

Record and replay: How a Canadian-made app is aiming to help Alzheimer's patients improve their daily lives

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HEALTH

PUBLISHED MARCH 3, 2019

UPDATED MARCH 4, 2019



Led by Morgan Barense, seen here on Feb 26, 2019, an associate professor and Canada Research Chair in cognitive neuroscience, University of Toronto researchers have created an app that mimics the function of the hippocampus, an area of the brain that is typically ravaged early on in Alzheimer's disease.

MOE DOIRON/THE GLOBE AND MAIL

Just as a titanium leg or a robotic hand can compensate for a missing limb, Toronto researchers believe a memory prosthetic may help people with Alzheimer's disease.

For the past four years, Morgan Barense and her research team have been developing a virtual hippocampus, using digital technology to mimic a brain structure that is critical for consolidating memories. Their result is a phone-based app, called the Hippocamera, designed to allow Alzheimer's patients to compensate for damage to this area of the brain.

A core function of the hippocampus is something called "hippocampal replay," she

explains. That is, the hippocampus acts like a movie projector, replaying memories over and over in high speed. Over time, with repeated broadcasts, the cortex, or the large outer portion of the brain, learns these memories, she says.

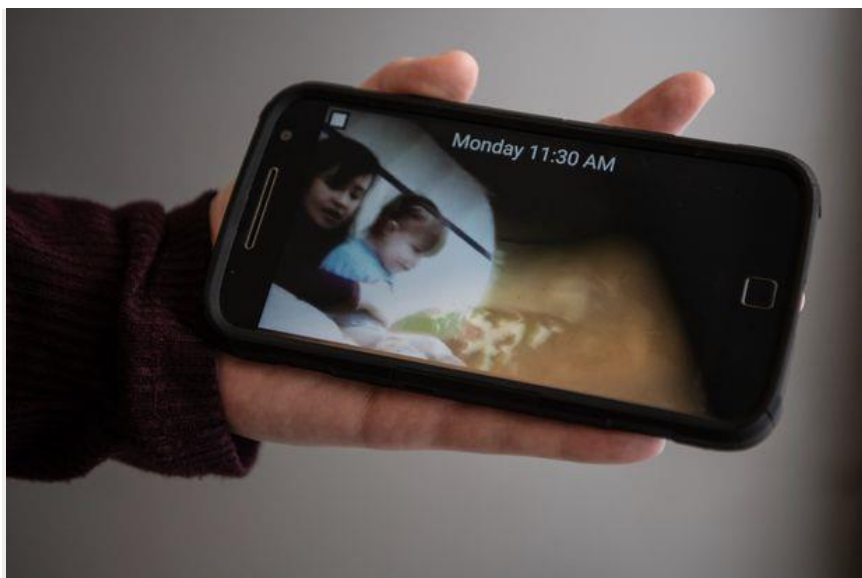
The Hippocamera, then, is like an external movie projector, designed with only two modes: record and replay. It allows users to record short video clips of daily events they wish to remember, prompting them to first give a brief verbal description. In the replay mode, the videos are shown in high-speed with audio of the user's verbal description played over top.

"We took everything that we knew about how the hippocampus supports memory and we rammed it all into this application," says Dr. Barense, an associate professor at the University of Toronto and Canada Research Chair in cognitive neuroscience.

The Hippocamera is part of an expanding field of digital memory augmentation, using technology to enhance people's ability to store and recall memories. At its most basic, these memory prosthetics take the form of wearable digital cameras, such as Google Glass or Microsoft's SenseCam, a now-discontinued device that automatically took photos to document users' daily lives. More futuristic experiments involve implanting electrodes or computer chips into one's brain to record brain signals involved in forming memories. The aim is to later stimulate their recall abilities by replaying these signals back to the brain.

Memory augmentation is nothing new. Ancient Greeks, for example, developed mnemonic devices, or techniques to organize and visualize material, to help them memorize lengthy orations, says Jesse Rissman, an assistant professor of psychology, psychiatry and biobehavioural sciences at the University of California, Los Angeles. But today, with advances in neurotechnology and the ubiquity of digital devices that can readily record and store our daily activities, "there's interest in how we might be able to use this to help people better remember their lives," Dr. Rissman says.

The use of brain implants to enhance memory is still very much at the experimental stage, being tested in animals and patients with brain injuries or illnesses, and is unlikely to become mainstream since it requires invasive surgery, he says. "But that said, the possibility of doing that is not as science fiction-y as it used to be."

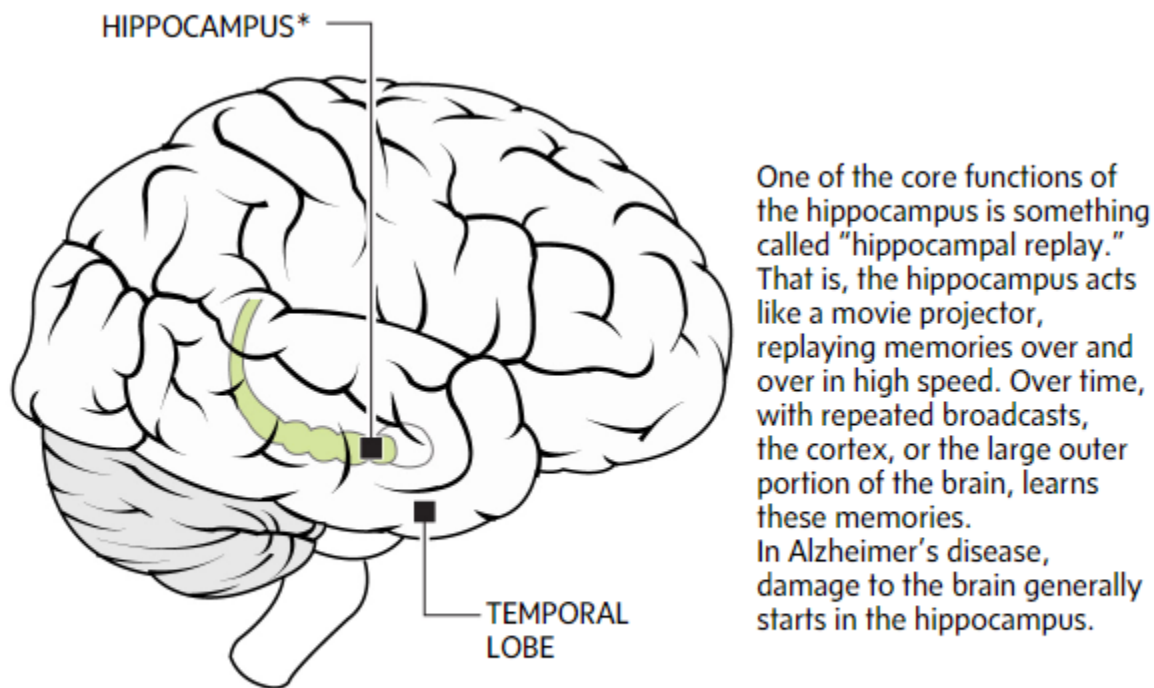


The team is now testing the app on patients with Alzheimer's.

In a U.S. military-funded pilot study published last year, scientists demonstrated that they could use implanted electrodes to record how participants' brains responded to visual memory tests. (The volunteers were patients receiving surgically implanted electrodes to treat epilepsy.) They found when they later stimulated the participants' brains, using the personal "neural codes" they recorded, the participants performed better on subsequent memory tasks.

On the spectrum of technological sophistication, the Hippocamera falls somewhere in between wearable cameras and brain implants.

In Alzheimer's disease, damage to the brain generally starts in the hippocampus, while other parts of the brain are spared, at least in the early stages of the disease. With this knowledge, Dr. Barense and her colleagues set out to create a tool that could do the job of the hippocampus, allowing the relatively undamaged parts of the brain to take over.



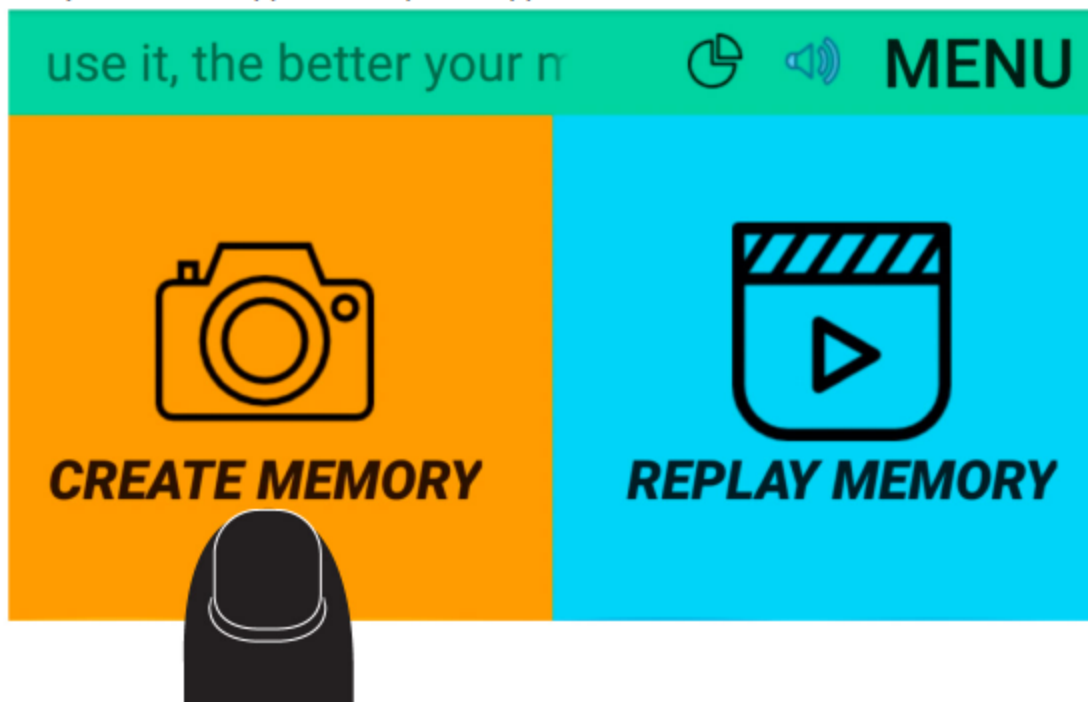
*Located within the temporal lobe on both right and left side of the brain

HOW THE HIPPOCAMERA PHONE-BASED APP CAN HELP WITH ALZHEIMER'S MEMORY LOSS

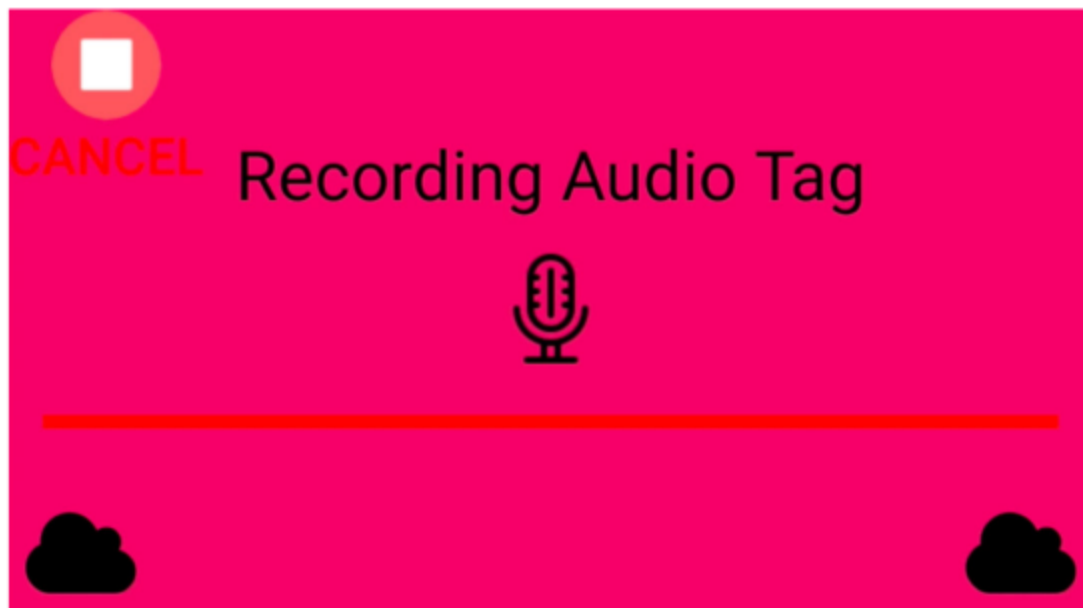
1. The patient finds themselves in a situation that they want to make a memory of..



2. They launch the Hippocamera phone app



3. The patient selects "create memory" for the event and is prompted to audio record a verbal explanation of what is happening.

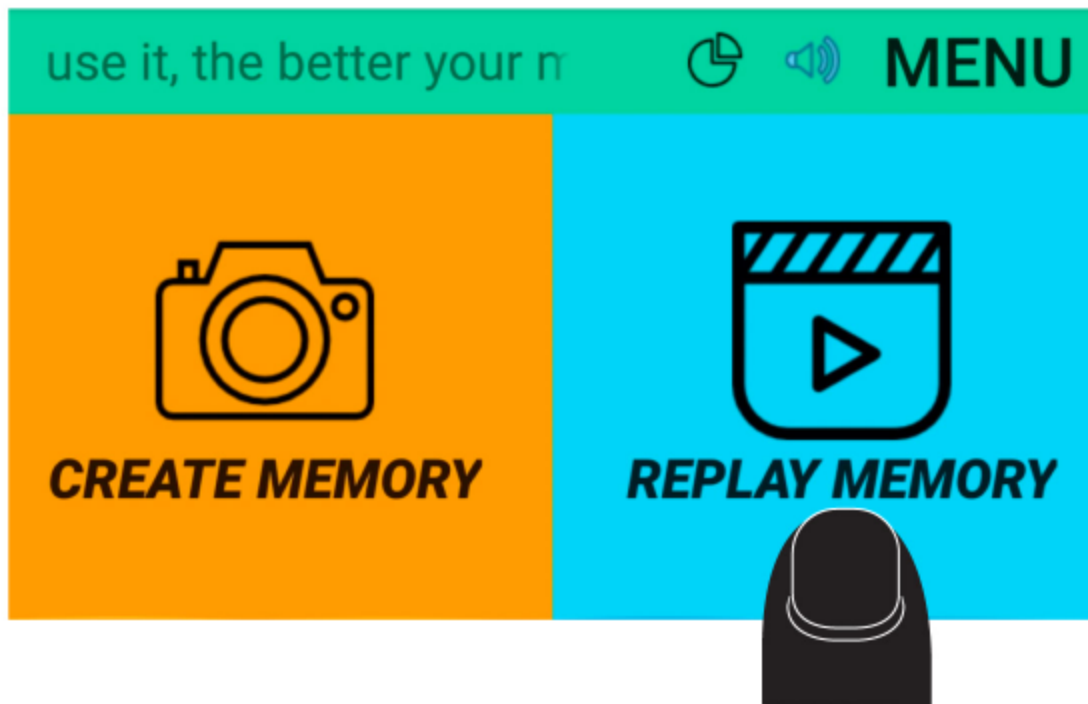


**"Claire is riding her bike
without training wheels"**

4. The app then starts a video recording.



5. Later in the day, the patient needs to watch the recorded memory multiple times.



6. The memory recordings are played at three times the normal speed, which mimics the activity of the hippocampus and how it stimulates the brain's cortex to create lasting memories.



TRISH McALASTER / THE GLOBE AND MAIL; IMAGES: CHRIS MARTIN

Dr. Barense and her team are still figuring out the optimal times and frequency at which the videos captured with the Hippocamera should be replayed. But in a spin-off study, they found participants were 10 times better at remembering material if they reviewed it immediately before going to sleep at night, compared with reviewing it after sleep.

In their tests of the Hippocamera, they asked more than 40 healthy older volunteers, ages 60 to 80, to record five events a day and watch replays six times a day, for two weeks. Only half of the recorded events were ever replayed, allowing the researchers to

determine how well the participants remembered these events, compared with the ones they recorded but never viewed.

Nearly three months later, participants remembered 40 per cent more details related to the events they had replayed during the initial two weeks of the experiment than those they never viewed. Brain scans also showed enhanced activity throughout their brains as they were asked to recall the events they had replayed.

The team is now testing the app on patients with Alzheimer's in the hope of not only improving their memory function, but also staving off further decline.

Even simply reviewing Facebook or Instagram photos can help people strengthen their memories of certain aspects of their experiences, Dr. Rissman says. However, this could come at a cost of losing other details, he says. For instance, viewing photos of your last vacation will likely improve your memory for what happened when you took those photos, but other aspects of your vacation may be forgotten.

What's more, each time we retrieve a memory, it also becomes vulnerable to change, he says. So if other people tell you about a related experience while you're recalling an event, there's a possibility some details of their story could become mixed into your own memory.

"Eventually, you might strongly believe that something that didn't happen to you actually did," he says.

Nevertheless, for individuals suffering from memory impairment, digital memory augmentation may improve more than just the accuracy of their recollections. Using wearable cameras to document and review patients' daily events has been shown to improve their emotional health and overall sense of well-being, Dr. Rissman says.

It may "help people to see the trajectory of their life, how much stuff they're doing, and also as each day passes, not lose the record of all those experiences" that make up their personal narratives, he says.