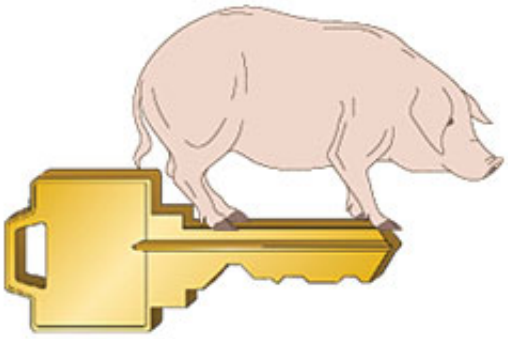
Brain imaging identifies best memorization strategies

August 3 2006



How would you remember this strange image? If you came up with the saying, the pig is key to this image, you would be using a verbal strategy, one of four that WUSTL psychologist Brenda Kirchoff found that subjects used to remember a series of odd images. Her findiings could have implications for aiding people with memory impairments and early onset Alzheimer's disease.

Exploring exactly why some individuals' memory skills are better than others has led researchers at Washington University in St. Louis to study the brain basis of learning strategies that healthy young adults select to help them memorize a series of objects. Using functional magnetic resonance imaging (fMRI), the researchers uncovered brain regions specifically correlated with the diverse strategies that subjects adopt.

Brenda Kirchhoff, research associate in psychology in the University's

School of Arts and Sciences, conducted this study in the then-Washington University lab of Randy L. Buckner, now a professor of psychology at Harvard University and investigator at the Howard Hughes Medical Institute. Their findings have been published in the July 20, 2006, issue of *Neuron*. (Kirchhoff is the article's first author and Buckner is senior author.)

"Randy and I were interested in exploring individual differences in memory — why some people are better at learning new information than others," said Kirchhoff. "Our main goal was to determine the learning strategies that people use and their relationship to memory performance. Secondly, we wanted to know if individual differences in learning strategies were associated with individual differences in brain activity."

What they found was that test subjects used two main self-selected strategies to learn new information. Use of the strategies was associated with better memory performance. Furthermore, individual differences in learning strategies could be correlated with MRI-detected biological activity in distinct brain regions.

Using the Washington University population as test subjects, Kirchhoff studied 29 right-handed, healthy young adults, ages 18-31, all of whom had normal or corrected-to-normal vision and reported no significant neurological history. Participants were given interacting object pair images and told to study them in anticipation of a memory test. For example, interacting objects included a turkey seated atop a horse and a banana positioned in the back of a dump truck. No other instructions were provided so that the subjects would choose their own encoding or learning strategies.

While earlier pilot studies had indicated that individuals use a variety of strategies to help them memorize new information, the following four strategies were the main strategies used by participants in this study,

according to Kirchhoff, including:

1) A visual inspection strategy in which participants carefully studied the visual appearance of objects.

2) A verbal elaboration — or word-based strategy — in which individuals constructed sentences about the objects to remember them.

3) A mental imagery strategy in which participants formed interactive mental images of the objects — similar to animated cartoons.

4) A memory retrieval strategy in which they thought about the meaning of the objects and/or personal memories associated with the objects.

Visual and verbal strategies improved memory

Selection of the first two strategies described above — visual inspection and verbal elaboration — resulted in improved memory results, according to Kirchhoff.

"Those individuals who used the first two strategies often had better memory performance than those who used them rarely or not at all," said Kirchhoff. "There's a great deal of variability in strategy use when people are free to choose their own learning techniques. We also discovered that individual people use multiple strategies to learn new information."

In addition to behavioral analyses of these learning strategies, Kirchhoff recorded the participants' brain activity patterns during learning using functional MRI.

"From brain imaging data, we were able to find a significant correlation between different learning strategies and brain activity," said Kirchhoff.

"We were excited to see that differences in brain activity patterns between people could be explained in part by differences in learning strategy use."

During functional MRI analyses of study participants, researchers focused on regions of the brain that previously had been shown to play important roles in processing information about words and objects. People who used a word-based learning strategy often had greater activity in left anterior brain regions thought to play important roles in thinking about words than people who used this strategy less frequently. In contrast, people who used a learning strategy based on studying the visual appearance of the object pairs often had greater activity in a left posterior brain region thought to play an important role in viewing and retrieving information about objects than people who used this strategy less frequently.

Changes in brain activity

"One very interesting aspect of these findings is how they reveal that not all of us memorize information in the same way. Differences in memorization strategies emerge both behaviorally and in brain activity patterns," said Buckner. "There have been a number of innovations in the last several years in medical technology that allow us to see brain activity patterns in individuals rather than averaged groups of people. These tools now allow us to see individual patterns of brain activity and how they differ from one person to the next.

"This is some of the earliest research to explore these individual learning strategies at both the behavioral level and brain level. The work is a testimony to the innovative and thorough approach that Brenda pursued. She undertook a very careful multilevel approach beginning with behavioral differences and eventually targeting the brain. Research has been undertaken to study individual differences in cognition and

memory previously. Brenda's work established a new path to pursue those differences at the brain level."

While this research is in its earliest stages, further studies may help provide behavioral modification treatments for individuals with memory impairment, including adults afflicted with age-related memory loss and early onset Alzheimer's disease.

"In the future, we are interested in studying the memory performance of older adults and people with memory impairments to determine if they use different learning strategies than those selected by young, healthy adults," said Kirchhoff. "The next step would be to see if training in the use of different learning strategies would help to improve their memory."

"It's an open question as to what degree the differences in memory of older adults and those with Alzheimer's disease can be modified by the learning strategies they adopt," said Buckner. "It's possible that the strategies adopted by younger adults could be adopted by older adults. We could then look to see if any of those new strategies accounted for memory improvement in older adults."

Source: Washington University in St. Louis