【Grant-in-Aid for Scientific Research(S)】

Integrated Science and Innovative Science (Comprehensive fields)

Title of Project： Neural basis of syntactic information processing

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Research Area：Neuroscience
Keyword：neural circuit, vocal communication

【Purpose and Background of the Research】

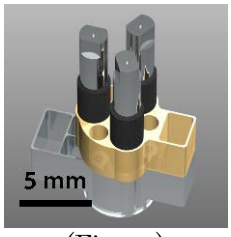
While vocal signals, including human languages, are composed of a finite set of acoustic elements, syntactic rules expand the diversity of vocal signals. To enable such syntactic vocal communication, brain must learn syntactic rules under the guidance of auditory information and generate motor commands for vocal signals according to the learned syntactic rules. However, the neural basis of syntactic processing remains largely unknown.

Songbirds, like humans, learn and maintain complex vocal signals composed of a finite number of acoustic elements called syllables. We showed that these avian species possess a computational ability to discriminate syntactic rules in vocal signals, and furthermore, we showed that they can acquire artificial syntactic rules from synthesized syllable strings and discriminate novel syllable strings according to the rules. To explore the neural representation of syntax for generating variable vocal signals, we studied neuronal activity in the vocal control system during singing. We found that basal ganglia-projecting neurons in the premotor area HVC transmit syntactic information.

Based upon these findings, we will further study how the songbird's brain extracts syntactic information from auditory signals and generates vocal commands precisely in accordance with the syntactic rules. In addition, we will also study sensorimotor integration of vocal signals in mammalian model animals.

【Research Methods】

To properly evaluate syntactic processing associated with vocal communication, we use an ultralight weighed motorized recording system (Figure) that enable recording of single-neuronal activity in freely behaving animals. We will investigate neuronal representation of syntax in upstream and downstream of the HVC in songbirds, and map the vocal-related cortical areas and study neuronal activity during the vocal communication in mammalian model animals. To study neuronal plasticity involved in the learning of syntactic vocal communication, we will apply advanced technologies such as genetically encoded tools for visualizing and manipulating neuronal activity.



(Figure)

【Expected Research Achievements and Scientific Significance】

One of the unique features of human language communication is assumed to be the processing of syntax, the hierarchical rules for the ordering of vocal elements. We will elucidate neural basis of perception, expression, and development of syntactic processing. The outcome of this project will, therefore, help our understanding of brain function underlying vocal communication, including human languages.

【Publications Relevant to the Project】

・Abe, K., and Watanabe, D. (2011). Songbirds possess the spontaneous ability to discriminate syntactic rules. Nat Neurosci 14, 1067–1074.

・Fujimoto, H., Hasegawa, T., and Watanabe, D. (2011). Neural coding of syntactic structure in learned vocalizations in the songbird. J Neurosci 31, 10023–10033.

【Term of Project】 FY2012-2016

【Budget Allocation】 167,800 Thousand Yen

【Homepage Address and Other Contact Information】

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