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CAN EXERCISING THE MIND IMPROVE OUR ABILITIES, OR IS IT JUST ANOTHER SELF-IMPROVEMENT FANTASY?

BY ANDREW ZALESKI

PHOTOGRAPH BY THE VOORHES





half-hour south of Baltimore, in a suburban office park, Kate Ortman is holding an open house. She's the proprietor of Brain Training of Maryland, a facility specializing in cognitive training programs aimed at one goal: improving brain function. About three-dozen curious visitors have shown up on this Sunday in late October. One of the employees giving demos is Kate's son, Greg, a soft-spoken 27-year-old. People watch colored bars on a computer screen blink as he



claps in time to a program called Interactive Metronome, pausing to explain how it had helped him.

Kate, a welcoming, chipper woman, used to be a life coach for young adults with attention-deficit disorder. She switched careers after Greg's older brother, Daniel, needed help recovering from a nine-hour brain surgery to relieve internal pressure caused by a congenital defect. She had learned online about cognitive exercises to improve activity in the cerebellum, the region affected by the operation. But the nearest providers for any of the therapies were an hour away, and Daniel would experience intense migraines after just 30 minutes in the car. So Kate took classes to become certified in two key programs: Interactive Metronome and Integrated Listening Systems. Over time, her dining-room-table practice expanded into Brain Boosters Greg Ortman and his mom, Kate, founder and CEO of Brain Training of Maryland a full-fledged business with office space, where she and her staff could attend to clients with brain impairments.

Companies have long hawked computer-based games or other programs predicated on the idea that you can enhance your brain function. Lumosity is probably the most well-known, thanks to ubiquitous advertisements pitching its online tools as a way to boost memory and processing. More recently, you may have heard about BrainHQ, a suite of computer-based exercises developed by San Francisco company Posit Science. New England Patriots quarterback Tom Brady swears by its ability to keep him alert on game day. Through mental workouts, the thinking goes, we can recover from a deficit or injury, stave off decline as we age, or simply become sharper thinkers.

The practice hinges on a concept scientists call "far transfer": that drilling in specific tasks will improve not just performance of those exercises, but also other everyday actions. Listen to music while standing on a balance beam, and your brain's processing speed will get better. Keep track of a rapidly blinking object on a computer screen, and you'll brake faster next time you're out driving.

If this sounds too good to be true, that's because, skeptics say, it is. In 2014, 75 neuroscientists and cognitive psychologists signed their names to a letter, published by the Stanford Center on Longevity and the Max Planck Institute for Human Development, challenging many of the claims that brain-training companies make. "To date, there is little evidence that playing brain games improves underlying broad cognitive abilities, or that it enables one to better navigate a complex realm of everyday life," they wrote. They objected to exuberant ads that were not supported by existing research, much of which showed mixed results or failed to rule out other reasons for cognitive improvements. They cautioned consumers to look out for conflicts of interest, anecdotal evidence, and overblown promises. Two months later, proponents responded with their own letter, signed by more than 100 scientists, arguing that a growing body of research demonstrates that "certain cognitive training regimens can significantly improve cognitive function, including in ways that generalize to everyday life."

A year and a half later, the Federal Trade Commission fined Lumos Labs, makers of Lumosity, \$50 million for deceptive advertising, citing "false or unsubstantiated real-world performance claims." The agency eventually suspended the fine after Lumos paid \$2 million in damages to the FTC. Brain training has nonetheless become a big business, expected to clear \$3.3 billion in sales by 2020, according to market-research firm SharpBrains. At Ortman's company, about 100 clients pay anywhere from \$200 to \$1,200 a month for help with conditions like ADD, dyslexia, stroke, and dementia. Those who, like Kate, use the techniques in their own practices say the empirical evidence is right in front of them. But the underlying question remains: Can training your brain make your life any better?

WORK IT SOME TECHNIQUES CAN BOOST CERTAIN COGNITIVE FUNCTIONS.



Mindfulness

Meditation is an ancient practice that rests on training your brain to focus its attention on the present moment, rather than the past or future. Studies suggest that using this technique over time can increase your ability to sustain attention. Recent research shows that even short-term use of this technique, when done properly, can help you concentrate, as well as improve visuospatial processing (how objects are shaped and arranged in a given area), working memory, and executive functioning. —*Claire Maldarelli*

CERTAIN COGNITIVE FUNCTIONS.

Meditate. It's easy.

LEARN HOW TO FIND YOUR CENTER WHEN THINGS GET CRAZY



Chill out Find a relaxing and comfortable position. You can meditate anywhere, even lying in bed or sitting at your desk. Inhale, exhale Without changing your natural breathing in any way, focus your attention on it. Try not to think about anything else. Pay attention If your mind wanders, which it inevitably will, bring your attention back to your breath as soon as you notice. Make it a habit Do this for five to 10 minutes every day. It might feel awkward at first, but soon you'll learn to ignore those thoughts.

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Puzzles



Half of Americans believe games like crossword puzzles and Sudoku keep them sharp. These cerebral pastimes may indeed improve something called working memory—your ability to recall things in the short term—but only because that skill is inherent to solving the puzzles themselves. You're not improving your overall brain health; you're just getting better at solving the puzzles. The connection between games and long-term memory improvement is tenuous at best.

One 2014 study on 488 residents of the Bronx did find that crossword participation delayed memory decline by more than 2.5 years, but dementia patients with this advantage saw an even sharper drop in cognitive function after that point. In other words, tackling word challenges might have some sort of benefit when it comes to keeping the mind nimble, but eventually your age will catch up with you. STEP 5



Get sharp When you need to focus, tune in to your breathing. Now you have your mind's attention and can turn it to whatever you need.

Still, since the media multitasking most of us do seems to have a detrimental effect on our ability to focus, a round of Sudoku could benefit you simply by pulling you away from your screen. —Rachel Feltman

INSTRUCTIONS Fill the Sudoku grid so

each column, row, and 3-by-3 square contains all digits from 1 to 9-no repeats in any row or column. Work left to right, top to bottom, narrowing down which numbers can go where. (Solution on page 124)



Memory Palace

Here's how memory athletes (read more on page 103) stuff their noggins with so much knowledge. –*RF*

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Pick a familiar place

Advanced athletes use dozens of locations, but you should start with one that you know well, like your front porch, or the inside of your office.



Chart a cognitive course Plan a route through that place, numbering each step at a specific landmark. If there isn't a path from spot to spot that feels logical to you, try moving counterclockwise.



Make a list

Place words along your mental route. If you need to buy eggs and bread, you might imagine a basket of eggs on the porch stairs and a loaf swinging from the doorknob. Absurd imagery is easier to remember than something realistic, so be creative.



Practice, practice, practice See how much of your list you can remember by superimposing it onto your memory palace. It will be difficult, but the more you try, the easier it will become. In time, you should be able to memorize just about any grouping of letters and numbers.



IN 2014, A 23-YEAR-OLD Greg Ortman found himself living in the basement of his parents' house, unemployed, and with an injured brain.

He'd grown up in the Baltimore suburbs, the fourth of six siblings and one of three adopted children. He'd

played high school football and was a good athlete-a compact, stocky running back. That, however, made him a target for linebackers. In his senior year of high school, he suffered his first concussion, and when he moved on to college football, he suffered three more. His memory grew foggy. He was constantly tired. Unable to keep up with his coursework, he dropped out as a sophomore in spring 2012. From there, he struggled through a string of low-level jobs. One day, while packing pallets at a warehouse, a box fell from above and conked him on the head. Concussion number five.

Virtually all concussions begin the same way: A blunt force causes the brain to move within the skull, stretching cell membranes and allowing potassium to seep out and calcium to leak in while blood vessels constrict. This interrupts the brain's electrical activity at the very time its cells are demanding more energy to kick-start recovery.

After his last concussion, Greg's symptoms grew even more debilitating: chronic fatigue, confusion, an inability to process what people said, splitting headaches. Behind the wheel of a car, he'd forget he was driving. He

"I STILL DON'T LIKE THIS MUSIC," GREG TOLD HIS MOTHER, "BUT I ALWAYS FEEL BETTER AFTERWARD."

had so many fender benders, he came to rely on others for rides. Quick to anger and increasingly depressed, he lost jobs and pushed friends away.

"There was very deep depression and thoughts," Greg says, reflecting back on those times, "like, suicidal, honestly. Just not thinking my life was worth it."

So he moved back home, with one condition: Kate insisted he wear special earphones for at least three hours a week and immerse himself in classical music. This was part of the Integrated Listening Systems, or iLs, therapy program. Mozart's masterpieces played at select frequencies, while tiny vibrations from the headset sent sound waves through Greg's skull. He hated it. "I was upset and angry, thought



Game On

After brain training, Greg returned to school and work. it was stupid, and didn't think it would work," Greg says.

Then one day at 6:30 in the morning, Kate recalls, "I come downstairs, and he looks at me

and says, 'I still don't like this music, but I always feel better afterward.'" Kate wasn't surprised at all. She had been hearing similar comments for years as the first hint of a client's progress.

Soon Greg coupled iLs with Interactive Metronome. Holding a trigger hooked up to a computer, he would listen to a cowbell beat while watching red, green, and yellow bars onscreen, and try to clap to the beat; success lit a green bar. Because the program tracked his timing to the millisecond, playing on cue was difficult at first. Eventually, though, Greg could stomp along with his feet, hit the sides of his legs, and clap hundreds of repetitions while standing on a balance board—all of it while keeping time.

"Two, three months down the road, I started noticing differences," Greg says. His memory improved, and he could multitask again. He held his temper more easily, and he no longer slept for most of the day.

Both techniques that Greg used are designed to improve the brain's response to stimuli. Our gray matter comprises about 100 billion neurons, each of which is capable of making several thousand connections. Networks of these nerve cells communicate by converting electrical signals into chemical neurotransmitters, which carry messages from neuron to neuron across synapses, the tiny spaces between the cells.

For decades, scientists held that the brain was a piece of hardware that matured into a fixed state and remained that way until old age. Neuroscience has recently shown that it is, in fact, pliable. As we begin to master a task, the brain establishes and strengthens all of the connections that contributed to its success. As it responds to visual, auditory, and motor-process stimulation, it actually changes shape and function, forging new connections and reforming old ones. This is called neuroplasticity. It's the linchpin of our ability to learn—and for the science undergirding brain training.



COMPANIES ROUTINELY cite neuroplasticity as evidence for brain training's value in their marketing literature. After all, they contend, if different cognitive interventions can help the brain shape-shift throughout life, then surely a host of

disorders—dyslexia, ADD, traumas like stroke and concussion, and the cognitive decline associated with old age—can be treated through training. Not only that, but even people with healthy minds should see gains if they are able to improve their working memory, the term of art for the organ's short-term ability to hold information and make use of it.

Makers of brain-training therapies and programs say they are designed to accomplish these benefits. Integrated Listening Systems claims to help reorganize the brain through stimulation of the cerebellum—the region at the base of the skull near the spinal cord—which manages motor output and communicates with the frontal lobes to help regulate memory, language, and emotions. "ILs repairs torn and disrupted pathways," says Ron Minson, clinical director of Integrated Listening Systems. "It is creating new neural pathways that have to do with listening, with organization—the big one is memory."

Interactive Metronome achieves a similar effect by synchronizing auditory and motor functions in its users, improving the brain's ability to process sensory inputs by speeding up its "neurotiming."

Other therapy programs use computerized games to provide the benefits. For example, BrainHQ created a product called Double Decision to help older adults improve their driving. It's a speed-training exercise meant

"<u>IF I WAS WAITING FOR</u> <u>RECOVERY, GREG WOULD</u> <u>STILL BE IN MY BASEMENT,"</u> <u>KATE SAYS.</u>

to augment peripheral vision. Depending on their needs, Brain Training of Maryland's clients may find themselves on a regimen of IM, iLs, and games by BrainHQ and other companies. Across all training methods, Kate tells her customers to look for coincidences or changes in their behavior. Maybe this week they remembered where they left their keys, or the quiz they took didn't seem so hard. "When coincidences become a pattern, you know that the training is starting to work," Kate says.

Studies appear to show brain training's ability to improve people's daily lives. Neurobiologist Nina Kraus, founder and director of Northwestern University's Auditory Neuroscience Laboratory, published a randomized, controlled study in 2013 demonstrating that BrainHQ's Brain Fitness Program could help older adults distinguish consonant sounds in noisy environments.

The boldest claims for neural training's efficacy come from the largest and longest cognitive intervention study ever conducted, the Advanced Cognitive Training for Independent and Vital Elderly, or ACTIVE. Funded by the National Institutes of Health, and begun in 1998, ACTIVE enrolled some 2,800 healthy adults over the

FORTIFY IT { THE BEST WAY TO KEEP YOUR NOGGIN IN SHAPE IS TO TAKE CARE OF THE REST OF YOU.

Master More



Studies suggest that learning something new—anything, really-helps preserve general mental acumen as you get older. The idea is that while doing a puzzle only stimulates certain aspects of memory and critical thinking, practicing an unfamiliar skill prompts the brain to create new cells and get bigger in areas that support lots of different cognitive functions. Not sure where to start? Some research suggests that learning a foreign language might be particularly beneficial, no matter how late in life. But keep in mind that these new hobbies need not be cerebral. Novelty is the real key. In fact, one 2013 study by the University of Texas at Dallas found that even guilting had a notable brain-boosting benefit for seniors, as long they had never practiced the craft before. There isn't really any data on how quickly the newness of a task wears off, so the safest move is to become a lifelong scholar and jack of all trades. -RF



Get Stronger

You should already know that hitting the gym will keep you feeling spry as time ticks by. But many studies suggest that physical activity can keep your mind more active too. That isn't just because it cuts down on your risk of conditions like diabetes and cancer. Exercise might actually help enlarge your hippocampus. There are a few reasons workouts might preserve your cognition. Perhaps it's simply that getting your heart rate up increases blood flow everywhere, with your head being no exception; studies suggest that just a few sessions of moderate aerobic activity could help stave off declines in brain health. It's also possible that the hormones you release during workouts contribute to the growth of brand-new brain cells. You might consider picking up a new hobby like dancing or tai chi, but even a brisk walk or jog three or four times a week can help keep your mind at its best. -CM



Eat Better



There's no superfood that can turn you into a late-in-life memory champ, but eating a well-balanced diet is necessary

for proper brain function. Plenty of nutrients help with this, like omega-3 fatty acids found in fish like salmon and vitamin E found in many oils, nuts, and spinach. Your body can't make omega-3 fatty acids, but your brain uses loads of them. Vitamin É is an antioxidant that helps protect neurons and other cells from substances that might damage them. And now researchers are zeroing in on another intellectual aid: lutein. Known for keeping eyes healthy by filtering blue light, this pigment might also play a role in cognitive functioning. In recent studies, scientists supplemented some children and college students with lutein. Those who received it scored higher on visual processing and other brainy tasks than their peers. You'll find it in spinach, kale, avocado, and eggs. –CM

age of 65. It divided them into a control group and three cognitive training groups for reasoning, speed of processing, and memory. The exercises included games like Double Decision, which participants played for at least 10 hours over six weeks. Investigators evaluated participants immediately after the training and at follow-ups as far as five and 10 years out. (A 20-year follow-up is forthcoming.)

Study subjects who were drilled in reasoning and speed of processing showed less decline in those abilities 10 years later versus the untrained ones, according to a 2014 report published in the Journal of the American Geriatrics Society. The biggest claim, however, came during the 2016 Alzheimer's Association International Conference: ACTIVE participants who had performed the speed of processing task showed 29 percent less risk of dementia a decade out compared to the control group.

"Most people will be protected from a progression to dementia by appropriate forms of engagement or training," says neuroscientist Michael Merzenich, a co-founder of Posit Science whose pioneering work on auditory neuroplasticity in the 1980s led to the invention of the cochlear implant. "It's just plasticity, and it's all reversible." Put another way, it turns out that science might be able to manipulate our minds in remarkable ways: "We can basically change the brain at will," Merzenich says. "I could train you and quite quickly turn your hand into a useless claw. ... Or I could take you and refine the way your brain represents information at speed or in the presence of noise so you're essentially a superior listener."



Sleep Longer



Sleep sounds like a major time suck—we spend a third of our lives in bed, after all-but our brains clean themselves out as we snooze. A series of channels in the

brain filter out metabolic wastes that build up throughout the day in our cerebral spinal fluid. This process demands too much energy to share resources with our waking brains. Without rest, waste accumulation impairs cognitive abilities, behavior, and judgment. One toxic protein called beta-amyloid builds in the brains of people with Alzheimer's disease, which has been associated with poor sleep. But snoozing isn't just about long-term health. Consider a pair of pivotal 2003 studies: Researchers increasingly deprived willing participants of one to five hours of sleep over a week, testing them daily to measure cognitive function. Both studies found deprivation led to poor performance. Most participants did best with seven to eight hours of shut-eye. -CM



Try Harder

Most of us use our smartphones for countless daily tasks. But taking digital shortcuts could be making our brains lazy. Try to remember the last time you read an actual map. If you can't, you aren't alone. But the less we force our noggins to navigate, the worse our way-finding skills become. A 2006 study by researchers at University College London compared the brains of taxi drivers, famous for their ability to zip around the city's confusing streets, with bus drivers, who follow set routes. The cab drivers had bulked-up hippocampi (the region of the brain in charge of navigation), which reflected their superior mental maps. A more recent UCL study compared brain activity in people who navigated a simulation program with an app to those trying to figure out a route for themselves. The latter group had far more activity in their hippocampi than the app users. So try ditching your phone once in a while. -CM



Do...Drugs?



Some medications, such as Adderall, have established benefits for conditions like Attention Deficit Hyperactivity

Disorder. But people increasingly pop other so-called nootropics too. You shouldn't take any drug unless advised by your physician, but science might one day support these newcomers. Psychostimulants-Adderall, caffeine, nicotine, and Ritalin-help performance. But this is true only with the proper dose. And any drug that makes your heart race comes with obvious potential downsides. Some users praise microdosing with hallucinogens like LSD or psilocybin; long assumed useful only for a crazy trip, anecdotal evidence suggests that doses too small to induce a high might brighten the mood and sharpen the mind-perhaps even treat PTSD with a therapist's help. But if you're tempted by illicit nootropics, try steeping a cuppa first. L-theanine, found in green and black tea, can combine with caffeine to boost mental faculties. -RF



OTHER RESEARCHERS' thinking has evolved more cautiously. In 2008, two investigators published a groundbreaking study in the Proceedings of the National Academy of Sciences. They demonstrated that young adults who played a game

designed to exercise their working memories showed improvements in their fluid intelligence-the ability to solve new problems-by scoring several points higher on intelligence tests. Brain training, the results suggested, wasn't just for people with cognitive deficits.

Since then, one of the study's authors has moderated

her expectations. Susanne Jaeggi is a neuroscientist and principal investigator at the Working Memory and Plasticity Laboratory at the University of California at Irvine. She's one of the scientists who signed the consensus letter questioning how effective brain training is in improving real-world outcomes for people.

There's no doubt that brain plasticity exists. What's not clear, she says, is whether training has the wide-ranging benefits some companies claim. At her lab, where her team develops brain-training programs for research, Jaeggi has observed that individuals respond to the techniques in different ways. Some show improvement; others don't. The NIH is backing an ongoing study into what makes some programs work.

"We have pretty good evidence that people across



Double Decision

This speedtraining game is designed to help older drivers augment peripheral vision. their life spans can get better in training with these specific games," she says. "Where it starts to become controversial is whether it might translate to other tasks that were not part of the training."

A systematic review of the studies cited by braintraining companies finds them lacking. The 84-page paper, published in 2016 by the Association for Psychological Science, even finds fault with the ACTIVE study: "In effect, each training regimen led to improvements on the trained task, with some near transfer to proximal measures of the same skill but no evidence of transfer beyond the trained task," the authors write.

"The vast majority of these studies don't actually look at transfer to some real-world activity," says co-author Zach Hambrick, a Michigan State University psychology professor. "They look at transfer to other laboratory tasks."

Even in young adults, the claim of transfer looks dubious, based on the results of a randomized controlled trial

"<u>WE SEE ABOUT 9,000 PATIENTS</u> <u>A YEAR AND DO NOT PRESCRIBE</u> <u>BRAIN-TRAINING GAMES FOR</u> <u>ANY," COLLINS SAYS.</u> published last summer in the Journal of Neuroscience by University of Pennsylvania researchers. Psychology professor Joe Kable says they expected that cognitive training with Lumosity would not only improve working memory in young adults, but that it also would influence their decision-making abilities: how willing they were to forgo immediate rewards for future ones. Instead, what they found was that cognitive training had no effect at all.

"Not only did we not see far transfer, which was disappointing, but we also didn't even see near transfer, which is kind of even more disappointing," Kable says. "I mean, we were really going after the question: Can you optimize cognitive ability? We saw no evidence for that."

Companies such as Lumosity grew their subscriber bases by advertising that brain training would have wide-ranging transfer effects. In its legal action against Lumos Labs, the FTC said that the claims Lumosity made—that its computerized, cognitive tasks could improve performance on everyday tasks, protect against cognitive decline, and even reduce impairment associated with health conditions such as traumatic brain injury and attention-deficit hyperactivity disorder—did not meet its standard of proof, which demands "competent, reliable, scientific evidence" to support health claims. "I think the FTC settlement is poorly understood and gets misrepresented," says Bob Schafer, Lumos Labs' head of research. "The settlement was about historical marketing materials from 2009 to 2014, not necessarily about the research we've published or the products."

Cases like Greg's are even trickier. There's scarce research examining whether iLs and IM training improves concussion symptoms. Greg saw neurologists, psychiatrists, and therapists. He exercised regularly. But nothing really helped him, he says, until he began brain training.

Still, at its most basic, scientists would consider Greg's story just that: an anecdote. And in terms of concussion, it's particularly difficult to assess the efficacy of a treatment for a condition that often naturally gets better over time, or for which the patient also underwent targeted treatments that make use of occupational therapy, physical therapy, psychotherapy, and other forms of cognitive remediation.

"I certainly wouldn't tell them not to do things that are helping them," says Micky Collins, director of the Sports Medicine Concussion Program at the University of Pittsburgh Medical Center. "Absence of proof doesn't mean proof of absence, right? I can tell you one thing: We see about 9,000 patients a year at our clinic, and we do not prescribe brain-training games for any of them."

Kate counters as only a parent could: "If I was waiting for recovery, Greg would still be in my basement. Unemployed. Angry. And not where he is today."



IN NOVEMBER 2017, GREG spent a long weekend in Washington, D.C., a trip that would have been nearly impossible for him a few years ago. He and his girlfriend visited the National Museum of African American History and Culture, appreciating

a moment of quiet contemplation amid the exhibits on offer, navigated the subway system, and walked throughout the noisy city—all activities that his concussion symptoms once prevented him from doing.

After a year of training, Greg went back to school. He graduated from community college this past May with his associate's degree. He lives and drives on his own again. He's personable and engaging. This past summer, he joined the nine-person staff at Brain Training of Maryland in addition to working as a personal trainer. It's hard to view him as anyone who was once fatigued and angry.

Science rightfully considers stories such as Greg's to be anecdotes and will have to continue the careful progress in settling the argument. What's needed is more research into how cognitive function might be improved through training to the point where it carries over into real-world behavior. Serious organizations like the NIH are doing work in that arena. There are also completed studies that have tried to assess real-world performance in one way or another, including the ACTIVE study, which clearly showed that training memory, for instance, improved memory performance.



In December 2017, the Journal of Cognitive Enhancement published a special issue focused on the merits of cognitive training. In an opening editorial, the guest editors, which included Susanne Jaeggi, conclude that brain training can be effective in improving everyday life tasks, but the evidence remains limited. Still, there are studies, including a couple in that special issue, that suggest that brain training has the potential to produce real-world effects. "But they're certainly not as clear-cut and as evident as many companies make it seem," Jaeggi says.

To Kate Ortman, Greg's results are pretty clear-cut: "This was not medication," she insists. "This was not therapy. This was training."

Soon Brain Training of Maryland will rebrand as Brain Train America, a reflection of the customers across the country who book virtual appointments. They're clients that, Kate says, have improved much in the same way as her own son. And for the first time since his concussions, Greg is living a different life. "I'm happy," he says, "and I'm ready to take on whatever life gives me."

Andrew Zaleski, a journalist based near Washington, D.C., writes frequently about business, science, and technology.

Bright Horizon

Kate Ortman is expanding her brain-training practice, booking clients nationally online.