

Exposure to colored light silences brain function

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Researchers at MIT have developed a method to shut down brain function in targeted neurons based on exposure to different colors of light.

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New research from the [Massachusetts Institute of Technology](#) (MIT) has shown that engineering neurons to express the genes *arch* and *mac*, which are derived from bacteria and fungi, can reversibly silence brain activity. Since these genes encode for light-activated proteins, the neurons stopped firing when researchers exposed the neurons to different colors of light.

The research was led by Ed Boyden, professor in the MIT Media Lab and associate member of MIT's McGovern Institute for Brain Research. "Silencing different sets of neurons with different colors of light allows us to understand how they work together to implement brain functions," said Boyden, in a press release. "Using these new tools, we can look at two neural pathways and study how they compute together. These tools will help us understand how to control neural circuits, leading to new understandings and treatments for brain disorders—some of the biggest unmet medical needs in the world."

According to MIT, the light-activated proteins created by *arch* and *mac* have the ability to lower the voltage in neurons, which prevents them from firing. Based on this ability, the researchers were able to expose the entire brain to light and selectively affect only those neurons that had been engineered with *arch* and *mac*. The neurons engineered to express *arch* are silenced by yellow light, and those that express *mac* are suppressed by blue light.

The researchers tested *arch* and *mac* in mice by loading the genes into viruses and inserting them directly into the mouse neurons. The researchers used optical fibers attached to lasers to flash different colors of light on the modified neurons, and then measured the resulting activity with electrodes.

"In this way, the brain can be programmed with different colors of light to identify and possibly correct the corrupted neural computations that lead to disease," Brian Chow, a postdoctoral associate in the Boyden lab, said in a press release.

This method could lead to new treatments for disorders like epilepsy, Parkinson's disease, chronic pain, and brain injuries. These disorders occur due to abnormal brain activity, which may be treated by silencing the expression of certain overactive neurons. According to MIT, this method is the first to provide precise control over timing of the shutdown of specific neurons.

The Boyden laboratory has had several breakthroughs in recent years leading up to this development. In 2005, in collaboration with researchers at Stanford University and the Max Planck Institute, Boyden's group created the first optogenetic technique to manipulate brain function using optics and gene delivery. In that breakthrough, the team used the light-activated ion channel ChR2 to selectively turn on neurons.

In 2007, the group used the light-sensitive protein halorhodopsin to inhibit the firing of neurons when activated. "But the genomic diversity of the world suggested that more powerful tools were out there waiting to be discovered," said Boyden.

According to MIT, the new multicolor light silencers are much better tools for manipulating brain function than those previously discovered. The study showed that neurons expressing *arch* were turned off with a higher level of precision and recovered faster than neurons expressing halorhodopsin.

"Multicolor silencing dramatically increases the complexity with which you can study neural circuits," said Xue Han, postdoctoral researcher in Boyden's lab in a press release. "We will use these tools to parse out the neural mechanisms of cognition." The researchers are continuing to work toward a human trial of *arch* and *mac* by next testing the neural manipulation in monkeys.

The paper, "High-performance genetically-targetable optical neural silencing by light-driven proton pumps," was published in *Nature* on Jan 7. Funding was provided by the [National Institutes of Health](#) and the [National Science Foundation](#).

Keywords: colored light timing shutdown neurons MIT



The research was led by MIT neurobiologist Ed Boyden. Source: MIT.