

# MENTAL FITNESS

BY KATHLEEN McAULIFFE ILLUSTRATION BY BRUNO MALLART

**S**eated before a computer screen, 85-year-old Madeline Hanson watches a story about Molly, a character in a yellow dress who is baking a cake in a kidney-shaped swimming pool. A helicopter flies down with a beater to whip the batter. Then, through headphones, Hanson hears a voice slowly ask: “What color is Molly’s dress? What shape is the swimming pool?”

The video game, created by Posit Science of San Francisco, is a tough mental workout dressed up in an entertaining package. It is one of a slew of novel cognitive training programs being marketed by neuroscientists for the purpose of rejuvenating aging brains. Other researchers with the same goal are promoting the targeted use of more conventional games and hobbies—for instance, playing Scrabble or bird-watching. These strategies, new evidence suggests, drive changes in neural pathways that underlie learning and may actually beef up the brain.

Fun, engrossing activities are strongly

**Want a sharper memory and a more agile mind? The solution might be just one video game away.**

encoded in memory because they engage our emotions, according to James Gee, a cognitive scientist at Arizona State University. “Any information associated with pleasure and excitement triggers dopamine release,” he says. Dopamine fosters exploration in search of reward, causing newly acquired knowledge, in Gee’s words, “to be stored more deeply and better remembered later.” Other neurochemicals that reinforce learning are stimulated by novelty, attention to fine detail, and attaining goals—all common features of games.

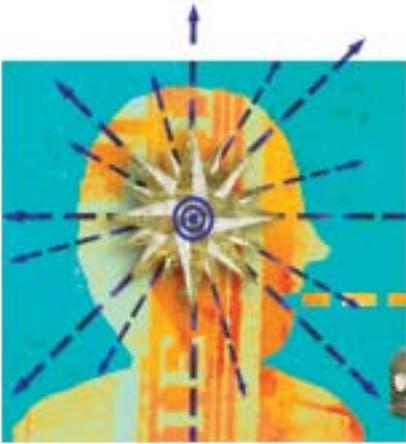
The latest crop of training programs attempt to exploit these insights into the brain’s inner workings to bolster learning and mental acuity. Hanson, at least, is con-

vinced that Posit Science’s intense video exercise has made her sharper. Recent studies confirm her perception, suggesting that game-based approaches can bring about stunning gains in episodic memory, attention, and agility of thought. Jeff Zimman, CEO and cofounder of Posit, says, “We’re at the beginning of a revolution in brain fitness that is akin to the physical fitness craze that took off in the 1970s.”

**Less than a decade ago**, most scientists accepted as an article of faith that our neural circuitry settles into its adult configuration by the end of childhood, but recent years have revealed that the mature brain is far from a static organ. Throughout life, stimulating activities spark the growth of new nerve connections and may even prompt a key memory center of the brain to produce neurons.

In 2006 British cognitive neuroscientist Eleanor Maguire discovered that London taxi drivers have literally grown into their jobs: A part of their brains involved in spatial memory is significantly larger than the





play video games, their visual-spatial acuity improves—especially their peripheral vision—and their reaction times are much faster,” reports Gary Small, director of the Center on Aging at UCLA. Cognitive scientists estimate that nearly half the information we assimilate enters through our eyes, and as we grow older, our ability to pay attention to things on the periphery declines. At the same time, the aged brain processes the stream of visual data much more slowly. Any activity that keeps these visual circuits in better working order may

### As people play video games, their visual-spatial acuity improves and their reaction times are faster.

same site in the brains of London bus drivers, who travel a fixed route. Musicians also show distinct neural changes. Behavioral neuroscientist Edward Taub of the University of Alabama at Birmingham finds that string instrument players devote more cortical real estate to the fingers that form notes on the strings than to the digits of the opposite hand, which simply clasps the bow. Taub says that musicians who begin playing as late as their forties may develop this pattern—more evidence that challenges can rewire the brain well into adulthood. Just-released research by gerontologist Elizabeth Zelinski of the University of Southern California goes even further, showing that people typically retain a great deal of brain plasticity well into their seventies.

Other studies bolster the case that intellectual pursuits help build neural reserves: richer, more efficient connections that help the brain compensate as it runs down with age. The more years of education people have, the longer it takes for them to fall victim to memory-robbing diseases like Alzheimer’s. People who are socially active or who engage in stimulating leisure activities experience a delay in mental decline. And the more time people spend in these engrossing pastimes, the greater their protection against age-related cognitive decline, notes Gene Cohen, a gerontologist at George Washington University in Washington, D.C. The Einstein Aging Study, conducted by Albert Einstein College of Medicine in New York City, shows that people who do crossword puzzles four days a week are half as likely to develop dementia as those who do them infrequently.

It is too early to predict whether younger generations weaned on video games and other interactive electronic entertainment will be afforded similar protection, but early indicators are encouraging. “As people

improve overall cognitive functioning.

Electronic games that require complex strategies and creative problem solving may exercise still more parts of the brain. These kinds of challenges, says Gee of Arizona State, build planning, memory, and reasoning skills. Some computer games that have commanded a massive following among children and young adults—for example, *World of Warcraft*—may even fine-tune social areas of the brain. As Gee points out, these games are played online with thousands or even millions of other devotees around the globe, and success depends on collaboration and teamwork.

The new appreciation of the brain’s ability to remodel itself in response to stimulation, coupled with baby boomers’ dread of mental decay, is spawning a burgeoning industry that promises a cognitive fountain of youth. Brain boot camps in which individuals are intensively drilled in mnemonic strategies are springing up across the country (one of them is led by Small). Books like *The Memory Bible* are selling briskly. So are electronic games like Nintendo DS’s *Brain Age*, played on a handheld game platform with a touch-sensitive screen. Web sites such as MyBrainTrainer.com proffer mental gymnastics touted to sharpen the mind. Cohen has just joined the fray, marketing a board game that aims to increase brain plasticity among patients suffering from Alzheimer’s or stroke-related dementia. In the game, players pick out pictures of friends and relatives and are asked questions about them.

Most neuroscientists agree that such approaches are probably helpful, but few purveyors of these products offer clinical data

to support their claims. Nor is it clear how the impact of these strategies compares with the effects of decades of reading, playing a musical instrument, or other passions pursued over a lifetime. “Whether the benefits are modest or great, we just don’t know,” says John Gabrieli, professor in the department of brain and cognitive sciences at MIT. “The manufacturers don’t even try to develop that information.”

A notable exception is Posit Science, which markets Brain Fitness, the video training program used by Hanson. Brain Fitness was developed by a team of neuroscientists led by Michael Merzenich, a co-inventor of both the cochlear implant and a highly regarded software package for treating dyslexia in children (see “The Elastic Brain” by Katherine Ellison in DISCOVER, May 2007). Merzenich insists on getting independent researchers to evaluate the efficacy of Brain Fitness. His latest results are encouraging enough to have had a trickle-down effect, aiding the credibility of the whole brain-fitness movement.

**The Posit Science system** strives to enhance the speed and accuracy of auditory processing and recall in the elderly. Exercises that become progressively more difficult teach discrimination of tones of different frequencies and speech sounds that the elderly often confuse. In many instances the computer slows down difficult-to-discern syllables and then gradually speeds them up to match the more challenging conditions in which natural conversation occurs. Like a game, the program engages the user with funny, whimsical stories and has other built-in rewards to stoke motivation.

The earliest clinical tests of Brain Fitness, from 2006, were preliminary and regarded with caution. Sherry L. Willis, professor of human development at Pennsylvania State University, expressed doubts at the time about brain-boosting programs in general. “The researchers need to see if they can train more-complex abilities, if they’re durable over five years, and whether training on these skills will transfer to everyday functioning,” she said.

Now an expanded investigation of the Posit Science method—the largest test ever of a widely available computer-based cognitive intervention—answers most of those questions. A randomized, prospective trial, it has involved 437 people 65 and older who either received 40 hours of train-



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ing with Brain Fitness or spent the same duration of time in a placebo intervention that consisted of watching educational DVDs and taking quizzes afterward. Last November at the annual meeting of the Gerontological Society of America, researchers reported results of the study. Compared with the control group, the Brain Fitness subjects increased their information processing speed (on tasks like picking out key details from a conversation) an average of 131 percent. Overall they showed a 10-year improvement in memory, so that 75-year-olds displayed the auditory recall of a typical 65-year-old. Subjects reported that they could hear better in noisy restaurants and recall names more easily; they were also less inclined to grope for words in midsentence. (Posit Science paid for the study, but some trials were conducted by outside scientists with no financial stake in the company, such as Zelinski at USC and neuropsychologist Glenn Smith at the Mayo Clinic in Rochester, Minnesota.)

Brain-plasticity training might also help older people struggling with memory disturbances of a more serious nature, according to MIT’s Gabrieli and cognitive neuroscientist Allyson Rosen at Stanford University. The two researchers evaluated the Brain Fitness program’s impact on patients diagnosed with mild cognitive impairment (MCI), a condition that typically progresses to Alzheimer’s within a few years. Six of the subjects did the standard Brain Fitness course; another six, constituting the control group, played a video game and read *The New York Times*. Over a two-month trial, all six subjects in the control group showed a decline in the activation of the left hippocampus, which processes auditory memory, and on average deteriorated on tests of verbal recall. In contrast, five out of the six subjects in the treatment group showed no reduction of activity in the hippocampus and on average improved their performance on verbal memory tests.

“Even though the study was very small, the findings were so robust that the results were statistically significant,” Gabrieli says. He cautions that more research is needed to confirm the benefits of the intervention, but he is enthusiastic about its potential: “The main thrust of treatment for MCI has been drug development, but drugs have side effects and so far have not been very effective. This is a much more naturalistic

approach toward rejuvenating the brain.”

It is not clear how well these results apply to other brain-plasticity tools based on games and play because Merzenich’s approach is rather different from other behavioral strategies. Most mental training programs on the market emphasize the learning of mnemonic tricks. Those may be useful for younger people, Merzenich argues, but for the older person they are like “kicking a dead horse.” A major reason cognitive function declines with age, he says, is that “the brain’s decoding process is degraded, and if you can’t fix that then you can’t restore memory.”

A young person processes about 8 to 10 auditory samples per syllable; an 80-year-old processes fewer than 2 samples per syllable. “That’s why the older individual’s understanding of speech and verbal memory are so fuzzy, and the same is true of the

## Strategies modeled on Brain Fitness are being developed for attention deficit disorder.

visual system,” Merzenich says. The only way to remedy the situation, in his view, is to speed up neural processing by challenging the brain with increasingly difficult stimuli. For his next version of Brain Fitness, Merzenich is expanding the program, which currently emphasizes auditory processing, to include exercises that strengthen visual processing as well as complex reasoning and planning. When the whole package is put together, he says, “I honestly believe we’re going to see 25 to 30 years in cognitive rejuvenation. That means the average 80-year-old will function cognitively like a 50-year-old.”

That is a grand goal, far beyond what Posit has achieved to date or what the current brain-plasticity studies have documented. But if Merzenich is right, a strenuous approach could do much more than mere fun and games to help the elderly maintain the intellectual firepower of their youth. Regular brain workouts may benefit other groups as well; strategies modeled on Brain Fitness are now being developed for youngsters with attention deficit disorder and for people suffering from head trauma, schizophrenia, and chemotherapy fog.

“We’re just at the start of figuring out what a really smart, systematic, and aggressive approach to behavioral intervention can achieve,” Gabrieli says. “It’s an exciting time.” ■