Optimizing Memory in the Adult Brain for Effectiveness in a Multitasking Society

By Donalee Markus, Ph.D.

> Michelle walked into the kitchen, paused, and looked around. Just moments before she knew that there was something she had to do in here. Now it completely slipped her mind. She searched for clues, something to prompt her memory. She opened cabinets and drawers, fingered the cool marble countertop, mentally retraced her steps. What had she been thinking about before she came in here? A mild anxiety crept over her. She shuddered to shake off the feeling that this was the beginning of the end. At 43 she feared she was beginning to lose her mind.

For many people the first sign of aging is a "senior moment" like the one described above—a sudden, inexplicable lapse of memory. Forgetting names or appointments, misplacing car keys or reports, not knowing why they entered a room or opened a drawer leads hundreds of thousands of Americans in their 40s and 50s to enroll in memory training courses every year. Small wonder—for many people memory loss is closely associated with more severe signs of senility, including loss of control over bodily functions, regression into infantile behavior, reversal of parent/child roles, and loss of mental competency. The specter of Alzheimer's disease looms large even in people who have no family history of the illness.

Research about Alzheimer's has lead to new insights into what it takes to maintain a healthy brain or at least slow down the aging process. Important physical factors include a diet rich in antioxidants and Vitamins A and E, regular exercise, adequate sleep, and stress-free relaxation. It's also important to stay socially active and mentally challenged.

Why then are the "baby boomers" (age 40+)—who are still actively engaged at work and in their communities, who recognize the value of good nutrition and healthy life styles—crowding into classrooms to learn how to remember strings of numbers and never forget a face or name? More than simple vanity and the refusal to grow old, these high-functioning, high-energy participants recognize the demands that our multitasking society of instant messages and global networks makes on them. Their refusal to be left behind and "put out to pasture" has lead to additional studies on the effectiveness of training the adult brain to function better and remember more clearly.

Less than a generation ago, conventional wisdom advised people to "grow old gracefully," to accept that their bodies and minds would deteriorate at a predictable rate and in a predictable way. Subsequent studies have proven that regular exercise and proper nutrition can slow down and sometimes even reverse some of the aging process. Additional studies by the National Institute on Aging (NIA), part of the National Institute of Health (NIH), have demonstrated that adult brains may be just as resilient and adaptable as the rest of their bodies, given the necessary resources and proper training.

In an unprecedented two-year program involving 2,802 participants, reported in the *Journal of the American Medical Association* (November 13, 2002 issue), researchers examined the short- and long-term effects ten hours of training in concentration, memory, or problem solving had on healthy, independent seniors ranging in ages from 65 to 94. Randomly assigned to groups of approximately 700, participants were either given no training (control group) or received specific instruction in one of the following: verbal episodic memory, ability to solve problems that follow a pattern, or visual search and identification. Researchers selected specific memory, reasoning, and speed of processing programs because they related well to daily living tasks such as "telephone use, shopping, food preparation, housekeeping, laundry, transportation, medication use, and personal finances."

The memory group learned strategies for remembering lists of words and the main ideas and specific details in stories. The reasoning group focused on detecting patterns and using that information to solve problems. Such skills are useful for filling out order forms and reading schedules. The speed of processing group practiced locating and identifying visual information as related to looking up telephone numbers, reading directions on prescriptions, and responding to traffic signs and signals.

After receiving group specific training for two hours a week for five weeks, testing showed 26% improvement in the memory group, 74% improvement in the reasoning group, and 87% improvement in the speed of processing group as compared to the no-training control group. Moreover, particularly with additional "booster" sessions, the training effects continued to be maintained as demonstrated by testing done two years after the initial study—counteracting, as Dr. Karlene Ball of the University of Alabama at Birmingham said, "The degree of cognitive decline that we would expect to see over a 7- to 14-year period among older people without dementia." However, the training showed no significant effect on the daily living tasks already performed by these independent seniors.

One might conclude that training which focuses on specific types of cognition—e.g. memory, reasoning, concentration—can improve efficiency even as we age, but does not make us significantly more effective. A reason for these mixed results may be that the specific types of training selected emphasized tasks primarily performed by the frontal lobes of the brain. The frontal lobes make up 40% of the adult brain. It was the last part of the human brain to evolve and is the last part to mature. It is where we plan, organize, correct, control, and generate options. It is also the first part of the brain to shut down and deteriorate with physical and/or emotional stress caused by the demands of modern life.

The 74% improvement in reasoning based on pattern detection and the 87% improvement in the speed of processing that emphasized visual search and identification in the NIA study would not have surprised Ian Robertson, a professor of psychology at Trinity College in Dublin, Ireland and the director of the Institute of Neuroscience. He has written extensively about the brain's potential for reorganizing itself through attention. In *Opening the Mind's Eye: How Images and Language Teach Us How to See*, he said "Precisely because imagery tends to be underused, it tends to be less habitual, less automatic—and hence, potentially at least, more flexible." The underused part of the brain referred to is the parietal lobes where sensory input is integrated, analogies are constructed, eye-hand coordination guided, and attention oriented. Although attention is under the control of the frontal lobes, and is key to learning and remembering, the parietal lobes play a central role in directing attention, controlling gaze, and integrating the components of what is seen. In conjunction with the temporal lobes, they enable the recall of strings of numbers and visual and other non-verbal memories.

Parietal lobes are extremely active in preschoolers, who think more visually than verbally. Formal education, with its focus on reading and writing, shifts the emphasis to language development. Unfortunately, this also tends to slow down the learning process and creative thinking. Studies show that combining words and pictures in our heads improves recall and understanding. Moreover, visual memories actually survive longer with age than language-based memories. This may be due in part because brain activity drops in the frontal lobes when attention is divided, as occurs when people multitask.

Of course, some people retain strong visual skills throughout their school years. Many of them become artists, architects, or engineers. The people who shift strongly to verbalization are more likely to have careers in law, administration, or journalism. The good news is that visualization can be improved with practice at any age. A frequently quoted study on London cab drivers (*Proceedings of the National Academy of Science*, April 11, 2000 issue) provides evidence that the intentional application of visual and spatial memory over an extended period of time may physically enlarge the hippocampus, a part of the cerebral cortex.

Cabbies are required to spend a minimum of two years learning the meandering geography of London and its landmarks. They then must pass a stringent test to prove they can transport passengers anywhere in the city, via the shortest route, without the use of street maps. Brain scans revealed that the more experienced cab drivers have significantly larger posterior hippocampuses than their less experienced colleagues. Although some have argued that people with unusually large hippocampuses may naturally drift toward cab driving, there is no evidence among cabbies in other cities with less demanding standards to support the claim. Expanding on experiments that Marian Cleeves Diamond, a biologist and neuroscientist at the University of California at Berkeley, originally conducted on rats in enriched environments over 25 years ago, the London study was the first to demonstrate that the adult human brain could be substantially changed through experience.

Besides visual and spatial recall, the hippocampus plays an important role in regulating the body's response to life-threatening emergencies. Chronic stress can lead to the loss of hippocampal neurons and the atrophying of dendrites that connect to other brain cells. Some of the post-traumatic stress disorders of war veterans, such as poor memory, are linked to shrunken hippocampuses. But it has also been discovered that new brain cells can be produced in the hippocampus even in adults. The significance of this can be seen in how people in their 20s memorize when compared to people in their 70s. Brain scans revealed that, when asked to memorize lists of words, both age groups utilized the left frontal lobe, but younger people also employed the hippocampus, associated with word-less memories. The young people, who were more used to taking tests, did something else as well that helped them remember better—according to Ian Robertson, they would "sort, shift, and categorize." It is a process that cognitive psychologist Fergus Craik of the University of Toronto calls "depth of encoding." When we actively process and organize information, we engage the frontal, temporal, and parietal lobes—thus strengthening the connections among them and enhancing recall.

NASA wasn't specifically interested in enhancing memory when it selected the *Designs for Strong Minds* (DSM) training program in 1999. Rather, the Agency wanted to enhance employee effectiveness under increasingly stressful conditions. It chose DSM because it is the only critical thinking course specifically designed to augment the brain functions of adults. It extensively utilizes graphic puzzles to teach and rehearse various ways of organizing information. DSM puzzles apply the same methods artists have employed for centuries to trick viewers into making assumptions about what they see and understand. But the puzzles are not merely optical illusions. To solve them the participant has to visualize the conditions that make some answers logical and others illogical. NASA received overwhelmingly positive verbal comments from participants in the program. An unprecedented 90% said they would recommend DSM to others, 83% wanted to see the program automated for computer access, and almost all wanted additional training.

When asked about the effects of DSM, numerous participants reported that they learned the following:

- To consider perspectives and points of view other than their own
- To become more open-minded
- To think about alternative understandings
- To become more analytical
- To become more objective

A subsequent focus group comprised of DSM alumni repeatedly emphasized how the training improved their intra-group communication and cooperation skills. NASA's Evaluation Design Consultant concluded that the benefits "stem from the emphasis on how varying perspectives contribute to problem solving."

Research by cognitive neuroscientist Stanislas Dehaene of the National Institute of Health and Medical Research (Inserm) in Paris and cognitive psychologist Elizabeth Spelke of Massachusetts Institute of Technology regarding how human brains perform mathematics may suggest that there is more to the DSM program than merely contributing to an intellectual understanding of varying perspectives. Brain scans indicate that people use different parts of their brains when doing different types of math. Our left frontal lobes "light up" when we make exact calculations, but our left and right parietal lobes are triggered when we make estimates and count on our fingers. Moreover, people who have difficulty with numbers, a condition known as "dyscalculia," are also apt to have problems conceptualizing time and direction. They tend to be chronically late, easily disoriented in new environments, usually make decisions based on intuition rather than logic, have difficulty planning activities and keeping track of money. It is not a question of intelligence or memory. People with dyscalculia can be highly articulate and excellent writers and readers. The issue is the functional integration of the brain.

People who have difficulty visualizing haven't learned how to see. Research by Stephen Kosslyn of Harvard demonstrates that the same parts of the brain that are engaged when we intentionally look at something "light up" when we just imagine seeing it. In other words, when we attentively look at something and try to determine its significance, we may also be improving our visual memories.

Memory enhancement is just the tip of the iceberg in terms of the capacity of the adult brain to learn. With practice the average person can memorize extensive lists of words and numbers that have little practical value beyond impressing one's friends at parties. To be truly effective, memory has to be linked to meaning and purpose. Mental training that employs visualization is crucial in developing the agility to use the information we remember in productive ways. Because the modern world demands more of us, we should not settle for less than the optimal use of our brains.

Suggested Reading:

The Cerebral Code: Thinking a Thought in the Mosaic of the Mind by William H. Calvin, The MIT Press, Cambridge, MA, 1998

The Number Sense: How the Mind Creates Mathematics by Stanislas Dehaene, Oxford University Press, New York 1999

Enriching Heredity: The Impact of the Environment on the Anatomy of the Brain by Marian Cleeves Diamond, Free Press, New York 1988

Mind Sculpture: Unlocking Your Brain's Untapped Potential by Ian Robertson, Fromm International, New York 2000

Opening the Mind's Eye: How Images and Languages Teach Us How to See by Ian Robertson, St. Martin's Press, New York 2002

The Mind and the Brain: Neuroplasticity and the Power of Mental Force by Jeffrey M. Schwartz, M.D., and Sharon Begley, HarperCollins Publishers Inc., New York 2002

Left Brain Right Brain: Perspectives from Cognitive Neuroscience by Sally P. Springer and Georg Deutsch, W.H. Freeman and Company, New York 1998