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Installing New Solar Panels Inside Your Head

An interview with **Edward Boyden**, Neurobiological Engineer
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The brain is really complicated. A cubic millimetre of your brain will have a hundred thousand cells called neurons, connected by a billion connections called synapses. It's the most complicated computer we can think of.

So my job is to figure out, how do we map the brain and all the wires and connections that help information flow? And how can we control the brain? Can we repair the brain when it goes wrong, in diseases that affect over a billion people around the planet?

What is optogenetics?

We developed physics- and chemistry-based strategies for mapping the brain and controlling the brain. One of the technologies that we've developed is called optogenetics; opto- because that means light, and -genetics because it turns out that genes, pieces of DNA, in the natural environment actually encode little solar panels: molecules that convert light into electricity. And it's important to know that brain cells compute using electricity.

So what do we do? We can take these genes from bacteria and fungi and algae; we put the genes into brain cells, using tricks from the field of gene therapy, and then we shine light on the brain, these little solar panels convert light into electricity, and that's how we can activate memories, shut down



seizures, all sorts of other mysteries of the brain that we can solve by perturbing in a causal way what's happening within the brain.

What are some practical uses for optogenetics?

Although optogenetics is a basic science tool, it's inspiring new therapeutics. My colleague Li-Huei Tsai has used our technology to discover a pattern of brain waves that activates the brain's immune system. This brain wave will actually turn on cells called microglia, and these go out and clean up the junk that builds up in Alzheimer's disease. So, inspired by that, we have been designing movies that people can watch that would activate the same pattern of brain activity, and maybe help treat Alzheimer's disease. We've begun the human trials already.

My long-term dream is that we can, through our knowledge of ourselves, maybe help humanity achieve a more enlightened state. But along the way it's very gratifying to realize that our technologies for mapping the brain and repairing the brain are having a lot of impact on therapeutics. Over a billion people around the world have some kind of brain condition, and basically nothing can be cured. So if we could help people with Alzheimer's and schizophrenia, depression and addiction, epilepsy and Parkinson's along the way, that would make me very happy.