Novel population of neurons identified that control binocular eye movements in 3-D space

November 12 2020, by Jeff Hansen

Credit: Pixabay/CC0 Public Domain

University of Alabama at Birmingham researchers have discovered a previously undescribed population of neurons that help control our eyes as they view in three-dimensional space.

During normal viewing, we direct our eyes between objects in the three-dimensional space many times a minute. With each change, the left and right eyes will rotate, generally in the same direction, but mostly by different degrees of rotation. These unequal movements are known as disjunctive saccades.

Disjunctive saccades differ from two other eye movements: one, called conjugate saccades, where the eyes rotate in unison, and one called symmetrical vergence eye movements, where the eyes rotate in equal but opposite directions. The underlying mechanism for disjunctive saccades is not known.

Several models of eye movement predicted the existence of a population of neurons called saccade-vergence burst neurons, or SVBNs, that would produce a burst of activity solely during disjunctive saccades, while not firing during the other two types of eye movements.

The UAB researchers, led by Julie Quinet, Ph.D., hunted for these putative neurons in a region of the midbrain located near to the oculomotor nucleus called the central mesencephalic reticular formation, or cMRF. Recent anatomical studies had suggested that the cMRF might contain premotor neurons involved in the neural control of disjunctive saccades.

Using brain recordings from trained rhesus monkeys, Quinet and colleagues found and recorded 18 SVBNs in the cMRF. "To our knowledge," said Quinet, a researcher V in the UAB Department of Ophthalmology and Visual Sciences, "no such class of cells has been reported in prior recording studies."

This novel population of SVBNs displayed three unique characteristics that were predicted by models: 1) The neurons discharged when animals performed a disjunctive saccade; 2) The neurons remained silent during the unison eye movement called conjugate saccades and also during the eye movement when the eyes rotate in equal but opposite directions, called symmetric vergence eye movement, and; 3) The neurons burst without regard to the direction—rightward or leftward—of the disjunctive saccade. Furthermore, the bursts of spikes during disjunctive saccades were highly correlated with vergence velocity—the speed at which the eyes move toward or away from each other.

Intriguingly, half of the recorded cells increased their firing rate for convergence disjunctive saccades, while half increased their firing rate for divergence disjunctive saccades.

Quinet and colleagues say that further studies of disjunctive saccades in brain areas that may supply input to SVBNs can help explain and advance solutions to treat strabismus, a condition in which eyes do not properly align with each other while looking at an object.

The results of this study and previous studies elsewhere and at UAB, Quinet says, suggest that SVBNs could play a role in all the components of the near triad responses—lens accommodation, pupillary constriction and vergence.

Co-authors with Quinet in the study, "Neural control of rapid binocular eye movements: Saccade-vergence burst neurons," published in the *Proceedings of the National Academy of Sciences*, are Kevin Schultz and Paul D. Gamlin, UAB Department of Ophthalmology and Visual Sciences; and Paul J. May, Department of Neurobiology and Anatomical Sciences, University of Mississippi Medical Center, Jackson, Mississippi.

More information: Julie Quinet et al, Neural control of rapid binocular eye movements: Saccade-vergence burst neurons, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.2015318117

Provided by University of Alabama at Birmingham