Articles
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Nonlinear Effects of Intrinsic Dynamics on Temporal Encoding in a Model of Avian Auditory Cortex

Neurons exhibit diverse intrinsic dynamics, which govern how they integrate synaptic inputs to produce spikes. Intrinsic dynamics are often plastic during development and learning, but the effects of these changes on stimulus encoding properties are not well known. To examine this relationship, we simulated auditory responses to zebra finch song using a linear-dynamical cascade model, which combines a linear spectrotemporal receptive field with a dynamical, conductance-based neuron model, then used generalized linear models to estimate encoding properties from the resulting spike trains. We focused on the effects of a low-threshold potassium current (KLT) that is present in a subset of cells in the zebra finch caudal mesopallium and is affected by early auditory experience. We found that KLT affects both spike adaptation and the temporal filtering properties of the receptive field. The direction of the effects depended on the temporal modulation tuning of the linear (input) stage of the cascade model, indicating a strongly nonlinear relationship. These results suggest that small changes in intrinsic dynamics in tandem with differences in synaptic connectivity can have dramatic effects on the tuning of auditory neurons.

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