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What Alcohol Actually Does to Your Brain and Body

Kevin Purdy | 11/09/10

Alcohol, like caffeine, has an enormous reputation but loose understanding in popular culture. Learn how it's absorbed and how fast, why it's essential to reality TV altercations, its paradoxical sexual effects, and its life-lengthening potential, whether red wine or Bud Light.

Everyone, it seems, takes their cues on how alcohol affects the mind and body from an eclectic mix of knowledge: personal experience, pop culture, tall tales of long nights, the latest studies to make the health news wires, and second-hand tips. You might have gathered that alcohol is a depressant, that it's dehydrating, that you can drink about one drink an hour and stay relatively sober. Some of that is true. But much of it depends on a large number of factors.

Let's dig into some of the things we do and don't know about alcohol. Relevant sources are linked where cited, but much of the background material comes from *Buzz: The Science and Lore of Alcohol and Caffeine* (new-ish Kindle edition linked there). It's a science-based tome written in a clear language by Stephen Braun, and was the main reference for our take on caffeine.
We're taking a few things for granted here: that you understand some of the basics of alcohol consumption, blood alcohol content, legal limits, what it feels like when you've had too much to drink, and the serious illness of alcoholism. We're not trying to help you get loaded quicker, or drink more for longer periods. We're digging into some of the science behind how you and alcohol interact.

It Works Differently on Full Stomachs, Young Women, Some Asians, and Aspirin Takers

Your body sees alcohol as a poison, or at least as something it doesn't actually want inside it. To fight back, and sober you up, humans produce an enzyme called alcohol dehydrogenase.

That enzyme gets its shot at your alcohol when it attempts to pass through the stomach lining, and when it reaches your liver, primarily. On contact, it snatches a hydrogen atom off the ethanol molecules in your drink, rendering it into non-intoxicating acetaldehyde. Humans can then use aldehyde dehydrogenase as a kind of clean-up crew, breaking down the acetaldehyde that's sometimes considered a cause of hangovers, along with dehydration. (For more on the myths versus reality of hangovers, see our guide to hangover cures).
Seems pretty simple, no? It's a fight between how much you can drink, versus how fast your enzymes can bust down your indulgences and their byproducts. But many factors affect certain people's production of the two alcohol-crushing compounds:

• Alcohol dehydrogenase (AD) is, for reasons not wholly understood, more effective in men than in women. Young men, in fact, may have up to 70 to 80 percent greater enzyme activity in the presence of alcohol. But men's AD effectiveness also drops off with age at a faster rate than in women, such that, by around 55 or 60, men may find themselves able to handle less alcohol than their female counterparts, all other factors being equal.

• A full stomach helps break down alcohol, but not because your food "soaks up" the alcohol. When you eat a big meal, your stomach's pyloric sphincter, a kind of release valve into the small intestine, closes tightly. Your body knows that you've got food that should get a good going-over in your stomach before it heads straight to the high-absorption small intestine, so it keeps it there, and the AD in your stomach has more time to work on the alcohol. Drink on an empty stomach, and the liquid quickly makes it into the small intestine, where there's more than 200 square meters of surface area for absorption into your body.

• Another big factor in alcohol absorption, and alcohol's effects, is genetics. Your great-great-grandparents have a say in how buzzed your Friday night gets, for sure, but for roughly one-third to half of Asian drinkers, it's more than a slight variance. Alcohol flush reaction, a flushing of the face when drinking, occurs because the enzyme "clean-up crew," aldehyde dehydrogenase, is mutated by just one amino acid. That changes how effective its molecules are in bonding with, and busting up, acetaldehyde. With excess acetaldehyde in their system, those with a flush reaction get red-faced, and can experience heart palpitations, dizziness, and severe nausea in extreme cases. Your own genetic makeup of AD and aldehyde dehydrogenase affect your ability to break down alcohol and its byproducts in similar fashion.

• Don't take aspirin before drinking, unless you love hangovers. Aspirinseriously cuts the effectiveness of your body's AD enzymes. In one 1990 study, the average blood alcohol levels of those who took two maximum strength aspirin tablets before drinking were an average of 26 percent higher than those who were aspirin-free. Other studies have suggested even more impact on your body's ability to break down alcohol. That also means more acetaldehyde in your system down the line, so you'll learn your lesson quickly if you're considering aspirin as a "helper."

Side Note: Absorption and Elimination Is a Curve, Not a Straight Line

Think you've got a handle on the basic one-drink-per-hour algorithm for your weekend nights? Check out this explainer from a forensic toxicology lab, which also links up an advanced Blood Alcohol Calculator. Your BAC moves through plateaus, responds differently to drinks higher than 20-25 percent alcohol by volume, and eliminates some alcohol in pure form—which is how police can measure it on your breath.

It Extends Your Life—Kind O

Every few weeks, it seems, a new study suggests a glass of wine, or sometimes any old drink, lengthens your life if you don't overdo it. Plucking just one out of the pile, you'll see that in *Alcoholism: Clinical and Experimental Research*, researchers followed 1824 people over a total of 20 years, as they aged between 55 and 65. Of those who abstained entirely, 69 percent died. Among those who drank in "moderate" amounts, 41 percent died—which was 23 percent less than the "light" drinkers. Even "heavy drinkers" fared better than abstainers, with just 61 percent passing away during the study period.

How could a substance that everybody and their five brothers tell you to go easy on extend your life? Popular theories center on the antioxidants andresveratrol compounds found in wines, or on the studies showing alcohol as increasing levels of HDL ("good") cholesterol.

But Jonah Lehrer at Wired points out the not-so-obvious: the link between a longer life and alcohol may not be direct, but it's likely very real. It relates to the long-term benefits of reducing stress, as well as alcohol's role in facilitating get-togethers and acting as a "social lubricant":

What does this have to do with longevity? In recent years, sociologists and epidemiologists have begun studying the long-term effects (*Direct PDF link*) of loneliness. It turns out to be really dangerous. We are social primates, and when we're cut off from the social network, we are more likely to die from just about everything (but especially heart disease). At this point, the link between abstinence and social isolation is merely hypothetical. But given the extensive history of group drinking—it's what we do when we come together—it seems likely that drinking in moderation makes it easier for us develop and nurture relationships. And it's these relationships that help keep us alive.

Theoretically, then, you might get some of the same benefits if you were a savvy, social Diet Coke drinker. But it's likely a combination of actual alcohol effects, along with their social expressions, that leads to study after study showing drinkers as getting some kind of life-extending benefit.

It Doesn't "Kill" Brain Cells, but Does Inhibit Them

It's true that at high concentrations, like the nearly 100-percent pure alcohol used in sterilizing solutions, alcohol can indeed kill cells and neurons (and nearly anything else). But given that the blood reaching your brain is only at 0.08 percent alcohol if you're legally intoxicated, or, say, 0.25 percent if you've just closed a major deal in Tokyo, it's not doing a lot of damage to your actual brain cells (liver cells and other organs, with long-term chronic abuse, are another matter).

Don't believe it? A major study by Grethe Jensen and colleagues in 1993 matched brain samples taken from both alcoholics and nonalcoholics, from groups of the two dead from non-alcohol-related causes. There were no significant differences found in either the number or density of brain cells between the groups. Misconception Junction tackles Jensen's study and the topic in more depth.

What alcohol can and does do to your brain is affect the way your neurons get their firing triggers from glutamate. It infiltrates the glutamate receptors in your synapses, hurting their ability to send off their normal "fire" messages. Alcohol has this impact all across your brain—the parts that control muscles, speech, coordination, judgment, and so on. Keep that in mind the next time you or someone else claims that they drive, golf, or otherwise perform some task better with alcohol's help. As Stephen Braun puts it in *Buzz: The Science and Lore of Alcohol and Caffeine*:

Substances such as cocaine and LSD work like pharmacological scalpels, altering the functioning of only one or a handful of brain circuits. Alcohol is more like a pharmacological hand grenade. It affects practically everything around it.

Side Note: That's Also Why It, Uh, "Inhibits" Sex

The studies and implications are numerous, to say the least, but if you want a thumbnail understanding of how alcohol, as Shakespeare put it, "provokes the desire, but ... takes away the performance," it has to do with the firing of nerves, in the brain and elsewhere, that would relax the arteries enough to get both parties moving. It's a bit more complex than that, and drinking in moderation can be a net benefit in some cases, but alcohol, paradoxically, doesn't help one specific region of your self to "relax."

Side Note 2: Alcohol is Particularly Effective at Inhibiting Memories

Like the sexual response, the way the brain makes memories is far from comprehensively understood. But it does seem linked to N-Methyl-D-aspartic acid, or NMDA, the receptor for which alcohol seems particularly adept at interfering with, according to Braun. Studies have shown that while subjects under alcohol's influence can recall existing memories, events happening during inebriation are regularly hard to remember. It varies with the amount consumed, and seems to top out at a serious 0.2 percent blood alcohol content, but anything from flimsy recall to full-on blackouts are possible due to alcohol's unique bond with the stuff that should make memories.

It Makes Other People Seem More "Intentional"

If you'd never been raised to think things through, you'd assume that most actions people took were fairly intentional, and possibly pointed at causing you harm. The same holds when people are asked to make snap

judgments about things happening. But give yourself any amount of time, and you'll generally think out all the reasons something could have happened, avoiding your natural intentionality bias and preventing heated arguments with otherwise close friends, bar altercations, and 80 percent of all reality show plots. *Image via terren in Virginia.*

But, as you might have guessed, that reasoned thinking gets lost when there's a night's worth of alcohol moving through your brain. In the *Personality and Social Psychology Bulletin*, researchers detail a study with 92 men, made to go three hours without food, then given a shot of either juice, or juice with more than a shot of pure alcohol. All the glasses were rimmed with alcohol to mask the placebos. The men thought they took part in a taste test, then did unrelated tasks for 30 minutes.

After that, they were asked to determine whether a series of deliberate, accidental, or vague stated actions ("He deleted the email," "She looked for her keys," "She tripped on the jump rope," etc.) were deliberate or accidental.Ars Technica sums up the results:

Nearly all the participants, no matter what condition, judged all the unambiguous statements correctly. However, when the actions were ambiguous and could have been performed either intentionally or unintentionally, the "drunk" participants were much more likely to perceive the actions as deliberate than the sober participants were.

The study showed that it didn't much matter whether a man *thought* he was drunk; the jump to conclusions about an intention only took place when someone actually *did* have too much in them.

It's a Terrible Sleep Aid

Ever heard the term "nightcap?" People have long believed that alcohol helps you get to sleep—and that part can be true, for some. Once you're asleep, though, alcohol's interaction with your brain can lead to some fitful sleep—and no sleep at all, especially if you consumed caffeine anytime close to hitting the pillow.

Just as with caffeine, your brain proves remarkably adept at adapting itself and responding to the ethanol molecules jamming up its receptors and interfering with neuron firings. It takes a bit for the brain to catch up, though, and when your brain starts kicking in and reclaiming all its nooks and crannies, it can wreak havoc on your crucial REM sleep, along with your more passive, general resting. If you've had caffeine, too, it's a drug that can take up to 5 hours to break down half a dose. If it's in your system at the same time as your brain is trying to compensate for alcohol, the combined "revenge" of both drugs can lead to some fairly restless sleep, according to Braun's *Buzz*.

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