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Neural control of 3-D gaze shifts in the primate.

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Abstract

The neural mechanisms that specify target locations for gaze shifts and then convert these into desired patterns of coordinated eye and head movements are complex. Much of this complexity is only revealed when one takes a realistic three-dimensional (3-D) view of these processes, where fundamental computational problems such as kinematic redundancy, reference-frame transformations, and non-commutativity emerge. Here we review the underlying mechanisms and solutions for these problems, starting with a consideration of the kinematics of 3-D gaze shifts in human and non-human primates. We then consider the neural mechanisms, including cortical representation of gaze targets, the nature of the gaze motor command used by the superior colliculus, and how these gaze commands are decomposed into brainstem motor commands for the eyes and head. A general conclusion is that fairly simple coding mechanisms may be used to represent gaze at the cortical and collicular level, but this then necessitates complexity for the spatial updating of these representations and in the brainstem sensorimotor transformations that convert these signals into eye and head movements.

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