Neural ensemble dynamics during vocal learning

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Abstract

Children acquire language through listening and imitating vocal sounds from parents or other adult members. Likewise, songbirds acquire birdsongs through listening and imitating vocal sounds from tutors. To acquire complex vocalization skills such as speech in humans and songs in songbirds, coordinated activity of neuronal populations in motor cortical areas is required [1-3].

Songbird is the ideal model to study how this coordinated activity develops through learning. In particular, the premotor area HVC plays an important role in song production and perception [4, 5], and it is functionally equivalent to Broca's area in humans [6, 7]. Zebra finch goes through two overlapping periods of song learning: a sensory (15 to 60 dph, days-post hatch) and a sensorimotor period (25 to 90 dph). During the sensory period the bird memorizes the tutor song, while during the sensorimotor period, the bird starts singing until its vocalization gradually matches the memorized song [8]. At around 90 dph, the song crystallizes, remaining mostly unchanged during adulthood. Recent studies during vocal learning [1, 9] indicate that HVC's neuronal dynamics is modulated by the tutor song. Unfortunately, so far, neural activity in HVC has been characterized over short time spans, from a few minutes to a few days, in different animals at different stages during development. Since song learning takes at least 60 days, the previous studies lack the time span required to understand the whole process.

Here we aim to determine how the activity of different neuronal subpopulations in HVC (e.g. HVC-projecting neurons to other nuclei (HVC_RA : projecting from HVC to RA, HVC_X : projecting from HVC to Area X) and inhibitory neurons (Interneurons in HVC)) is modulated by auditory inputs while the bird is learning its song during vocal learning period. To do so, we combine the expression of genetically encoded activity indicators, and miniscope (single photon microscopy) in freely moving birds or two- photon microscopy in head-fixed birds to perform longitudinal recording of neuronal activity in HVC. In this way, we can characterize the entirety of the song learning process at the population level with single-cell resolution.

Keywords: *vocal learning, premotor neurons, neural network, brain imaging*

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Biography

I am a PhD candidate in physics, foreseeing graduation on Aug. 2019, and working with Prof. Dr. Richard Hahnloser at ETH Zurich. During my bachelor at POSTECH, I double majored in physics and life science to establish a general background in biophysics. To study the brain more specifically, I specialized in neuroscience at EPF Lausanne, Switzerland. t ETH Zurich, I study songbirds to understand how complex motor behaviors, such as vocal learning and production, are represented in the brain.