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# A Little Device That's Trying to Read Your Thoughts

By DAVID EWING DUNCAN

SAN DIEGO — Already surrounded by machines that allow him, painstakingly, to communicate, the physicist [Stephen Hawking](#) last summer donned what looked like a rakish black headband that held a feather-light device the size of a small matchbox.

Called the [iBrain](#), this simple-looking contraption is part of an experiment that aims to allow Dr. Hawking — long paralyzed by amyotrophic lateral sclerosis, or Lou Gehrig's disease — to communicate by merely thinking.

The iBrain is part of a new generation of portable neural devices and algorithms intended to monitor and diagnose conditions like sleep apnea, depression and autism. Invented by a team led by Philip Low, a 32-year-old neuroscientist who is chief executive of [NeuroVigil](#), a company based in San Diego, the iBrain is gaining attention as a possible alternative to expensive sleep labs that use rubber and plastic caps riddled with dozens of electrodes and usually require a patient to stay overnight.

“The iBrain can collect data in real time in a person's own bed, or when they're watching TV, or doing just about anything,” Dr. Low said.

The device uses a single channel to pick up waves of electrical brain signals, which change with different activities and thoughts, or with the pathologies that accompany brain disorders.

But the raw waves are hard to read because they must pass through the many folds of the brain and then the skull, so they are interpreted with an algorithm that Dr. Low first created for his Ph.D., earned in 2007 at the University of California, San Diego. (The [original research](#), published in The Proceedings of the National Academy of Sciences, was done on zebra finches.)

About the Hawking experiment, he said, “The idea is to see if Stephen can use his mind to create a consistent and repeatable pattern that a computer can translate into, say, a word or letter or a command for a computer.”

The researchers traveled to Dr. Hawking's offices in Cambridge, England, fitted him with the

iBrain headband and asked him “to imagine that he was scrunching his right hand into a ball,” Dr. Low said. “Of course, he can’t actually move his hand, but the motor cortex in his brain can still issue the command and generate electrical waves in his brain.”

The algorithm, called Spears, was able to discern Dr. Hawking’s thoughts as signals, which were represented as a series of spikes on a grid.

“We wanted to see if there was any change in the signal,” Dr. Low said. “And in fact, we did see a change in the signal.” NeuroVigil plans to repeat the study in large populations of patients with A.L.S. and other neurodegenerative diseases.

These preliminary results come as Dr. Hawking’s ability to communicate diminishes as his disease progresses. The 70-year-old physicist, whose mind has produced crucial insights in theoretical physics as well as the best-seller “A Brief History of Time,” now needs several minutes to generate a simple message. He uses a pair of infrared glasses that picks up twitches in his cheek. His team in Cambridge, England, has dubbed this the “cheek switch.”

“Dr. Low and his company have done some outstanding work in this field,” Dr. Hawking said in a statement. “I am participating in this project in the hope that I can offer insights and practical advice to NeuroVigil. I wish to assist in research, encourage investment in this area, and, most importantly, to offer some future hope to people diagnosed with A.L.S. and other neurodegenerative conditions.”

The physicist has also worked with other inventors seeking to better elucidate his thoughts. Engineers at the semiconductor and computing giant Intel recently hooked up a customized computer to communicate with his cheek-reading infrared glasses, along with a voice synthesizer, a webcam for using Skype, and special monitors. Intel is developing new face-recognition software that can monitor subtle changes in expression and may help Dr. Hawking communicate more efficiently.

Scientists not connected with Dr. Low say they are encouraged by the iBrain’s potential. “Philip Low’s device is one of the best single-channel brain monitors out there,” said Ruth O’Hara, an associate professor of psychiatry and behavioral sciences at Stanford University Medical School. She plans to use the iBrain for autism studies. NeuroVigil has not said what the device will cost.

“I can’t speak to the veracity of his latest data,” which has not been published, Dr. O’Hara added, “but the preliminary data I have seen is compelling. It could be a significant contribution to the field as a window into brain architecture.”

Dr. Terry Heiman-Patterson, a neurologist and A.L.S. specialist at the Drexel University College of Medicine, said she was in discussions with NeuroVigil to use the device on A.L.S. patients, to

see how they fared with it in comparison with instruments that use multiple channels and electrodes.

“Dr. Low is researching signals that look for intent, which is becoming very exciting because it looks like they may be able to do it — for Stephen Hawking and for others with A.L.S.,” Dr. Heiman-Patterson said.

“Patients want to be able to communicate beyond the yes or no with an eye blink. They want to send an e-mail, and turn off the light and, even more, to have a meaningful conversation.”

Monitors like the iBrain are also being used to assess whether experimental neurological drugs are working in clinical trials.

In 2009, NeuroVigil completed a deal with the drug giant Hoffmann-La Roche to test the iBrain. Neither company has released details of their early tests. NeuroVigil’s strategy, Dr. Low said, is to run clinical trials with Roche and other partners in industry and academia, and to seek approval from the Food and Drug Administration.

Other companies also make single-channel brain monitors, but unlike NeuroVigil they sell the devices and software directly to consumers online.

[Zeo](#), for example, based in Massachusetts, concentrates on measuring sleep patterns through a smartphone app or a clock-radio device — available for \$99 and \$143, respectively. [Emotiv Systems](#), in San Francisco, offers its Epoc headset for \$299 plus a range of apps and add-ons that include neurofeedback, 3-D brain-mapping tools and games like Angry Birds, all using a combination of thoughts and facial muscle movements recorded by several electrodes that are in contact with a customer’s head.

“We have no plans to take an academic route,” said Zeo’s chief executive, Dave Dickinson, who added that his company’s customers had logged one million hours of sleep time. He would not say how many devices had been sold. Emotiv was founded in 2003 and has reportedly shipped 10,000 devices.

Dr. Low plans to team up again with Dr. Hawking this summer in Cambridge to present their initial data at a [neuroscience meeting](#) in early July. NeuroVigil will continue to work with Dr. Hawking and his team to refine their technology to decipher signals generated by Dr. Hawking’s thoughts. “At the moment I think my cheek switch is faster” than the brain-computer interface, Dr. Hawking said in an e-mail sent by an assistant, “but should the position change I will try Philip Low’s system.”

Much work remains, however, including the integration of Dr. Hawking’s brain waves with the

computers and devices that allow him to communicate.

“Wouldn’t it be wonderful,” Dr. Low said, “to have a mind like Stephen Hawking’s be able to communicate even a little bit better?”

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