Comparison of the effectiveness of classic amplitude vs coherence neurofeedback - research carried out using protocol based on individual EEG

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INTRODUCTION
Non-invasive neurostimulation methods, such as neurofeedback (NF) may affect activity of neural networks, potentially leading to cognitive enhancement. Here we present new training paradigm - based on cognitive task and compared it to the traditional methods.

DATA AND METHODS
We examined 110 healthy adults (55 women) assigned to one of two NF paradigm groups: Task based NF Coherence protocol and traditional NF amplitude one. All subjects in both groups participated in 20 x NF training sessions. In each paradigm group participants were divided into three subgroups based on the way the stimuli were presented: VR group - training in virtual reality, 2D group - training with a monitor; Sham group, a control, training in VR but with sham feedback.

NF Amplitude Protocol
We analyzed people undergoing the classic amplitude neurofeedback training, which consisted of amplifying the amplitude in the beta2 frequency range (18-25Hz) in the parietal cortex (P3 and P4). This protocol was selected on the basis of the literature showing that strength in the beta frequency is connected alertness and attention and support for learning processes [1], however after the training cycle we did not notice any significant improvement in any of the cognitive tests used. We suspect that the reason for the lack of such improvement was the use of the same protocols for all subjects. The lack of a significant correction resulting from the classic amplitude training prompted us to treat this group as an active control group, which we then compared with the date of coherence training based on an individual diagnosis.

NF Coherence Protocol
Training protocol was based on diagnostic procedure preceding proper NF training. The diagnostic procedure included 3 sessions of delayed-match-to-sample DMTS task combined with EEG registration (19-channel DigiTrack Elmko). DMTS task comprised of control and attentional trials. Control trials did not required allocation of attention and memory. The signal from 3x DMTS sessions was averaged in order to minimize the variability characteristic for the EEG signal and due to plastic changes in neural networks resulting from the learning process. Further, statistical methods based on phase locking value (PLV) analysis were used to investigate changes in synchronization of neural activity [3].

The coherence in given band and electrode pairs differentiating the EEG signal accompanying the successful attentional trials from the control trials from two to four pairs of electrodes with the greatest difference between PLV between attention and control trials were selected for the protocol.

CONCLUSIONS AND PLANS FOR THE FUTURE
In this study, we aimed to find effective methods based on the individual diagnosis of EEG recording that could be used in neurofeedback training to improve working memory and attention processing.

We plan to use the collected data and methods developed to automate the diagnostic process using neural networks that have learned to classify and select individual neurofeedback training protocols in order to increase the effectiveness of therapeutic procedures in future.

To conclude, coherence training protocol is a more effective NF method than the common amplitude training protocol.