

**Department of Biomedical Engineering**

**Seminar Announcement**

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Massachusetts General Hospital

& Harvard Medical School

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Science and Technology Center

Room 136, 10:00am

**Restoring sensory function with neural prostheses: towards the development of more effective devices and stimulation strategies**

**Abstract:**

My lab focuses on the design, development and optimization of neural prostheses that target the CNS. Most of our work to date has focused on visual prostheses and has included devices that target the retina or the visual cortex. Retinal devices consist of electrode arrays that are implanted in subjects with outer retinal degenerative diseases such as macular degeneration or retinitis pigmentosa. Each electrode in the array is intended to focally activate a small region of surviving retinal tissue, thereby generating a distinct visual percept (phosphene) that is spatially confined to a narrow region of visual space; simultaneous stimulation from multiple electrodes can, in theory, form more complex spatial patterns. In practice, single phosphenes can indeed be reliably elicited but the creation of more complex spatial vision has proven challenging and the overall quality of artificial vision remains quite limited. This is not entirely surprising as the healthy retina uses highly complex patterns of neural signaling to convey information to the brain while the neural patterns that arise from electric stimulation are thought to be much simpler and thus do not match well to physiology. It is likely that this disparity makes the neural signal hard to interpret and thus limits the quality of artificial vision. Using a combination of computational modeling, electrophysiology and immunochemistry, my lab studies the responses of single neurons to artificial stimulation and uses this knowledge to develop new and more powerful stimulation strategies including approaches that better replicate certain aspects of natural signaling. I will describe some of our key findings in my talk. More recently, my lab has also begun to develop a prosthesis designed for implantation into visual cortex, e.g. a device that could be used by those with nearly all forms of blindness, including traumatic injury to the eyes. Our approach uses an array of implantable micro-coils that magnetically stimulate nearby neurons; such an approach is a potentially attractive alternative to conventional micro-electrodes because the asymmetric fields from micro-coils can be harnessed to selectively target or avoid specific types of cortical neurons. For example, vertically-oriented pyramidal neurons can be strongly activated while horizontally-oriented passing axons are avoided; this helps to better confine activation from each coil to a focal region and thus better replicates the complex spatial patterns of activity that arise from complex spatial objects. The use of inductive activation also overcomes some of the instability that can arise with implantable cortical micro-electrodes. For example, magnetic fields pass readily, through even severe encapsulation, e.g. that which arises secondary to the foreign body responses triggered by implantation. Much ongoing effort has confirmed the selectivity and stability of micro-coils and my talk will describe this effort as well as our efforts to move this technology into clinical testing.



**Biography:**

Shelley Fried is the Director of the Neural Prosthetic Research Laboratory at Massachusetts General Hospital. He is also an Associate Professor in the Department of Neurosurgery at Harvard Medical School and a Health Scientist at the Boston VA Medical Center both in Boston, MA. Dr. Fried has a PhD in Vision Science from UC Berkeley where he retinal neurobiology. He did postdoctoral training at both UC Berkeley and at the Massachusetts General Hospital in Boston studying the neural response to artificial stimulation. His current research focuses on developing improved methods and strategies of artificial stimulation. Much effort in the lab is devoted to exploring the biophysical basis by which neurons respond to artificial stimulation. Active areas of research include electric stimulation of the retina, magnetic stimulation of primary visual cortex and the factors affecting propagation of artificially-elicited neural activity. Prior to obtaining his PhD, Dr. Fried worked for 12 years in the medical device industry developing a wide range of anesthesia and respiratory therapy products.