# CORTICO-MUSCULAR FUNCTIONAL INTERACTION BASED ON MOTOR TASK PERFORMANCE

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（様式 2）

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論 文 名　：　CORTICO-MUSCULAR FUNCTIONAL INTERACTION BASED ON MOTOR TASK PERFORMANCE
(運動課題に基づく脳皮質−筋活動間の機能的相互作用)

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## 論　文　内　容　の　要　旨

The functional interaction of brain and muscle signals plays an important role in our daily lives. We have to perform various motor tasks using different movements to accomplish our tasks daily. The movements and motor tasks that we use and perform every day finally become a goal. Such goals are the output of motor task performance. The brain and muscles act synchronically during motor task performance to achieve the movement goal. The principles of cortico-muscular interaction play an essential role in the rehabilitation systems of stroke patients, the treatment of motor-impaired people, and the treatment of dyskinesia, Alzheimer's disease, and Parkinson's disease. In order to understand the basic principles of brain and muscle function for future brain-computer interface (BCI) technology, it is important to understand the cortico-muscular functional interaction and its neurophysiological principles.

Although there were well-documented findings of functional interaction with maintained voluntary contraction, executed precision-pinch tasks, static isometric contraction tasks, wrist flexion and extension tasks, and cortico-muscular functional interaction comparison in real movement, the movement intention stage, motor imagery stage, and movement observation condition were lacking in the study. Thus, this study will explore brain-muscle functional interaction and its neurophysiological principles during these tasks as a preliminary study of brain-muscle functional connectivity.

In this study, four different motor performances were applied, such as real hand grasping movement (RM), movement intention (Inten), motor imagery (MI), and only looking at the virtual hand in a three-dimensional head-mounted display (3D-HMD) (OL). This study involved thirteen healthy right-handed participants from Kyushu University. We explored the cortico-muscular functional interaction with the linear coherence method, the nonlinear mutual information method, and the nonlinear mutual information delay time method. The objectives of this study are to investigate the functional interaction of brain-muscle signals and their coupling delay times based on four different motor tasks, to explore the anatomical and neurophysiological principles of brain and muscle function that can lead to cortico-muscular interaction, and to discover consistent and reliable facts about cortico-muscular interaction based on unresolved research issues.

The results proved that brain–muscle functional interaction and delay time change according to motor task performance. Quick synchronization of localized cortical activity and motor unit firing causes good functional interaction, and this can lead to a short delay time between signals. In addition, the motor system inside the human body works hierarchically to accomplish the predefined movements or reach the

goals that we set. Those motor systems interact with each other via diverse tracts such as descending motor pathways and ascending motor pathways. Thus, brain and muscle signals can flow with bi-directionality between efferent and afferent pathways. This study will provide consistent and reliable facts about cortico-muscular functional interaction that resulted from our experimental research for rehabilitation systems and a future Brain-Computer Interface (BCI) system.