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Start/stop signals emerge in nigrostriatal circuits during sequence learning.

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About the work

Organism behavior can be organized as sequences of particular actions or movements. The organization of behavior as sequences of actions is complex and requires the proper initiation and termination of the sequence, i.e. identifying the first and the last elements within the behavioral sequence. Although the study of innate behavioral sequences and fixed action patterns controlled by central pattern generators has received substantial attention, the neural mechanisms underlying the learning and execution of acquired behavioral sequences remain largely unknown. The basal ganglia circuits, particularly the dorsal striatum and its dopaminergic afferents have been implicated in skill learning and the "chunking" of actions. Importantly, the initiation and termination of sequences of voluntary movements is severely impaired in disorders affecting the striatum and its dopaminergic inputs, like Parkinson's and Huntington's diseases.
Consistently, the learning of novel sequences is also compromised in disorders affecting these circuits. However, the exact role of the striatum and nigrostriatal dopamine in the initiation and termination of newly acquired, self-generated action sequences has not been explored. In present study, we developed

a self-paced operant task in mice, taking advantage of the combined power of precise behavioral analysis, genetic manipulation and in vivo physiological recording. By investigating the behavioral microstructure and correlated neural activity in this task, we found that neurons in nigrostriatal circuits can signal the initiation and termination of self-paced action sequences, i.e. neurons in the dorsal striatum and substantial nigral selectively fire in the start or the stop of a series of sequential actions.

About the author

Xin Jin obtained his B.A. degree in physics in 2002 and finished his Ph.D. training in neuroscience with Dr. Peiji Liang at Shanghai Jiao Tong University in 2007. His Ph.D. work was focused on visual information processing in the retinal circuits, combining theoretical and empirical approaches and published the work as three papers on Biological Cybernetics etc. major computational neuroscience journals. After graduation, he joined Dr. Rui Costa's lab at the National Institutes of Health in 2007 for postdoctoral training to investigate the neural mechanism of action learning and underlying information processing in the basal ganglia circuits.

He was a visiting postdoctoral fellow of Champalimaud Neuroscience Program at Instituto Gulbenkian de Ciencia from September to November in 2010. Together with Dr. Rui Costa, he has developed a series of new operant behavior tasks in mice to study how the brain, particularly the basal ganglia circuits, learn and execute action sequences, and elucidated some very important molecular and circuits mechanisms underlying sequence learning. These findings may have significant implications in both health and diseases. Part of his postdoctoral work was already published as three papers on Nature, Journal of Neurophysiology etc. and the rest are under submission. Besides employing a wide range of cutting-edge experimental techniques from mice genetics to in vivo electrophysiology, his research emphasizes on quantitative and computational analysis of the neural activity and learning, and aims ultimately to understand the general principles governing the neural circuit computation and behavior.