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Team captures first-ever 'twitch' of the eye's night-vision cells as they detect light

by Nanyang Technological University

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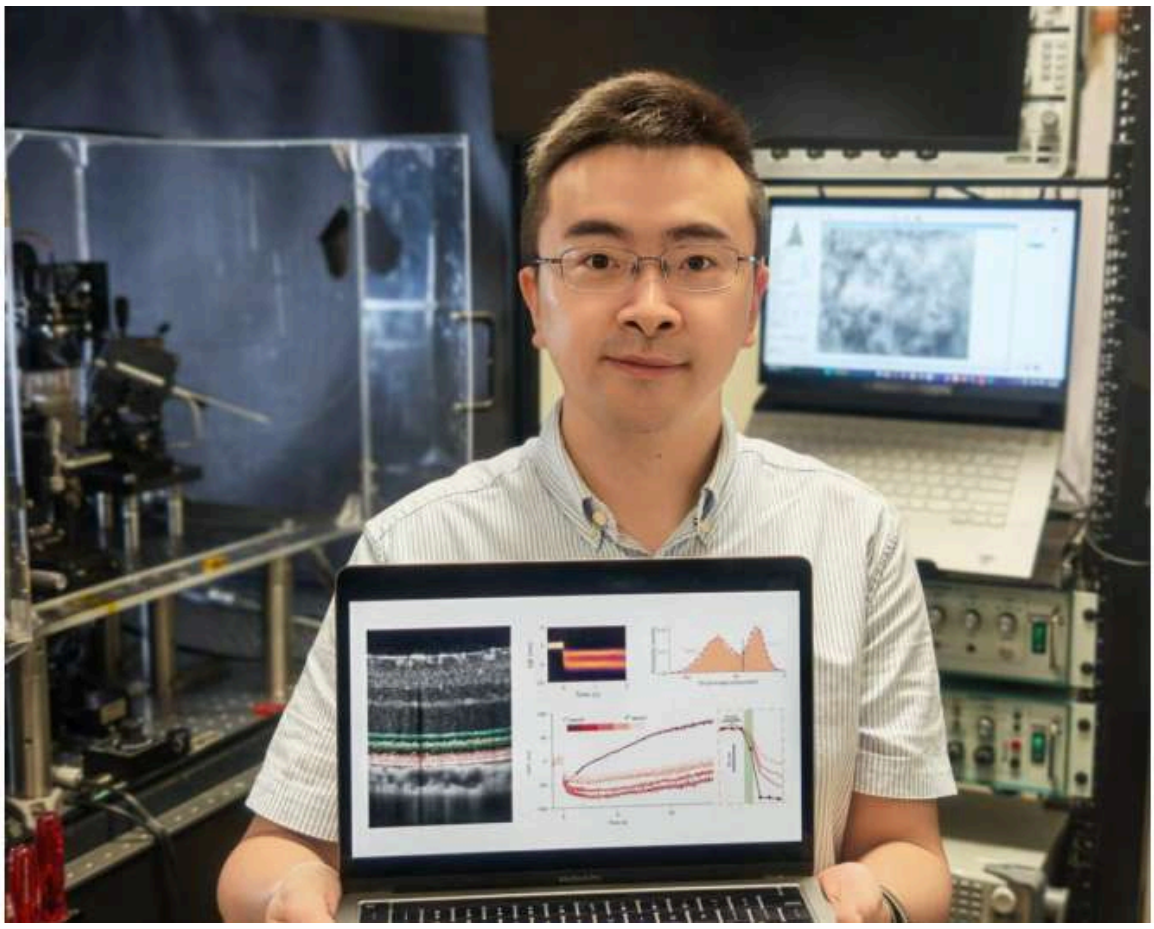


Nanyang Assistant Professor Tong Ling, NTU Singapore, whose advanced imaging method is pioneering new ways of assessing the loss of vision. He is holding a laptop with an image taken using optoretinography (ORG), which can detect incredibly small movements in eye cells. Credit: NTU Singapore

For the first time, an international research team led by Nanyang Technological University, Singapore (NTU Singapore) has recorded a tiny mechanical "twitch" in living human and rodent eyes at the exact moment a rod photoreceptor detects light.

The research breakthrough could provide a new, noninvasive way to assess retinal health and enable earlier diagnosis of blinding eye diseases, according to the research team, which involves

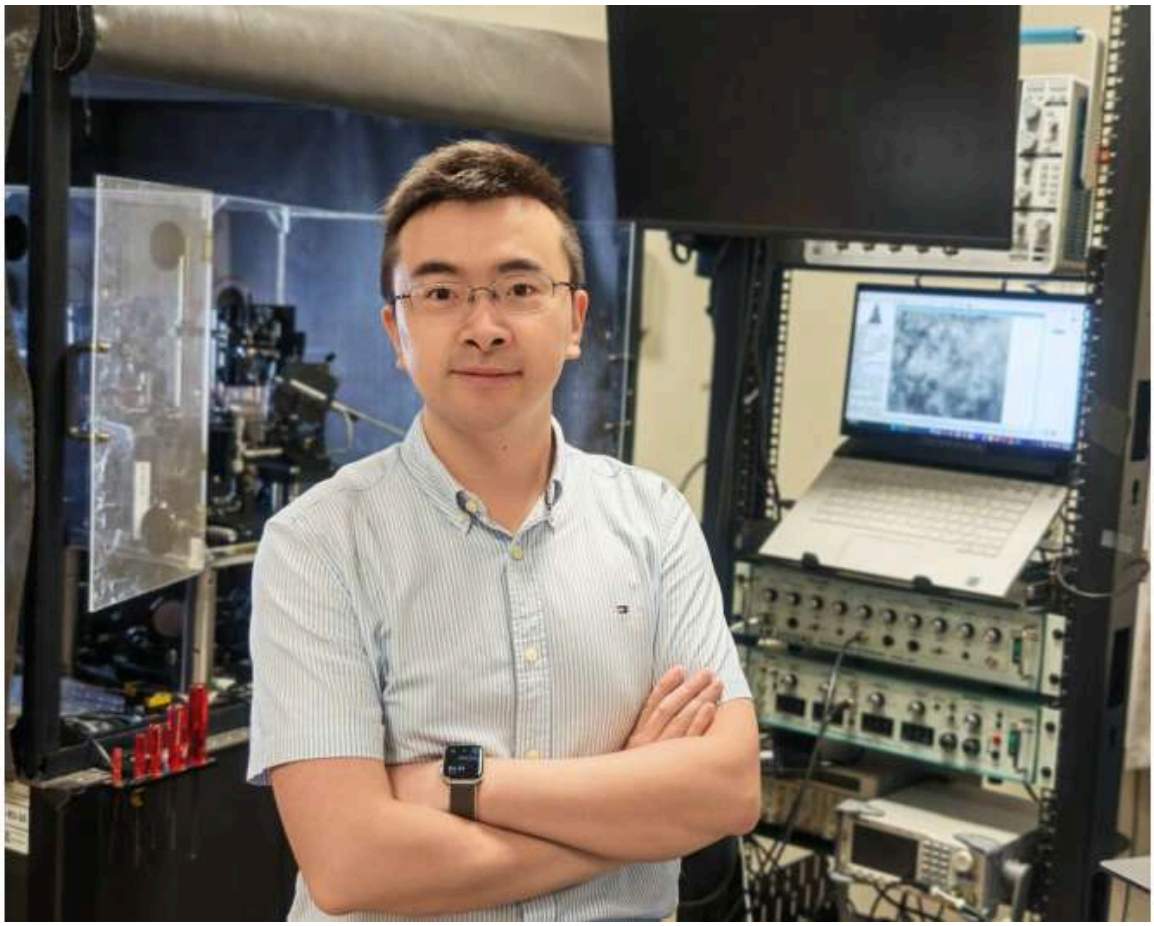
multiple institutions including the University of Washington (UW), Singapore Eye Research Institute (SERI), and Duke-NUS Medical School.

The findings were presented by Dr. Ling at the Association for Research in Vision and Ophthalmology 2024 Annual Meeting and published in the journal *Light: Science & Applications*.

Rod photoreceptors are the cells in the eye that enable us to see in low-light conditions. These "night-vision cells" are extremely sensitive and are often the first to deteriorate in eye conditions such as age-related macular degeneration. However, existing tools to study and measure rod photoreceptor function are limited in their sensitivity and can be uncomfortable for patients.

Lead investigator Dr. Tong Ling, Nanyang Assistant Professor at NTU's School of Chemistry, Chemical Engineering and Biotechnology, said, "The 'twitch' of the eye's night-vision cells is akin to the ignition spark of vision. We have long known that these cells produce electrical signals when they absorb light, but no one had, until now, ever reported the accompanying mechanical contraction of these cells inside the living eyes of humans or rodents."

"The findings reveal a fundamental step in the process by which rod photoreceptors detect light and send visual information to the brain. These cells make up about 95% of all photoreceptors in the human retina," Dr. Ling, who is also affiliated with NTU's School of Electrical & Electronic Engineering, added.



Nanyang Assistant Professor Tong Ling, NTU Singapore, whose advanced imaging method is pioneering new ways of assessing the loss of vision. Credit: NTU Singapore

Noninvasive eye imaging for the future

Using an advanced imaging method called optoretinography (ORG), which can detect incredibly small movements in eye cells without any dyes or labels, the research team discovered that rod photoreceptors undergo a rapid contraction of up to 200 nanometers within roughly 10 milliseconds of light reaching the retina—faster than a single flap of a hummingbird's wings.

By combining their measurements with biophysical modeling, they found that this tiny motion is caused when rhodopsin—the eye's light-sensitive molecule—is activated by light. This response is one of the earliest steps in converting light into electrical signals that the brain can interpret as vision.

Co-corresponding author, Professor Ramkumar Sabesan, a vision scientist at the University of Washington School of Medicine, said, "This is the first time we've been able to see this phenomenon in rod cells in a living eye. Rod dysfunction is one of the earliest signs of many retinal diseases, including AMD and retinitis pigmentosa. Being able to directly monitor the rods' response to light gives us a powerful tool for disease detection and tracking treatment responses earlier and with greater sensitivity than any conventional diagnostic instrument."

Why this matters for patients

Rod photoreceptors are often the first cells to deteriorate in diseases that cause blindness. Along with the technique developed by the same research group and published in *Nature Communications* in 2024—which measures the rod photoreceptors' relatively slow movements in response to dim visual stimuli—the new approach detailed by the research team provides a noncontact, noninvasive method for clinicians to detect and monitor rod function.

Giving an independent comment, Professor Jost Jonas, an ophthalmologist, clinical scientist and Chairman of the Department of Ophthalmology, Heidelberg University, Germany, said, "Optoretinography as a brand-new technique is clinically and scientifically very interesting and promising, since it allows for the first time the noninvasive visualization of movements of the cellular structures in a living person's eye at the nanoscale. This holds true for the rods as photoreceptors as well as for other cells in the retina."

"It may thus open new avenues to better understand retinal cells in their working and in their relationship with neighboring cells, as well as clinically allow a more detailed, and potentially earlier, diagnosis of retinal diseases, in particular of disorders primarily affecting the photoreceptors," added Professor Jonas.

The research brought together biomedical engineers, physicists, and clinical scientists from various institutions, including teams led by Professor Leopold Schmetterer, and Associate Professor Veluchamy Amutha Barathi at SERI and Duke-NUS, who provided key expertise in retinal imaging and rodent models for the study.

Publication details

Optoretinography reveals rapid rod photoreceptor movement upon rhodopsin activation, *Light: Science & Applications* (2025). DOI: 10.1038/s41377-025-02149-6