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Wednesday, September 1st • 11:00 • FNO–01 / 117

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Role of monkey superior colliculus in head-unrestrained gaze shifts

We recently proposed a quantitative neural population model to explain how cells in the midbrain superior colliculus contribute to the trajectory and kinematics of saccadic eye movements *(Goossens and Van Opstal: J Neurophysiol 2006; Van Opstal and Goossens: Biol Cybernet 2008)*. Briefly, the model holds that each spike from each recruited cell contributes a tiny, but fixed contribution to the saccade ("spike vector") that only depends on its location within the collicular motor map. The saccade then results from dynamic linear summation of all spike vectors. This extremely simple model predicts a linear relation between a cell's cumulative number of spikes, CS(t), and the straight imaginary trajectory of the eye, S(t-tau), between initial and final positions (tau is lead time, 20 ms). We tested this simple model for >20000 head-fixed saccades to visual targets across the oculomotor range. The mean correlation between CS(t) and S(t-tau) was >0.8 for all 150 cells. Interestingly, when using actually measured spike trains to simulate saccades, the model produced straight eye-movement trajectories with the correct velocity profiles and nonlinear main-sequence properties, although horizontal and vertical brainstem burst generators were kept linear and independent.
However, the superior colliculus is involved in gaze shifts (displacement of the eye in space), rather than in saccadic eye-in-head movements. Here we test a strong prediction of the model: the linear relation between dynamic spike counts and instantaneous gaze-displacement should also hold for head-free gaze shifts, in which kinematics and relative eye and head contributions to the gaze trajectory vary substantially from trial to trial. We recorded from 40 single units in two monkeys trained to make large head-unrestrained gaze shifts (up to 85 deg amplitude) to flashed targets in the frontal hemifield. Gaze shifts were elicited throughout a cell's movement field. Our data support the simple linear spike-count model.

Host:

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Guests are welcome !