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A healthy future for optogenetics

A clever combination of optics and genetics may allow neuroscientists to identify and control brain circuits with unprecedented precision.

By Jeff Bairstow

The term "optogenetics" swung rapidly across my lexical horizon almost a year ago with a Scientific American article (Sept. 24, 2008) by Gero Miesenböck, the eminent Wayneflete Professor of Physiology at Oxford University. In a fascinating feature entitled "Neural Light Show: Scientists Use Genetics to Map and Control Brain Functions," Miesenböck describes how a clever combination of optics and genetics may allow neuroscientists to identify and control brain circuits with unprecedented precision. Note the use of the word "control." I'll come back to that critically important topic later.

Just imagine peering directly into the brain of a frantic laboratory rat or, in the due course, into the brain of a leading optogenetics researcher and seeing the neurons flashing away. The mind boggles. Further on, we may be able to use bursts of laser light to determine what is causing the brains of Alzheimers patients to fail. After many years of stumbling down the research pathways of optogenetics, we may be able to "restart" those failing neurons and restore patients to normality without the need for invasive surgery. Debilitating motion disorders such as Parkinson's disease would likely benefit also. The mind boggles even further.

But, first let me return to the origins of the word "optogenetics." I have not yet been able to identify the person who conceived this term, although the word seems to come into advanced use in the 1990s. In the past, many scientists have used an optical model to describe the brain at work. For example, in 1937, the famous Oxford University professor Sir Charles Scott Sherrington waxed lyrical in describing brain activity as "an enchanted loom where millions of flashing shuttles weave a dissolving pattern ... a shifting harmony of subpatterns."

The idea of using light to start or stop neurons in living animals was also proposed some decades ago by the famous Nobel Prize–winning scientist, Francis Crick, and was demonstrated in 2006 by a young team of neuroscientists led by Karl Diesseroth, a professor of bioengineering and psychiatry at Stanford University. By the way, Diesseroth has a short but very informative video on his optogenetics research on You Tube, which I recommend highly.

In vogue

Optogenetics is now getting some major exposure in the popular media. Naturally a whole host of blogs follows every twitch in the field, which means that the bulls of Wall Street cannot be far behind. Wikipedia describes optogenetics as an emerging field that combines optics and genetics to probe neural circuits at the high speeds needed to understand brain information processing. But complex genetic engineering and biophysical problems are slowing developments of commercial applications. Restrictive legislation may also slow research.

However, initially, optogenetic therapy appears to offer a series of silver bullets. Although researchers can perform elegant experiments on laboratory rats, the U.S. Food & Drug Administration is, quite rightly, restricting such experimentation for now.

Optogenetics needs specialized hardware application agreements for often untested new machines. For example, special fiber-optic tools are needed to allow investigation of specific cell types that will be needed for research deep inside the brain. The genetically modified cells may make areas of the body very sensitive not only to laser light but also to sunlight. All this suggests that it may be many years before optogenetics offers a reliable diagnosis, much less a definitive cure for Parkinson's disease or any other major brain disease.

There are also a host of potential social issues to be considered. For example, would optogenetics be used for mind-altering drugs for personal recreation or for making foreign terrorists and domestic criminals more compliant? Who would regulate the techniques and products made possible by optogenetics? These questions do not have easy answers and the more complex optogenetics becomes, the tougher the questions get, in my view. Nonetheless, I am impressed by the work that has been reported so far and I believe the future will be bright for optogenetics.

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