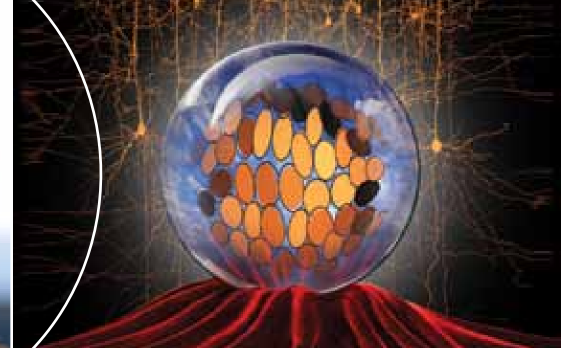

Tatyana Sharpee

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"Neurobiologists are on a perennial quest to understand how the brain codes and processes information. In the past, scientists had to rely on simplified objects on a computer screen. I try to take it a step further and analyze how brain cells respond to natural stimuli because some neurons only respond when a certain object comes into view. Scenes from our environment provide a rich ensemble of various object combinations sure to drive any sensory neuron at some point."

Circuits in the nervous system, built from cells and the connections between them, cannot be made as regular as circuits in engineered man-made systems. Yet animals can detect and act on signals in the environment with precision that not only rivals that of engineered systems, but consumes much less energy (the brain is estimated to "run" on 12 Watts of power). Neurons in the retina only respond when a stimulus appears within an approximately round window covering a small part of the visual field that the eye sees. Theoretically, one would expect to obtain the best resolution if these windows, known as receptive fields, were circular and arranged on a perfect triangular lattice. Indeed, receptive fields are roughly circular and are positioned on a roughly triangular lattice, but imprecisely so. In collaboration with Charles Stevens, Sharpee and her team were surprised to find that the combination of these two types of irregularities yielded a near perfect performance. By comparison, performance dropped by a third when receptive fields either were made perfectly circular or irregular receptive fields were adjusted to follow an ideal lattice.

These results suggest new strategies for improving the performance of retinal implants that could help restore vision in blind people. Retinal prosthetic devices rely on an array of electrodes implanted near the retina to send electrical signals to the brain through remaining neurons in the retina. Although the implants themselves are regular arrays, irregularities arise at the interface with the neural tissue, in part because cells can move from their original positions over time. Thus, visual performance of the implant can be reduced when signals derived from a given portion of visual space are sent to cells that normally respond to a somewhat different part of the visual field. The same algorithms that Sharpee and her colleagues used to predict receptive fields in a healthy retina can now be used to find the optimal outlines of the regions of visual space that should be associated with a particular electrode.

For more information, please visit
salk.edu/faculty/sharpee.html

Left to right:
Jeffrey Fitzgerald, Adam Calhoun, Sophie Liu, James Jeanne, Alfred Kaye, Ryan Rowekamp, Tatyana Sharpee, Saeed Saremi