FEB 15, 2018 @ 12:39 PM EDITOR'S PICK

Study Explores How To Master A Skill You've Only Practiced In Your Mind

Andréa Morris, CONTRIBUTOR

I cover S.T.E.A.M. (Science, Technology, Engineering, Art and Math). **FULL BIO**

TWEET THIS

- Practicing in your mind primes the brain to take action.
- subjects in the study were able to physically master tasks they had only practiced in their minds.

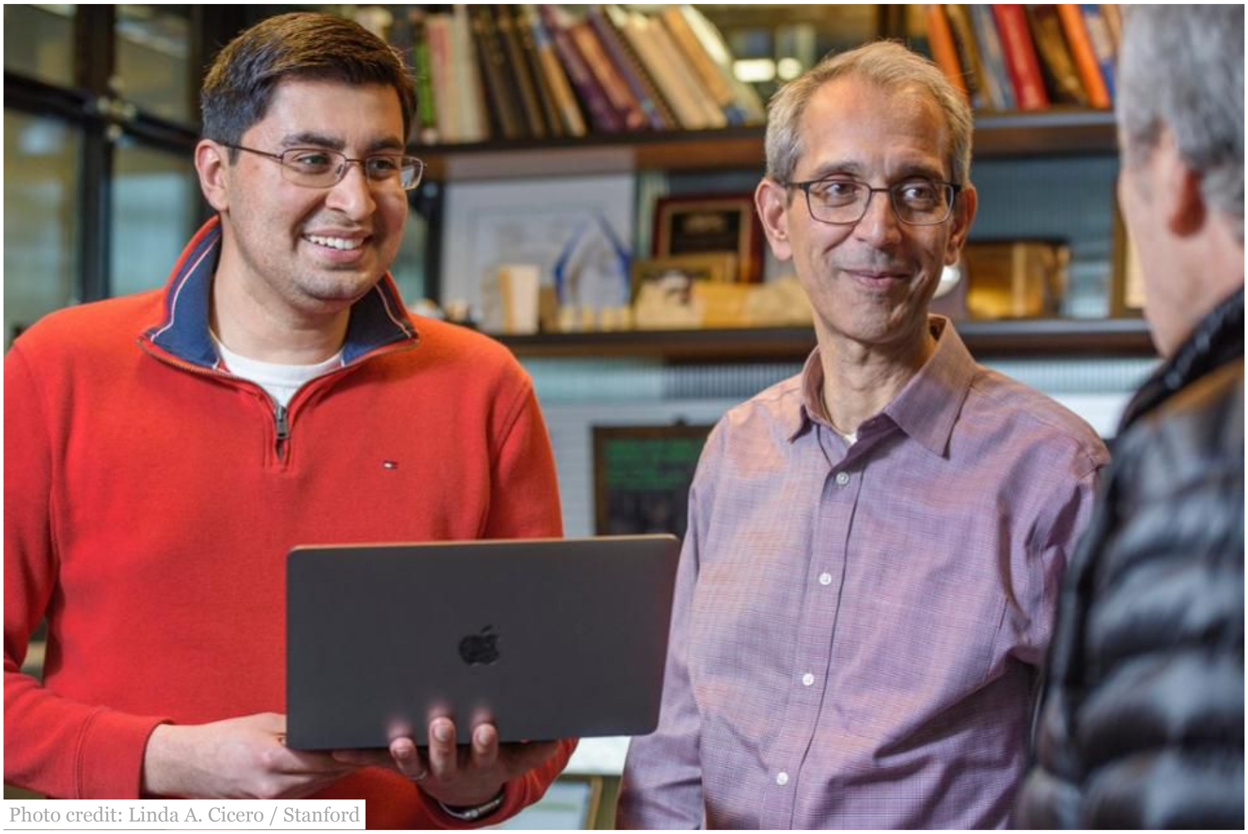
Photo credit: Linda A. Cicero / Stanford

Vyas and Shenoy in their lab at Stanford

"The question is, what happens when you try to learn a motor task without physically doing the task?" asks Saurabh Vyas, Stanford bioengineering graduate student and lead author of a paper published today in *Neuron*.

The answer? Practicing in your mind primes the brain to take action. With feedback on mental practice, subjects in the study were able to physically master tasks they had only practiced in their minds.

What the researchers saw.

Vyas and his colleagues used an intracortical brain-computer interface (iBCI). The device is implanted in the motor cortex, allowing neural activity to be interpreted by a computer. Subjects outfitted with iBCIs for this study were two monkeys. They practiced moving a cursor across a screen using only their minds. When they got that down, they were thrown an obstacle. The researchers changed the biometric so that brain signals used to move the cursor up now moved it in a different direction. The subjects quickly adapted.

Vyas and his colleagues observed systematic changes in activity in the motor cortex where the subjects responded mentally to the obstacle and learned to accommodate it.

Then, when the monkeys tried to do the movements with their hands and arms, they were successful. They even accounted for the obstacle, without ever having practiced it for real.

“They're not actually moving their limbs or any part of their body,” says Vyas. “They're just sort of sitting there. And somehow all of the learning that happens in their head literally affects their ability to move their arm.”

Mental rehearsal.

Mental rehearsal means you imagine yourself doing a practice run to help improve the outcome when you do it for real. Many self-help books devote whole chapters to the use of visualization exercises to achieve peak performance. Everyone from professional athletes, to CEOs, and musicians tout its benefits for improving performance outcomes. If you’ve ever tried it, you’ve probably felt it helped.

FEB 15, 2018 @ 12:39 PM 1,497 EDITOR'S PICK

Study Explores How To Master A Skill You've Only Practiced In Your Mind

Andréa Morris, CONTRIBUTOR
I cover S.T.E.A.M. (Science, Technology, Engineering, Art and Math). **FULL BIO**
Opinions expressed by Forbes Contributors are their own.

Continued from page 1

TWEET THIS

- Practicing in your mind primes the brain to take action.
- subjects in the study were able to physically master tasks they had only practiced in their minds.

Mental rehearsal belongs to a class of behaviors called *covert behaviors*. Covert behaviors, including thinking and imagining, are behaviors carried out internally and are not directly observable by anyone other than the person experiencing them.

Because covert behaviors are difficult to study, trying to isolate what makes mental rehearsal effective is a major challenge. Understanding the mechanism can help us harness and potentially amplify the benefits of mental rehearsal.

Mental rehearsal + feedback = covert rehearsal.

Vyas says mental rehearsal differs in one important respect from what the test subjects did. Subjects with iBCIs who perform tasks using only their mind get real-time feedback about how they're doing. Adding the element of feedback upgrades mental rehearsal to what Vyas calls *feedback mediated visualized practice or covert rehearsal*. Covert rehearsal produces reliable and measurable learning about how to execute physical tasks that you've only ever performed in your mind.

The covert learning model allows researchers to zero in on the effects of practicing movement in your imagination. " Here we're able to quantify it. On a trial by trial basis," says Vyas. "We can make very precise statements about why learning transfers or under what conditions it transfers."

Imagine yourself practicing free throws. "You could do that all day long," Vyas says, "but you have no way of knowing if the way you're imagining or the way you're visualizing is correct. With feedback, you know, on a millisecond by millisecond level, if what you're imagining is actually making the task better or worse. Therefore, you're going to adjust in real-time." On the spot feedback, reevaluation and course correction–it's everything we do when we learn hands-on in the real world. Mind-machine interfaces provide a kind of kinesthetic learning for your brain.

It's all in the planning.

Vyas found that covert rehearsal triggers motor preparation for when you're planning to take action. "Your neurons are active even before you make a movement," says Vyas. "If I ask you to go grab a cup of coffee, there's that brief period of time where you look at the cup of coffee and you don't actually move yet, but you're sort of planning to go to grab that cup of coffee." Vyas says he and his colleagues have implicated motor preparation as 'the key magic sauce' that transfers the benefits of practicing in our mind to real-world performance outcomes.

Why this technology was developed.

Locked-in Syndrome is a term used to describe a state of severe paralysis where the sufferer has no means of communicating and interacting with the world. Until modern brain imaging, people who suffered from various forms of severe paralysis were thought to be vegetative–while actually being fully aware and alert, thinking, feeling, and sensing everything going on around them, and *to* them. iBCIs are a prosthesis surgically implanted into the brain to allow patients trapped in immovable bodies to communicate and interact with the world. These interactions are moderated by machines that detect and react to brain patterns arising from deliberate mental activity, i.e. covert behavior (thinking). Vyas's colleague and the study's senior author, Krishna Shenoy, had a breakthrough last year with three successful human clinical trial patients using iBCIs.

"Prosthetics has largely been deemed a technology to help people with paralysis and it was never considered something that could be used to study the brain itself," says Vyas. He's enthusiastic that a technology built on what we knew about the brain can now be used to learn more about the brain, including how thinking impacts performance.

FEB 15, 2018 @ 12:39 PM 1,497 EDITOR'S PICK

Study Explores How To Master A Skill You've Only Practiced In Your Mind

Andréa Morris, CONTRIBUTOR
I cover S.T.E.A.M. (Science, Technology, Engineering, Art and Math). **FULL BIO**

Continued from page 2

TWEET THIS

- Practicing in your mind primes the brain to take action.
- subjects in the study were able to physically master tasks they had only practiced in their minds.

Invasive vs. noninvasive brain-computer interfaces.

For the biohacking self-improvers reading this, artificial motor-skills acquisition using iBCI is still a ways off. Mostly because of the 'intracortical' part of the iBCI acronym. Implanting the device requires brain surgery. Biomedical researchers motivated to help patients in critical need aren't exactly clamoring to use invasive technology as a novelty. Nor or they eager to expose more animals to this type of testing than absolutely necessary. It's why studies of this kind are typically done on only two subjects instead of dozens. "The standard practice in our field, taking ethics and everything into consideration is always to replicate the study multiple times in one animal and then repeat everything in a second.” Presently, Vyas feels the use of invasive BCI should be restricted to two applications: helping people with paralysis and various other neurological disorders, and using the technology in a neuroscience laboratory as an instrument to better understand how the brain works.

“The electrode arrays, the pieces that listen to your brain activity, are implanted inside your head,” says Vyas. The advantage of an implant? “The more invasive you get, the better picture you get of what your neurons are doing. As you get farther and farther away from the neurons, the picture gets fuzzier and fuzzier and therefore the resulting utility also sort of gets weaker and weaker.”

But wait...

Fuzzier, noninvasive neural images can still be useful for some applications. In fact, they’re widely marketed to consumers. You may have seen an EEG (electroencephalography) meditation headset for sale in a mall kiosk. Some years back, the company MyndPlay came out with an interactive short film. Using a noninvasive BCI headset with EEG sensors pressed to your scalp, you determine the outcome of the narrative. As the story unfolds on-screen, your goal is to maintain a balance of beta waves (concentration) and alpha waves (relaxation). Lose your cool-headed focus and the brainwave meter in the corner of the screen flies into a red zone while your getaway car careens off a cliff. The same company has a video game designed to help you stay calm and focused during archery practice to help hit the bullseye. Whether such games can help transfer mentally rehearsed motor skills into physical motor skills is yet to be tested.

“I think there's a host of applications for which EEG could very well be useful." In the paper, Vyas suggests applications like rehabilitation, where a stroke patient might be instructed to visualize movement with their hand while a physical therapist moves their hand for them. The patient would get sensory feedback about how to control their own neural activity to help regain mobility. "In fact..." Vyas thinks a moment, "it would be interesting to evaluate if a similar transfer of mentally practiced motor skills happens by using just EEG."

Note: The study's funding came from the National Institutes of Health, the National Science Foundation, a Ric Weiland Stanford Graduate Fellowship, a Bio-X Bowes Fellowship, the ALS Association, the Defense Advanced Research Projects Agency, the Simons Foundation and the Howard Hughes Medical Institute.

My book, *The Science of On-Camera Acting,* can be found here. Check out my TV projects and other media, here.