

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

Humanities and Social Sciences (Social sciences)



**Title of Project : Brain mechanisms behind executive function:
Uncovering operating principles of the mind by
applying innovative techniques to the structural
and functional organizations of neural circuits.**

Kenichiro Tsutsui
(Tohoku University, Graduate School of Life Sciences, Associate
Professor)

Research Area : Experimental Psychology

Keyword : Physiology

【Purpose and Background of the Research】

“Executive function” is a higher cognitive process that is necessary for achieving goal-directed behavior, including the inhibitory control of instinctive desires and the planning and execution of actions on the basis of inferred outcomes of possible actions. Cases in clinical neuropsychology indicate that the prefrontal cortex serves as the neural basis of executive function. The purpose of this study is to investigate the neural basis of executive function within the prefrontal cortex.

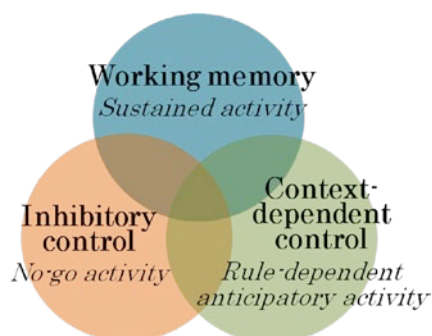


Fig. 1 Elements of executive function and their correlates in neural activity in the prefrontal cortex.

So far several characteristic neuronal firing patterns have been identified within the prefrontal cortex as shown in Fig. 1. 1) Sustained activity: Some prefrontal neurons show sustained activity while the subject is holding information related to a sensory cue or intended motor action. This activity is thought to be related to working memory. 2) No-go activity: Some prefrontal neurons show phasic or tonic activity in response to a sensory cue for withholding a response. This activity is thought to be related to the inhibitory control of motor habit or instinctive actions. 3) Anticipatory activity: Some prefrontal neurons show a gradual increase of firing anticipating a sensory or motor event in a specific behavioral context. This activity is thought to be related to the context dependent control of behavior.

【Research Methods】

In order to fully understand the neural mechanisms behind the executive function, it is

necessary to reveal the structural and functional organization of the neural circuits in which these prefrontal-specific activities arise. In this study, by using a new technique to label individual neurons with fluorescent protein after recording their activity extracellularly, we perform various histological analyses on the labeled neurons whose functions have been identified during the behavioral performance. This method should enable us to directly compare the chronically recorded neuronal activity and the histological characteristics of the recorded neurons, for the first time in the long history of behavioral electrophysiology. We also intend to apply in vitro electrophysiology to identified types of neurons in order to investigate their functional properties in more depth.

【Expected Research Achievements and Scientific Significance】

This study will reveal the neural mechanisms behind executive function on the neuron and circuit level in detail for the first time, and will contribute to our understanding of the executive functions and operating principles of the mind. Moreover, it will provide important indications for the curing of neural disorders related to the prefrontal cortex, such as schizophrenia, depression/bipolar disorder, autism, and ADHD.

【Publications Relevant to the Project】

Yamada M, Pita MC, Iijima T, Tsutsui K. (2010). Rule-dependent anticipatory activity in prefrontal neurons. *Neurosci Res.* 67: 162-71

【Term of Project】 FY2012-2016

【Budget Allocation】 144,700 Thousand Yen

【Homepage Address and Other Contact Information】

<http://researchmap.jp/kenichirotsutsui>
tsutsui@m.tohoku.ac.jp