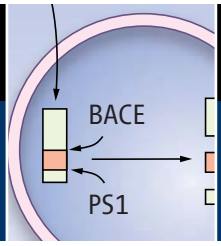


Gene linked to late Alzheimer's
314

Another round on stem cells
315

NEUROBIOLOGY

A Surprising Connection Between Memory and Imagination

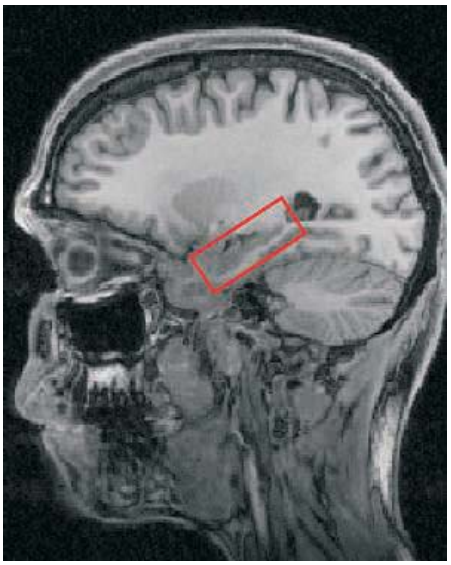
People with amnesia struggle to remember their past. They may also struggle to envision their future, according to a new study. Researchers have found that people with amnesia caused by damage to the hippocampus, a brain region intimately tied to memory, have difficulty envisioning commonplace scenarios they might reasonably expect to encounter in the future.

The findings challenge long-held views about the function of the hippocampus and the nature of memory, says Lynn Nadel, a cognitive neuroscientist at the University of Arizona in Tucson. "The claim here is that the same system we use to remember the past we also use to construct possible futures," says Nadel.

In the new study, published online this week by the *Proceedings of the National Academy of Sciences*, cognitive neuroscientist Eleanor Maguire of University College London and colleagues examined five amnesic patients. All of them had severe memory deficits caused by damage to the hippocampus; they had great difficulty forming new memories and recalling events that happened after their injuries. Ten healthy individuals who matched the patients' ages and education levels participated in the study as controls.

Maguire's team asked each subject to imagine and describe several ordinary experiences, such as meeting a friend or visiting a beach, a pub, or a market. The healthy subjects provided rich descriptions, remarking for example on the curve of a beach, the sound of waves hitting the shore, and the feel of burning hot sand. The amnesic patients were able to follow the researchers' instructions, but their descriptions were far less vivid. They described fewer objects, fewer sensory details such as sounds and smells, and fewer thoughts or emotions that might be evoked in the imagined scenario. The patients' responses on a questionnaire indicated that what they saw in their mind's eye were fragmented collections of images rather than coherent scenes.

The work suggests that the hippocampus may have a broader role in cognition than many researchers have thought, says Morris Moscovitch, a cognitive neuroscientist at the University of Toronto in Canada. The textbook view is that the main function of the hippocampus is to encode new memories, creating an initial memory trace that is eventually filed away to the cortex for long-term storage. In this view, the hippocampus is not needed to maintain or retrieve memories once they've been stored in the cortex. If this view were correct, Maguire says, the patients in her study, who did not have substantial damage to the cortex, should have been able to construct imaginary experiences by drawing on memories formed before their injuries. But their inability to integrate those memories into a coherent imagined scene suggests that the hippocampus does more than simply record current events.



The Janus center? The hippocampus (red box) may be as important for imagining the future as it is for remembering the past.

Nadel, Moscovitch, and others have argued in recent years that the traditional view of the hippocampus's role is too narrow. Work from Moscovitch and colleagues, for example, suggests that the hippocampus binds together elements of remembered scenes to create vivid and coherent memories. Maguire's findings point to a similar role in constructing imagined scenes, Moscovitch says. "In order to have vivid constructions of the past, the future, or of imaginary events, you always need the hippocampus," he says.

The idea that thinking about the past has much in common with thinking about the future has ancient roots, says Yadin Dudai, a neuroscientist at the Weizmann Institute of Science in Rehovot, Israel: "In prescientific times, many people thought that the role of memory is not necessarily to remember the past but to enable you to imagine the future." In modern times, Dudai says, the notion was resurrected by the memory researcher Endel Tulving, who speculated that the ability to predict the future was a major driving force in the evolution of memory. Even so, Dudai says, only very recently have studies like Maguire's begun to provide experimental evidence that memory and imagination may share neural circuitry.

More evidence comes from a functional magnetic resonance imaging study now in press at *Neuropsychologia*. Cognitive neuroscientist Donna Addis and psychologist Daniel Schacter of Harvard University scanned the brains of healthy volunteers who had been asked either to recall a vivid memory or to envision a future experience. Both situations activated a similar network of brain regions, including the hippocampus, the researchers found.

If the hippocampus does turn out to be as important for imagination as it is for memory, that could have interesting implications for aging, Addis says. The hippocampus is one of the first brain regions to show signs of deterioration as we get older, and Addis has recently found evidence that the ability to envision future experiences declines in parallel with memory as people age. Meanwhile, Moscovitch is examining the work of famous artists and novelists to see whether the detail of their work declined in their later years. The picture of the hippocampus that's emerging suggests yet another compromise facing us in old age, he suggests: "Age will contribute wisdom because you can draw on a lot of past experience, but that experience may not be quite as rich as it used to be."

–GREG MILLER

CREDIT: ELEANOR MAGUIRE