Medical Xpress

Your adolescent brain on alcohol: Changes last into adulthood

April 27 2015

Credit: Kevin Casper/public domain

Repeated alcohol exposure during adolescence results in long-lasting changes in the region of the brain that controls learning and memory, according to a research team at Duke Medicine that used a rodent model as a surrogate for humans.

The study, published April 27 in the journal *Alcoholism: Clinical & Experimental Research*, provides new insights at the cellular level for how alcohol exposure during adolescence, before the brain is fully developed, can result in cellular and synaptic abnormalities that have enduring, detrimental effects on behavior.

"In the eyes of the law, once people reach the age of 18, they are considered adult, but the brain continues to mature and refine all the way into the mid-20s," said lead author Mary-Louise Risher, Ph.D., a post-doctoral researcher in the Duke Department of Psychiatry and Behavioral Sciences. "It's important for young people to know that when they drink heavily during this period of development, there could be changes occurring that have a lasting impact on memory and other cognitive functions."

Risher and colleagues, including senior author Scott Swartzwelder, Ph.D., a professor of Psychiatry and Behavioral Sciences at Duke and Senior Research Career Scientist at the Durham VA Medical Center, periodically exposed young rodents to a level of alcohol during adolescence that, in humans, would result in impairment, but not sedation. Afterward, these animals received no further exposure to alcohol, and grew into adulthood - which in rats occurred within 24 to 29 days.

Earlier studies by the Duke team and others have shown that adolescent animals exposed to alcohol grow into adults that are much less adept at memory tasks than normal animals - even with no further alcohol exposure.

What has not been known is how these impairments manifest at the cellular level in the region of the brain known as the hippocampus, where memory and learning are controlled.

Using small electrical stimuli applied to the hippocampus, the Duke team measured a cellular mechanism called long-term potentiation, or LTP, which is the strengthening of brain synapses as they are used to learn new tasks or conjure memories.

Learning occurs best when this synaptic activity is vigorous enough to build strong signal transmissions between neurons. LTP is highest in the young, and effective learning is crucial for adolescents to acquire large amounts of new memory during the transition to adulthood.

The researchers expected they would find abnormally diminished LTP in the adult rats that had been exposed to alcohol during their adolescence. Surprisingly, however, LTP was actually hyperactive in these animals compared to the unexposed rodents.

"At first blush, you would think the animals would be smarter," Swartzwelder said. "But that's the opposite of what we found. And it actually does make sense, because if you produce too much LTP in one of these circuits, there is a period of time where you can't produce any more. The circuit is saturated, and the animal stops learning. For learning to be efficient, your brain needs a delicate balance of excitation and inhibition - too much in either direction and the circuits do not work optimally."

Importantly, the LTP abnormality was accompanied by a structural change in individual nerve cells that Swartzwelder, Risher and colleagues identified. The tiny protrusions from the branches of the cells, called dendritic spines, had appeared lanky and spindly, suggesting immaturity. Mature spines are shorter and look a bit like mushrooms, refining cell-to-cell communication.

"Something happens during adolescent alcohol exposure that changes the way the hippocampus and other regions of the brain function and how the cells actually look - both the LTP and the dendritic spines have an immature appearance in adulthood," Swartzwelder said.

Risher said this immature quality of the brain cells might be associated with behavioral immaturity. In addition to spine changes in the hippocampus, which affects learning, colleagues of the Duke group have shown structural changes in other brain regions that control impulsiveness and emotionality.

"It's quite possible that alcohol disrupts the maturation process, which can affect these cognitive function later on," she said. "That's something we are eager to explore in ongoing studies."

The researchers said additional studies would focus on the longer-term cognitive effects of alcohol on brains, along with additional cellular changes.

Provided by Duke University Medical Center