EEG-based quantitative measures to support the clinical prognosis of disorders of consciousness

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Introduction: People who survive a severe brain injury can suffer from disorders of consciousness (DoC), a clinical condition characterized by alteration in arousal and awareness that leads to states defined as MCS (Minimally Conscious State) or UWS (Unresponsive Wakefulness State). The process of exiting from DoC is still not clear and it is important to identify markers in bio-signals to predict patients' prognosis with a high accuracy level [1].

Material, Methods and Results: The study involved 58 subjects clinically diagnosed as DoC (40 MCS, 18 UWS) whose clinical condition was followed-up after three months (T_1). Patients were divided in two groups according to the assessment at T_1: 28 positive (O+) and 30 negative outcomes (O-). O+ patients exited the disorder at T_1 recovering communication with the external environment, while O- either didn't change their state or passed from UWS diagnosis to MCS diagnosis or vice versa or died. At study entry EEG signals (19 electrodes according to 10-20 system) were acquired during 5 minutes of resting state. Partial Directed Coherence (PDC) was used to estimate functional resting state network [2] and complex connectivity measures were evaluated according to graph theoretical approach [2]. A statistical analysis was then applied to find indices significantly different between O+ and O-. We found higher values for O+ in comparison with O- for: left-right (LR) influence in delta, theta and alpha bands, inter-hemispheric connections (IHC) in delta and alpha bands, antero-posterior right (APR) connections in delta and theta bands (Fig. 1, panel a). The combination of the significant three indices evaluated in the different bands was used to train a SVM classifier aimed at predicting patients' prognosis. The features that obtained the best classification performance (i.e., accuracy: 85%, AUC: 85%) were: APR connections and IHC in delta band and LR influence in alpha band (Fig. 1, panel b).

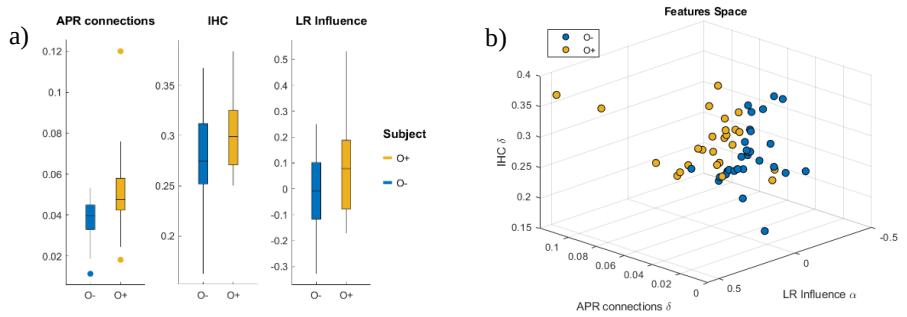

Figure 1. *a) Boxplot reporting indices distribution obtained for O+ and O- patients; panel b) features space used to classify O+ from O- patients.*

Discussion: The re-emergence of connectivity patterns has been already demonstrated to be an indicator of recovery of consciousness, especially fronto-parietal connections [4]. In the present study, this result is supplied by the additional information of the direction of the connections and the pertinent hemisphere.

Significance: The present study predicts with high accuracy the process of consciousness recovery relying just on quantitative connectivity indices calculated with advanced techniques from EEG signal acquired at resting state.

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