Comparing the Language Abilities of Typically Developing and Dyslexic Children Aged 7 to 11 Using Quantitative Electroencephalography

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Extended Abstract

Aim

As one of the primary characteristics of individuals with dyslexia, challenges with language skills, particularly phonological processing, are classified as a form of specific learning disability. Linguistically speaking, the issue of specific learning disability is crucial, as children with learning disabilities lack adequate linguistic knowledge and are therefore unable to communicate effectively. Different functions of brain regions contribute to language difficulties in individuals with dyslexia, according to the findings of recent neurological studies. Hence, taking into account the efficacy of electroencephalography, the objective of this research endeavor is to examine the various EEG variables associated with the development of linguistic impairments in children with dyslexia, as well as to compare the language abilities of typically developing and dyslexic children while their EEG eyes are open.

Methodology

The present study employed a descriptive-analytical approach. During the academic year 2020-2021, the statistical population of the study comprised all students with dyslexia (aged 7 to 11 years) who were referred to psychologists at the Mehraz Andisheh Clinic in Shiraz. A cohort of 20 children diagnosed with dyslexia (13 boys and 7 girls) was purposefully sampled and compared to a cohort of 19 typically developing children who were matched in pairs according to chronological age and gender. The Wechsler Intelligence Scale for Children (WISC-IV) was utilized in the diagnostic process for children diagnosed with dyslexia. Further investigations have utilized quantitative electroencephalography (QEEG) patterns to contrast EEG frequency band variations between typically developing and dyslexic children. In order to conduct this research, the subject assumed a seated position in front of the laptop monitor. Subsequently, the participant cleansed the skin on their forehead and ears with medical alcohol before donning the specialized headgear of the apparatus. On the participant's skull were affixed a total of 19 electrodes for standard electroencephalography recording, in accordance with the international 10-20 system. The electrode locations were as follows: Fz, F7, F8, F3, F4, Cz, C3, C4, Fp1, Fp2, T3, T4, T5, T6, Pz, P3, P4, O1, O2. As possible references, electrodes A1 and A2 were positioned on the ear canals. Echocardiogram data was acquired using an eWave amplifier. EEG recordings were performed while the subjects remained in a resting state with their eyes open for a duration of 5 minutes, without engaging in any tasks. For the purpose of extracting quantitative data for each participant, NeuroGuide software was utilized to analyze the recorded EEG offline. Fast Fourier transform (FFT) analysis was implemented in order to evaluate EEG frequency regions. The statistical analyses were conducted utilizing SPSS software, specifically version 23.0. A significance level of $p<0.05$ was established for each analysis. The Wilcoxon test was utilized to examine differences in EEG frequency bands between groups.

Findings

The QEEG within-group findings indicated that the alpha (12.41 ± 14.75) and beta (5.34 ± 9.37) rhythms in the posterior region and the beta rhythm in the frontal region (13.83 ± 12.16) increased significantly in the control group, with statistical significance at the $p<0.001$ level. However, there was no statistically significant variation observed in the brain waves of the left and right hemispheres, frontal and posterior regions, or hemispheres affected by dyslexia. Conversely, the QEEG between-group findings revealed that dyslexic children exhibited greater absolute power in the delta and theta regions, as well as the left and right hemispheres, in the frontal and posterior areas, when compared to the control group. However, the control group demonstrated greater absolute power in these areas when compared to the dyslexics.

Conclusion

Consistent with previous research in this domain, the current study's results validate the presence of an atypical linguistic network among children diagnosed with dyslexia. We discovered through this research that by analyzing the cerebral regions of people with dyslexia, we can gain a greater understanding of the factors that contribute to language difficulties in this population. In other words, the results suggest that analyzing brain waves could be a valuable method for identifying language skills in those with dyslexia, and that modifying these patterns could potentially yield beneficial outcomes in the clinical management of dyslexic patients.

Keywords: Dyslexia, Language Skills, Normal Children, Quantitative, Electroencephalograph.