

# **SCIENCE FILE; Watching the Mind at Work; Using scanners on volunteers, experts find that the more mental activity a viewed item produces, the more likely it will be recalled.**

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## **Abstract:**

*Anxious to combat the memory problems of Alzheimer's disease, amnesia and other such impairments, brain experts are working to understand how some experiences can be recalled with clarity half a century later, while other equally important memories are lost almost instantly.*

*Using a noninvasive brain scanner, independent teams of neuroscientists at Stanford, Harvard and Washington University in St. Louis captured images of mental activity in the instant the brain encodes an experience into long-term memory.*

*The brain images record how levels of blood flow change every few thousandths of a second in response to neural activity. They also showed that the formation of memories involving words was concentrated on the left side of the brain. Visual memories stimulated greater activity on the right side, the researchers said.*

## **Full Text:**

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Filed in the human card catalog of the brain is an index of experience, reinforced by emotion and cross-referenced with sensory cues: chords that recall a graduation ceremony, a scent of honeysuckle that brings back a humid summer stroll, the taste of a pastry dipped in tea that restores a lost childhood.

Yet the memories that slip away are equally the stuff of life: the familiar face without a name, the missed appointment, the anniversary overlooked.

By necessity, the mirror of memory reflects an imperfect patchwork of the past onto the present. To remember too much is to drown in experience; to remember too little is to lose ourselves.

Anxious to combat the memory problems of Alzheimer's disease, amnesia and other such impairments, brain experts are working to understand how some experiences can be recalled with clarity half a century later, while other equally important memories are lost almost instantly.

For the first time, researchers now have recorded a memory in the making, identifying brain regions that influence what we can remember and what we may forget.

## **'A Significant Step Forward' in Science**

The findings, reported recently in *Science*, "mark a significant step forward" in understanding why memories endure, said British memory expert Michael D. Rugg of the University of St. Andrews.

In recent years, researchers have determined that there is no single way the human brain handles memory. There appear to be interlacing systems of storage and retrieval among the brain's billions of neurons and synapses.

Learned skills, like riding a bicycle or juggling, are stored one way, knowledge of a native language another. Some information is stored only momentarily in what researchers call working memory. Unless an individual pays close attention to the new information for at least eight seconds, however, it will be lost. Short-term memory also can quickly overflow if more than seven or so items accumulate.

Through a process called encoding, some sensations, experiences, ideas and facts do find their way from the temporary working memory into a more lasting place in the brain's neural networks.

Using a noninvasive brain scanner, independent teams of neuroscientists at Stanford, Harvard and Washington University in St. Louis captured images of mental activity in the instant the brain encodes an experience into long-term memory.

### Different Regions for Words and Pictures

They studied parts of the brain involved in forming memories of both words and pictures.

They discovered that the survival of a memory is determined in the moment that the brain attempts to translate an experience into a pattern of neural connections. The longer that two brain regions--the prefrontal lobes and the parahippocampal cortex--are active, the more likely a word or a picture will be remembered, the researchers found.

The brain images record how levels of blood flow change every few thousandths of a second in response to neural activity. They also showed that the formation of memories involving words was concentrated on the left side of the brain. Visual memories stimulated greater activity on the right side, the researchers said.

"We are looking at the brain activity as we are giving birth to a new memory," said Harvard psychologist Daniel L. Schacter, author of "Searching for Memory: The Brain, the Mind and the Past." He helped investigate verbal memories.

"What happens in a second or two--in the {neural} encoding operations we carry out--can determine the fate of that experience for a lifetime," Schacter said.

The two research teams took different approaches to investigating what happens when the brain turns experience into memory.

The Stanford team, led by neuroscientist James B. Brewer, focused on the formation of visual memories.

In the Stanford experiments, six volunteers were shown 24 color landscape photographs and interior scenes while the researchers recorded their brain responses with a functional magnetic resonance imaging (fMRI) machine. During several sessions, the volunteers were asked to judge whether each picture was an indoor or outdoor scene.

Thirty minutes later, they were shown the photographs again as part of a larger collection of images and asked whether they recalled any and how well they remembered them.

"As they were seeing the pictures, we were recording the brain responses picture by picture. We looked at the relationship of the brain activation to the subsequent memory . . . to predict which pictures would be well-remembered," said Stanford psychologist John D.E. Gabrieli.

"We found a number of places that had this property where the degree of activity would predict how well people would remember."

## Cause of Varied Neural Responses Still Unknown

In all, the visual memories were associated with six areas of high activity in the bilateral parahippocampal cortex, which is known to play a key role in memory, and one area in the prefrontal cortex. The magnitude of the activity in these areas allowed the researcher to predict how well the images would be remembered.

"It is at the very heart of forming a memory," Gabrieli said.

Researchers led by brain imaging expert Anthony D. Wagner of the Harvard Medical School and Massachusetts General Hospital looked at what happens when words are turned into memories.

In the Harvard experiment, a dozen volunteers were given a series of simple word tests while their brains were being scanned.

In four sessions in the scanner, they were shown lists of words and asked to decide whether a word represented an abstract concept, such as love or misery, or a concrete one, such as chair or flower. Presented with another set of terms, they were asked to judge the physical appearance of the word: whether, for example, it was printed in upper- or lower-case letters. In a second battery of tests, they were shown words every two seconds during six consecutive sessions in the brain scanner.

Similar brain regions were active whether a word was later remembered or forgotten, but the greater the magnitude of the mental activity the more likely it was that a term would later be recalled, the researchers determined.

"I am fairly confident that we are visualizing processes intimately related with or doing the work of storing the memories and encoding the experience," Wagner said.

But neither team knows yet what prompts the greater mental activity that seems to cement something in memory.

"We don't know the source of those small differences in neural activity," Wagner said. "We can speculate it may have something to do with the interaction between an individual's knowledge and the word. Certain things may just be more meaningful, and that may bring in additional mental processing."

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### The Birth of Memory

For the first time, researchers have recorded a memory in the making. Using a noninvasive brain scanner, neuroscientists from Stanford, Harvard and Washington University in St. Louis captured images of mental activity in the instant the brain turns an experience into a memory. They found brain regions involved in forming memories of both words and pictures. Below, the red and yellow highlighted areas showed increased brain activity.

Visual memories stimulated greater activity on the right side of the brain, in the areas circled above. The magnitude of the activity in these areas allowed the researcher to predict how well the images would be remembered. Similar brain regions were active whether a word was remembered or forgotten, but the

greater the magnitude of the mental activity the more likely it was that a term would be recalled. The images at right show an aerial view of the brain; the red and yellow areas show greater brain activity.

Sources: Stanford University, Harvard Medical School, Massachusetts General Hospital, Washington University, Science.

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