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A MODEL OF ADAPTATION IN THE CEREBELLUM FOR LEARNING THE MODULATION OF THE VESTIBULO-OCULAR REFLEX (VOR).

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The gain of the VOR in monkeys is modulated by many inputs including eye position, vergence angle and otolith signals. These inputs insure stabilization of retinal images during head movements regardless of gaze direction, head rotation axis and translation. We have shown that a dynamical model which combines these inputs can match the VOR dynamics observed in monkeys (Coenen & Sejnowski, NIPS 8, MIT Press). Based on a cerebellar theory that we have developed, we have extended this dynamical model to explain anticipatory gain changes of the VOR with vergence movements (Snyder & King; Vision Res. 32:3,1992). In the model, the cerebellum predicts the sensory feedback which is used to improve performance. Adaptation in the cerebellum and the cerebellar nuclei is mediated by the inferior olive. We demonstrate the importance of synchronous firing of climbing fibers for appropriate adaptation when the synergy of multiple Purkinje cells is necessary for good performance.

The modulation of the VOR with eye position, vergence and otolith inputs is a highly nonlinear function which can be learned with our model. Computer simulations of the model indicate how the cerebellum may selectively combine input signals to adaptively reduce VOR retinal slip. This is accomplished by constructing predictive representations of neural signals which can modulate the gain of the VOR in anticipation of new behavioral conditions.

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