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# **Abnormal ontogenesis and neurophysiological mechanisms speech disorders in children**

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The basic neuropsychological knowledge about the localization of higher mental functions and speech are based on the neurosurgical studies of adult patients [1]. Therefore, the model of abnormal ontogenesis of perinatal origin can be used to study the development of the brain activity of the child. Treatment children with mental disorders by tDCS can to take a high therapeutic effect and allows to study of the formation of

new skills and abilities, including impressive and expressive speech, as well as communicative functions – in cases of autism spectrum disorders.

**Methods.** EEG were performed 19 electrodes according to the International 10–20 system in control group without developmental lags and in children with mental disorders (112 subjects), mean age 6.1 years old, SD = 1.5; (diagnoses F 83, F 80.1, F 80.2 etc. according to the ICD -10). The InfoMax algorithm was used, in order to obtain estimates of the ICA components [2]. The ICA components topographies together with the sLORETA imaging approach were used for data visualization [3]. MANOVA was used to evaluate significant differences within the three groups of the children.

**Results.** We can assume that hypothetic sources of slow rhythms can be detected in the EEGs children with mental disorders in the frontotemporal cortices. It has been shown that the intensity of slow components increased corresponding to the degree of mental retardation severity. Longitudinal EEG studies in children with mental disorders revealed at various stages of correction by tDCS a significant increase in the spectral power of  $\alpha$ -activity as well as a significant activity decrease in the left hemispheric frontotemporal areas. It is also shown that the group of children with autism was characterized by higher power in both the  $\Theta$ - and  $\beta$ - frequency bands in the EEG global component, which is related to widespread synchronous activity across the entire cortex, with maximum amplitude in the frontal cortex [4]. These neurophysiological changes are related to executive function and social cognition systems. The children with mental disorders undergoing tDCS treatment exhibited increase the power spectrum of  $\alpha$ -activity in the parietal-occipital regions was more pronouncedly in the right hemisphere (after more than three tDCS courses) [5]. Our new analysis of spectral power of the EEG in a state with eyes closed condition showed a significant increase of the  $\alpha$  – peak frequency 9.2 Hz in the occipital areas (O2 and O1) to the tDCS group (see Fig1, the line 3) compared with the non tDCS group (the line 2) and the control group (the line 1),  $F(2.77) = 4.02$ ,  $p < 0.02$ . The  $\alpha$ -peak frequency was 8.6 Hz for the non tDCS group; it was 8.9 Hz for the control group.

**Discussion.** The actual separation of the neurophysiological mechanisms of abnormal ontogenesis (dysfunction, impairment, disbalance interhemispheric relationships, or immaturity of the brain structures) is difficult. Many authors have reported on the special role of the left hemisphere in the mechanisms of many mental processes that have a speech basis, indicating the importance of interhemispheric interaction for optimal brain function. Our results can be used as the neurophysiological markers of the clinical efficacy of tDCS.

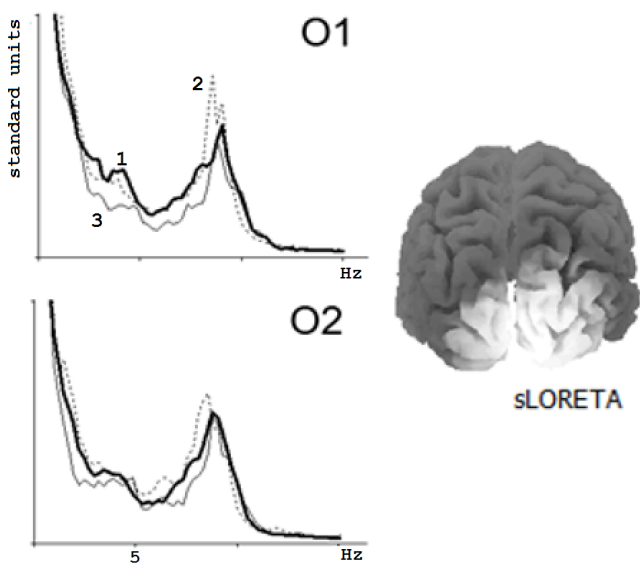


Fig.1. An intergroup comparison of the raw EEG spectral power in the occipital cortex

### *References*

1. Luria A.R. 1966. Higher Cortical Function in Man. New York: Basic Books.
2. Delorme A., Makeig, S. 2004. EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *J. Neurosci. Methods.* 134, 9–21.
3. Pascual-Marqui R.D. 2002. Standardized low resolution brain electromagnetic tomography (sLORETA): technical details. *Methods & Findings in Exp. & Clinical Pharmacology*, 24D, 5–12.
4. N.Ju. Kozhushko, Zh.V. Nagornova, S.A. Evdokimov, N.V. Shemyakina, V.A. Ponomarev, E. P. Tereshchenko, J.D. Kropotov. 2018. Specificity of spontaneous EEG associated with different levels of cognitive and communicative dysfunctions in children. *Int. J. Psychophysiology*, 128, 22–30. <https://doi.org/10.1016/j.psych.2018.03.013>
5. Kozhushko N. Yu., Evdokimov S. A. 2019. Age-Related Changes in EEG Formation during Transcranial Direct Current Stimulation. *Human Physiology*, 4, 364–369. DOI: 10.1134/S0362119719040054

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