

Encounters with Alcohol Transcript

Last year, Americans spent 218 billion dollars on alcohol. To put this in perspective, we spend 700 billion dollars per year for the entire United States Military spending. That means that alcohol sales alone are enough to fund nearly a third of our defense budget, which is the largest single expenditure in the federal budget. The amount of money we spend on alcohol is enough to fund the California public K-12 school system for nearly four years, and is approximately equal to the annual economic output, or GDP, of the entire country of Ireland. Evidently, we Americans love our alcohol.

Unfortunately, our love of alcohol comes with a price, a price even higher than what we spend on the alcohol itself. Excessive alcohol consumption cost our country about 250 billion dollars per year, in healthcare, lost workplace productivity, criminal justice, and car accidents. We spend more to clean up the damage from alcohol than we do buying the stuff itself.

I don't bring up these statistics to advocate for a second coming of Prohibition, because that's both impractical and highly unpopular. Alcohol does provide an important social function in American society, and it's one of the many centerpieces of our culture. I bring up these facts not to demonize alcohol completely, but to get us thinking about the relative benefits and risks of alcohol. As teenagers in a world full of social drinking, the decision to drink is largely a decision of weighing the positives and negatives- the enjoyment and the consequences. My goal in this episode is to explore the benefits, and more importantly, the risks of teenage drinking, so that you are better prepared to weigh decisions about alcohol in your own life. Today, I ask: what are the negative effects of alcohol on the teenage brain, and in teenage life? Are certain kinds of alcohol or drinking behaviors more dangerous than others? And finally, how can we as adolescents protect ourselves while still enjoying social life in modern America?

I want to start this podcast at the most basic level possible: the chemical properties of alcohol, and how those properties interact with the human body. Alcohol is an organic chemical, meaning that it's carbon-based, which is created by fermenting certain carbohydrates, such as grapes or wheat. This is highly tangential, but for the record, alcohol fermentation is facilitated by yeast, a single-celled organism that allows us to brew beer and distill liquor. Anyway, alcohol is a fairly simple chemical that has three unique effects on the human body: it is a diuretic, a disinfectant, and a nervous system depressant. A diuretic is any chemical that makes us urinate, by inhibiting the release of a hormone that makes us retain water. For this reason, excessive alcohol consumption can lead to dangerous dehydration. The second property of alcohol is that it is a disinfectant, meaning that it can kill organisms by screwing up the proteins that make them up, which is called denaturing their proteins. Alcohol is actually toxic to human cells, but our liver generally does a good job of metabolizing alcohol before it can harm the rest of our body.

Unfortunately, though, the liver sometimes sacrifices itself in the process- many heavy drinkers eventually develop liver disease, and alcohol can destroy heart muscle and cause stomach ulcers as well. This doesn't happen overnight, but it's always important to remember that alcohol, on the most basic level, is a poison to the human body. It's a poison we can manage in moderation, but it has the potential to be incredibly harmful after years of consumption, especially when we drink more than a serving or two at a time.

The final property of alcohol- its function as a nervous system depressant- is the most important to this episode, because it's the property that makes alcohol pleasurable, addictive, and most dangerous. Depressants are any chemicals that slow down brain activity. Many sleep medications and anti-anxiety medications, such as Ambien, Valium, and Xanax, are also depressants. While it's still unclear exactly how alcohol functions in the brain to produce every one of its side effects, one of the key functions of alcohol is to enhance the activity of a neurotransmitter called GABA. GABA is one of the most important chemicals in the brain. Its job is to inhibit neural activity- in other words, it quiets down our brain cells. GABA is especially important for mitigating fear and anxiety, both of which result from overexcited neurons. This is why so many people use alcohol as a way to relax and reduce anxiety during stressful time or at social events- alcohol boosts the efficiency of our anti-anxiety brain chemicals, allowing us to relax and avoid social and life stressors.

This isn't to say that alcohol is a safe and wonderful way to reduce anxiety in the brain. First of all, our brains evolved to regulate themselves without psychotropic drugs messing up brain chemistry. Any substance that drastically alters our brain's chemical balance is potentially harmful, and alcohol proves to be among the most dangerous chemicals that we can expose to our brains. In the short term, alcohol can seriously impact our motor skills and memory. Motor skills, including balance, reaction, and general coordination are controlled by a brain region called the cerebellum, which looks like a bulge coming off the bottom of the brain. Unfortunately, alcohol has an especially strong impact on the cerebellum, which is why drunk people often lose their balance and their ability to perform tasks that require a lot of coordination. As we all know, this is why drunk driving is so dangerous- just two servings of alcohol triples the risk of a car accident in the average woman (for men, it takes about another serving, because of average size). Alcohol also severely impairs memory- in fact, alcohol is classified as an amnesic chemical, meaning that it causes amnesia. An alcohol blackout- when you wake up in the morning and can't remember events from the previous night- is a form of clinical amnesia. Alcohol doesn't typically erase old memories, but it prevents us from turning experiences into short-term memories, hence the blackout. For the record, this is not uncommon- 51 percent of college students that drink alcohol report having had a blackout at some point in their lives. 40 percent have done so in the last year.

Finally, though it's not wholly neurobiological, I want to talk about the violence and sexual aggression associated with alcohol. Most of us will end up attending a college party where alcohol is present, and most college campus violence and sexual assault occurs because of parties like these. About half of college women have been victims to unwanted sexual advances, and about a quarter report rape or attempted rape during their college years. Though we often think of sexual offenders as twisted, terrible people, many of them are simply too intoxicated to make good decisions. Alcohol impairs inhibition, meaning that we are more likely to act on every desire and impulse while under the influence. 60 percent of sexual offenders were intoxicated at the time of the assault. When intoxicated, men are cognitively impaired, making it harder to perceive whether a woman is interested in sex. Very often, men who have been drinking believe that their sexual advances were encouraged, because their alcohol-saturated prefrontal cortex cannot properly receive social cues. This doesn't excuse sexual assault, of course- instead, it shows that men have a responsibility to limit their drinking to a level at which they can still make proper and informed decisions. The same is also true of women involved in sexual assault. According to a survey from the Harvard School of Public Health, 72 percent of rape victims reported that they were "so intoxicated they were unable to consent or refuse." This makes me incredibly upset, because it shows that sexual assault could be avoided in the vast majority of cases if both the perpetrator and victim had chosen not to drink. When it comes to drinking and sexual assault, it truly is a two way street: men and women would both be much safer, from victimization and criminal charges, if they reduced alcohol consumption.

All in all, motor impairment is dangerous for the obvious reason of driving risks, while amnesia and poor decision-making are huge concerns for college campuses with regards to sexual assault and identifying crimes. However, the most important dangers of alcohol to teenagers are not the acute symptoms of intoxication, but the long-term ramifications of drinking. As we learned in the episode *Your Brain on Pot*, the teenage brain sustains more long-term damage from marijuana than the adult brain, and this trend applies to alcohol as well. As we will see, drinking, especially binge-drinking, can wreak havoc on the developing brain, leaving lifelong psychological and physiological scars in the brain.

Unfortunately, one of the biggest dangers of alcohol in teenagers actually seems like an advantage in the short term: teenagers, on average, do not experience as many of the negative symptoms of intoxication that adults do. This is because teenagers have less GABA receptors than adults. As we discussed, alcohol's depressant effects occur because alcohol enhances GABA reception in the brain. With less receptors, we teenagers don't experience the same amount of relaxation, motor impairment, and general slowness in the brain that adults do. We naturally have a greater tolerance to alcohol than adults, but that doesn't mean our brains are safer from alcohol. Instead, it means that we can drink more- sometimes much more- without passing out and losing motor functioning. Our ability to binge drink and remain functional is the

single biggest danger of drinking to adolescents. We often assume that our brains are safe if we don't feel hammered. But a few servings of alcohol ingested in a short period, regardless of your intoxication symptoms, will incur brain damage and addictive tendencies in the teenage brain.

In the teenage brain, alcohol's most important target for destruction is the hippocampus. The hippocampus, located in the very middle of the brain in the limbic system, is the brain area that creates and stores memories. As we talked about before, alcohol temporarily impairs the hippocampus from creating new memories in all people. In adolescents, though, the damage goes further. Michael Taffe at the Scripps research institute studied a group of primates, some of whom drank during adolescence, and others who drank only during adulthood. He found that the primates who drank during adolescence had more nerve damage in their hippocampus, and were unable to form new neurons and connections with the same efficiency of non-drinking primates. The primates that started drinking as adults did have short-term hippocampal impairment while drunk, but the effects were not long-term. Another study of rat brains similarly found that adult rats could recover from hippocampal damage due to alcohol, while teenage rat brains never could. In teenagers, but not adults, repeated drinking kills cells in the hippocampus and also makes it more difficult for the hippocampus to create new neurons and new connections. In essence, drinking as a teenager permanently affects performance on memory tasks. In concurrence with these findings, researchers have observed that college-age students with histories of binge drinking consistently performed worse on memory tasks than equivalent peers without drinking history.

Alcohol's destructive effects on the teenage brain do not stop at the hippocampus, either. Alcohol use has also been shown to decrease the size and efficiency of the prefrontal cortex, which handles abstract thought, reasoning, and higher-order brain functions that make us intelligent. This impairs human functioning on a wide range of cognitive tasks, and may lead to decreased decision-making skills. Finally, Susan Tapert and colleagues at UCSD found that adolescent drinkers had what looked like little dings in their brain's white matter, the coating that insulates our neural circuits and makes our brains run more efficiently. It seems that alcohol can damage this kind of tissue all around the brain, explaining why attention and cognitive tasks are harder for those with a teenage drinking history. In fact, Tapert observed that the cognitive performance of heavy adolescent drinkers was about 10 percent lower than that of abstinent peers. In other words, drinking as a teenager could be a difference between an A and a B for the rest of your life.

And, of course, we cannot forget about addiction. About 7 percent of adults, or about 16 million adults, suffer from diagnosed alcoholism in the United States alone- and, of course, this only accounts for the adults who have gone in for a diagnosis- millions more live with a drinking

problem but no formal assessment. According to the *Journal of Substance Abuse*, about 40 percent of people who begin drinking at age thirteen or before will develop a diagnosable alcohol-abuse disorder- over five times the overall national prevalence. Additionally, 40 percent of current alcoholics state that they began drinking heavily between the ages of 15 and 19, the prime window for addiction to become entrenched in the brain. Alcohol, in addition to enhancing GABA, also increases the production of dopamine, the pleasure chemical that we've spoken about a lot before on this podcast. We teenagers are especially sensitive to dopamine and pleasure, and so have a heightened desire to engage in risky behaviors that make us feel good- like drinking alcohol. Our brains are also very plastic, meaning that they rewire very easily in response to our experiences and the substances we put into our bodies. As teenagers, when we drink, we get a pleasurable sensation that immediately changes the way our brain is wired- and it wires to crave more alcohol. The more we drink, and the more episodes of drinking that we partake in, the more this new addictive pathway gets ingrained into the limbic system. Once we hit adulthood, this pathway becomes much harder to change, so pleasurable alcohol experiences now easily translate into substance abuse problems later.

Evidently, alcohol use during adolescence is not ideal- it damages our memory, makes our brains less efficient, and can lead to addiction and many other forms of bodily damage, like liver disease, down the road. In a perfect world, alcohol probably wouldn't exist- and if it did, no one would drink until they were twenty five years old and the brain had exited its hyperplastic state. But we do not live in a perfect world, of course, and teenage drinking will never go away. For many of us, drinking is an almost necessary component of social life. It's basically impossible to avoid being offered alcohol as a teen, and drinking can help us to be more talkative and extroverted in a social setting. It's completely unrealistic for me to advocate total abstinence from alcohol, unless I want to join the ranks of forever-ignored government-sponsored programming. I'd love it if I could singlehandedly remove alcohol from adolescent life, but since I can't, I'm going to end this episode discussing how we can drink in the safest way possible. Living in the world that we do, with ample alcohol and social drinking, how can we best protect our brains from long-lasting damage?

The single most important factor to consider when we talk about teenage drinking is the amount of alcohol consumed in a single night. Most of the studies I've discussed in this episode have looked at the effects of binge drinking- consuming four alcoholic beverages for women, and five for men, in a span of several hours. Remember when I mentioned that alcohol damages account for 250 billion dollars annually? 77 percent of that- a whopping 191 billion dollars- is a direct result of binge drinking episodes. What's worse, 90 percent of the alcohol consumed people under the age of 21 is consumed in the context of binge drinking. I believe this is the result of two things: first, most teenage drinking occurs in social situations with large amounts of alcohol present; second, we can't purchase alcohol, so when we do have the ability to drink at a party or

other function, we are more likely to overdo it because of the relative scarcity of alcohol in our lives. It may seem justified to drink 5 servings of alcohol in a single night if you only drink once a month, but that could not be further from the truth.

In the scientific world, binge drinking is called chronic intermittent exposure to alcohol. Chronic intermittent exposure is essentially the pattern of heavy drinking followed by a period of withdrawal. It is this pattern that wreaks so much havoc on the brain. Adults who reported binge drinking during adolescence have worse life outcomes on basically any scale you employ: income, alcohol dependence, illicit drug use, mental illness, homelessness, and social class. Blackouts destroy hippocampal tissue, and furthermore increase our risk of being the perpetrators and victims of sexual assault. If you are drinking more than three servings of alcohol on even a very occasional basis, you can expect your brain to suffer from it.

Unfortunately, there is very limited data about how much alcohol a teenager can drink without incurring brain damage. This is primarily because researchers cannot conduct studies on adolescent human beings while they are intoxicated, to observe the effects on the brain. Underage drinking is illegal in the US, and that law applies to scientists in well. Even in European countries, where underage drinking is legal, it is considered highly unethical to give alcohol to minors for scientific purposes, especially at binge-levels. Most of the research related to alcohol exposure is derived from studies of non-human animals, like primates and rats. According to Markwiese and colleagues, it seems that adolescent rats endure hippocampal damage with much lower levels of alcohol exposure than adult rats. In maze tasks, the adolescent rats forgot their maze training with much less alcohol than the adults, who could retain their memory of the maze at low alcohol levels.

The best information that we have suggests that teenagers are best off drinking nothing at all. That being said, more is always worse. Binge drinking will always be more dangerous than having a single serving of alcohol, both in the moment and in the long-term. If you are completely opposed to giving up social drinking, at least keep your alcohol consumption to a minimum. Limit yourself to a single beer or two, and make sure to eat before drinking- food in the stomach slows the absorption of alcohol. As we learned in Episode 2, teenagers are especially susceptible to risky behavior in the presence of peers. Our limbic systems, the reward part of the brain, takes over when we are in social situations, compromising our rational, decision-making prefrontal cortex. Combined with alcohol, you will not be in a good position to make decisions when at a party with other teenagers. This means that you must, must plan ahead and map out your actions during parties before you arrive. Tell yourself in advance that you will only have one serving of alcohol, and know exactly what you will do and say to avoid getting hammered, especially if others are offering you more alcohol. Know how you'll get home and what friends will be at the party to help you stay safe.

I hate to sound patronizing, but I need to reiterate the lesson that you've hopefully heard at school or from your parents: never accept a drink that is not in its original bottle or can, especially if you are a female, and never leave your drink unattended. Nearly five percent of rape victims are estimated to have received a date rape drug from the perpetrator, according to US Department of Justice, and very often these drugs are mixed into a woman's drink. I'd like to take a moment to talk about one of the most common date rape drugs, known as Rohypnol, the drug used to get someone "roofied." Rohypnol is a depressant, just like alcohol, and actually affects the exact same GABA neurotransmitters that alcohol does. However, Rohypnol is much stronger than alcohol, especially in its amnesic effects, leaving victims completely unaware of events from the preceding night. This can make identifying a criminal extremely difficult. According to a recent rape victim interviewed on 20/20, Rohypnol cause her to lose all memory within three minutes of taking a drink laced with the drug, and she did not "wake up" from her intense amnesia until she was in the middle of being assaulted. This is not to scare you, exactly, but to say that it's absolutely critical to keep your drink in hand at all times.

Finally, I want to make a comment about the dangers of combining alcohol with other drugs. Because alcohol and marijuana are both heavily used and abused in the US, many of us will find ourselves in situations where we are offered both at the same time. We still don't know much about the molecular interactions between marijuana and alcohol, but it appears that alcohol makes the body absorb THC, the active psychotropic ingredient in marijuana, much faster. This often leads to intense dizziness, vomiting, and intense muscle weakness. Drinking before smoking weed also increases the likelihood of having a psychotic episode and the accompanying hallucinations. Drinking and getting high together also drastically increases the risk of getting in a car accident, above the rate of drinking alone. We are still investigating what exactly happens in the body when we smoke and drink simultaneously, but anecdotal data suggests that the experience is both dangerous and generally terrible- people feel like they are going to die.

On the subject of combining drugs, I should also talk about mixing alcohol with prescription medications. Many of us take medications on a daily basis without thinking about it, but it's critical that we maintain awareness of the drugs already in our system when we are in the position to drink alcohol. Never drink while you have another depressant in your system, such as the anti-anxiety medication Valium or a sleep aid like Ambien. The combined power of alcohol with another depressant relaxes the body to a potentially lethal extent, and can cause extreme dizziness, loss of muscle control, memory loss, and death. On the flip side, combining alcohol with a stimulant, such as the ADHD drugs Adderall and Ritalin, can mask the effects of alcohol, making you unaware of how intoxicated your body truly is. You might feel alert and focused after several drinks, but your body and brain are still suffering from the negative effects of alcohol on human cells. Many people die from over-drinking while on ADHD medication. If you

are prescribed an opiate such as OxyContin, do not even think about touching alcohol; opiates combined with alcohol cause slowed breathing and lowered blood pressure, eventually resulting in a coma and death. Essentially, if you must drink, do so on a drug-free system. Alcohol pairs well with food, not medication.

I am under no illusion that this podcast is going to usher in a teenage-specific, 21st century revival of Prohibition. Alcohol is a part of American culture, and to my passive disappointment, it's not going away anytime soon. All of us will end up drinking in college, if not by the time we leave high school. Nonetheless, I hope this episode has made you think about your own choices regarding alcohol, and what the consequences are for our developing brains. Alcohol is a drug, just like marijuana or cocaine, and we have to remember that consuming psychotropic substances is never harmless. Binge-drinking especially threatens our memory and cognitive speed, and even consuming moderate amounts of alcohol has ramifications down the road. When you do find yourself with a drink in hand, don't go back for a second or third pour. Don't get hammered. Even if it blacking out didn't harm the brain, it still endangers your personal safety, forms addictive cravings, and, if nothing else, leaves you feeling terrible the next morning. As teenagers, we all have to decide where we find a balance between pleasure and safety, and I hope that this episode has changed the way you approach that boundary with alcohol for the better.