Study shines a light to understand the body's balance system

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The researchers for the study. Credit: The University of Queensland

Finding out what's happening in the brains of people with balance disorders, such as vertigo, might be one step closer following new research on the vestibular system, which controls balance and movement.

An interdisciplinary University of Queensland team of optical physicists and biologists has found a novel way, using optical tweezers, or focused beams of light, to understand the vestibular system while animals are still, not moving.

School of Biomedical Sciences' Associate Professor Ethan Scott said the vestibular system, which detects gravity and motion, was crucial to survival, but the nerve circuits processing vestibular information were not completely understood.

School of Mathematics and Physics' Professor Halina Rubinsztein-Dunlop said this new research was significant because it demonstrated that optical trapping was sufficiently powerful and precise to move large objects, it and set the stage for functional mapping of vestibular processing.

"It opens the door to using other techniques that can help us understand the neural circuits in the brain that mediate vestibular perception and may also ultimately benefit people with vestibular disorders such as dizziness, vertigo and imbalance", said Associate Professor Scott.

"The vestibular system, found in the inner ear in most mammals, had always been hard to study, because it was active in response to movement."

"Movement makes it difficult to record using neurons in the brain, and this has complicated past studies of the vestibular system," he said.

"We needed a way to activate the vestibular system without the animal moving."

The solution came in the form of optical physics and a technique called optical trapping, or using highly focused laser beams to physically hold and move microscopic objects, similar to tweezers.

"By focusing a laser at the edge of an object, we can apply physical forces to it," said Professor Halina Rubinsztein-Dunlop of the School of Mathematics and Physics at UQ.

Dr Itia Favre-Bulle, a postgraduate at the time of the study and now a postdoc on the continuation of the project, working with the Scott and Rubinsztein-Dunlop teams, brought this theory to practice using zebrafish as a model.

Dr Favre-Bulle targeted an infrared laser toward the otoliths, or ear stones, of larval zebrafish, thus placing forces on them similar to the forces that would result from actual movement.

This resulted in behavioural responses like those that zebrafish larvae display when undergoing real-world vestibular stimuli, like acceleration or rolling, even though the animals were still.

"From a technical standpoint, this is exciting because these are the largest and most optically complex objects that have been manipulated with optical trapping, and the technique was effective even though the targets were deep within a living animal," Dr Favre-Bulle said.

More information: Itia A. Favre-Bulle et al, Optical trapping of otoliths drives vestibular behaviours in larval zebrafish, *Nature Communications* (2017). DOI: 10.1038/s41467-017-00713-2

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