Research sheds new light on how the brain forms and recalls memories

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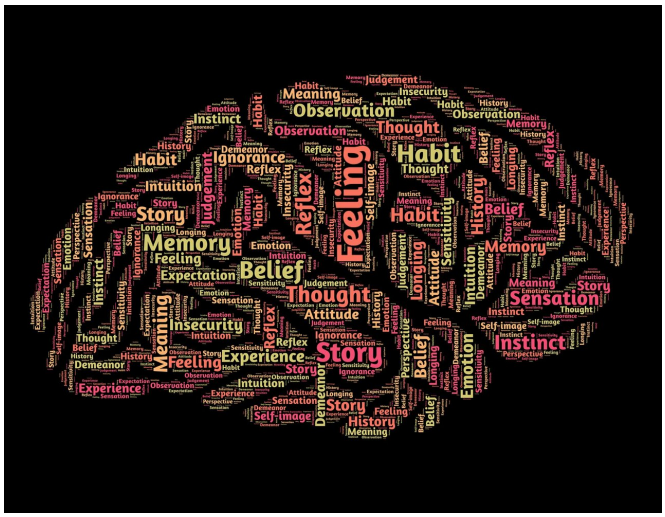

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Neuroscientists at the University of Birmingham have proved how different parts of the human brain work together to create and retrieve episodic memory.

Models suggested that, during formation of a memory, information is routed from cortex to hippocampus whilst retrieving a memory should see this information flow in reverse.

Birmingham researchers demonstrated in humans, for the first time, that this flow of information into and out of the hippocampus can be tracked by brain oscillations—alpha waves reflecting cortical activity, whilst gamma oscillations mirror hippocampal activity.

Patients suffering from memory loss may benefit from the research, which sheds new light on the way the brain processes and retrieves memories.

Led by Dr. Simon Hanslmayr, researchers at the University of Birmingham and University Hospital, Erlangen, Germany have published their findings in the journal *PNAS*.

Dr. Hanslmayr, reader in cognitive neuroscience, commented: "In order to fix something that is broken, one needs to understand how it works in the first place. Our study shows how the neocortex and the hippocampus interact to form and retrieve memories.

"Understanding this interaction is key for the development of neurostimulation devices that could help alleviate memory problems in clinical populations. Our fresh understanding will help answer a critical question in modern neuroscience, namely how different brain regions interact to create memories."

An episodic memory is a highly detailed memory of a personally experienced event. Formation and retrieval of such memories hinge upon the brain processing information relevant to the event and binding this information into a coherent episode.

Existing theory suggested that information processing is made possible by neocortical alpha/beta oscillatory networks, while creating the memory is facilitated by hippocampal theta and gamma oscillations.

This theoretical framework proposed that the two mechanisms must co-operate, as an isolated failure of either would produce the same undesirable outcome: an incomplete memory trace.

Birmingham and Erlangen researchers discovered that directional coupling between the two brain regions with power decreases in the neocortex preceding and predicting power increases in the hippocampus during memory formation.

They observed that the process reversed during memory retrieval, with hippocampal power increases preceding and predicting neocortical

powerdecreases.

"These results suggest that a bidirectional flow of information between the neocortex and hippocampus is fundamental to formation and retrieval of episodic memories," said Dr. Hanslmayr.

"We uncovered evidence of this interaction, as well as demonstrating that distinct hippocampal gamma frequencies contribute to memory formation and retrieval, with "fast" gamma making possible encoding and "slow" gamma facilitating retrieval."

More information: Benjamin J. Griffiths et al. Directional coupling of slow and fast hippocampal gamma with neocortical alpha/beta oscillations in human episodic memory, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1914180116

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