



Mind Games

Computerized cognitive exercise is big business.

But do the industry's claims stand up?

BY AMY PATUREL, M.S., M.P.H.

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They are serious, **targeted exercises.**”

—MICHAEL MERZENICH, M.D.

On a warm night in April 2005, Marine Lance Corporal Steven Schulz was on patrol in Fallujah, Iraq, as vehicle commander of his platoon when a bomb blasted near the front of his Humvee. The insurgents had set up a chain of over 50 improvised explosive devices (IEDs) hidden under some concrete curbing. Only one of the bombs exploded, but it propelled shrapnel and concussive force through Steven’s unprotected window.

“He lost about 90 percent of his right frontal lobe, along with other injuries through the main cerebral artery,” says Steven’s mother, Debbie Schulz. “He still has some shrapnel in his brain.”

Just 20 years old at the time, Schulz lost vision in his right eye and is partially paralyzed on the left side of his body. After the injury, he wasn’t able to focus mentally for more than three minutes at a time. He watched TV, but once the scheduled programming began, he would switch channels so he could tune into commercials. “Those 15 to 30 seconds of an ad were about how much time he could attend to a plot line,” says Debbie. It wasn’t until almost three years after Schulz’s injury that Debbie learned about Posit Science’s computerized Brain Fitness Program on a Web site for war veterans.

A BURGEONING INDUSTRY

Developed primarily for the aging brain, computerized brain training programs are booming, so to speak. With the first wave of baby boomers now past 60, scientists (and manufacturers) are working around the clock to come up with creative mental workouts to help keep the brain in top shape. Computerized brain workouts like HappyNeuron, CogniFit, Lumosity, and Posit Science’s Brain Fitness Program are becoming increasingly popular. According to business estimates, Americans are buying the industry’s claims, to the tune of \$225 million per year—a figure that is expected to grow to \$2 billion by 2015.

Since there are few drug options available to protect

cognition, boomers aren’t the only people relying on these programs for their cognitive health. People with Alzheimer’s disease and dementia, multiple sclerosis, Parkinson’s disease, and other neurologic conditions—along with their caregivers—are hoping that brain training can improve cognition.

“Computer programs have been used for 25 to 30 years for people who have had strokes or other kinds of brain impairments. So it’s not new,” says Elizabeth Zelinski, Ph.D., professor of gerontology and psychology at the Leonard Davis School of Gerontology at the University of Southern California. “What you’re trying to do is establish new connections in parts of the brain that haven’t been injured, or in some cases, you’re trying to re-inforce old connections.”

The goal is for people to start with activities that are mildly challenging and continually increase the level of difficulty—all while having fun. Some anecdotal and study data are encouraging, suggesting that computerized brain training can in fact improve memory and attention in older adults.

Most programs, such as Posit Science’s Brain Fitness Program, are divided into time blocks so patients at all levels of cognitive function can receive tailored training. “When I found out the program was in four 15-minute segments, I thought there is no way this is going to work because of Steven’s shortened

attention span. But we went ahead and tried it,” says Debbie. “The 15 minutes were tough at first, but he did it.” Schulz started with two blocks of 15 minutes and gradually built up to three. After about three weeks, he was able to sit for an entire hour working through the program.

“It didn’t take long to start seeing some pretty good results in his attention span,” says Debbie. “The fact that he could sit for an entire hour and do the whole program independently was amazing, because he wasn’t able to do anything by himself for an hour at that point. The other big change was that his cognitive processing was much faster. Before the program, when someone asked him a question, there was a delay of about 15 to 30 seconds where he tried to figure



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BRAIN TRAINING SOFTWARE

Founded in 2002, **Posit Science (positscience.com)** has a scientific advisory board of university professors and sponsors a number of clinical trials. Their Brain Fitness Program was designed to improve auditory processing and memory, while DriveSharp aims to strengthen the cognitive skills for safe driving.

out how to answer it. But after a couple of months working with the program, his brain started working faster. He responded more quickly and even came up with witty replies that were appropriate to the conversation.”

But those weren't the only improvements. Schulz's motivation to learn slowly recovered and his executive function—for example, his ability to plan ahead—started coming back. So while he still can't sit through an entire sitcom, he can focus on a computer exercise for 20 to 30 minutes at a time.

Experts say it's not unusual for someone with a severe traumatic brain injury, a stroke, or other major cognitive deficits to recover significant brain function. In fact, studies on Posit Science's Brain Training Programs show that patients with traumatic brain injury, AIDS-related cognitive loss, stroke, and mild cognitive impairment show large-scale improvements in memory, cognition, and quality of life.

The results from one such study, the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) study—funded by Posit Science Corporation—were impressive. Researchers recruited 487 adults to participate. Half of the participants used Posit Science's computerized Brain Fitness Program for 40 hours during the eight-week period, while the other half spent an equal amount of time watching educational DVDs. At the end of the eight-week study, those who trained on the Brain Fitness Program processed information twice as fast, with an average increase in response time of 131 percent. The DVD watchers, however, did not show any significant improvements in response time. Participants who used the Brain Fitness Program performed as well as those 10 years younger on memory and attention tests for which they did not train.

Before you log on to your computer and play a few games of Solitaire, researchers caution that not all computer games will produce similar results. “We don't call these exercises ‘games.’ They are serious, targeted exercises,” explains Michael Merzenich, M.D., professor emeritus at UC San Francisco and Chief Scientific Officer of Posit Science, the brain training program Schulz used after his injury. “We designed these intensive training exercises to improve neurological function through the use of near-optimum training regimes that progressively ‘drive’ brains in corrective—that is, functionally-empowering—directions.” For example, there are sound exercises that require you to arrange syllables in the same order you heard them or distinguish between sounds.



HappyNeuron (happy-neuron.com) was founded in 2000 and offers brain-training CDs as well as an online subscription. The company also sponsors several clinical trials. Members of their scientific advisory board have backgrounds in neurology, neuropsychology, cognitive psychology, and educational science.

Another exercise involves story telling: You have to move a player to the bank and withdraw \$10; the challenge is to follow a series of sequential steps.

BUILDING BRAIN RESERVES

With such successful results, it's no surprise that brain training has become big business, especially following recent scientific discoveries about brain plasticity, a concept that refers to the brain's ability to create new connections in response to mental stimulation, even among the elderly.

“We used to think that the brain is fixed—that you're born with 200 billion nerve cells, and by the time you're one year old, you've jettisoned about 100 billion of those cells and that's your maximum capacity,” says Bob Bender, M.D., medical director of the Orr Center in West Des Moines, IA. “But over the last 15 years, we've learned that the brain is very plastic, and we continue to form new brain cells until we die.”

That finding is not entirely new. Back in the 1950s, a young psychologist studied taxi drivers in London because, in order to get their license, they had to know an incredibly complex system of roads. He reviewed brain images from these drivers and found they had very large hippocampi, the memory centers in the brain. The question was: Did you have to have a large hippocampus to become a taxi driver in London, or did the hippocampus respond to the challenge?

“We're convinced it's the latter,” says Dr. Bender, “and if that's true, then we should all be able to improve our brain function.”

“The brain responds to whatever is in the environment,” says Dr. Zelinski. “So if you set up the environment with certain kinds of stimulation that require attention, the brain will actually change structurally or functionally in terms of how efficiently it processes information.” It's like an incredibly malleable computer that physically changes as it learns.

Say you're learning Spanish. You learn that the word for mother is *madre*. Initially you have to concentrate to remember that word, but if you continue studying Spanish, over time, it will come to you seamlessly. “When you develop a higher level of proficiency, that reflects the fact that the brain has made more connections and laid down a pathway so you don't have to concentrate to call up a memory. It's just there,” says Dr. Bender.

If you do challenging activities, like learning a new language, learning how to play a musical instrument, or learning Karate (which incorporates both mental and physical activity), you cre-

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ate these new neural pathways and connections that can be used as “cognitive reserve.” Think of it as a mental savings account that you can tap into during times of need. By building these reserves, some experts believe you can stay sharp throughout your life. And if you do begin to suffer from cognitive decline, those experts claim, it will take longer for symptoms to develop.

In fact, that was how 65-year-old Nancy Scalise of Palos Hills, IL, recovered after surgery to remove a brain tumor in May 2008. Before the diagnosis, Scalise regularly built up her brain reserves by taking classes, keeping physically and socially active, and playing Mahjong (a game of matching tiles) on the computer. “I was pretty good at finding the matching tiles before the time expired,” says Scalise. “After surgery, Mahjong became a real challenge. I could not believe that I had lost my proficiency at the game.” But that’s not all she lost. Soon she discovered she couldn’t remember how to do basic things.

“I had staples in my head where they made the incision, and I wanted to cover it with a scarf,” she explains. “I couldn’t even remember how to tie a scarf.” The state of Illinois took her driver’s license away and she lost her independence. Before long, she began isolating herself from friends and family because she was terrified of using the wrong words in conversation. “I didn’t want to talk for fear of what I might say,” she says. “It really shook my confidence.” Then she discovered HappyNeuron, a computerized brain training program that offers quick cognitive workouts that people can do from the comfort of their own homes.

After working with the program for about a month, Scalise noticed her memory was improving. She could remember basic instructions, and her visual/spatial cognition improved. Just eight months later, she was able to re-apply for her driver’s license. She passed the test and was back on the road in January 2009. “If it weren’t for those cognitive games, I don’t know where I would be today,” she says.

CONVENTIONAL WISDOM

Not everyone believes these computerized brain games are any better for your brain than, say, crossword puzzles or Sudoku. In fact, the National Institute on Aging recently con-

vened a panel of experts to review the scientific literature, and they concluded that there’s not sufficient data to support brain training programs to prevent dementia or Alzheimer’s disease, despite the impressive results of the IMPACT study.

“I wouldn’t spend \$2,000 to \$3,000 on some sort of brain game,” says Yonas E. Geda, M.D., M.Sc., associate professor of neurology and psychiatry at the Mayo Clinic in Rochester, MN. “I am more likely to get better at playing the game (just as any other activity practiced rigorously); however, my skill in a fancy brain game may not transfer to improvement in general aspects of cognitive function.”

To test that transfer, British researchers recruited 11,430 people to participate in a six-week online study in which they trained several times each week on cognitive tasks designed to improve reasoning, memory, planning, visuospatial skills, and attention. Although subjects improved on every single one of the cognitive tasks that were trained, their overall cognitive abilities didn’t improve—even on tasks that were closely related.

“Nobody is following anyone into the supermarket to see if they’re making mistakes or forgetting what they were supposed to buy,” says Dr. Zelinski. What we need now, experts say, are studies investigating whether really challenging the brain can result in improved cognitive function both in the virtual world and the “real” world.

Previous research shows that both exercise and computer use, individually, decreased the risk of dementia. One study published in the January 2010 issue of *Archives of Neurology* found that any frequency of moderate physical exercise reduces the risk of developing mild cognitive impairment (MCI). A second study presented at the 61st annual conference of the American Academy of Neurology in Seattle, WA, suggests that mentally stimulating activities such as knitting, quilting, reading books, playing games, and doing computer exercises are associated with a 50 percent decreased risk of MCI.

Emerging research suggests that the two together—exercise and mental stimulation—may have a combined effect. The exact mechanism of action is unclear; however, researchers have suggested that mentally stimulating activities may enhance syn-

CogniFit (cognifit.com) was founded in 1999 by cognitive psychologist Shlomo Breznitz, Ph.D. Most of their scientific advisory board have backgrounds in psychology. The CogniFit Personal Coach offers an assessment of your skills before you begin, and the CogniFit Senior Driving Program focuses on 10 cognitive skills involved in driving.

aptic activity, while physical exercise may increase blood flow to the brain, and that the two in combination may have a synergistic effect.

So instead of coughing up cash for expensive computerized programs, Dr. Geda recommends getting back to basics—walking, cycling, swimming, and reading—and trying to do meaningful things in life that give you a sense of purpose. Several studies have indicated that simple physical exercise, such as brisk walking, may be beneficial for brain function.


MAKING WAVES

While some critics say there's not enough evidence yet to prove that computerized brain programs work, advocates (including many neurologists) say there's good reason to believe that computerized brain activities may lower the risk of cognitive decline.

The key to success though, is in the amount and type of training you try. "Studies that have shown promising results for brain fitness programs tend to employ much more rigorous training than was used in studies that show no effect," says Dr. Zelinski. "Most of the casual games like you might see on Facebook (like Farmville), don't have the level of intensity and complexity that's required to make any real changes beyond getting better at what you're doing."

In fact, experts agree that in order to form new connections in the brain and strengthen the ones you already have, you have

LUMOSITY



Lumosity (lumosity.com) is the first general brain fitness program from Lumos Labs, formed in 2005. Their scientific advisory board is comprised of several university-affiliated neuroscientists. The company offers a variety of online games that are visually appealing and claim to boost and sharpen cognition.

to push yourself to the limit of your comfort zone. That means training for at least an hour a day on tasks that become progressively more difficult.

"It doesn't do any good to play a 'brain game' at your current level or just answer questions you already know," says Dr. Bender. "Unfortunately, a lot of training programs don't stress the need to move up in skill level."

No one is suggesting that computerized brain training can magically transform your mental capacity overnight. If you've been forgetful over the past two

years (like Scalise), you won't suddenly have the memory of a healthy 18-year-old. Instead, the changes may be subtle. "It improves your life in so many little ways," Scalise says. "I feel more competent. I know how to get from point A to point B again."

The trick, say experts, is to learn at every opportunity, whether by becoming proficient at computerized brain training or learning a new language, taking a pottery class, or picking up a musical instrument. The goal is to challenge the mind constantly. And if that challenge comes on a Mac or a PC, so be it.

"The Brain Fitness Program isn't necessarily glamorous like fast video games, so that was an obstacle we had to overcome with Steven," says Debbie Schulz. "But he saw the benefits and he kept doing it." The results have been worth it. When asked how the brain fitness program helped him, Schulz replies, "It made me think clearer and feel more into things." That's a prescription we could all benefit from. NN

BRAIN TRAINING:

A Buyer's Guide

While several companies have developed brain fitness programs to help people improve their memory and other cognitive skills, only a few of these programs offer personalized training for those skills that are most important and in most need of development. Unfortunately, according to Michael Merzenich, M.D., professor emeritus at UC San Francisco and Chief Scientific Officer of Posit Science, there are only a half-dozen commercially serious efforts—and those are of highly variable scientific and brain-health value. Elizabeth Zelinski, Ph.D., the Rita and Edward Polusky Professor of Aging and Education and professor of gerontology and psychology at the Leonard Davis School

of Gerontology at the University of Southern California, and her team are currently developing a set of purchasing guidelines for consumers. In the meantime, here are a few things to look for:

- ▶ **Does the company have a scientific advisory board?**
- ▶ **Are university-based researchers involved?**
- ▶ **Have they done clinical trials?**
- ▶ **Are the programs transferable to the "real world"?**
- ▶ **Have those transfers been observed in older people?**

"Once you find the right program, really think about whether you would use the program enough for it to have a chance to work," says Dr. Zelinski. "This type of training is hard and it takes a real commitment."