2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

Effects of Visual Feedback on Event-Related Desynchronization During Isometric Grasping

Kosei Nakayashiki[1], Yoshikatsu Hayashi[2], Tamami Sudo[1], and Toshiyuki Kondo[1]

Abstract— **Event-related de-synchronization (ERD) is a feature of the EEG that reflects sensory-motor processing in the brain. ERD is generated not only by motor execution but also by motor imagery, but the mechanism is not well understood. In this study, we hypothesize that the generation of ERD is related to the motor planning process in the brain based on our previous work which reported that ERD was maintained during isometric grasping with visual force feedback. To clarify the effect of visual force feedback on the resultant ERD, we compared the generation of the ERD in four conditions; visual force Feedback (FB), No Visual (NV), visual stimuli Playback (PB), and Visual Only (VO). As a result, we confirmed significant difference in ERD generation between the conditions PB and FB in the somatosensory cortex, but not in the motor cortex.**

Clinical relevance— **Contribute to the improvement of the accuracy of brain-computer interfaces by investigating brain activity during the maintenance of body movements.**

I. INTRODUCTION

In recent years, with the development of brain function measurement, various studies have been conducted to understand the brain, such as modeling neural activity [1]. Event-related de-synchronization (ERD), one of the EEG features, is generated by actual movement and motor imagery, and is expected to be applied to the BCI neuro-rehabilitation for the people with motor dysfunction. However, the mechanism of ERD generation has not been clarified. Our previous study suggested that ERD is related to motor planning rather than to the generation of motor commands [2]. In the study, ERD disappeared even though the muscles were exerting force while maintaining the grasp. On the other hand, in the experiment conducted at a later date, ERD was observed when an ongoing grasping force level was given as visual feedback. Therefore, based on the hypothesis that ERD is generated by force regulation, the present study investigated ERD during the maintenance of grasping movements with different visual feedback conditions.

II. METHOD

Ten healthy men and women in their 20s were asked to maintain a right-handed grasping movement for 4 seconds, and the EEG was measured during the task. EEG was measured from 64 electrodes (g.tec: g.HIamp, g.LADYbird) arranged according to the 10-20 method with a sampling frequency of 256 Hz. The subjects were asked to grip a grip strength meter with a target value of 30%MVF (maximum voluntary force). A bar was displayed on the screen, and the length of the bar reflected the magnitude of %MVF. Movement and visual stimulation were performed under the following four conditions. Feedback(FB): Displays a bar that reflects the %MVF that the subject is demonstrating in real-time. No Visual(NV): Hide the bar. Playback(PB): Display a bar that moves to reflect the %MVF of a pre-recorded data.Visual Only(VO): The subject does not perform any hand movements, and a moving bar is displayed to reflect the data during practice. To sum up, each condition was designed to investigate the effects of visual feedback/stimulus, and VO for visual stimulus only, NV for grasping motion only, PB for grasping motion and uncorrelated visual stimulus, and FB for grasping motion and visual force feedback. The order of the tasks in each condition was randomized, and overall, 40 tasks were performed per condition.

III. RESULTS

In the mu-ERD of C3 (the right primary motor cortex), little ERD was seen in VO. In PB and FB, mu-ERD continued to occur throughout the exercise. In NV, mu-ERD was weaker than in PB and FB, but no significant difference was found. Beta-ERD was not significantly different between conditions. In CP3 (the right somatosensory cortex), mu-ERD was significantly weaker in VO as in C3, while the beta-ERD was significantly larger in the FB condition than the other three conditions.

IV. CONCLUSIONS

The experimental results showed that there was no significant difference in ERD with and without feedback (PB and FB) in the motor cortex, but that a significant difference in beta-ERD in the somatosensory cortex. Therefore, it is plausible to think that the feedback processing during the maintenance of the grasping motion is performed in the somatosensory cortex.

ACKNOWLEDGMENT

The research was supported by JSPS KAKENHI (Grant numbers JP20H02111 and JP19H05727)

REFERENCES

[1] Nguyen PTM, Hayashi Y, Baptista MDS, Kondo T. Collective almost synchronization-based model to extract and predict features of EEG signals. Sci Rep. 2020 10;10(1):16342.

[2] Nakayashiki K, Saeki M, Takata Y, Hayashi Y, Kondo T. Modulation of event-related desynchronization during kinematic and kinetic hand movements. Journal of NeuroEngineering and Rehabilitation. 2014 May;11(1):90.

[1]K. Nakayashiki, T. Sudo and T. Kondo are with Dept. of Computer and Information Sciences, Tokyo University of Agriculture and Technology, Japan, Email: nakayashiki@livingsyslab.org, t_kondo@cc.tuat.ac.jp

[2]Y. Hayashi is with Department of Biomedical Science and Engineering, University of Reading, UK