

Sensitivity and invariance to natural stimulus variations in the neural discrimination of songs in field L of the songbird

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To correctly recognize and discriminate between natural stimuli, a sensory system must be able to deal with the natural variations in the stimuli. However, relatively little is known about the sensitivity or invariance of neural representations to such perturbations in the auditory system. Songbirds can discriminate between and recognize individuals despite natural variations in their songs. Motivated by this behavioral observation, we investigated the invariance in neural discrimination of songs in field L (the analogue of primary auditory cortex) in the zebra finch.

We examined invariance to two types of stimulus perturbations that occur naturally: 1) variations in intensity, which could be caused by a change in the distance to the source and 2) multiple renditions of the same bird's song which contain timing differences. Previously, we have quantified the accuracy of neural discrimination using a classification of neural spike trains based on the spike distance metric. Here, we investigated whether neural spike trains could be correctly classified, despite the variations in intensity and in renditions.

We found some cells that are highly sensitive to intensity and others that are intensity invariant over a broad range of stimulus amplitude. A varying amount of invariance was also observed in different field L neurons to different renditions of individual songs. Our results indicate that although some neurons in field L are sensitive to variations in intensity ($n = 20$) and renditions ($n = 21$), a subset of neurons are relatively invariant to such perturbations ($n = 5$, 4 for intensity and renditions, respectively). These invariant cells may contribute to the ability of songbirds to discriminate between and recognize conspecific individuals in the face of natural stimulus variations.

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