Researchers identify novel brain network that plays wide role in memory and learning processes

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One of the more heartbreaking realities of Alzheimer's is the moment when a loved one struggling with the disease no longer fully recognizes a family member or close friend who is caring for them.

Now, new research from Washington University in St. Louis has identified a novel learning and memory brain network that processes incoming information based on whether it's something we've experienced previously or is deemed to be altogether new and unknown, helping us recognize, for instance, whether the face before us is that of a familiar friend or a complete stranger.

Forthcoming in the September issue of the journal , the study pulls together evidence from multiple neuroimaging studies and methods to demonstrate the existence of previously unknown and distinct functional brain network, one that appears to have broad involvement in human memory processing.

"Activity in this network tells us if you're looking at something that you perceive to be novel or familiar," said Adrian Gilmore, first author of the study and a fifth-year psychology doctoral student in Arts & Sciences at Washington University. "When an individual sees a novel stimulus, this network shows a marked decrease in activity. When an individual sees a familiar stimulus, this network shows a marked increase in activity."

Study co-authors are Kathleen B. McDermott, PhD, professor of psychology in Arts & Sciences and of radiology at Washington University School of Medicine in St. Louis; and Steven Nelson, PhD, a graduate of the neuroscience doctoral program at Washington University.

Nelson is now the neuroimaging core chief at the U.S. Department of Veterans Affairs VISN 17 Center of Excellence for Research on Returning War Veterans in Waco, Texas. McDermott is principal investigator and director of Washington University's Memory and Cognition Lab.

Described by study authors as the Parietal Memory Network (PMN), the new memory and learning network shows consistent patterns of activation and deactivation in three distinct regions of the parietal cortex in the brain's left hemisphere -- the precuneus, the mid-cingulate cortex and the dorsal angular gyrus.

Activity within the PMN during the processing of incoming information (encoding) can be used to predict how well that information will be stored in memory and later made available for successful retrieval. The PMN exhibits opposite patterns of activity depending on whether the information being retrieved is recognized as new or familiar -- the more familiar the information, the more activity in the PMN, the study found.

Researchers identified interesting characteristics of the PMN by analyzing data from a range of previously published neuroimaging studies. Using converging bits of evidence from dozens of fMRI brain experiments, their study shows how activity in the PMN changes during the completion of specific mental tasks and how the regions interact during resting states when the brain is involved in no particular activity or mental challenge.

This study builds on research by Marcus Raichle, MD, the Alan A. and Edith L. Wolff Distinguished Professor of Medicine, and other neuroscience researchers at Washington University, which established the existence of another functional brain network that remains surprisingly active when the brain is not involved in a specific activity, a system known as the Default Mode Network.

Like the Default Mode Network, key regions of the PMN were shown to hum in a similar unison while the brain is in relative periods of rest. And while key regions of the PMN are located close to the Default Mode Network, the PMN appears to be its own distinct and separate functional network, preliminary findings suggest.

Another characteristic that sets the PMN apart from other functional networks is that its activity patterns remains consistent regardless of the type of mental challenge it is processing.

Many regions of the cortex jump into action only during the processing of a very specific task, such as learning a list of words, but remain relatively inactive during very similar tasks, such as learning a group of faces, The PMN, on the other hand, exhibits activity across a wide range of mental tasks, with levels rising and falling based on how much a

task's novelty or familiarity captures our attention.

"It seems like the amount of change relies heavily on how much a given stimulus captures our attention," Gilmore said. "If something really stands out as old or new, you see much larger changes in the network's activity than if it doesn't stand out as much."

The consistency of these patterns across various types of processing tasks suggests that the PMN plays a broad role in many different learning and recall processes, the research team suggests.

"A really cool feature of the PMN is that it seems to show its response patterns regardless of what you're doing," Gilmore said. "The PMN doesn't seem to care what it is that you're trying to do. It deactivates when we encounter something new, and activates when we encounter something that we've seen before. This makes it a really promising target for future research in areas such as education or Alzheimer's research, where we want to foster or improve memory performance broadly, rather than focusing on specific tasks."

Source:
Washington University in St. Louis
