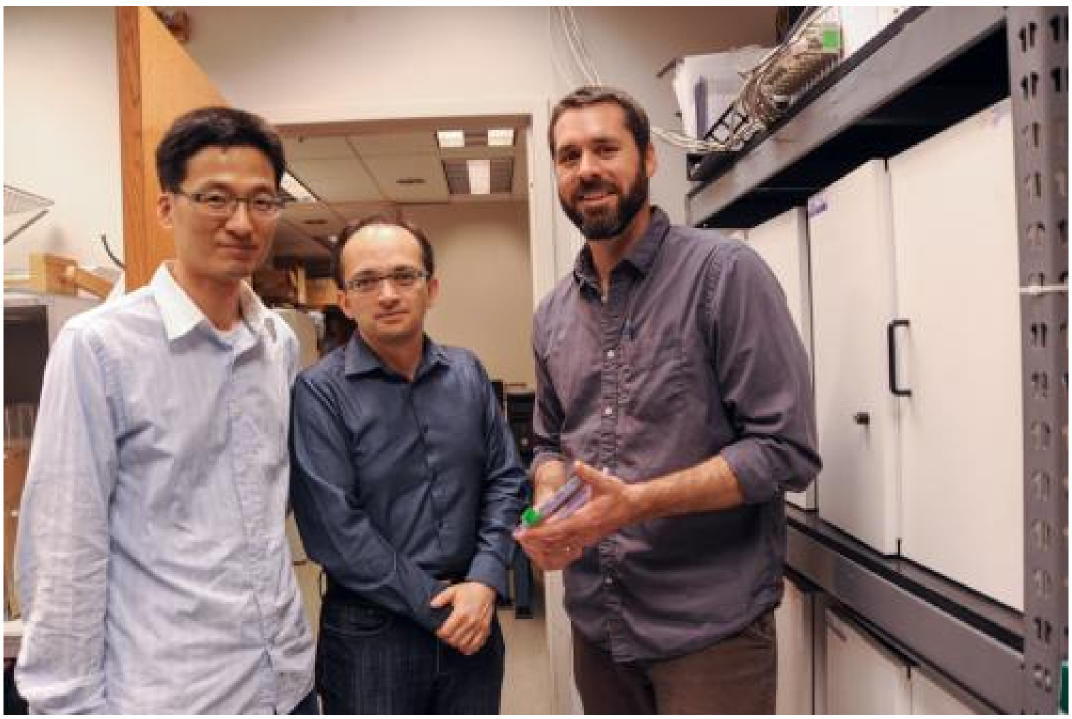
Medical Xpress

Neuroscience research examines neural synchronization patterns during addiction

June 4 2013



Researchers at Indiana University-Purdue University Indianapolis (IUPUI) are using mathematical modeling to better understand how neurons behave during drug addiction or disease. The IUPUI team includes (L to R): Sungwoo Ahn, Ph.D.; Leonid Rubchinsky, Ph.D.; and Christopher Lapish, Ph.D. Credit: School of Science at IUPUI

A cross-disciplinary collaboration of researchers in the School of Science at Indiana University-Purdue University Indianapolis (IUPUI) explores the neural synchrony between circuits in the brain and their behavior under simulated drug addiction. The two-year study could have broad implications for treating addiction and understanding brain function in conditions such as Parkinson's disease.

Advanced mathematical models coupled with extensive laboratory testing revealed recurrent stimulant injections in rodents resulted in neural circuits that could easily synchronize but were more likely to become unstable. In other words, the introduction and restriction of drugs over time caused neurons to lose their ability to engage supervisory control over brain function and behavior. Researchers noticed these short periods of desynchronization were much more prevalent and caused changes in neurobiology and behavior.

"A better understanding of the dynamics of neural synchrony could have very important implications for understanding the addicted brain and may provide a physiological target to understand persistent neural changes that contribute to the probability of relapse," said Christopher Lapish, Ph.D., assistant professor of psychology at IUPUI.

Lapish, with expertise in neurophysiology and addiction, and Leonid Rubchinsky, Ph.D., associate professor of mathematical sciences, collaborated on the project with support from the IUPUI Institute for Mathematical Modeling and Computational Science. Rubchinsky is an applied mathematician and neuroscientist who has extensively studied the neurophysiology of Parkinson's disease.

Sungwoo Ahn, Ph.D., a post-doctoral fellow in mathematical sciences, also co-authored the study, recently published in the *Cerebral Cortex* scientific journal.

The research was patterned after the various stages of drug addiction: the first introduction of amphetamines, periods of abstinence that model withdrawal and then relapse.

The neural synchrony patterns of models injected with a stimulant were compared to those injected with a saline solution. Short periods of desychronization were prevalent in both groups, but the drug-affected group displayed a marked connection between synchrony and brain function. Synchrony has long been considered to play an important role in how the brain processes data, so any disruption of this pattern could hold significant research value, according to the published study.

"Through these long and progressive experimental examinations, we were able to explore the different areas of the brain and how they are connected to each other," Rubchinsky said. "In addition to understanding, monitoring, diagnosing and treating addiction, this type of study is helpful in better understanding how the normal brain works."

This collaboration moves scientists closer to understanding brain function and disruptions, Rubchinsky said, by incorporating mathematical models that recreate events and reactions in the brain over time. Lapish agreed, saying computational science ultimately will drive the growth and success of future neuroscience research.

"Neuroscience is an inherently data-rich science and, by combining experimentalists with theorists, there is a tremendous potential for discovery," Lapish. "The interactive effects of this collaboration are certainly greater than the sum of its parts. We're able to create a fully dynamic picture of this process that would not be possible without combining these two areas of expertise."

Moving forward, the team will continue to seek funding to advance their research methods and better understand the role of synchrony in brain function. By doing so, scientists could map the progress and deterioration of neural circuits in various scenarios.

More information: A complete abstract of the research can be found on the *Cerebral Cortex* website: cercor.oxfordjournals.org/cont … bht110.full.pdf+html

Provided by Indiana University