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HEALTH & SCIENCE

Steps to a nimble mind: Physical and mental exercise help keep the brain fit

Neuroscience is uncovering techniques to prevent cognitive decline.

By Kathleen Phalen Tomaselli, *AMNews* correspondent. Nov. 17, 2008.

The brain -- containing 100 billion neurons, 900 billion glial cells, 100 trillion branches and 1,000 trillion receptors -- reacts to stimuli in a series of electrical bursts, spanning a complex map of connections. Whether calculating an algorithmic equation or learning the tango, our brain continuously changes in response to our ideas, actions and activities.

Each time a dance step is learned, for instance, new pathways are formed. "Dancing is excellent for the brain and body," says Vincent Fortanasce, MD, clinical professor of neurology at the University of Southern California in Los Angeles. He wrote the *Anti-Alzheimer's Prescription.* "Not only are you moving around more, your brain is in constant motion as it recalls steps and movements."

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It's an example that highlights a wave of new thinking about the importance of brain fitness.

Until recently, conventional wisdom held that our brains were intractable, hard-wired computers. What we were born with was all we got. Age wore down memory and the ability to understand, and few interventions could reverse this process. But increasingly, evidence suggests that physical and mental exercise can alter specific brain regions, making radical improvements in cognitive function. "When you challenge the brain with new skills and new ways of doing things, it increases connections in the brain," says Ericka P. Simpson, MD, a neurologist who co-directs the MDA Neuromuscular Clinics and directs the ALS clinical research division at the Methodist Hospital System Neurological Institute in Houston. "It increases synaptic density."

With nearly 72 million Americans turning 65 over the next two decades, physicians need the tools to handle growing patient concerns about how to best maintain brain health. Armed with this new brand of science, frontline physicians will be better equipped to address the needs of aging baby boomers, already in the throes of the brain fitness revolution. "They are the gatekeepers of information, and people listen," says Eduardo Locatelli, MD, MPH, a

neurologist and medical director of the Florida Neuroscience Center in Fort Lauderdale. Dr. Locatelli implements brain fitness techniques for his postsurgery epilepsy patients as well as patients who present with mild- to moderate-stage Alzheimer's and dementia. "Encourage new experiences. ... Use it or lose it. Challenge it and gain."

The plastic brain

Within the brain, the pathways and regions that are most utilized generally grow and become stronger while other parts shrink. "The brain is very Darwinian, it's survival of the fittest," says Edward Taub, PhD, a behavioral neuroscientist at the University of Alabama at Birmingham, who has researched neuroplasticity since the 1970s. "At one time it was believed we did not use 90% of our brain. That is false. The brain is a zero sum game. Every part of the brain is used. It has enormous plasticity."

Thus, by challenging the brain and forcing the use of different pathways, brain maps can be altered. And such changes offer young and old -- even brain-injured individuals -- an opportunity to learn or re-learn things. "Vocabulary can increase into age 90," says Gary J. Kennedy, MD, a professor in the Dept. of Psychiatry and Behavioral Sciences at Albert Einstein College of Medicine. He also directs the geriatric psychiatry division at Montefiore Medical Center in the Bronx, N.Y. "As people age they may be slower, but they are capable of more and more complex projects."

Brain volume shrinks up to 1% every year after age 65.

To best illustrate neuroplasticity, consider stroke patients with damaged limbs. Contrary to traditional therapy, which works to strengthen the good limb, Taub restrains the uncompromised limb, forcing patients to use the damaged arm or leg. The therapy, constraint-induced movement therapy, also known as CI therapy, helps to rewire the brain.

"The more you use it, more neurons are available ... the more demand for cortical space and the more the patient is able to use the [damaged] arm," Taub said. Over time, small steps lead to improvements in activities of daily living. Ultimately, the damaged limb, at least in part, recovers because, although the brain does not regrow damaged areas, it re-routes around them.

When the brains of CI patients were examined, a tremendous increase in grey matter was detected, and interestingly, Taub says, the healthy part of the brain was recruited for the task. Some of Taub's research was published in the Nov. 1, 2006, *Journal of the American Medical Association.*

CI applications are now being explored for other forms of brain injury.

Young brains, old brains?

Mental agility begins declining around age 24, says Dr. Fortanasce. But there is a big difference between agility and capacity. "I may be slower, but what I know now far outweighs what I knew at 24," he says. "Some individuals perform their greatest creative work in late life. Verdi, for example, composed *Othello* at 73 and *Falstaff* at 79."

Greg Jicha, MD, PhD, assistant professor of neurology at the University of Kentucky College of Medicine, shares related stories, such as that of an 82-year-old who learned to play the trumpet. "I've heard people say, 'You can't teach an old dog new tricks.' That can't be further from the truth," says Dr. Jicha, who also heads the healthy brain aging research group at the university's Sanders-Brown Center on Aging. "When you look at the plasticity of the adult brain, it is amazing."

Mental agility, but not capacity, begins declining around age 24.

But age also brings anatomic changes. Brain weight and blood flow to the brain decrease by 20%. The number of fibers and nerves decrease by 37%. And brain volume shrinks up to 1% every year after age 65. Dr. Fortanasce also points to hormonal shifts, with the presence of dopamine and serotonin diminishing as cortisol, an aging hormone, increases. "Between age 20 and 70, we lose nearly 90% of youth hormones."

So what keeps some brains younger than their chronology? Experts point to a prescription of neurobics. This concept includes life-long learning, trying new things, a healthy diet, social interactions, sleep and physical activity. "Exercise can actually increase neurogenesis and increase the size of the hippocampus," says Dr. Fortanasce, who promotes isometrics and weight-bearing exercise. "Exercise also increases youth hormones. And novelty, doing new things, builds branches."

In a 2006 study in the *Journal of Aging and Physical Activity*, Brandeis University researchers found that strength training increased the participants' working memory span. The higher the level of resistance, the more memory improved, suggesting that strength training benefits not only the muscles but also the mind.

Dr. Locatelli suggests reversing daily patterns. People who take the same route to work every day need to push themselves beyond their comfort zones. A person can try to eat using his or her weaker hand, for instance. Or someone could listen to another type of music than the type usually favored. Activate unfamiliar areas of the brain, Dr. Locatelli says. The key is new places, socializing with different people, and reading new things.

And primary care physicians can help communicate this message.

"When a patient expresses concern about memory loss, never cast it off as associated with age," says Tom Perls, MD, MPH, associate professor of medicine at Boston University Medical Center. Dr. Perls also heads the New England Centenarian Study. "This is an incredibly serious issue. Losing brain function is devastating." Ask about memory. And rule out other conditions like depression or low thyroid first. "Encourage them to exercise the brain in novel and complex ways," he says.

Exercising new connections

So what about dance steps? At McGill University in Montreal, researchers found that the tango may be better than walking for improving execution of complex tasks because it incorporates elements found in standard neurological rehabilitation programs. It's also fun

and social.

Participants, ages 62 to 90, were randomly assigned to a walking group or a tango dancing group, meeting two hours twice a week for 10 weeks. The tango group improved in balance, posture and motor coordination, as well as cognition.

Physical and mental exercise improve cognitive function.

According to new research published in the October issue of the journal *Nature Neuroscience*, University College London scientists say complex brain processes that enable the memorization and replication of activities such as playing the piano or riding a bicycle require the execution of complicated sequences of movements involving dozens of muscles. According to their research, pianists who learned and practiced their art from an early age had elevated amounts of myelin. This finding suggests that when people learn new skills, myelination might occur. Earlier studies indicated that brains of patients diagnosed with senile dementia had lowered amounts of myelin.

The emphasis, though, is the importance of embracing the complex and novel. And Joe Hardy, PhD, a cognition neuroscientist who develops brain plasticity training programs, says some common-sense advice from physicians is not based on good evidence. "They often recommend doing crossword puzzles," he says. "But evidence suggests that crossword puzzles are not helpful."

Hardy has been developing brain games for the San Francisco-based company Posit Science. The games -- the Brain Fitness Program and Insight -- have been tested in several randomized clinical trials funded by the National Institutes of Health. The results indicate that the brain age clock can roll back 10 years. "The key thing in terms of exercise for the brain: You need to do new things, thus forming new paths," he says.

Some have even compared this new era in brain health to the 1950s, when heart health came to the fore. "New things are coming out all the time, and we are going to see a revolution in brain health," Hardy says. "I think this is going to change the way people age."

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ADDITIONAL INFORMATION:

Increasing cognitive reserve

Who will live to be 100?

In a bit of fortune-telling fun, a series of lifestyle-related questions might offer a calculated prediction. The Life Expectancy Calculator can help patients find out how they rate right now and how changes in diet, exercise or sleep patterns might add years to the forecast. The calculator is available online (www.livingto100.com). This tool was created by Tom Perls,

MD, MPH, associate professor of medicine at Boston University Medical Center, who heads the New England Centenarian Study.

A related and very important question is whether your patients' brains -- or maybe your own -- will stay young as bodies age.

According to Dr. Perls, building cognitive reserve delays the onset of memory loss, and research suggests that novel and complex brain activities can delay cognitive decline and extend lifespan. "There's a natural tendency to lose muscle as we age," he says, and by building cognitive reserve, people are exercising their temporal lobes as they would their quads.

Dr. Perls has categorized a series of games based on cognitive function, available online (fun.eons.com/brain_games). For instance, stimulating areas in the temporal and frontal lobes with games that focus on recall and retention of past and present information targets memory. For language, focus on the parietal lobe with word-building games that prompt production and understanding of spoken and written communication. Exercising the frontal lobe can be done with problem-solving puzzles and strategy games in which players control and apply mental skills.

For motor function, engage the parietal lobe edge with navigation-type games that encourage body movement through the interaction of the brain, nerves and muscles. For visual-spatial skills, stimulate the occipital and temporal lobes. Games involving discrimination, perception, attention and tracking objects visually can achieve this goal.

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London cabbies have bigger hippocampi

London cabbies' brains grow on the job. According to studies by scientists at the University College London Institute of Neurology -- the first published in the April 11, 2000, issue of *Proceedings of the National Academy of Sciences* with follow-up research presented in 2006 and 2007 -- these professional drivers have a larger posterior hippocampus, the brain region tied to learning and navigation.

Researchers credit complex daily tasks, such as navigating a labyrinth of 320 standard routes in a six-mile area, with increasing brain size. And functional MRI demonstrated that the longer on the job, the bigger the brain.

Still, there may be a price. As brain regions continually competed for space, the posterior hippocampus grew while the anterior hippocampus, which is associated with memory, decreased. "The brain has enormous plasticity," says Edward Taub, PhD, a behavioral neuroscientist at the University of Alabama at Birmingham. He has studied neuroplasticity since the 1970s. "Every part of the brain is used. The more you use a function, it may be at the expense of another."

As an outgrowth of the early taxi driver studies, U.S. scientists began exploring the effects of employing complicated navigational skills. At Brandeis University in Waltham, Mass., scientists created the virtual taxicab video game to study the way brains work. As subjects play, they become increasingly proficient in navigating complex routes, which researchers believe is tied to building cognitive maps of the environment.

Additionally, German scientists reported in the June 2006 issue of *The Journal of Neuroscience* that the brains of German medical students, while studying for final exams, showed increases in the posterior hippocampus, similar to the London cabbie study. Three months later, according to MRI imaging, the hippocampus had returned to its former size.

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Life Expectancy Calculator (www.livingto100.com)

Dr. Perls' brain games (fun.eons.com/brain_games)

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