Modelling response properties across the orientation map in visual cortex

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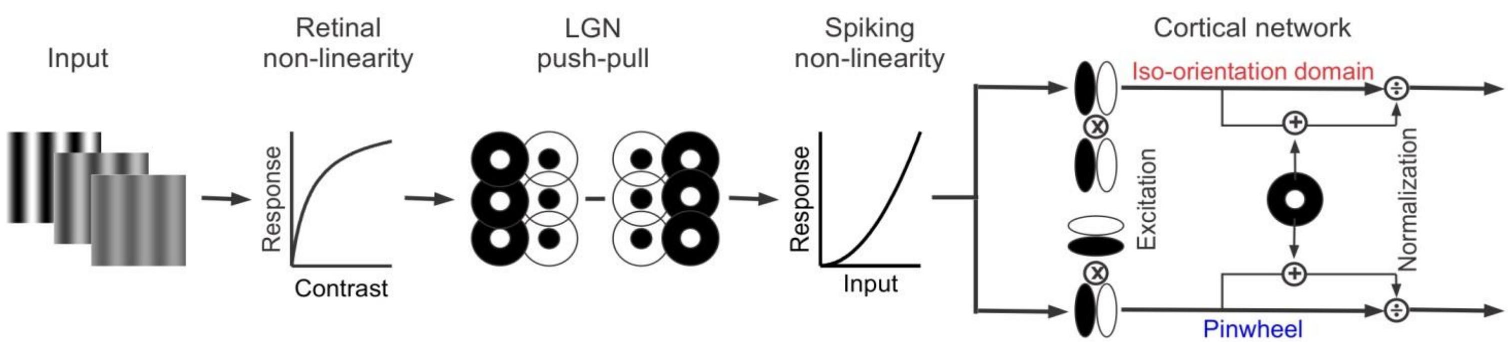
Stimulus orientation in the primary visual cortex of primates and carnivores is mapped as iso-orientation domains radiating from pinwheel centers, where orientation preferences of neighboring cells change circularly. Whether this orientation map has a function is debated, because many mammals, such as rodents, do not have such maps. Here we model our physiological results that two fundamental properties of visual cortical responses, contrast saturation and cross-orientation suppression, are stronger within iso-orientation domains than at pinwheel centers. Our model expands on a standard thalamic model of cross orientation suppression, and explains differences between orientation domains by intra-cortical excitation (not normalization) from neighboring oriented neurons, balanced by inhibition from un-oriented neurons. The functions of the pinwheel mosaic can be inferred from the model's outputs: Narrower tuning, greater cross-orientation suppression and higher contrast gain of iso-orientation cells, lead to extraction of extended object contours from images. In contrast, broader tuning, greater linearity and less suppression of pinwheel cells generate selectivity for surface patterns and textures.



MODEL OUTPUT

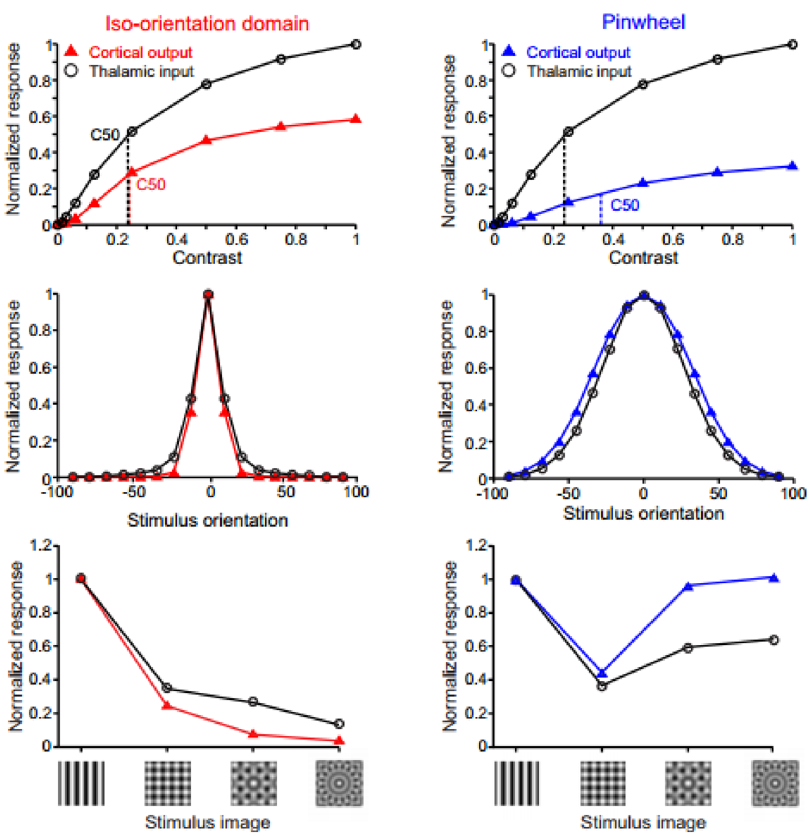
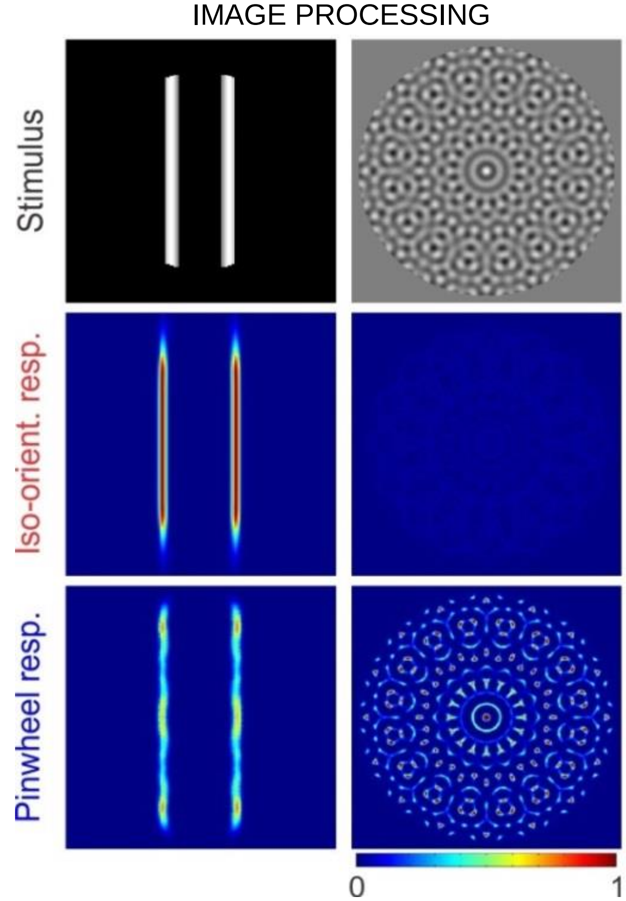


IMAGE PROCESSING



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