

Seminar Series | Biological Sciences

Date & Time July 4, 2023, 17:00 pm

Venue Seminar Room 103,

Science Frontier Laboratory —先端科学研究棟—

Vocal motor control in canary song



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The canary songbird was instrumental in establishing the contemporary neuroscience study of avian vocal learning. Pioneering work by Nottebohm and colleagues mapped the central neural pathways controlling bird songs in canaries, highlighting the crucial role of nucleus HVC in song regulation. This research laid the groundwork for understanding the neural basis of sensory-motor learning in canaries and other songbirds.

Later studies revealed that canary songs exhibit a hierarchical structure with innate rules guiding song development. Intriguingly, young canaries were found to accurately mimic abnormal synthetic songs, which later evolved to display the signature canary phrasing as the birds matured. This demonstrated the separation of imitation and innate song constraints as distinct, temporally-segregated processes – unrestricted imitation during youth followed by adherence to adult rules.

The neuronal mechanisms of canary song syntax can be studied using head-mounted microscopes and multi-electrode arrays adapted for songbirds. Recent studies have identified neurons in the premotor nucleus HVC that encode past transitions across multiple phrases. For some neurons, HVC activity reflects the previous behavioral context, and this working memory may provide the information needed to generate long-range correlations in transition statistics.

Canary syllables can be replicated through simple biophysical models involving smooth oscillations in air pressure and syrinx muscular tension. However, the intricacy of song syntax presents considerable challenges in song quantification, which can be addressed using various machine-learning approaches for sequence analysis. The combination of simple canary syllables and complex syntax provides an outstanding opportunity to examine higher-order aspects of song control that remain elusive. We propose that canaries serve as a valuable model to study circuit mechanisms of behavior chunking (syllables) and hierarchical motor control (phrases, phrase transitions, and long-range syntax), briefly discuss new technologies and behavioral analysis tools for the study of birdsong neuroscience.



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