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RESEARCH NEWS

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Training Improves Age-Related Memory Decline

Studies using a powerful imaging technique that measures brain activity indicate that some cognitive deficits associated with aging may not be completely irreversible. By comparing brain activity as young and older adults were asked to memorize a series of words, researchers have found that one type of memory-processing deficit often seen in the elderly might be improved by explicit training.

In an article that was published online on February 16, 2002, by the journal *Neuron*, Randy Buckner, a Howard Hughes Medical Institute investigator at Washington University in St. Louis, and his colleagues report that elderly subjects showed two distinct kinds of cognitive-processing deficits -- called "under-recruitment" and "non-selective recruitment"-- when asked to perform memory tasks. Buckner also discussed the new studies in a press conference at the American Association for the Advancement of Science meeting in Boston on February 16.

In under-recruitment, older subjects are less able to spontaneously recruit specific areas of the brain that aid in memory processing. In non-selective recruitment, older subjects tend to draw on regions of the brain that are not useful in memory processing tasks.

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- Randy L. Buckner

While older people can likely learn techniques to help overcome under-recruitment deficits, said the scientists, non-selective recruitment seems to increase with age. According to Buckner, the researchers began their comparative experiments based on many past studies that have shown a reduction in cognitive abilities with age.

“For a long time, we have known that as people age they start to have difficulties with higher-level-controlled cognitive processes,” said Buckner. “For example, sometimes older adults have difficulty in novel situations where they must respond flexibly to memorize things.” Considerable evidence has indicated that the cause of these deficits might be reduced functioning of the frontal cortex -- the region of the brain responsible for higher-level intellectual processing. For example, said Buckner, testing of older people has shown that they exhibit milder versions of cognitive difficulties seen in people who have suffered damage to their frontal cortex.

In designing the experiments, Buckner and his colleagues knew that memorization produces concerted brain activity in the frontal cortex, so they sought to map neural activity in the frontal cortex when both younger and older adults were asked to memorize a series of words.

In their studies, the scientists used functional magnetic resonance imaging (fMRI), which can precisely map enhanced blood flow in specific regions of the brain. Increased blood flow reflects greater activity in regions of the brain that are utilized during mental tasks. The scientists concentrated on imaging three areas of the frontal cortex. Two were in the left hemisphere and one in the right hemisphere of the brain. Since the left hemisphere is dominant in language-processing, regions in that hemisphere would be expected to show increased activity during memorization of words, while the right-hemisphere would remain inactive. The third area of the frontal cortex that the researchers studied is known as prefrontal cortex, which is intimately involved in effective memorization of verbal material.

A total of 62 subjects were used in the studies. The younger adults were in their 20s, and the older adults were in their 70s and 80s. The older adults were chosen for the study because they were healthy and free of any signs of dementia disorders such as Alzheimer’s disease.

The scientists conducted two kinds of experiments in which subjects were asked to remember words presented to them while in the fMRI machine. In the first study, the younger and older adults were simply shown words and asked to intentionally try to remember them later.

“As previous studies had shown, we confirmed that the older adults did not recruit the critical frontal regions as much as the younger adults,” said Buckner. The older adults also showed non-selective recruitment of cortical regions that would not aid memory processing, he said.

Next, Buckner and his colleagues sought to determine whether this deficit could be remedied by giving the subjects a strategy to aid memory processing. “Just asking subjects to memorize words requires an individual to come up with his or her own strategy, which is a difficult thing,” said Buckner. “So, in the second experiment we presented words one at a time and asked the subjects to make a decision about what category the word fell in --

for example, whether it was abstract or concrete. And when we did that, the older adults showed increased activity in these frontal regions, and their memory performance improved."

The researchers found that memory support strategies had no effect on non-selective recruitment in the older subjects. Younger adults selectively activated the left-hemisphere frontal regions area when they memorized words. This selectivity streamlines information processing and makes it more effective, Buckner said. The fMRI data showed that older adults recruited both left- and right-hemisphere frontal regions, even with support in encoding their memories.

"So, the findings of these studies reflect a situation where the cup is half full or half empty, depending on how you look at it," said Buckner. "The situation with regard to overcoming memory deficits in aging is much more promising than we thought. It could have been the case that the frontal regions in the older adults had atrophied or undergone cellular deterioration to the extent that they were inaccessible to these individuals. But that was not the case. These regions were potentially available to participate in solving these tasks, but the older adults were under-recruiting them."

The findings suggest that cognitive training that encourages older adults to use available frontal cortex areas could improve memory, said Buckner. Research has not yet shown exactly what kind of training would be most effective, he said, although he and his colleagues are now beginning to study that question.

Washington University neurologist John Morris, a senior author of the *Neuron* study, said "these results show that the reduction in processing capacity of the brain with aging is not completely an irreversible process. They give us a basis for believing that cognitive rehabilitation therapies might be helpful in aging-related cognitive illnesses. And, the findings emphasize that the aging brain still can function at a very high level and keep healthy older people living active, independent lives."

According to Morris, an important question to address in future studies is the relation between the cognitive deficits found in healthy elderly people and in those with Alzheimer's disease. "Are the kinds of deficits reported in these studies truly age-related and separate from Alzheimer's disease, or is one just an elaboration of the other? We really don't know the answer," he said.