Duke UNIVERSITY News & Communications

June 01, 2005

Brain-Scanning Life's Memories Yields New Insights

Researchers at Duke have figured out how to study how the brain recalls autobiographical memories

Wednesday, September 29, 2004

Print This Page

DURHAM, N.C. -- Neuroscientists at Duke University have figured out how to study with rigorous experimental control how the brain recalls autobiographical memories -- the memories of a person's past experiences. Their new "photo paradigm" involves having subjects take photographs that they later recall in the laboratory while their brains are being scanned.

The researchers said their study revealed that the brain uses much of the same machinery for both autobiographical memory and the type of memory elicited in previous laboratory studies. However, the new technique also disclosed significant brain function differences between laboratory memory and autobiographical memory.

The researchers published their findings in the November 2004 issue of the Journal of Cognitive Neuroscience. First author on the paper was Roberto Cabeza of the Center for Cognitive Neuroscience and the Department of Psychological and Brain Science at Duke. Other co-authors were Steven Prince, Sander Daselaar, Daniel Greenberg, Matthew Budde, Florin Dolcos, Kevin LaBar and David Rubin. The research was sponsored by the National Institutes of Health.

According to Cabeza, in the past there have been significant experimental inconsistencies between controlled laboratory studies of memory and studies of autobiographical memory. These studies seemed to indicate that the brain may function differently in the two processes. In typical controlled studies, subjects are asked to remember items they have previously seen in the laboratory, such as words presented on a computer screen. There have been several studies in which subjects are asked to recall autobiographical memories. However, the problem has been that such studies have not been designed to rigorously control what those past experiences have been.

"Rather than believing that autobiographical memory is a different form of memory than laboratory memory, we think that the differences reflected how the memory was measured," said Cabeza. "So, we started by analyzing the similarities and differences between laboratory conditions and the real-world conditions in which we encode memories.

"For example, the events in our everyday lives are encoded in a vivid three-D world and involve perceptual and sensory information not common in the laboratory," Cabeza said. "Laboratory studies are typically done in a perceptually poor environment, and the laboratory memories aren't as relevant to the subject. The events that we remember from our lives are those that involve us as an actor or interested observer."

To study autobiographical memory rigorously, the researchers decided to create such memories in subjects and then study their recall in the laboratory under controlled conditions. To make such memories, they dispatched volunteer subjects around the Duke campus with cameras, instructing them to take pictures of campus scenes. The subjects were also instructed to remember the taking of each picture as an individual event, noting the physical conditions and their psychological state, such as their mood and associations with the subject of the images.

Back in the laboratory, the subjects were shown a selection of campus photos they had not taken. Finally, they were shown a mix of their photos with those they had not taken while their brains were being scanned using functional magnetic resonance imaging (fMRI). They were asked to press a key to indicate whether they were seeing a photo they had taken, a photo seen in the laboratory or a new photo. In the widely used fMRI brain-scanning method, harmless magnetic fields and radio signals produce brain images that reveal blood flow to each part of the brain. Such blood flow reflects brain activity.

"In autobiographical memory studies, it is very difficult to control the accuracy of memories and the various factors that affect encoding," said Cabeza. "This technique enabled us very good control of when and how the memories were formed and how they are recalled."

The researchers found that recalling the autobiographical memories activated many of the same brain areas as laboratory memories -- the medial temporal lobe and the prefrontal cortex. "Thus, our study does support the basic validity and generalizability of laboratory memory studies," said Cabeza.

However, in addition, autobiographical memory recall activated brain areas associated with "self-referential processing" -- that is, processing information about one's self. Autobiographical memories also activated brain regions associated with retrieval of visual and spatial information, and the memories more intensely activated the region associated with recollection.

"Greater activation of self-referential areas makes sense because people are more involved in their own autobiographical memories," said Cabeza. "And greater activation of the visual and spatial areas fits well with evidence that we remember events that happen in the real world with more vivid sensory recall. Finally, greater activation of recollection areas in the hippocampus makes sense because memory of events involves more intense recollection."

According to Cabeza, their new technique and findings not only add to understanding of the nature of memory processing. The new method may be useful to investigate memory deficits in normal aging and memory disorders such as Alzheimer's disease.

"An advantage of this paradigm in studying memory disorders is that it allows for very good control over memory-encoding conditions," said Cabeza. "Otherwise, it's extremely difficult to compare autobiographical memory in different populations. They may differ in terms of their memory function, lifestyles, socioeconomic status and many other variables."

Insights from such studies could aid development of new therapy approaches, he said. For example, research has revealed that the elderly or people with memory disorders can perform daily tasks better if they are given coaching that involves them in experiencing tasks, rather than just tutoring them.

"Some people have argued that many of the deficits we see in elderly in the laboratory are less pronounced in real life, because in real life there is a lot of environmental support that we typically don't provide under laboratory conditions," said Cabeza.

For more information, contact: Dennis Meredith | (919) 681-8054, (919) 417-6581 (cell) | dennis.meredith@duke.edu