Finger tapping shows that alcoholics may recruit other brain regions for simple tasks

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Chronic drinking is associated with neurocognitive deficits due to neuropathological changes in the structure, metabolism, and function of the brain. One of the consequences of neuropathological brain abnormalities in the cerebellum of alcoholics has been impairment of motor functioning. A new study using functional magnetic resonance imaging (fMRI) during a finger-tapping exercise has found a weakened relationship between frontal lobe and cerebellar activity in alcoholic individuals.

Results will be published in the February 2012 issue of *Alcoholism: Clinical & Experimental Research* and are currently available at Early View.

"Chronic alcohol exposure most commonly causes deficits in visuospatial skills and problem solving, while problems with learning and memory can also be observed," said Baxter P. Rogers, research assistant professor at the Vanderbilt University Institute of Imaging Science and corresponding author for the study. "But a commonly unappreciated deficit is in motor functions: for instance, balance when standing can be affected by dysfunction of the cerebellum as can the ability to perform rhythmic movements."

Rogers and his colleagues used fMRI to examine 10 uncomplicated chronic alcoholic patients after five to seven days of abstinence and once signs of withdrawal had lessened, as well as 10 matched healthy controls. "We used fMRI during a finger-tapping exercise to examine functional

connectivity between cerebellar and cortical brain regions because fMRI measures the function of the entire brain painlessly and non-invasively, and functional MRI can identify specific brain regions that are involved in tasks, and that are affected in disease," explained Rogers.

Although it may seem an unsophisticated movement, finger tapping is a simple, rhythmic movement that can be used to study the function of the parts of the brain that are often damaged by chronic drinking, such as the cerebellum and the frontal lobes. "Finger tapping is also a very convenient task for the MRI environment, and output from the task is easily described by counting the number of taps in a given amount of time," said Rogers.

"In addition, finger tapping recruits portions of both the cerebellum and frontal cortex," he added. "Previous research strongly suggested that both are affected in alcoholism, especially the cerebellum." The study authors focused on the prefrontal, frontal, temporal, and parietal cortex regions of the brain.

"The key finding was that the relationship between frontal lobe and cerebellar activity was weaker in alcoholic people, even a week after they had stopped drinking," said Rogers. "The weaker relationship between these regions in alcoholics might reflect direct injury to one or both of these parts of the brain, disruption of frontal-cerebellar neural pathways that connect these regions, or some sort of compensation for injuries elsewhere in the brain. It could even be that a weakened relationship between these brain regions was present prior to when a person started drinking which actually predisposes people to alcoholism in the first place."

Rogers explained that while they found that the alcoholic patients could produce the same number of finger taps per minute as did the normal controls, they employed different parts of the brain to do so. This

suggested that alcoholics needed to compensate for their brain injury. "That is, they may need to expend more effort, or at least a different brain response, to produce a normal outcome on simple tasks because they are unable to utilize the brain regions needed in an integrated fashion," he said. "However, if the task becomes more complex, we predict that performance may break down and alcoholics may seem impaired when tested. This is the big advantage of studying simple tasks that alcoholics can perform at normal levels: we can identify the 'brain strategy' – the brain regions that are activated – to perform the task. fMRI allows us to go below the surface, so to speak."

While this study supports other research showing problems in the frontal-cerebellar brain circuits in alcoholic patients, Rogers said its major contribution is related to studying the simple tasks that alcoholics apparently perform quite "normally."

"In many studies, the focus has been on the focus was on neuropsychological testing of alcoholics," said Rogers. "Researchers focused on examining complex tasks – such as memory and problem solving – that alcoholics cannot perform as well as normal controls to determine what parts of their brain were dysfunctional. Now that we have fMRI available to help us determine the areas of the brain that are activated in the performance of tasks, the study of simple tasks may also be very informative. Complex tasks clearly show abnormalities in fMRI, but it becomes impossible to determine whether the fMRI differences observed are due to the impaired performance or brain differences that account for the impaired performance. Our study allows us to infer that changes in brain strategies are employed in performance of the task, which may lead to new approaches to rehabilitation."

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