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Auditory synchronization at the delta frequency band is altered in school-age children with Autism Spectrum Disorder and associated with language comprehension

Научный руководитель – Драгой Ольга Викторовна

Samoylov Ilya Valer'evich
Аспирант
Национальный исследовательский университет «Высшая школа экономики», Москва, Россия
E-mail: ivsamoylov@hse.ru

Background: Previous studies have shown that one of the neurophysiological mechanisms of language impairments in children with Autism Spectrum Disorder (ASD) is atypical processing of basic features (temporal and spectral characteristics) of auditory stimuli in the central auditory pathway and in the primary auditory cortex (Edgar et al., 2015). One of the reliable paradigms that allows to assess basic features of auditory processing and to register a neural response (level of synchronization) from presented auditory stimuli at a specific frequency is auditory steady-state response (ASSR) (Kuwada et al., 1986), where participants are presented with amplitude- or frequency-modulated tones or sequences of clicks. The majority of studies using ASSR in the ASD population have been focused mostly on the synchronization at the high frequency range, i.e., high beta and gamma (e.g., Ahlfors et al., 2023). However, the association between low-frequency cortical activity and language skills has also been confirmed in children with ASD (Wang et al., 2023).

Objective: Firstly, we aim to explore synchronization within the delta frequency band in the primary auditory cortex of children with ASD, comparing it to TD controls at the source level using Magnetoencephalography (MEG). Secondly, we also aim to conduct a source estimation analysis between the two groups. Thirdly, our objective is to investigate the associations between neural responses to 2Hz stimuli and language proficiency scores in children with ASD.

Methods: MEG data was collected from 20 children with ASD (5 females, aged 8.-14. years, Mage = 10.03, SD = 1.7) and 20 TD children (9 females, aged 7.-12. years, Mage = 9.11, SD = 1.3).

During the recording, the children were instructed to remain still in a chair under MEG and focus on a static image of a fixation cross on the screen in front of them while listening to auditory stimuli. Auditory stimuli were pure tones with a duration of 1 second with amplitude modulation set up at 2 Hz. A total of 90 auditory stimuli with 2000 ms inter-stimulus interval were presented binaurally at the 83.7 dB sensation level and were transmitted through plastic tubes with foam tips inserted into the ears.

Results: In the comparison of neural synchronization to auditory stimuli at the delta-band, we observed a significant statistical main effect of group (t = 2.06, p = 0.04), indicating lower power in the ASD group. The findings also demonstrated significant differences in the Y and Z coordinates in the right hemisphere. Specifically, the topology of the 2 Hz ASSR was more superior (t = -2.03, p = 0.02) and posterior (t = 1.77, p = 0.03) in TD children compared to children with ASD. Furthermore, the results indicated a significant main effect of language comprehension score and the amplitude of event-related fields: lower amplitude was associated with lower language skills (t = 2.12, p = 0.04).

Источники и литература

1) References: Ahlfors SP, Graham S, Bharadwaj H, Mamashli F, Khan S, Joseph RM, et al. No Differences in Auditory Steady-State Responses in Children with Autism Spectrum Disorder and Typically Developing Children. J Autism Dev Disord 2023. https://doi.org/10.1007/s10803-023-05907-w. Edgar JC, Fisk IV CL, Berman JI, Chudnovskaya D, Liu S, Pandey J, et al. Auditory encoding abnormalities in children with autism spectrum disorder suggest delayed development of auditory cortex. Mol Autism 2015;6:69. https://doi.org/10.1186/s13229-015-0065-5. Galambos R, Makeig S, Talmachoff PJ. A 40-Hz auditory potential recorded from the human scalp. Proceedings of the National Academy of Sciences 1981;78:2643–7. https://doi.org/10.1073/pnas.78.4.2643. Wang X, Delgado J, Marchesotti S, Kojovic N, Sperdin HF, Rihs TA, et al. Speech Reception in Young Children with Autism Is Selectively Indexed by a Neural Oscillation Coupling Anomaly. The Journal of Neuroscience 2023;43:6779–95. https://doi.org/10.1523/JNEUROSCI.0112-22.2023.