New mouse brain map may illuminate origins of mental illnesses

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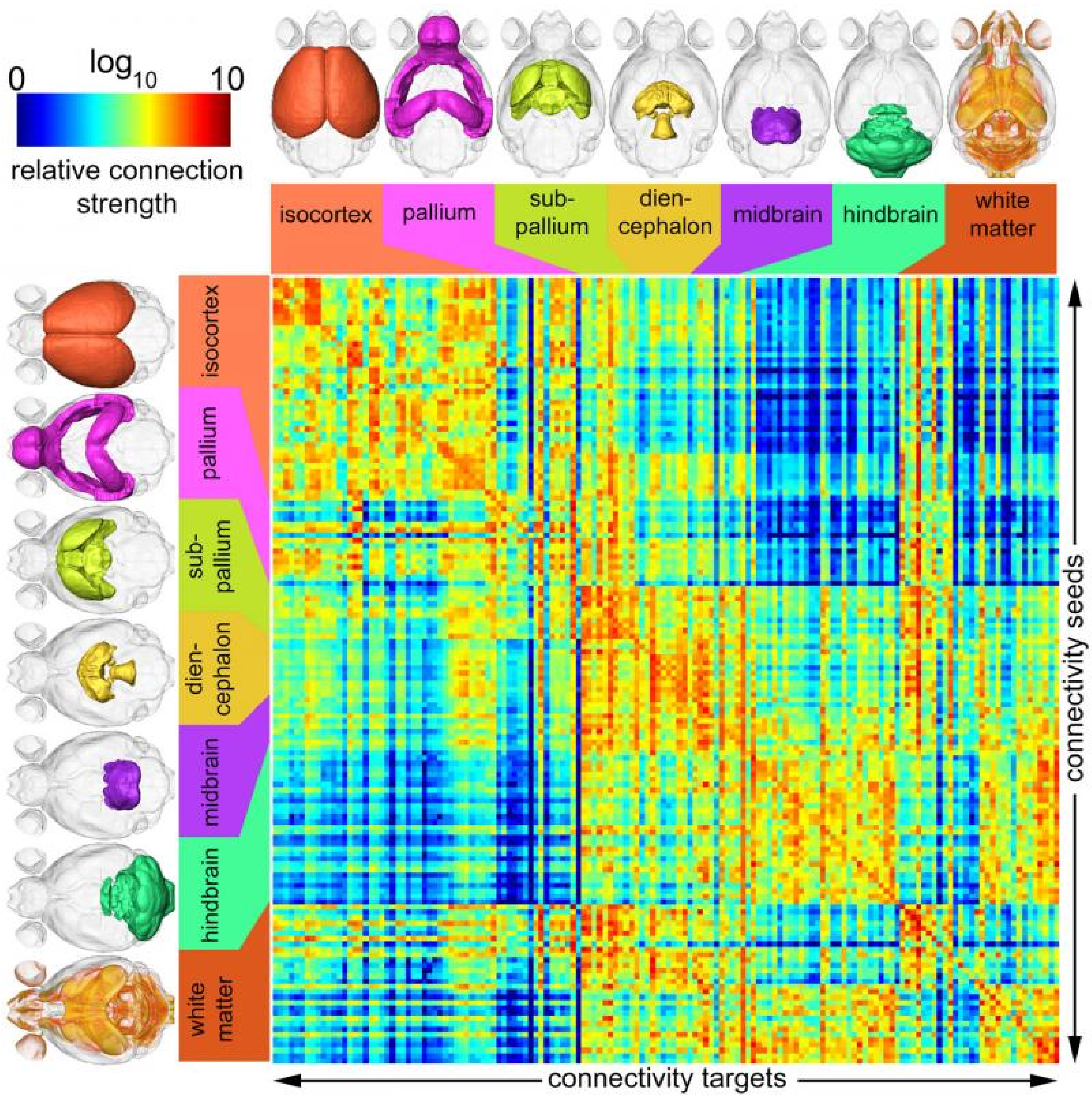

A connectivity matrix maps each region of the mouse brain and its probable connectivity to other brain structures. The researchers are currently building an online portal for scientists around the world to access the full directory of digital files to guide their own research into mouse neurocircuitry. Credit: Duke Medicine

Scientists at Duke University have released a highly detailed model of connections in the mouse brain that could provide generations of neuroscientists new insights into brain circuits and origins of mental illness, such as depression and schizophrenia. The findings are published in the journal *Cerebral Cortex*.

Scientists conduct millions of experiments every year with mice, which have been genetically modified to mimic human disease. Having a far more precise model of the mouse brain will enhance knowledge about the connection between genetics and corresponding human disease, according to G. Allan Johnson, director of the Duke Center for In Vivo Microscopy.

"Interest in structural brain connectivity has grown with the understanding that abnormal neural connections play a significant role in neurologic and psychiatric diseases," Johnson said. "Examining brain connectivity in small animals can help us better identify problems in the diseased brain, and apply that knowledge to humans."

The scientists created the connectome, or map of brain circuitry, by performing an MRI scan of the brain of a healthy mouse at spatial resolution more than 100,000 times greater than that of a conventional clinical MRI. Data were acquired using diffusion MRI, which traces the pathways of nerve fibers called axons throughout the brain.

The accuracy of the connectome is determined by the spatial resolution and the number of different angles scanned. These new data are more than 1,000 times more precise than previous diffusion MRI scans of the mouse brain, Johnson said.

"Prior approaches to provide maps of the mouse brain have relied on fluorescent dyes injected into the brain," Johnson said. "The brain is then cut in thin slices, digitized and put back together again in a computer. It's a time-consuming process."

Producing these high-resolution MRI images also has its challenges, he said. Scanning even a tiny mouse brain at such close detail creates a daunting amount of data that has in the past made such a project impractical, Johnson said.

But banks of high-powered computers have now allowed the scientists to capture and house the data and mathematically manipulate them to create the large 3-dimensional, digital models.

"This study mapping the connectivity of the mouse brain at high resolution could potentially have a profound and far-reaching effect on the neuroscience research community," said Richard Conroy, Ph.D., director of the Division of Applied Science & Technology at the National Institute of Biomedical Imaging and Bioengineering. "Given the brain's complexity, we are still unraveling how it is organized. This study dramatically improves our ability to resolve the connections between different regions of the brain, which could lead to more accurate neuroscience data and fewer inferences. This new map could potentially contribute to insights on neurological diseases and disorders."

A colorful connectivity matrix accompanies the journal article (pictured), charting each region of the mouse brain and its probable connectivity to other brain structures. The researchers are currently building an online portal for scientists around the world to access the full directory of digital files to guide their own research into mouse neurocircuitry.

Provided by Duke University Medical Center