EEG indices of responsiveness in Minimally Conscious State

V. Galiotta[1,2*], I. Quattrociocchi[1,3], V. Caracci[1], J. Toppi[1,3], M. D'Ippolito[1], P. Aricò[3,4,5], D. Mattia[1], F. Cincotti[3], R. Formisano[1], A. Riccio[1]

[1]Fondazione Santa Lucia IRCCS, Rome, Italy; [2]Dept. of Psychology, Sapienza University, Rome, Italy; [3]Dept. Of Computer, Control and Management Engineering, Sapienza University, Rome, Italy; [4]Dept. of Molecular Medicine, Sapienza University, Rome, Italy; [5]BrainSigns srl, Rome, Italy

*Via Ardeatina, 306, 00179, Rome, Italy. E-mail: v.galiotta@hsantalucia.it

Introduction: Minimally Conscious State (MCS) is a clinical condition characterized by reproducible, but inconsistent signs of consciousness [1]. Fluctuations of responsiveness contribute to the misdiagnosis rate and prevent from effective interactions with MCS patients [2]. These clinical fluctuations might also greatly limit the use of any Brain-Computer Interface (BCI) for communication purposes. The objective of the present study was to identify neurophysiological indices of responsiveness in MCS patients, investigating the connection between EEG background activity and the presence of a P300 ERP (*Event-Related Potential*) response to an oddball paradigm, considered a sign of higher level of responsiveness with respect to its absence [3].

Material, Methods and Results: EEG (19 channels, sampling frequency 250Hz) was recorded from 16 MCS patients (6 females; mean age±standard deviation=44.0±15.9) during a 5-minute resting-state period, followed by an auditory passive oddball paradigm. According to the visual inspection of the ERP waveforms elicited by the oddball paradigm, patients were divided in two groups based on the presence ("P300" group; n=9) or not ("no P300" group, n=7) of the P300. EEG data were pre-processed and spectral indices were extracted to characterize EEG background activity. In particular, we considered relative powers in three frequency bands (delta, theta, alpha), the theta/beta ratio (TBR), the median frequency and the spectral edge frequency (SEF). Independent samples t-test was used to compare spectral indices between the "P300" and "no P300" groups. Results reported in Figure 1 showed that the TBR in Cz (t=2.24; =0.042) and in Fz (t=2.20, p=0.047) and the SEF in Cz (t= -2.97, p=0.01), resulted significantly different between the two groups.

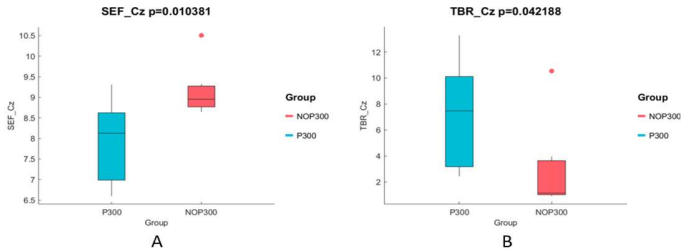

Figure 1. *Boxplot representation of the significative differences between the "P300" and the "no P300" groups in the SEF and in the TBR in Cz.*

Discussion: Our results showed that TBR and SEF indices in the resting state are related to the presence/absence of the P300 in an oddball task; this highlights the possibility to disambiguate responsiveness of MCS patients from the EEG background activity. Such disambiguation would represent a step toward the characterization of the EEG background activity related to the fluctuation of responsiveness and to the identification of a responsive period suitable for interaction with patients.

Significance: Although preliminary, these results support the possibility of identifying neurophysiological indices of responsiveness within the fluctuations in MCS patients. This would sustain the rehabilitation process and the implementation of a "timely" BCI to support the interaction with MCS patients.

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