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EEG power bifurcation in the transition zone beta to gamma – from motor function to cognition – in Alzheimer and Long COVID patients versus healthy controls revealed by quantitative EEG time series analysis of lateral EEG data

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Abstract Text:

Background: Similar EEG abnormalities suggest a nexus from Long COVID (LC) to Alzheimer‘s (AD) and probably to Parkinson‘s disease (PD). Symptoms like memory loss hint to a common cause. Ranasinghe (2020) showed EEG alpha slowing and hyper- and hyposynchrony for AD. In LC generalized EEG slowing (Antony, 2020) was reported. There is evidence that switching between brain hemispheres is necessary for scenery and object processing (Brincat, 2021), being disturbed in AD (Maass, 2020). However, explicitly lateral EEG for AD is rarely investigated. We calculate frontal asymmetry index (FAI) for F4/F3 EEG electrodes, which is normally used at alpha frequency for assessing emotional states in major depression (Davidson, 1998), not only for alpha but for further frequencies of AD patients. This possibly yields new biomarkers for AD and LC.

Method: FAI := logarithm of quotient between F4/F3 power, calculated for frequencies up to 120Hz of AD data taken from (Valladolid, Abasolo, 2017) and (Naples, Babiloni, 2018). AD and healthy control (HC) resting state EEG data from Valladolid were semi-automatically artifact-corrected and subdivided into 5s-epochs. For AD patients and HCs the average of all 5s-epochs was used for FAI. We recently determined power spectra and FAI from full-length 10min resting-state EEG for an LC patient, suffering from tremor. EEG power was calculated by averaged 5s-epochs of raw-data for F4/F3 for frequencies up to 100Hz.

Result: In Fig. 1 (Valladolid) FAI for F4/F3 is shown. A definite bifurcation occurs at 30Hz distinguishing AD group from HC. The power spectrum of an LC patient shows also at 30Hz frequency (Fig. 2) a significant increase, revealing high Beta EEG power conforming with severity of PD-symptoms (O’Keeffe, 2020). Changing sign of asymmetry (i.e. FAI ~ 0.3) can be observed at 30Hz (Fig. 3).

Conclusion: The application of FAI in the full frequency range shall further be investigated as a new biomarker for AD and LC. The EEG frequency range from 25Hz to 35Hz appears to be an important transition zone from motor function to cognition. Abnormalities in this frequency range might be linked to AD, PD and LC and could open a new diagnostic window.

Tables and Figures:

Figure 1.png (133.2KB)

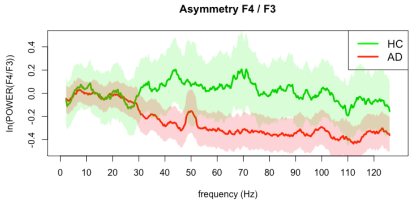

Figure 1: Publicly available AD and HC EEG data were taken from (Smith, 2017, data from https://datashare.is.ed.ac.uk/handle/10283/2783). Abasolo et al (2017) conducted preprocessing of EEG data to remove artifacts. The frontal asymmetry index FAI was calculated according to the formula FAI=ln(POWER(F4/F3)) with POWER defined by power spectral density (PSD). FAI was calculated for all frequencies up to 120Hz. The standard deviations of the AD and HC groups are indicated by the shaded areas. Note that the bifurcation between AD and HC takes place in the vicinity of 30Hz in the beta frequency range. Only small overlaps between the standard deviations of AD and HC can be observed for higher frequencies than 30Hz.

Figure 2.png (90.6KB)

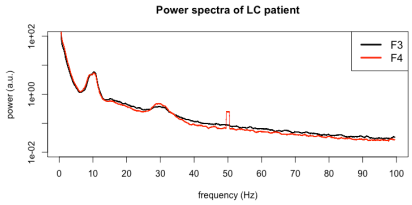

Figure 2: The EEG investigation of a Long COVID (LC) patient with Parkinson-like symptoms (tremor without any previous Parkinson history) shows for F3 and F4 spectra a significant increase of power at 30Hz. Note that above 10 Hz the curve of F4 power strictly lies below F3, except in the vicinity of 30Hz, indicating that this small frequency segment within the beta frequency band seems to play an important role for the occurrence of Parkinson-like symptoms in Long COVID. In currently ongoing EEG examinations the 30Hz abnormality can also be observed at other EEG electrodes, especially for Cz reference, see poster presentation. Remarkably, for this montage a corresponding 20Hz increase of power can be found.

Figure 3.png (64.0KB)

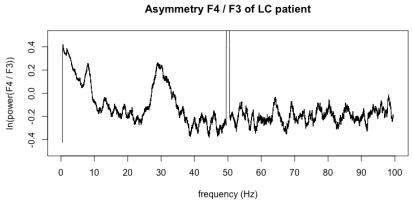

Figure 3: FAI of the Long COVID (LC) patient, whose EEG spectra for F4 and F3 were shown in Figure 2 with the anomaly in the curve of FAI at 30 Hz. This indicates that FAI could be used as a differential diagnostic tool for LC patients as well as for AD patients, see Figure 1.

Title:
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Do you plan to upload figures or tables to supplement your abstract text?
Yes

Theme:
Biomarkers

Topic:
Neuroimaging

Sub Topic:
Differential diagnosis

Learning Objectives:

Distinguish healthy patients from patients who are suffering from Alzheimer's disease by applying the frontal asymmetry index (FAI) to EEG data.
Identify patients at risk for developing Parkinson-like symptoms in Post COVID syndrome.

Keywords:
Alzheimer's disease, COVID-19 and parkinson's disease

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