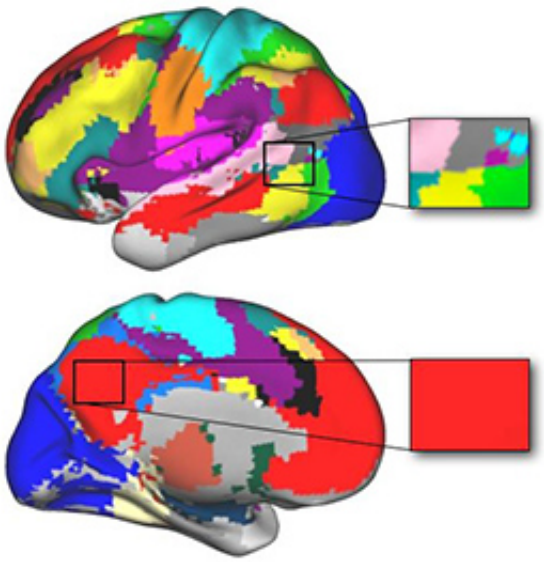
Damage to brain 'hubs' causes extensive impairment

October 14 2014, by Michael C. Purdy



Colors illustrate different networks of the brain. Researchers have discovered that injuries to a brain hub (top), where the boundaries of several networks come together, can be much more devastating than similar injuries in other parts of the brain (bottom). Credit: Steven E. Petersen

Injuries to six brain areas are much more devastating to patients' abilities to think and adapt to everyday challenges than damage to other parts of the brain, scientists at Washington University School of Medicine in St. Louis have learned.

Brain mapping highlighted the regions, which are "hubs" where multiple brain networks come together. The networks make it possible for parts of the brain to work with each other to complete cognitive tasks.

The findings offer a new perspective on how injury impairs brain function. This may help better predict the effects of strokes, trauma and other brain damage and one day could lead to reassessment of the risks of some brain surgeries.

"This isn't ready for application in the clinic yet, but as we get a better feel for where these and other hubs are found in the brain, they may factor into surgical decision-making," said co-senior author Steven Petersen, PhD, the James S McDonnell Professor of Cognitive Neuroscience in Neurology. "The risks of surgeries to these sites could include significant impairment of attention, memory, language, speech and many other cognitive functions."

Petersen noted that some psychological disorders, such as schizophrenia, disrupt a similarly broad range of brain functions. He speculated that problems with the sites highlighted by the new study may contribute to these conditions.

The findings are available online from the Proceedings of the National Academy of Sciences.

Petersen and his colleagues at Washington University School of Medicine identified the sites by mapping brain networks, which make it possible for parts of the brain to work with each other to complete cognitive tasks.

Their maps highlighted hubs, regions where the boundaries of multiple networks come together in one spot. Scientists had not previously identified the regions as areas that made important contributions to brain

function.

"We wondered, though, if the hubs were sites where all the different networks talk to each other," Petersen said. "If that's true, damage in these areas could disrupt several networks, impairing multiple mental functions."

To test their theory, the researchers collaborated with colleagues at the University of Iowa, including Daniel Tranel, PhD, and David Warren, PhD. Tranel heads the Iowa Neurological Patient Registry, a database of patients who suffered strokes and other brain injuries.

In addition to noting the location of damage, the database includes detailed information on behavioral and cognitive effects of the injuries. The information includes findings from tests of memory, speech and reasoning, and assessments of the patients' abilities to deal with "real-world" problems such as holding a job, getting along with family members and going through daily routines. The latter were measured via questionnaires and reports from patients' family members.

The scientists identified 19 patients with brain injuries centered on one of six hubs. The researchers compared them to 11 patients with similarly sized injuries in one of two areas of the brain far from any hubs.

"The patients with injuries to a hub had considerably more impairment," Petersen said. "For example, 18 of the 19 patients with harm to a hub experienced 'real-world' problems, while less than half of the group with injuries far from hubs had such difficulties."

According to Petersen, the findings may help explain anecdotal reports of patients who suffered relatively small brain injuries yet experienced surprisingly significant disabilities and impairments.

"It would have been very difficult to identify these hubs based solely on studies of patients, because injuries that only affect a hub are relatively rare," he said. "But our basic research studies led us straight to them, and the information in the Iowa database and the efforts of their researchers allowed us to test our theory."

Provided by Washington University School of Medicine in St. Louis