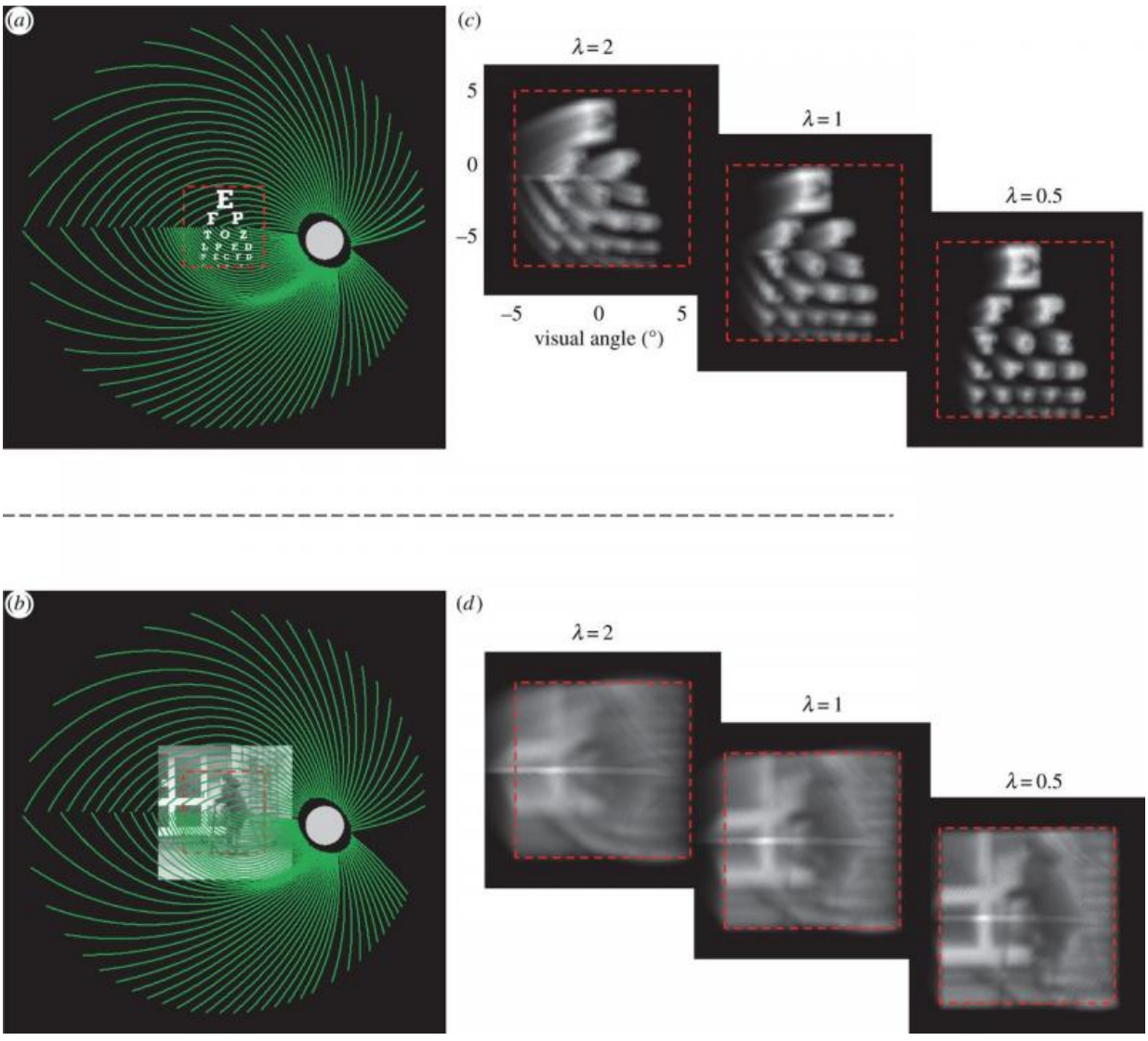
What would the world look like to someone with a bionic eye?

August 3 2015, by Deborah Bach



The black and white images show visual distortions that might result from electric prostheses that enable vision by stimulating the retina. Credit: Ione Fine

and Geoffrey Boynton / University of Washington

Various sight recovery therapies are being developed by companies around the world, offering new hope for people who are blind. But little is known about what the world will look like to patients who undergo those procedures.

A new University of Washington study seeks to answer that question and offers visual simulations of what someone with restored vision might see. The study concludes that while important advancements have been made in the field, the vision provided by sight recovery technologies may be very different from what scientists and patients had previously assumed.

In a paper published Aug. 3 in the journal *Philosophical Transactions B*, UW researchers used simulations to create short videos that mimic what vision would be like after two different types of sight recovery therapies. Lead author Ione Fine, a UW associate professor of psychology, said the simulations are unprecedented.

"This is the first visual simulation of restored sight in any realistic form," she said. "Now we can actually say, 'This is what the world might look like if you had a retinal implant.'"

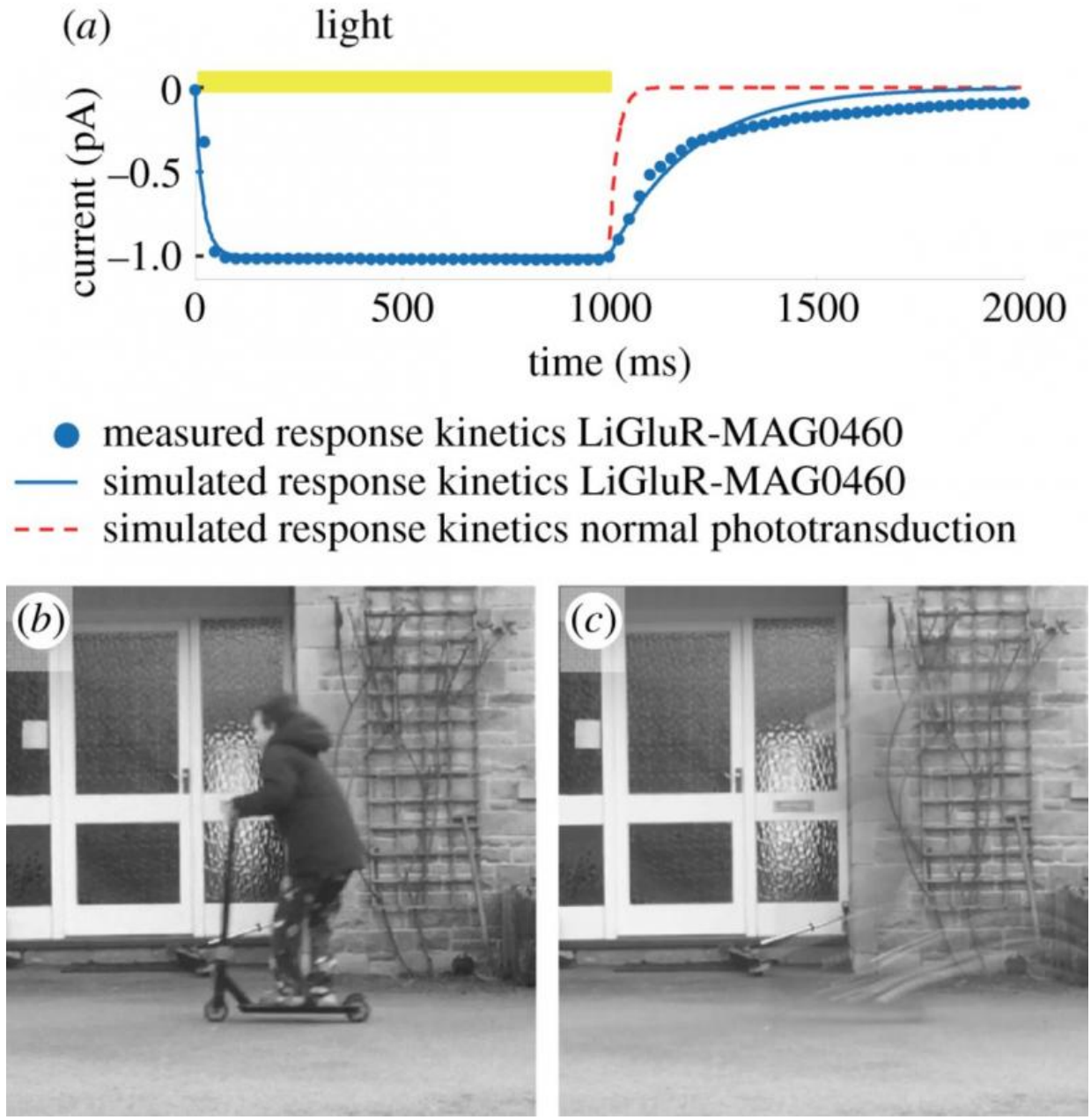
Fine said the paper aims to provide information about the quality of vision people can expect if they undergo sight restoration surgery, an invasive and costly procedure.

"This is a really difficult decision to make," she said. "These devices involve long surgeries, and they don't restore anything close to normal vision. The more information patients have, the better."

More than 20 million Americans aged 18 and older have experienced vision loss, according to the American Foundation for the Blind, and rates of vision loss are expected to double by 2030 as the nation's population ages.

For many of these patients, vision loss occurs after light enters the eye and lands on the retina, a thin layer at the back of the eye that contains millions of nerve cells.

Among those are cells called rods and cones, which convert light into electrical impulses that are transmitted to vision centers in the brain. Loss of rods and cones is the primary cause of vision loss in diseases such as macular degeneration or retinitis pigmentosa.



Limitations in sight recovery technologies can cause fast-moving objects to seemingly disappear, as shown in the above image of a child on a scooter. Credit: Ione Fine and Geoffrey Boynton / University of Washington

But those diseases leave most remaining neurons within the retina

relatively intact, and various technologies under development aim to restore vision by targeting the surviving cells.

This is a pivotal time for the industry, Fine said, with one company that has a device on the market and several others set to enter the market in the next five to 10 years.

Two of the most promising devices, she said, are electric prostheses, which enable vision by stimulating surviving cells with an array of electrodes placed on the retina, and optogenetics, which insert proteins into the surviving retinal cells to make them light-sensitive.

But the devices have a major shortcoming, co-author Geoffrey Boynton said, since stimulating the surviving cells in a retina is unlikely to produce vision that is close to normal.

"The retina contains a vast diversity of cells that carry distinct visual information and respond differently to visual input," said Boynton, a UW psychology professor.

"Electrically stimulating the retina excites all of these cells at the same time, which is very different from how these cells respond to real visual input."

There are similar issues with optogenetics, Boynton said. "The optogenetic proteins that are currently available produce sluggish responses over time, and they are limited in the number of different cell types that they can separately target," he said.

These limitations in both technologies mean that patients may see fuzzy, comet-like shapes or blurred outlines, or they may experience temporary visual disappearances if an object moves too fast.

Previous simulations of restored vision have used a "scoreboard model," a grid of dots similar to the scoreboard at a football game, in which each electrode produces a visible dot in space. Together, that collection of dots is intended to demonstrate what someone with restored vision will see.

Fine said the new simulations show that the scoreboard model, which is sometimes used to test devices, doesn't provide a good representation of the quality of vision sight restoration technologies are likely to produce.

More realistic models are needed, she said, to give patients, clinicians and researchers a better idea of how those technologies will work in the real world.

Fine said better simulations can provide valuable information about how implants need to be improved to produce more natural vision.

"As these devices start being implanted in people, we can compare different types of devices and the different perceptual outcomes of each," she said. "The path to fully restored eyesight is an elusive target. We need to start developing more sophisticated models of what people actually see.

"Until we do that, we're just shooting in the dark in trying to improve these implants."

More information: *Philosophical Transactions B*, Published 3 August 2015. DOI: 10.1098/rstb.2014.0208

Provided by University of Washington