Multiple thought channels may help brain avoid traffic jams

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Brain networks may avoid traffic jams at their busiest intersections by communicating on different frequencies, researchers at Washington University School of Medicine in St. Louis, the University Medical Center at Hamburg-Eppendorf and the University of Tübingen have learned.

"Many neurological and psychiatric conditions are likely to involve problems with signaling in brain networks," says co-author Maurizio Corbetta, MD, the Norman J. Stupp Professor of Neurology at Washington University. "Examining the temporal structure of brain activity from this perspective may be especially helpful in understanding psychiatric conditions like depression and schizophrenia, where structural markers are scarce."

The research will be published May 6 in *Nature Neuroscience.*

Scientists usually study brain networks — areas of the brain that regularly work together — using magnetic resonance imaging, which tracks blood flow. They assume that an increase in blood flow to part of the brain indicates increased activity in the brain cells of that region.

"Magnetic resonance imaging is a useful tool, but it does have limitations," Corbetta says. "It only allows us to track brain cell activity indirectly, and it is unable to track activity that occurs at frequencies greater than 0.1 hertz, or once every 10 seconds. We know that some signals in the brain can cycle as high as 500 hertz, or 500 times per second."

For the new study, conducted at the University Medical Center at Hamburg-Eppendorf, the researchers used a technique called magnetoencephalography (MEG) to analyze brain activity in 43 healthy volunteers. MEG detects very small changes in magnetic fields in the brain that are caused by many cells being active at once. It can detect these signals at rates up to 100 hertz.

"We found that different brain networks ticked at different frequencies, like clocks ticking at different speeds," says lead author Joerg Hipp, PhD, of the University Medical Center at Hamburg-Eppendorf and the University of Tübingen, both in Germany.

For example, networks that included the hippocampus, a brain area critical for memory formation, tended to be active at frequencies around 5 hertz. Networks constituting areas involved in the senses and movement were active between 32 hertz and 45 hertz. Many other brain networks were active at frequencies between eight and 32 hertz. These "time-dependent" networks resemble different airline route maps, overlapping but each ticking at a different rate.

"There have been a number of fMRI studies of depression and schizophrenia showing 'spatial' changes in the organization of brain networks," Corbettta says. "MEG studies provide a window into a much richer 'temporal' structure. In the future, this might offer new diagnostic tests or ways to monitor the efficacy of interventions in these debilitating mental conditions."

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