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Robust detection method of motor imagery activity for neurorehabilitation: a preliminary study in healthy participants and hemiplegic stroke patients

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***Abstract*— We propose a novel event-related desynchronization (ERD) detection method that provides a motor imagery cue when the mu band power at rest is kept larger than a predetermined threshold for a certain period. In this study, we investigated the optimal resting threshold and its duration, and its effect on improving the measured ERD. In both healthy adults and patients, the ERD power of the proposed method was significantly increased compared to the conventional method without a threshold.**

***Clinical Relevance*— The proposed method could contribute to accurately evaluate the motor imagery ability in patients and facilitate motor-imagery-based neurorehabilitation.**

I. Introduction

ERD is a decrease in the mu (8 - 13 Hz) band activity of the primary motor cortex related to motor imagery or motor execution. Based on the relevance of ERD power with the motor functional recovery in stroke patients [1], neurorehabilitation for stroke patients aims to increase ERD power from the affected motor cortex. However, the detected ERD power may be unstable since the calculation of ERD depends on the mu band power value at rest that precedes motor imagery or execution, which could be variable [2]. Therefore, we propose a novel ERD detection method. To detect stable ERD, the proposed method provides a motor imagery cue when the mu band power at rest is kept larger than a predetermined threshold for a certain period.

II. Methods

Six healthy adults (mean age 23.5 ± 2.0 years, 3 men and 3 women) and 6 hemiplegic stroke patients (mean age 66.8 ± 10.1 years, 3 men and 3 women) participated in the experiment. We calculated the average intensity of the resting state mu band power from the electrode placed over the motor area of the dominant hand of the healthy participants and that of the paralyzed hand of the patients, respectively. Varying the resting threshold ranged among 70 - 100% of the average intensity of resting-state mu-band power and the duration for 1 - 3 seconds, we determined the combination of the threshold value and the duration that participants could meet at least 3 times in 2 minutes. Participants underwent a motor imagery task in which the motor imagery cue is visually presented when the mu band power meets the predetermined threshold (proposed method). They also performed another motor imagery task in which the motor imagery cue is presented at regular intervals regardless of their mu band activity (conventional method). The mean ERD power was calculated as previously described [1] and compared between the two methods.

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III. Result

Five and 4 out of 6 healthy participants and patients were able to maintain 80 and 70% or more of the average intensity at rest for 1 second, respectively.

In both healthy participants and patients, the ERD power of the proposed method was significantly increased compared to the conventional method without a threshold (Figure 1).

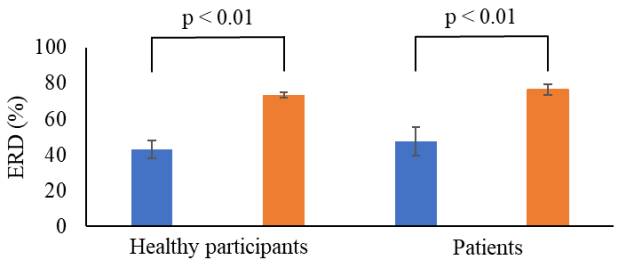

Figure 1. Comparison of mean ERD power between conventional (blue) and proposed (orange) methods.

IV. Discussion & Conclusion

These results suggest that the proposed method could more robustly and accurately determine the individual ability to modify motor cortical activities in both healthy and patient populations, contributing to more reliable neurorehabilitation for patients with stroke and hemiparesis. In addition, training to increase resting-state mu-band power could be effective for patient rehabilitation in reducing the tension of the paralyzed limb.

References

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