Day 4: 15 June 2022, Wednesday

Session:	**Breakout 6**
Date:	**15 June 2022, Wednesday**
Time:	**1030 - 1200**
Venue:	**Hibiscus 3706**

Abstract Number: **275**

MEDUSA: A Novel Platform for Modern Non-Invasive Brain-Computer Interfaces

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Brain-computer interfaces (BCI) have rapidly evolved in recent years, gaining momentum for alternative communication, environmental control, rehabilitation, neurofeedback, or entertainment. However, this heterogeneity, together with the technical complexity of designing and developing fully operative BCIs, hindered this advance. At this point, it seems crucial to create flexible, scalable, and easy-to-use tools to reduce the development time of these systems, allowing researchers to test prototypes and perform experiments faster. In this work, we present MEDUSA, a novel platform especially designed to optimize the implementation of modern BCI applications. MEDUSA has been developed in Python, with a visually appealing graphical user interface, and following a modular design with standardized communication protocols connecting its different components. Conceptually, MEDUSA is divided in 3 modules: acquisition, visualization, and applications. The acquisition module provides core functions to record and save signals in real time using the lab-streaming layer (LSL) protocol, which is compatible with most of the bio-signal recording devices in the market. The visualization module implements time, frequency and time-frequency graphs to plot the signals in real time. Finally, MEDUSA applications are programs with standardized workflow and control protocols that include online signal processing and feedback functionalities compatible with Unity. Currently, MEDUSA has a complete suite of ready-to-use applications based on electroencephalography (EEG): spellers based on event-related potentials (ERP), steady-state visual evoked potentials (SSVEP) and code-modulated visual evoked potentials (c-VEP), motor-imagery (MI) based applications, and neurofeedback (NF). Moreover, the signal processing methods used in these applications (and more) are distributed in a separate Python package that can be used independently. This package includes from basic functionalities (e.g., temporal and spatial filters) to state-of-the-art methods for EEG processing, such as deep-learning models (e.g., EEG-Inception). Additionally, base functions and templates are provided to facilitate the development of custom applications, that can be shared afterwards with the community.

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Overnight Slow Waves Differ In Children Suffering From Sleep Apnea and Might Characterize Their Cognitive Impairment

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Recent studies have shown a distinguishing sleep electroencephalographic (EEG) behaviour in children suffering from obstructive sleep apnea (OSA). Particularly, the role of the low delta band (0.1-2 Hz) has been highlighted when characterizing both typical polysomnographic variables and cognitive alterations. This work aims at evaluating the differences in the overnight Slow Waves (SW) EEG features in children suffering from OSA. Accordingly, eight EEG channels (F3, F4, C3, C4, O1, O2, T3 and T4) were recorded from 294 children during the night. The spectral entropy (SE) of low delta, the maximum of the spectral power of the slow oscillation (Mso), and the frequency where this is located (Fso) were used to furtherly characterize the low delta band in each channel. Children were split into controls (N=176), mild OSA (N=98), and moderate-to-severe OSA (N=20) for comparison purposes. Our results show that Mso and Fso reached statistically significant differences (p-value<0.05) among groups in 8 and 7 EEG channels, respectively, while SE only showed differences in F3. However, a correlation analysis controlled by age, sex, and wake time after sleep onset, conducted using 1.000 bootstrap replicates, showed significant values in the moderate-to-severe group between SE and the apnea-hypopnea index (R=-0.56 in F3), the respiratory arousal index (-0.65 to -0.70 in F3, C3, and T3), the Peabody picture vocabulary test (0.63 to 0.74 in F3, C3, C4, O1, O2, and T3), and the expressive vocabulary test (0.53 in C4). Mso only showed significant correlation with apnea-hypopnea index (0.62 in O1), whereas Fso only reached significant correlation with designing copy test (0.58 and 0.63 in F3 and F4). All in all, we show that overnight SW might contain crucial information to characterize both sleep apnea and its cognitive related consequences, being SE and Fso particularly useful for impairments in language and visual-spatial processing, respectively.