Getting in your head

Jeff Reinke, Editorial Director

Professor Edward S. Boyden is probably one of the few individuals on the planet who is actually best described as a brainiac.

Currently serving as the principal investigator at the Massachusetts Institute of Technology’s Synthetic Neurobiology Group, Boyden’s mission is to develop tools for controlling and observing the dynamic circuits of the brain. And when you consider that over a billion people worldwide suffer from brain disorders that include migraines, Alzheimer’s, strokes, depression, epilepsy, Parkinson’s and more, Boyden’s work really hits home.

His efforts were recently recognized by being tabbed as the inaugural recipient of the Institution of Engineering and Technology’s (IET) A. F. Harvey Engineering Research Prize. Boyden plans to use the proceeds in his development of an implantable prosthetic. This device will detect the electrical activity associated with seizures and respond by emitting light to rapidly drive or silence key neurons, effectively halting the seizure.

Despite this incredible and demanding work, the good professor took a couple minutes to sit down and discuss what fuels him, his proudest accomplishments, and of course, what would be his super power of choice.

Jeff Reinke: What passions, preferences or influences lead you down your current career path?

Edward S. Boyden: I guess I've always been a philosopher at heart - wondering how the universe came to be the way it is, and how the matter of the brain computes our thoughts and emotions. I studied chemistry, then physics and electrical engineering, working on topics such as how physical systems could be used to perform computations.

But it seemed to me that the biggest philosophical frontiers lay in the brain - how

does it compute the mind? So when I worked at Bell Laboratories for a brief period of time, I decided that this was an area ready for new technologies to help reveal underpinnings of how the brain works.

JR: What do you find to be the most interesting or intriguing aspects of your work?

EB: I find it fascinating that the brain –each cubic meter of which contains a hundred thousand neurons with a billion connections between them - can compute our thoughts, emotions, and feelings, and enable us to understand things, create art and so forth. Building technologies that help neuroscientists understand this, is fascinating to me.

Of course, brain disorders affect perhaps a billion people around the world, and helping them is a top priority as well. Knowing more about the circuits that make up the brain will reveal new drug targets and new therapeutic modalities.

JR: Right now the U.S. faces some challenges in getting kids interested in math and science and, as a result, careers such as engineering. Do you have any thoughts on how to create a stronger interest in these areas?

EB: I think people need to understand that scientists don’t just read textbooks – we struggle with ambiguity, trying to extract meaning from tough experiments, and it's a highly creative and aesthetic set of actions. Maybe more people would be scientists if they thought of research as a heist story about hacking into the vault of secrets of the universe.

JR: What is the primary focus of your current work?

EB: The brain is an incredibly dense, heterogeneous circuit made out of billions of cells called neurons, each of which is connected to thousands of others. Understanding how these cells derive their computational powers from the molecules that make them up, how these cells work together in circuits to implement behavior, and how to fix brain disorders when these cells and circuits go awry, requires new tools.

We are devising a series of tools to help confront these problems, including optogenetics(controlling neural circuits with light), as well as robotic and molecular tools for analyzing the cell types of the brain and how they achieve their computational properties.

JR: Who are your heroes or people you look up to and admire?

EB: I think a lot about the physicists who, from the concrete and comfortable safety of equations and atoms, turned to the ambiguity and messiness of biology in the first half of the 20th Century, and then bravely plowed in. The book Time, Love, Memorydescribes a bunch of these peopleand how they tried to extract the principles of life.

JR: If you could wake up tomorrow morning knowing one thing that you don't know

today, what would it be?

EB: How the brain generates consciousness and feelings.

JR: If you could have any super hero power, what would it be and why?

EB: This is always a tricky one, because the best super hero power would be the ability to create new super hero powers, and then to practice and acquire those new powers! But assuming that kind of answer isn't allowed, I suppose the ability to control matter with the mind would be pretty useful.

JR: We'll be doing a webinar together on September 25. Without giving too much away, what do you think will be the biggest takeway for viewers/attendees?

EB: I'll talk about new technologies, both molecular and micro-fabricated that we've been developing which enable neurons to be very precisely controlled using light. I'll also talk about robotic methods for analyzing the cell types of the brain.

I'll discuss how these technologies can be used to study the circuits of the brain, as well as how they can lead to new prototype, diagnostic and therapeutic modalities.

To learn more about the work Dr. Boyden is doing, as well as details of the upcoming webinar: Engineering the Brain, click here:

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