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Scientists Use Colored Lights to Program Brain Activity

07 January 2010

Jessica Berman | Washington

Scientists in the United States have developed a powerful new method to help calm the abnormal brain activity associated with diseases such as epilepsy and Parkinson's. The technique involves the use of laser light stimulation of special proteins implanted in key areas of the brain.

So-called neural "super silencers," were developed by scientists at Massachusetts Institute of Technology from two genes found in fungi and bacteria. The genes, called Arch (ARK) and Mac, are responsible for making light-sensitive proteins that help the organisms convert light into energy.

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But when those genes are inserted into the brain, neurons can be engineered to express the proteins, making it possible to manipulate them with a laser beam and calm irritated nerve cells that are responsible for epilepsy, Parkinson's disease and chronic pain syndromes.

Ed Boyden is a professor of brain and cognitive sciences at MIT. He is the lead author of a study that showed how neurons containing the genes could be turned on and off with pulses of laser-beam light. "If you could turn off those neurons that are behaving inappropriately just for the right amount of time, that allows you to cancel out the aberrant neural dynamics with fewer side effects than if you were to bathe the entire brain in a pharmacological agent," he said.

Boyden says the laser light activates the genetically modified brain cells, lowering the voltage in the neurons and stopping them from firing inappropriately.

"We've shown in the current paper that we could express these molecules from fungus and archi-bacteria and so on and they would express just fine for months in mice. And we also showed we could get safe and effective optical silencing of these neurons. When we turned the light off, the neurons just go back to their normal activity," he said.

Scientists are now trying to develop a neural feedback system that would

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become active when brain cells start to become over-stimulated, as in the case of epilepsy. "So, for example, one of the things we are working on is can we detect a certain brain state using electrodes the same way that it's been done for almost a hundred years and use it to monitor the brain and then deliver a pulse of light just at the right time to shut down a pathological state in the brain," Boyden said.

With the new tools, Boyden says researchers may someday be able to identify and correct complex neural networks that lead to disease by engineering different neurons to respond to different colors of light.
For example, in the study, researchers found that brain cells implanted with the Arch gene were silenced by yellow light, while neurons modified by the Mac gene were silenced by blue light.

"We're screening even more species now to try to broaden our ecological biodiversity screen. But we're also starting to do longer and longer measurements of the safety and efficacy in more clinically interesting scenarios," he said.

Boyden's team has begun experimenting with light-sensing proteins to calm the brains of non-human primates.

While the use of light tools to treat human brain diseases is still a long way off, Boyden says other researchers are starting to use the technology to develop new and improved drugs.

Ed Boyden and colleagues describe their work programming brain activity with light-sensing genes this week in the journal Nature.

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