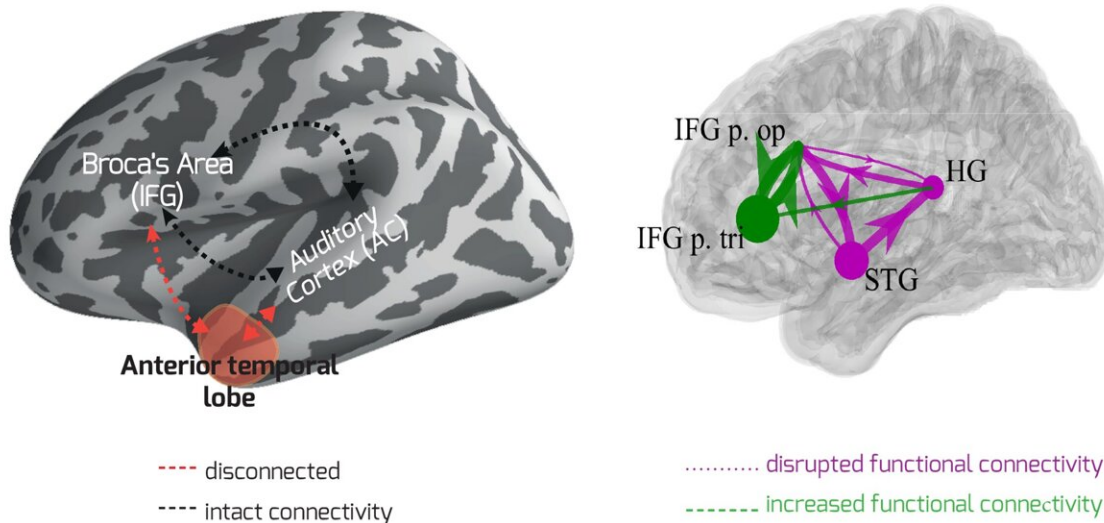


Rare pre- and post-operative recordings show what happens after the brain loses a hub

December 8 2023, by Jennifer Brown



The loss of a semantic brain hub leads to **immediate neural system impact** and **incomplete compensation** by frontal language and auditory cortical areas.

Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-42088-7

A University of Iowa-led team of international neuroscientists have obtained the first direct recordings of the human brain in the minutes before and after a brain hub crucial for language meaning was surgically disconnected. The results reveal the importance of brain hubs in neural networks and the remarkable way in which the human brain attempts to compensate when a hub is lost, with immediacy not previously observed.

Hubs are everywhere. The hub of a bicycle wheel, with spokes shooting out from the center, keeps the wheel from collapsing when the bicycle is ridden. Airport hubs connect cities across the world. And social hubs like [coffee shops](#) or online social networks are places people gather for interaction.

The human brain has hubs, too—the intersection of many neuronal pathways that help coordinate [brain activity](#) required for complex functions like understanding and responding to speech. However, whether highly interconnected brain hubs are irreplaceable for certain brain functions has been controversial.

By some accounts the brain, as an already highly interconnected neural network, can in principle immediately compensate for the loss of a hub, in the same way that traffic can be redirected around a blocked off city center.

With a rare experimental opportunity, the UI neurosurgical and research teams led by Matthew Howard III, MD, professor and DEO of neurosurgery, and Christopher Petkov, Ph.D., professor and vice chair for research in neurosurgery, have achieved a breakthrough in understanding the necessity of a single hub.

By obtaining evidence for what happens when a hub required for language meaning is lost, the researchers showed both the intrinsic importance of the hub as well as the remarkable and rapid ability of the brain to adapt and at least partially attempt to immediately compensate for its loss. The findings were [reported recently in the journal *Nature Communications*](#).

Evaluating the impact of losing a brain hub

The study was conducted during [surgical treatment](#) of two patients with

epilepsy. Both patients were undergoing procedures that required surgical removal of the anterior temporal lobe—a brain hub for language meaning—to allow the neurosurgeons access to a deeper brain area causing the patients' debilitating epileptic seizures.

Before this type of surgery, neurosurgery teams often ask the patients to conduct speech and language tasks in the [operating room](#) as the team uses implanted electrodes to record activity from parts of the brain close to and distant from the planned surgery area. These recordings help the clinical team effectively treat the seizures while limiting the impact of the surgery on the patient's speech and language abilities.

Typically, the recording electrodes are not needed after the surgical resection procedure and are removed. The innovation in this study was that the neurosurgery team was able to safely complete the procedure with the recording electrodes left in place or replaced to the same location after the procedure.

This made it possible to obtain rare pre- and post-operative recordings allowing the researchers to evaluate signals from brain areas far away from the hub, including speech and language areas distant from the surgery site. Analysis of the change in responses to speech sounds before and after the loss of the hub revealed a rapid disruption of signaling and subsequent partial compensation of the broader brain network.

"The rapid impact on the speech and language processing regions well removed from the surgical treatment site was surprising, but what was even more surprising was how the brain was working to compensate, albeit incompletely within this short timeframe," says Petkov, who also holds an appointment at Newcastle University Medical School in the UK.

The findings disprove theories challenging the necessity of specific brain

hubs by showing that the hub was important to maintain normal brain processing in language.

"Neurosurgical treatment and new technologies continue to improve the treatment options provided to patients," says Howard, who also is a member of the Iowa Neuroscience Institute. "Research such as this underscores the importance of safely obtaining and comparing electrical recordings pre and post-operatively, particularly when a brain hub might be affected."

According to the researchers, the observation on the nature of the immediate impact on a neural network and its rapid attempt to compensate provides evidence in support of a brain theory proposed by Professor Karl Friston at University College London, which posits that any self-organizing system at equilibrium works towards orderliness by minimizing its free energy, a resistance of the universal tendency towards disorder.

These neurobiological results following [human brain](#) hub disconnection were consistent with several predictions of this and related neurobiological theories, showing how the [brain](#) works to try to regain order after the loss of one of its hubs.

In addition to Petkov and Howard, the research team included researchers in the UI Departments of Neurosurgery, Radiology, and Psychological and Brain Sciences, as well as colleagues from Newcastle University, UCL, and University of Cambridge in the UK, and from Carnegie Mellon University, University of Wisconsin-Madison, and Gonzaga University in the United States.

More information: Zsuzsanna Kocsis et al, Immediate neural impact and incomplete compensation after semantic hub disconnection, *Nature Communications* (2023). [DOI: 10.1038/s41467-023-42088-7](https://doi.org/10.1038/s41467-023-42088-7)

Provided by University of Iowa

Citation: Rare pre- and post-operative recordings show what happens after the brain loses a hub (2023, December 8) retrieved 29 April 2024 from <https://medicalxpress.com/news/2023-12-rare-pre-post-operative-brain-hub.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.