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Talk Title:
Cortical and subcortical circuits for response inhibition

Abstract:
The inhibition of an already initiated but inappropriate response in a particular situation is critical for adaptive behavior. Multiple cortical and subcortical areas are known to be involved in response inhibition. However, it is poorly understood how the neural circuits among the areas are organized and implemented to achieve response inhibition. Two approaches via multimodal techniques are required to understand brain circuits for cognitive functions: 1) measure the neural activity and 2) modulate the neural activity and examine the causal impact. In the first part of my talk, I will show two cortical processing streams that run during response inhibition in humans. We used functional magnetic resonance imaging (fMRI) to identify the essential areas for response inhibition during a stop-signal task. Time-resolved single-pulse transcranial magnetic stimulation (TMS) was applied during the task. We found three critical timings of transient disruption in the essential cortical areas belonging to two distinct cerebrocortical networks. Furthermore, single-pulse TMS following sustained suppression via repetitive TMS revealed the stopping stream originating from the ventral posterior inferior frontal cortex (IFC) and the other from the dorsal posterior IFC that works in a later phase. These results suggest that the two streams implement distinct processes in a parallel manner. In the second part of my talk, I will present the experiments with an emerging intervention technique, transcranial ultrasound stimulation (TUS). TUS can noninvasively stimulate both the cortical surface and deep brain structures with high spatial accuracy. TUS was applied to the right anterior putamen, a task-related region in the striatum identified via fMRI, and revealed significant impairments in stopping performance. Diffusion MRI further identified a cortical counterpart of the anterior putamen in the anterior IFC, and TUS to the anterior IFC showed significantly impaired stopping performance. These results suggest that the newly identified anterior IFC-anterior putamen circuit in the indirect pathway serves as an essential route for stopping.

Biographical Information:
Dr. Takahiro Osada is an Associate Professor in the Department of Neurophysiology at

Juntendo University School of Medicine. He received his Ph.D. in 2007 from the University of Tokyo. His research interests span human cognitive functions and the autonomic nervous system with the use of neuroimaging and intervention techniques. He received the Promotion Award for Young Scientists from The Physiological Society of Japan in 2022.