# Natural correlations improve spectrogram reconstruction from songbird auditory midbrain responses.

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Zebra finch songs contain structured spectrotemporal correlations which the nervous system might might exploit perceptually [1]. To quantify how this structure could be used we have reconstructed birdsong spectrograms by combining the spike trains of neurons from the zebra finch auditory midbrain, the mesencephalicus lateralis dorsalis (MLd), with information about the correlations present in song.

Previous work has successfully modeled MLd neuronal responses using spectrotemporal receptive fields (STRFs) which filter selective features of the song spectrogram [2,3]. Building on this work, we model the distribution of spike responses given stimuli with a generalized linear model (GLM). We decode song spectrograms from neural responses by calculating the maximum a posteriori (MAP) estimate of song spectrograms. This optimal Bayesian decoder has recently been explored in simulations [4], but has not previously been applied to auditory data. To quantify the dependency of reconstructions on spectrogram statistics, we combine the GLM likelihood with a series of prior distributions, incorporating an increasing degree of statistical information about zebra finch song.

We found that a population of MLd spike trains combined with an uncorrelated Gaussian prior can estimate the amplitude envelope of song spectrograms. We combined the same responses with Gaussian priors that have spectral or temporal correlations matched to those of zebra finch songs. We found that using priors which incorporate spectral correlations yielded better reconstructions than priors with strictly temporal correlations. However, as expected, the best reconstructions combine MLd responses with both spectral and temporal correlations matched to song. Also, spectral blurring induced by the STRFs turns out to have a limited impact on reconstruction accuracy. These results suggest that there is a significantly enhanced benefit to the bird if MLd responses are processed by neuronal circuits with access to the prior spectral information about song, rather than just temporal correlations.

References

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