Computer model shows changes in brain mechanisms for cocaine addicts

September 22 2009

These are doctoral students in the MU Computational Neurobiology Center. The Computational Neurobiology Center is engaged in collaborative research that explores aspects of functioning of both invertebrate and vertebrate brains Credit: Photo taken by Nancy McMullen

About 2 million Americans currently use cocaine for its temporary side-effects of euphoria, which have contributed to making it one of the most dangerous and addictive drugs in the country. Cocaine addiction, which can cause severe biological and behavioral problems, is very difficult to overcome. Now, University of Missouri researchers Ashwin Mohan and Sandeep Pendyam, doctoral students in the Department of Electrical and Computer Engineering, are utilizing computational models to study how the brain's chemicals and synaptic mechanisms, or connections between neurons, react to cocaine addiction and what this could mean for future therapies.

"With cocaine addiction, addicts don't feel an urge to revolt because there is a strong connection in the brain from the decision-making center to the pleasure center, which overwhelms other normal rewards and is why they keep seeking it," Pendyam said. "By using computational models, we're targeting the connection in the brain that latches onto the pleasure center and the parameters that maintain that process."

Glutamate is the major chemical released in the synaptic connections in the brain; the right amount present determines the activity of those connections. Using the computational model, MU researchers found that in an addict's brain excessive glutamate produced in the pleasure center makes the brain's mechanisms unable to regulate themselves and creates permanent damage, making cocaine addiction a disease that is more than just a behavioral change.

"Our model showed that the glutamate transporters, a protein present around these connections that remove glutamate, are almost 40 percent less functional after chronic cocaine usage," Mohan said. "This damage is long lasting, and there is no way for the brain to regulate itself. Thus, the brain structure in this context actually changes in cocaine addicts."

Mohan and Pendyam, in collaboration with MU professor Satish Nair, professor of electrical and computer engineering, and Peter Kalivas, professor and chair of the neuroscience department at the Medical University of South Carolina, found that the parameters of the brain that activate the pleasure center's connections beyond those that have been discovered must undergo alteration in order for addicts to recover. This novel prediction by the computer model was confirmed based on experimental studies done on animal models by Kalivas' laboratory.

"The long-term objective of our research is to find out how some rehabilitative drugs work by devising a model of the fundamental workings of an addict's brain," said Mohan, who will attend Washington

University in St. Louis for his postdoctoral fellowship. "Using a systems approach helped us to find key information about the addict's brain that had been missed in the past two decades of cocaine addiction research."

More information: Moham and Pendyam's research has been published in *Neuroscience* and as a book chapter in New Research on Neuronal Network from Nova Publishers.

Source: University of Missouri-Columbia (news : web)