EEG Microstates, Motor Control Modes and Visual Feedback Loop during an Arm & Leg Cycling Exercise – a Pilot Study

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Introduction

In the case where the nervous closed-loop system between the muscle sensation feedback and the motor cortex is not working anymore (e.g. after an SCI) it is to investigate if the nervous loop-system could be partly re-initiated through other feedback paths like visual perception. To promote optimal rehabilitation, it seems relevant to investigate the impact of the visual feedback loop on brain activity. This study was designed as a pilot study with ethical approval for healthy participants only. The aim of this study was to investigate the effect of cyclic movement on the temporal brain dynamic compared to the resting brain activity captured via EEG microstate analysis, thus providing the first baseline for EEG microstates recorded during movement.

Materials and Methods

14 healthy subjects performed a cycling exercise on the Bi-Pedal device. The protocol was divided into EEG resting state recordings and EEG recordings on steady movement tasks, two times active movement and two times passive movement and each condition had two subconditions; with visible leg movement or without visible leg movement. The EEG measurement was recorded using the wireless 19-channel DSI 24 (Dry Electrode EEG) headset.

Fig. 1 Participant cycling with EEG measurement on the Bi-Pedal device from the rehaLab, BFH

Data were processed using the Matlab-based toolbox EEGLAB . The microstate analysis was done with the Matlab-EEGLAB-based plugin Microstate. Statistics were done with R-studio. Comparisons were made between rest and passive movement, between passive and active movement and between the legs visible or not during passive and active movement. Outcome measures included temporal microstate parameters Time Duration [s], Frequency of Occurrence [1/s] and Time Coverage [%].

Results

All microstates obtained showed a 4-map solution according to the literature [1]. The Resting State-Passive movement comparison resulted in a significant Condition-effect, which resulted in shorter durations but a higher occurrence of microstates in passive movement compared to rest. The passive-active comparison showed no condition or interaction effect. Neither did the comparisons of the view with and without leg movement.

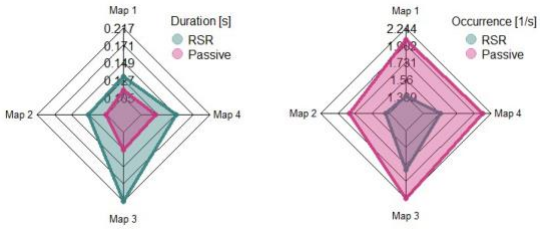

Fig. 2 Microstate parameter Time Duration (left) and Frequency of Occurrence (right), .4 map solution, recorded in two conditions (Resting State, blue surface; and Passive Movement, red surface)

Discussion

For the Resting State - Passive results, I suggest that some properties of this distinct difference between the brain dynamics in rest and passive movement can be used as a neuromarker in rehabilitation, as a landmark on the way to recovery. There are some consistent descriptive differences between active and passive movement that need further investigation. As for the differences in view with or without leg movement, future studies with disabled participants will bring more information about this.

References

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