# Chronic drinking leads to reduced cortical thickness in frontal and temporal brain regions

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Researchers already know that chronic misuse of alcohol can cause widespread damage to the brain. While previous studies examined cortical atrophy in individuals with alcoholism, none examined alcohol-associated atrophy using cortical thickness measurements to obtain a regional mapping of tissue loss across the full cortical surface. This study does so, finding that alcohol damage occurs in gradations: the more alcohol consumed, the greater the damage.

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

"Before advances in neuroimaging technology, the degree to which alcohol affects the brain across different levels of alcohol use, and how it may interact with other health factors, was unclear," said Catherine Brawn Fortier, a neuropsychologist and researcher at the VA Boston Healthcare System and Harvard Medical School as well as corresponding author for the study. "We now know that alcohol has wide ranging effects across the entire cortex and in structures of the brain that contribute to a wide range of psychological abilities and intellectual functions. This is the first study to precisely measure the variation in the thickness of the cerebral cortex, which is the thin layer of neurons that one sees on the surface of the brain and supports all higher-level human cognition."

Fortier explained that the brain is usually divided up into two broad kinds of tissues: gray matter, consisting of neurons which are the critical cells that support brain function; and white matter, consisting of the connections among large groups of those cells. Alcohol has an impact on both gray and white matter, with the greatest impact affecting parts of the brain called the frontal and temporal lobes. "These brain areas are critical to learning new information and, even more importantly, in self-regulation, impulse control, and the modification of all complicated human behaviors," she said. "In other words, the very parts of the brain that may be most important for controlling problem drinking are damaged by alcohol, and the more alcohol consumed, the greater the damage."

Fortier and her colleagues compared high-resolution structural magnetic resonance scans from 65 participants in two demographic groups: 31 abstinent alcoholic participants (20 men, 11 women) and 34 nonalcoholic control participants (20 men, 14 women). Images were used to create cortical-surface models, and cortical thickness was then estimated as the distance between the gray matter/white matter boundary and the outer cortical surface.

"Previous studies were only able to compare large brain regions," said Fortier, "whereas this method allowed us to look at areas as small as a tenth of a millimeter and compare them across the entire brain. This approach allowed us to identify very subtle but significant alcohol-related damage across the entire brain revealing two primary findings. First, the outermost layer of cortex across the entire brain was reduced in our sample of recovered alcoholics. Second, alcohol's effect on the brain is continuous across a wide range of drinking behavior and appears to be dose specific. Pathology is often thought of as occurring as an all-or-none phenomenon—you either have brain damage or you don't. This study shows that the damage occurs in gradations, and the more you drink, the greater the damage."

"This study documents, for the first time, the dynamic nature of the neuropathology associated with chronic heavy alcohol use," added Terence M. Keane, associate chief of staff for research & development at the VA Boston Healthcare System and assistant dean for research at Boston University School of Medicine, "and is a major concern among the veterans that both of us serve. The results may explain why alcoholism may be so difficult to treat: alcohol damages the very neural systems that are critical to achieving and maintaining abstinence."

"A widespread reduction in cortical tissue in recovered alcoholics indicates that even with abstinence, cognitive abilities are compromised in former drinkers," said Fortier. "Severe reductions in frontal brain regions can result in a dramatic change to personality and behavior, taking the form of impulsivity, difficulty with self-monitoring, planning, reasoning, poor attention span, inability to alter behavior, a lack of awareness of inappropriate behavior, mood changes, even aggression. Severe reductions in temporal brain regions most often result in impairments in memory and language function."

"This study represents a technological and methodological tour de force," said Keane, "documenting with great precision how widespread the effects of alcohol use are on the cerebral cortex and how those effects may change with abstinence. These results will ultimately be important for clinicians, patients and their families because they show that the brain is very sensitive to all levels of alcohol use and that abstinence may result in some reversal of damage and presumably mental abilities. The results also provide the intriguing observation that the brain damage of alcohol is part of what makes abstinence and recovery so difficult."

"I think what is most important for other medical professionals to know and pass on to their patients is that alcohol misuse is not without consequences," said Fortier. Not only is the brain impacted, but the very brain structures that are the most impacted are the ones that you need to change problematic behavior. However, it is also important to note that although brain tissue is compromised by alcohol, it can recover to some degree with maintained abstinence. This could be a motivational factor in maintaining sobriety."

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