers and develop identities distinct from those formed at home, curiosity about substances and access to them often increases. At the age of 12, approximately one in 100 adolescents reports consuming alcohol in the previous month. The prevalence increases to nearly one in four by age 17. Racial and ethnic differences in alcohol use also emerge during this period, SAMHSA reports illustrate. Among students aged 12–17, past-month alcohol use is reported by 11.9 percent of white students, 8.6 percent Hispanic or Latino students, 7.8 percent American Indian or Alaska Native students, 6.0 percent black or African-American students, 5.8 percent Asian students and 10.8 percent of students of two or more races.

Alcohol consumption, including binge drinking, has declined significantly among adolescents since the beginning of the new millennium. Between 2002 and 2017, past-month alcohol use by adolescents aged 12–17 decreased from roughly 17.5 percent to 9.9 percent, and binge
drinking declined from 10.5 percent to 5.3 percent, according to SAMSHA data. Although these declines certainly are good news, they revealed a new and troubling issue. The declines in drinking were much larger among young males than young females, leading to a reversal of long-established gender differences in alcohol use. By 10th grade, young males have long exhibited higher levels of alcohol use and binge drinking than females. By senior year, the differences once were quite large and remained so throughout adulthood. These gender differences have reversed, and females are now more likely than males to drink, binge drink and report being drunk by 10th grade. In 2000, 48.3 percent of males and 38.6 percent of females in 10th grade reported drinking in the past month. In 2017, the gender difference was reversed, and 22.1 percent of females reported drinking compared with 17.1 percent of males, according to a paper released by the Institute for Social Research, University of Michigan. The reversal also is evident at college campuses. Female college students now are more likely to drink and binge drink than male students. Among those not in college, males still drink slightly more, but the gaps have narrowed greatly. Gaps in use of other drugs have narrowed, too.

Research into the effects of alcohol on the adolescent brain suggests alcohol can alter the normal course of brain maturation during the teen years.

This is Your Brain

Research into the effects of alcohol on the adolescent brain suggests alcohol can alter the normal course of brain maturation during the teen years. It also has become clear that male and female brains follow different developmental paths during adolescence, and as a result, males and females might be motivated to drink alcohol for different reasons. Until 25 years ago, it was assumed that brain development was largely completed before the age of 10, but we now know the organization and functioning of the brain go through complex changes during the second decade of life to prepare us for the demands of adulthood.

The brain can be divided into two types of tissue – gray matter and white matter. Gray matter contains mostly neurons, the brain cells that organize themselves into complex circuits and communicate with each other using chemicals called neurotransmitters. These neuronal circuits allow us to think, feel and act. When we learn something new, neurons in the circuits are altered in ways that allow us to store and reuse what we learned at a later time. The second type of tissue, white matter, is composed mostly of glial cells. Glial cells play diverse roles in brain function and health. In a process called myelination, they wrap themselves around the circuits formed by neurons and help the circuits communicate quickly and efficiently. Without glial cells, circuits formed by neurons would not function.
As the first decade of life comes to a close, gray matter volumes in several areas of the brain, including frontal lobes regions that govern important cognitive and social functions, reach their peak. The increase in gray matter represents an overproduction of neuronal circuits. This sets the stage for widespread gene-and experience-driven pruning and fine-tuning of brain circuitry during adolescence. Across the second decade of life, gray matter volumes decline as lesser-used points of contact within circuits are eliminated and often-used points of contact are strengthened. The decrease in gray-matter volumes across adolescence is accompanied by an increase in white-matter volumes. As circuits are molded by experience during adolescence, the amount of white matter surrounding the circuits increases to ensure the circuits function at the highest possible level.

Changes in brain circuits during development are strongly influenced by interactions with the world. As a result, brain plasticity during the teen years allows each individual to be tailored to fit the environments with which they interact. Anything we do with our time contributes to molding our brains. There are no do-overs with adolescence. Once we emerge as young adults with fine-tuned and myelinated brain circuits, the ability to shape and mold our brains diminishes. As such, adolescence is a vital time for learning and personal growth. The changes that occur during this stage of life tend to stick with us and influence our behavior for decades to come. The fact that adults will travel long distances to reunions to see fellow students they attended high school with for a few years many decades earlier is a good example of just how important our adolescent experiences are for shaping our identities.

Research indicates that regular drinking, particularly binge drinking, during adolescence can alter how the brain develops, damage important brain areas, produce lingering deficits in cognitive functions and lead to the development of an alcohol use disorder, according to a 2017 article in *Frontiers in Psychology*. In one recent study, researchers recruited 295 adolescents aged 12–16 with limited experience with substances. After roughly six years, subjects were given tests of learning and memory. The more alcohol subjects drank in the previous three months, the worse they performed on a variety of measures. When subjects were sorted into moderate (no more than four drinks on an occasion), binge (five–nine drinks on an occasion) and extreme binge (10-plus drinks on an occasion) categories based on peak drinking in the previous month, belonging in the extreme binge category was associated with bigger learning and memory impairments. Extreme binge drinkers recalled 8 percent–12 percent fewer items than moderate drinkers. Additional studies suggest binge drinking during the teen years is associated with smaller frontal lobe gray matter volumes and a smaller corpus callosum, a highway of cells that allows the two sides of the brain to communicate and coordinate. Alcohol
also interferes with white matter formation within the frontal lobes. It is unclear whether the detrimental effects of the brain are fully reversible.

**When we do things the brain assumes are good for our survival, the reward system is activated. When the system is activated, it releases the neurotransmitter dopamine. This leads to positive reinforcement (i.e., pleasure) and makes us want to repeat the behavior**

**Built to Learn**

The adolescent brain is built to learn. Malleable brain circuits allow us to acquire new information and skills with relative ease. To help an individual figure out which new experiences to repeat, the brain comes equipped with circuits providing reinforcement. When we do things the brain assumes are good for our survival, the reward system is activated. When the system is activated, it releases the neurotransmitter dopamine. This leads to positive reinforcement (i.e., pleasure) and makes us want to repeat the behavior. Alcohol and other drugs essentially trick the brain into thinking something important just happened and that the behavior should be repeated. Because the activation of the reward system by alcohol and other drugs is much stronger than the activation produced by natural reinforcers like food or water, the brain assigns a great deal of value to the drug and the stimuli related to it. Repeating the behavior can eventually lead to development of a habit wherein use of the substance becomes seemingly automatic and difficult, if not impossible, to control. Studies show the reward circuitry in the brain becomes highly active when adolescent binge drinkers are shown pictures of alcohol, reflecting the strong positive associations formed between alcohol and the cues associated with it.

For a long time, it was assumed that activation of the reward circuitry is the primary means by which all people learn to like alcohol and other drugs and why they continue to use them. However, it is now clear that many people drink and use other drugs for negative reinforcement more so than for positive reinforcement. Negative reinforcement reflects feeling good because a drug reduces a negative state, such as pain or anxiety, leading to relief. Differences in how brain development unfolds in male and female adolescents give rise to differences in the reinforcing effects of alcohol. It appears that positive reinforcement might be more important, at least initially, for motivating substance use in males than females. For young males, alcohol increases dopamine release in the reward system, and the amount of increase is associated with the amount of intoxication they report. This relationship does not occur in females, suggesting their reward systems might be less responsive to alcohol.
In contrast to males, young females tend to be more likely to report drinking for the purpose of negative reinforcement. Alcohol produces negative reinforcement in part by calming activity in a brain area known as the amygdala. The job of the amygdala is to attach emotions, like fear and anxiety, to stimuli. For instance, think of the intense fight or flight feelings that might occur if a bear jumped out in front of you or the percolating anxiety you might feel if you have an upcoming exam. The amygdala helps keep us vigilant and alive. However, it also can generate a great deal of emotional discomfort. Quieting the amygdala with alcohol can make it easier to socialize and cope with life, at least temporarily. But repeated drinking leads to tolerance and rebound increases in anxiety and discomfort when the alcohol wears off. Regardless of what draws someone to alcohol initially, there is a natural shift toward drinking for negative reinforcement as tolerance and withdrawal develop.

Positive and negative reinforcement facilitate learning. It is well-known that the earlier people start to drink alcohol the more likely they are to drink excessively and develop an alcohol use disorder. It seems likely that the intense learning that occurs naturally during adolescence makes it easier to acquire both healthy and unhealthy habits, such as alcohol misuse. For this reason, preventing or delaying the onset of alcohol and other drug use for as long as possible is recommended to allow the brain to learn healthy habits and coping skills and to minimize the risk of developing a potential lifelong drinking problem.