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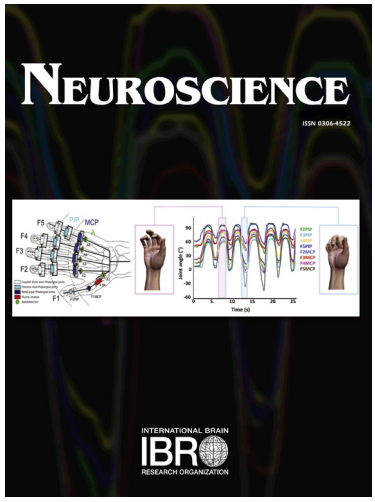

Comparison of mechanisms for contrast-invariance of orientation selectivity in simple cells

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Comparison of mechanisms for contrast-invariance of orientation selectivity in simple cells

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Highlights:

1. A single mechanistic model was used to compare feedforward mechanisms of contrast-invariance.
2. Thalamocortical (TC) synaptic noise was sufficient to widen tuning for low contrasts to that for high contrasts.
3. Weak TC synaptic depression removes some offset but strong depression disrupts the stimulus/response relationship.
4. Only broadly tuned inhibition could completely counteract the remaining offset at all contrast levels.
5. Broadly-tuned inhibition from simple cells maintain response gain but complex cells reduce this gain.

Running Head: Contrast-invariance mechanisms

Keywords: contrast-invariance, orientation selectivity, simple cells, mechanistic modeling

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Abstract

The simple cells of the visual cortex respond over a narrow range of stimulus orientations, and this tuning is invariant to the contrast at which the stimulus is presented. The inputs to a single cell derive from a population of thalamic cells that provide a bell-shaped tuning width and offset that increases with stimulus contrast. Synaptic depression, noise and inhibition have been proposed as feedforward mechanisms to explain why these features do not appear in simple cells. The extent to which these three mechanisms contribute to contrast-invariant orientation tuning is unknown. Consequently, the aim was to test the hypothesis that these mechanisms do not contribute equally. Unlike previous studies, all mechanisms were examined using the same network model based on Banitt et al. (2007). The results showed that thalamocortical synaptic noise was essential and sufficient to widen tuning widths at low contrasts to that of higher contrasts but could not counteract the offset at higher contrasts.