【Grant-in-Aid for Young Scientists(S)】

Integrated Science and Innovative Science (Comprehensive fields)

Title of Project : The neural mechanism of Bayesian integration in the perceptuo–motor system

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Research Area : Health/Sports science - Physical education

Keyword : Higher brain function science

【Purpose and Background of the Research】

Events that we encounter in our daily environment are highly variable. For example, when playing catch, the ball pitched by your partner is not constant but instead fluctuates in course and speed. Let us also look at our own bodies. Unlike most electric signals, there is significant noise within the neural activity that signals our sensory and motor functions.

Although both the external and internal environments are highly variable, the body can generate dexterous and stable perception and motor outputs. What mechanism enables the body to do so? Answering this question is a significant goal in sports science, physical education and cognitive and brain science.

In theory, by using "Bayesian integration", the central nervous system (CNS) can minimize the effect of the external and internal variability and obtain the optimal estimate of a target that should be perceived or controlled. Recent behavioral studies have shown that Bayesian integration plays a role in the processing of the human perceptuo–motor system. It remains unclear, however, how the CNS realizes Bayesian integration. This project aims to elucidate the neural mechanism of Bayesian integration in the perceptuo–motor system.

【Research Methods】

To analyze the neural mechanism underlying Bayesian integration, this study plans to combine psychophysical methodology and the following neurophysiological techniques:

- Functional Magnetic Resonance Imaging (fMRI): fMRI can identify the brain regions that are associated with Bayesian integration.
- Transcranial Magnetic Stimulation (TMS): TMS can transiently inhibit brain function in specific areas. By using the TMS, we can confirm the roles of the brain regions.
- Electroencephalogram (EEG): we will use the EEG to estimate the timing or order of activity in the brain regions.
- Reflex measurement: we will test the possibility of the involvement of the spinal cord neurons that mediate activity between the brain and behavior.

【Expected Research Achievements and Scientific Significance】

If this project identifies the brain regions (or the neural substrates) that are associated with Bayesian integration, what roles the brain regions play and the order of activation of these brain regions, we can make significant progress in elucidating the neural mechanisms underlying Bayesian integration. Conversely, these findings can further develop the Bayesian integration theory based on physiological data.

Bayesian integration is an optimal strategy that maximizes the success rate of our perceptual and motor behaviors. If the underlying mechanisms are elucidated, significant progress will be made in the basic and general understanding of human perceptuo–motor control, and the methods employed for the education or training of human skills can be modified accordingly. Moreover, these findings could contribute to the planning of a more effective rehabilitation program or even to the development of robots that behave like skilled athletes or craftsmen.

It should also be noted that, whereas Bayesian integration can maximize the success rate, it also decreases the sensitivity to low-frequency events. Thus, focusing on such a property and analyzing the mechanism may contribute to the development of effective countermeasure systems for human errors.

【Publications Relevant to the Project】

- Miyazaki M et al. Bayesian calibration of simultaneity in tactile temporal order judgment. *Nature Neurosci* 9: 875-877, 2006.
- Miyazaki M et al. Testing Bayesian models of human coincidence timing. *J Neurophysiol* 94: 395-399, 2005.

【Term of Project】 FY2009-2013

【Budget Allocation】 79,900 Thousand Yen

【Homepage Address and Other Contact and Information】

http://www.waseda.jp/wias/eng/researches/plofile/plof_m_miyazaki.html