Poster 57667:
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

QUESTIONS & ANSWERS:

Q: *What is the „Frontal Asymmetry Index“ (FAI) und for what is it used?*
A: When we measure neural activity levels at certain frequencies at electrode sites on opposing hemispheres of the brain, i.e., on the left part and the right part of the scalp, the resulting power spectra will be different, say for electrode F3 compared to electrode F4. If the power at a certain frequency is higher on the right side (F4) than on the left side (F3), the frontral asymmetry index (FAI) yields a number larger than 1, implying that there is more activity in the right-hand hemisphere. When the FAI is smaller than 1, we have more activity in the left-hand hemisphere. Therefore, the FAI is a measure of the frontal lateralization.
The FAI can be used to assess the motivational state of the patient. Higher band power in the left hemisphere (i.e., FAI < 1) indicate positive feelings, motivation and joy, whereas higher band power in the right hemisphere correspond to fear or sadness.

Q: *What is the definition of „Long COVID“ and „Post COVID syndrome“, respectively?*
A: Long COVID or Post COVID syndrome are terms which are used to describe the fact that some patients experience symptoms caused by malfunction in different organs long after the initial period of an acute COVID infection. The symptoms can e.g. include cognitive disfunction, motor impairments, extreme fatigue and chronic cough.

Q: *What is „EEG spectral energy“?*
A: The signal we get when measuring an EEG contains a mixture of slower and faster waves, i.e., waves with low and high frequencies from 0 to about 100Hz. The EEG spectral energy shows how large the contribution to the total signal of each frequency is. For example, if there are a lot of waves with a frequency of 10Hz, the EEG spectral energy will have a high value at 10Hz.

Q: *What are „EEG beta band anomalies“?*
A: The EEG beta band ranges from 13Hz-30Hz. Spectral EEG power peaks at certain frequencies reveal a higher activity close to these frequencies. Especially peaks in the range from 19 to 21Hz are considered to be pathological, associated with slowing of movements (Pogosyan et al, 2009). Moreover, even immunosuppression (Garza & Singer, 2020) can be induced, when performing 20Hz neurostimulation. Since these peaks do not occur in healthy people we call this an EEG beta band anomaly.

Q: *What are „EEG beta band bursts“?*
A: According to Tinkhauser et al (2017 and further publications) the occurrence of EEG beta band anomalies (e.g. at 20Hz) is associated with the appearance of „bursts“, a kind of „EEG beta signal packets“ with a certain amplitude and duration. Tinkhauser et al (2020) and O’Keeffe (2020) showed, that amplitude and duration of

beta bursts are correlated with the severity of Parkinson's disease symptoms. A cumulative effect of bursts at particular beta frequencies (anomalies) leads to the observed peaks in the frequency spectrum, attributed e.g. to tremor appearance.

Q: *What is „sensory neuromodulation"?*
A: „Current forms of clinically applied neuromodulation, including devices such as (implanted) deep brain stimulators (DBS) and various, noninvasive methods such as transcranial magnetic stimulation (TMS) and transcranial current methods (tACS, tDCS), have been studied extensively. The potential strength of neuromodulation of a sensory organ is access to the same pathways that natural environmental stimuli use and, importantly, the modulatory signal will be transformed as it travels through the brain, allowing the modulation input to be consistent with regional neuronal dynamics… sensory neuromodulation is well suited to, ideally, repair dysfunctional brain oscillators, thus providing a broad therapeutic approach for neurological diseases." (citation from *Black and Rogers: Sensory Neuromodulation, Frontiers in Systems Neuroscience, 2020)*

Q: *What is „sensory 40Hz gamma neurostimulation" and „sensory 40Hz gamma neural entrainment", respectively?*
A: The 40Hz frequency in the lower gamma frequency band (> 30Hz) appears to be a crucial frequency for cognitive functions. It is a kind of reference frequency, e.g. in association with theta band (4-8Hz) frequencies, defining the attentional focus or ultra short working memory. Alzheimer patients experience a shift of EEG gamma power, either (mostly) to frequencies < 40Hz, but also in some cases to frequencies > 40Hz, hereby affecting memory function and attention capabilities. „Sensory 40Hz gamma neurostimulation" and/or „sensory 40Hz gamma neural entrainment" is a method, first developed in early mouse models by Iaccarino, Singer and Tsai (2016). This method was applied to Alzheimer patients by the same researchers in several further clinical trials. The neurostimulation takes place with 40Hz light flashes and 40Hz acoustical clicks, applied for a certain time day by day to the patients. First results of these trials have been published by Chan & Tsai (2021) and Singer & Lah (2021), revealing good improvements of memory and sleep behavior, stopping of brain atrophy but only small effects on the reduction of Amyloid Beta plaque and p-Tau neurofibrils. The conclusion was, that a much longer exposition time would be needed until significant results of Amyloid Beta and p-Tau reduction could be observed.