Simultaneous multi-neuronal recording from anesthetized Bengalese finch HVC with high-density silicon electrodes

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Birdsong is a complex vocalization composed of various song elements organized according to sequential rules. Songbirds have a specialized set of discrete brain nuclei for song production and learning. Past electrophysiological studies revealed the inter-nuclei interaction and their hierarchical organization for song production. Although the multi-neuronal interactions within the single nucleus are important to decipher the information coding of the song, simultaneous recording from a local circuit has not been reported. It has been difficult to record multi-neuronal activities from a tiny brain area of about several hundreds of microns.

In this study, we tried to record the multi-neuronal activities of anesthetized Bengalese finch HVC with 16-channel high-density silicon electrodes. We simultaneously recorded up to 26 well-isolated single units from a tiny brain area HVC of the same individual. HVC contains at least three classes of neurons: neurons that project to the RA, neurons that project to area X, and interneurons. We identified some of the recorded neurons into each class by antidromic activation from RA and from area X. Neural responses to bird’s own song and their correlated dynamics between neuronal ensembles were analyzed. Functional connectivity within HVC was extracted as a mono-synaptic interaction or a weak interaction based on their crosscorrelograms. As a result, we obtained a functional network induced by the song stimulation. Ongoing studies try to analyze the context dependent changes of the functional network.

These techniques will give us excellent tools to understand local circuit mechanism to recognize sequential sensory stimuli and also to generate complex motor sequences.