Study finds chronic alcohol use shifts brain's control of behavior

August 23 2013

(Medical Xpress)—Chronic alcohol exposure leads to brain adaptations that shift behavior control away from an area of the brain involved in complex decision-making and toward a region associated with habit formation, according to a new study conducted in mice by scientists at the National Institutes of Health.

The finding provides a biological mechanism that helps to explain compulsive alcohol use and the progression to alcohol dependence. A report appears online in the *Proceedings of the National Academy of Sciences* (*PNAS*).

The brain's prefrontal cortex is involved in decision-making and controlling emotion, while the dorsal striatum is thought to play a key role in motivation and habit formation. Past studies have shown that alcohol dependent individuals show problems with skills mediated by the prefrontal cortex such as impulse control. These same individuals often show exaggerated neural response in the dorsal striatum to alcohol-related cues.

To investigate whether changes in the dorsal striatum might account for these observations, researchers led by Andrew Holmes, Ph.D., in the Laboratory of Laboratory of Behavioral and Genomic Neuroscience at NIAAA, measured changes in the brains of mice that were chronically exposed to alcohol vapors.

He and his colleagues found profound changes in the dorsal striatum of

these mice, including the expansion of neuronal dendrites, the branching projections of the nerve cell that conduct signals. Such changes are also seen with chronic exposure to drugs such as amphetamine. These structural changes were associated with changes in synaptic plasticity, the brain's ability to change in response to experience, and reduced activity of endocannabinoid receptors, which are part of a signaling system that may play a role in sensation, mood, and memory.

"These findings give important insight into how excessive drinking affects learning and behavioral control at the neural level," said Kenneth R. Warren, Ph.D., acting director of the National Institute on Alcohol Abuse and Alcoholism (NIAAA). "The shift to increased striatal control over behavior may be a critical step in the progression of alcoholism."

"The changes we observed suggest that the manner in which the dorsal striatum signaled and adapted to environmental information has been altered by alcohol," said senior author Dr. Andrew Holmes. "The findings imply that chronic drinking may set up a concerted set of adaptions in this key brain region that produce a bias for striatal control over behavior."

Such changes could contribute to the emergence of habitual and compulsive patterns of behavior in alcohol abuse, and suggest that treatments designed to normalize striatal function may be an important approach for alcohol treatment.

Dr. Holmes and his colleagues add that their findings suggest that drug abuse doesn't simply impair brain functions, but instead produces a complex set of adaptations that tamp down the function of some brain regions while dialing up the function of others.

Indeed, the researchers found that chronic alcohol actually improved the ability of mice to learn to make choices on a touchscreen.

"Improved performance on learning tasks that we know depend on the dorsolateral striatum is particularly interesting because it suggests that alcohol could prime the brain to favor other dorsal striatal behaviors – including things like habit formation, which may foster addictive patterns of behavior," said Dr. Holmes.

More information: DePoy, L. et al. Chronic alcohol produces neuroadaptations to prime dorsal striatal learning, *PNAS*, 2013 Aug 20. [Epub ahead of print]

Provided by National Institutes of Health

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