Model: The superior colliculus and microsaccade generation

Authors		
First name	**Middle name**	**Last name**
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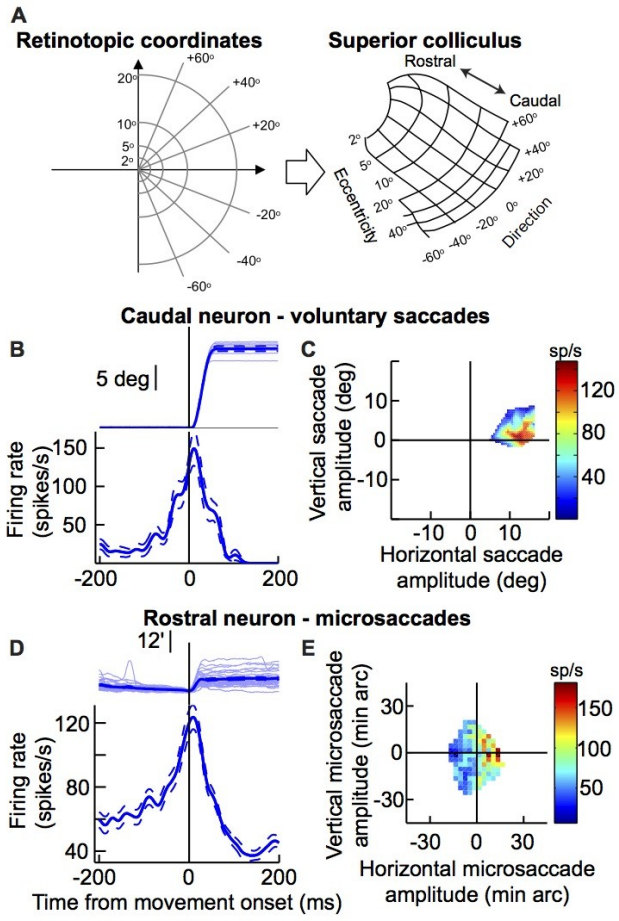
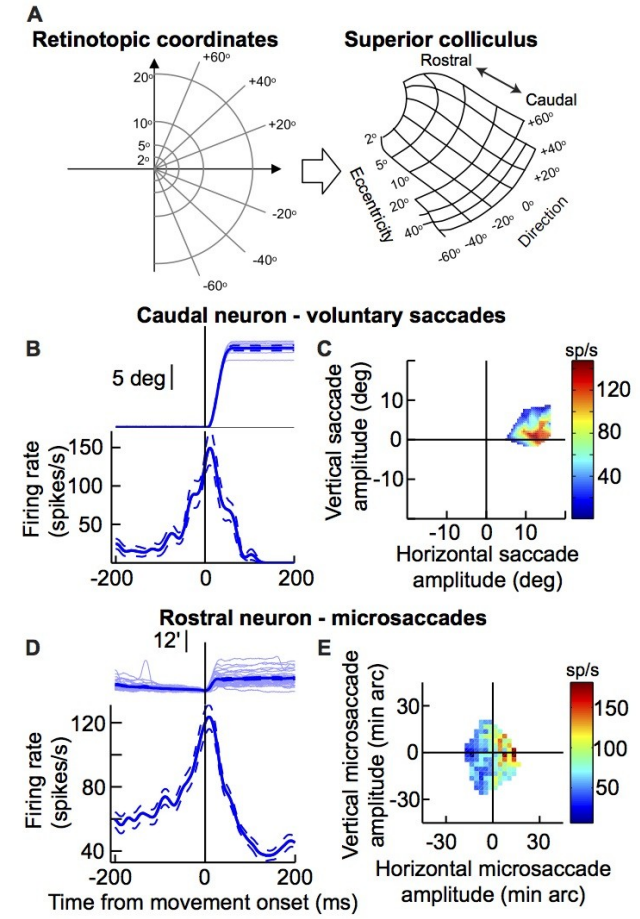
Brief Description *	The superior colliculus (SC) is thought to provide a spatial population coding of selected target locations for saccadic eye movements. Read-out of the population activity in the SC by downstream brainstem pre-motor neurons allows these latter neurons to generate appropriate velocity and position commands for the eye muscles to execute the desired eye movement specified by the SC population code. For the case of	
Narrative *		
Tags	fixation, microsaccade, saccade, Superior colliculus	

Architecture

Diagrams



This figure shows a summary of experimental findings motivating the model. The top panel shows the retinotopic mapping of SC space (e.g. Ottes et al., 1986). The middle panel shows saccade-related activity in the SC portion concerned with peripheral eccentricities. The bottom panel shows microsaccade-related activity in the SC portion representing small eccentricities. The similarity seen between the two portions motivates the concept of the model in which the rostral portion is governed by population coding and is not functionally distinct from the caudal portion.



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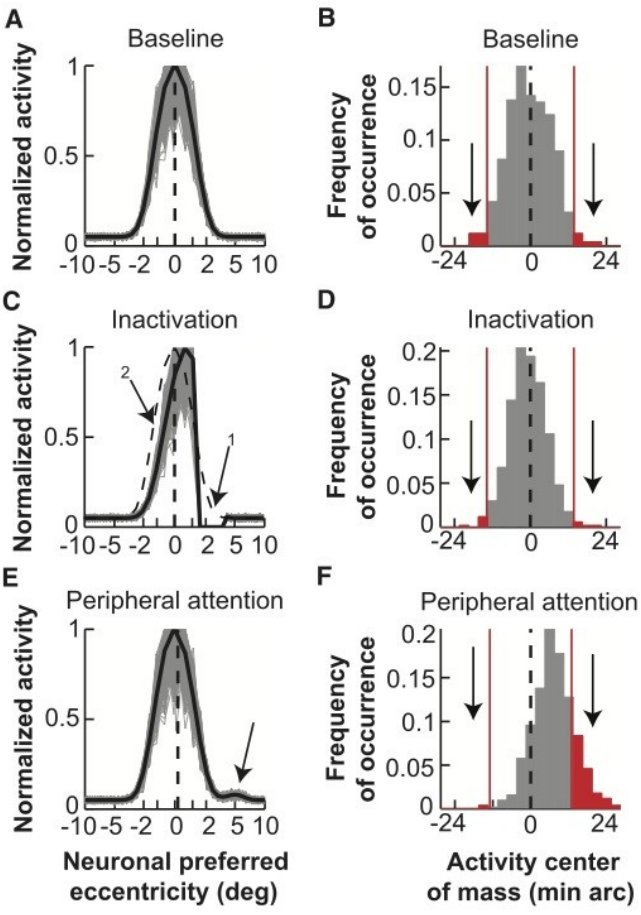
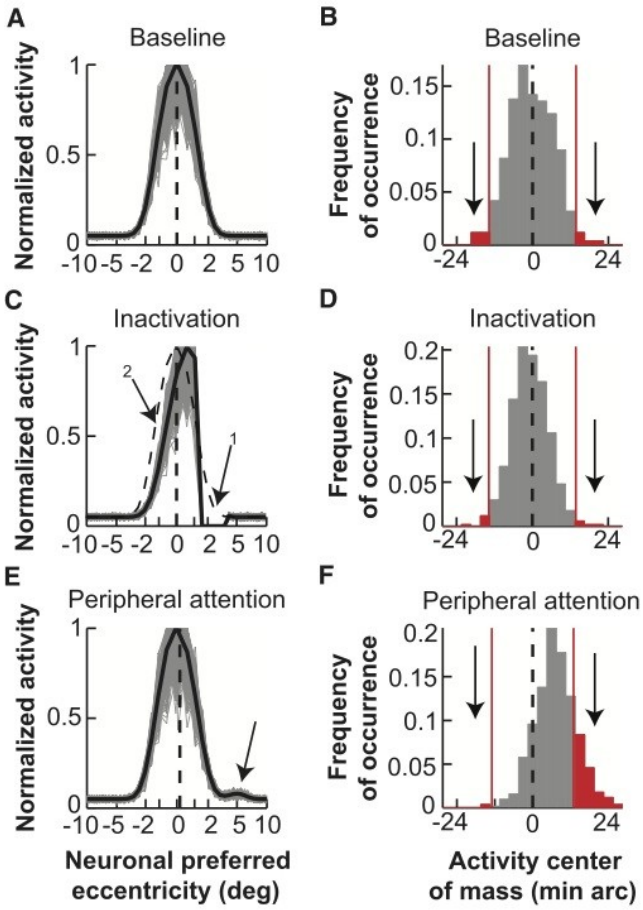


The model makes specific predictions about changes in microsaccades and eye position as a result of modulations in SC activity (see SED and SSR).



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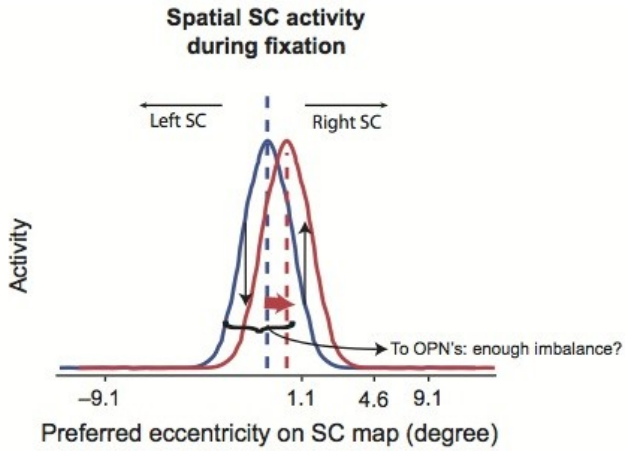
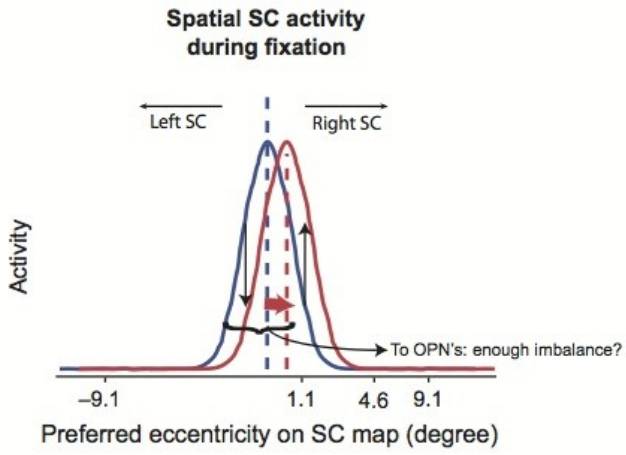


Model explaining how the rostral (or foveal) SC can contribute to microsaccade generation. The figure shows a one-dimensional representation of the SC map. During fixation, activity is centered bilaterally on the rostral SC representing foveal and parafoveal regions. Due to the spatial specificity of individual rostral SC neurons for individual microsaccades (Hafed et al., Science, 2009), prior to a given movement, a set of neurons coding the movementâ€™s endpoint will increase their activity whereas others preferring other spatial locations will decrease (vertical black arrows). This results in an effective spatial shift in the locus of the entire population of activity during fixation (red population profile with horizontal red arrow). If a microsaccade were to occur as a result of this shift, omnipause neurons in the brainstem would pause, but clearly the rostral SC would not be entirely inhibited. Thus, the anatomically-known excitatory projections from the SC to OPNs (black curved arrow) do not necessarily gate the onset and offset of OPN activity (i.e. issue a FIXATE or SACCADE command). Instead, they may allow OPNs to apply a threshold on whether sufficient biases in SC activity exist to justify



triggering a movement.
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Inputs		
Name	**Data Type**	**Description**
Foveal target position	real	The foveal target location is specified as a distributed representation in SC coordinates according to the visuomotor mapping of space into anatomical coordinates (e.g. Ottes et al., Vision Res., 1986).
Outputs		
Name	**Data Type**	**Description**
Instantaneous center of mass of SC population	real	The read-out of the SC activity
States		
Name	**Data Type**	**Description**
Variability	real	To model changes in neural activity, it is assumed that there is intrinsic variability in SC neurons. This causes shifts in the SC population profile. Once a shift is large enough to exceed some threshold, a microsaccade may be triggered.