Rigorous visual training teaches the brain to see again after stroke (w/Video)

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This image shows a participant in a visual recovery experiment at the University of Rochester Medical Center performs a visual test. Credit: Richard Baker/University of Rochester

By doing a set of vigorous visual exercises on a computer every day for several months, patients who had gone partially blind as a result of suffering a stroke were able to regain some vision, according to scientists who published their results in the April 1 issue of the *Journal of Neuroscience*.

Such rigorous visual retraining is not common for people who suffer blindness after a stroke. That's in contrast to other consequences of stroke, such as speech or movement difficulties, where rehabilitation is common and successful.

"We were very surprised when we saw the results from our first patients," said Krystel Huxlin, Ph.D., the neuroscientist and associate professor who led the study of seven patients at the University of Rochester Eye Institute. "This is a type of brain damage that clinicians and scientists have long believed you simply can't recover from. It's devastating, and patients are usually sent home to somehow deal with it the best they can."

The results are a cause for hope for patients with vision damage from stroke or other causes, said Huxlin. The work also shows a remarkable capacity for "plasticity" in damaged, adult brains. It shows that the brain can change a great deal in older adults and that some brain regions are capable of covering for other areas that have been damaged.

Huxlin studied seven people who had suffered a stroke that damaged an area of the brain known as the primary visual cortex or V1, which serves as the gateway to the rest of the brain for all the visual information that comes through our eyes. V1 passes visual information along to dozens of other brain areas, which process and make sense of the information, ultimately allowing us to see.

Patients with damage to the primary visual cortex have severely impaired vision - they typically have a difficult or impossible time reading, driving, or getting out to do ordinary chores like grocery shopping. Patients may walk into walls, oftentimes cannot navigate stores without bumping into goods or other people, and they may be completely unaware of cars on the road coming toward them from the left or right.

Depending on where in the brain the stroke occurred, most patients will be blind in one-quarter to one-half of their normal field of view. Everything right or left of center, depending on the side of the stroke, might be gray or dark, for instance.

Building on blindsight

Despite the stroke, the patients' eyes are taking in visual information. It's just that the damaged brain cannot make sense of it to create vision.

Huxlin's team sought to build on this "blindsight" - visual information, of which the patient is unaware, that still reaches the brain. A few past studies have shown promise for the idea of building on blindsight to improve a person's vision.

"The question is whether we can we recruit other, healthy regions of the brain to benefit the person's vision. Can we train those brain regions so hard and stimulate the brain to such a degree that this visual information is brought to consciousness, so the person is aware of what they're seeing?" said Huxlin.

Huxlin began the study with seven people, four women and three men, ranging from their 30s to their 80s, who had had a stroke anywhere from eight to 40 months before the experiment began. All had suffered substantial damage to the primary visual cortex. The funding to support the work came from Research to Prevent Blindness, the Pfeiffer Foundation, the Schmitt Foundation, and the National Eye Institute.

The team focused on motion perception, since it's an aspect of vision critical for most everyday tasks. The team's aim was to see if the brain's middle temporal region, which was healthy in the participants, could be stimulated so extensively that it could take on some of the tasks normally handled by the visual cortex.

The five participants who performed the training and completed the experiment had significantly improved vision. They were able to see in ways they weren't able to before the experiment began. A few found the experiment life-changing - a couple of participants are driving again, for instance, or have gained the confidence to go shopping and exercise frequently.

Following the dancing dots that can't be "seen"

To do the experiment, participants fix their gaze on a small black square in the middle of a computer screen; scientists use a sensitive eye tracker to make sure patients keep staring at the square.

Every few seconds, a group of about 100 small dots appears within a circle on the screen, somewhere in the person's damaged visual field - in other words, when the patients stare at the square, they don't initially see the dots. The dots twinkle into existence, appear to move as a group either to the left or the right, then disappear after about one-half second. Then the patient has to choose whether the dots are moving left or right. A chime indicates whether he or she chose correctly, providing feedback that lets the brain know whether it made the right choice and speeding up learning.

But how do patients choose if they can't consciously see the dots?

"The patients can't see the dots, but they're aware that there is something happening that they can't quite see. They might say, 'I know that there's something there, but I can't make any sense of it,'" said Huxlin, who is also a faculty member in the departments of Ophthalmology, Neurobiology and Anatomy, Brain and Cognitive Sciences, and in the Center for Visual Science.

But the brain is able to make some sense of it all, even though the patient is unaware that he or she is seeing anything. When forced to make a choice, patients typically start out with a success rate of around 50 percent by guessing. Over a period of days, weeks or months, that number goes to 80 or 90 percent, as the brain learns to "see" a new area, and the visual information moves from blindsight to consciousness. Patients eventually become aware of the dots and their movement.

As patients improve, researchers move the dots further and further into what was the patient's blind area, as a way to challenge the brain, to coax it to see a new area.

"Basically, it's exercising the visual part of the brain every day," said Huxlin. "It's very hard work, very grueling. By forcing patients to choose, you're helping the brain re-develop."

The patients in the study did about 300 tests at a time, which translated roughly to sitting in front of a computer for 15 to 30 minutes once or twice a day, every day, for nine to 18 months. It's an exhausting task, especially for someone whose brain is working extra-hard to accomplish it.

Source: University of Rochester Medical Center (news : web)