ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 6, Issue 3, pp: (480-484), Month: July - September 2018, Available at: www.researchpublish.com

Electrophysiological Profile in Learning Disabilities Children with and Without Mild Cognitive Impairment

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Abstract: **This study compares the average frequencies of EEGs' baseline activity among children who present learning disabilities with and without a mild cognitive impairment. The study aims to verify, 1) whether the average frequency calculation is a mathematical quantifier capable of presenting differences between these EEGs, which was not observed by visual analysis, 2) comparing the differences between the two groups. Procedures: The average frequency was calculated for electrodes in six areas on the scalp: frontal, temporal and centro-occipital for the right and left sides. Results: In all analyzed regions, the average frequencies was lower for the group with a mild cognitive impairment, and these differences were statistically significant for the left frontal, right frontal, left temporal, right temporal and left central-occipital regions. Conclusion, 1) The average frequency's calculation of EEGs with regards to learning disabilities children with and without mild cognitive impairment is able to identify quantitative differences for the two groups, 2) learning disabilities children with mild cognitive impairment present lower average frequencies in their EEGs than learning disabilities children without mild cognitive impairment.**

Keywords: **Learning Disabilities, Quantitative Electroencephalography, Cognitive Impairment.**

1. INTRODUCTION

The present study aimed to evaluate whether the processing of biological signals, obtained from electroencephalogram (EEG) records using the average frequency (AF) calculation is able to provide objective information, not observed for the visual analysis from these tests. EEG data were used from learning disabilities (LD) children with and without mild cognitive impairment (LCI), and AF was assessed, from baseline cortical activity. The use of AF in EEGs among children presenting LD with and without LCI was chosen since it is a quantitative tool of easy execution and replicability, and there are few data in literature evaluating AF under this condition. The diagnosis of conditions such as LD and LCI are systematically based on clinical observations and application of psychometric tests, most of them being significantly influenced by cultural, environmental, familiar and scholar contexts in which these children live (1). The use of electroencephalography, particularly quantitative electroencephalography (qEEG) as a study tool has been widely used in research, aiming to reduce the subjectivity involved in the these children's evaluation (2; 3).

This study's objective was to compare the AF of LD children with and without LCI. Moreover, it was accepted as null hypothesis (H0) the absence of differences between the two groups' means as well as for the non-null hypothesis (H1) the presence of differences between means in the two groups. At the same time the AF quantifier was verified in order to be adequate for such evaluation.

2. MATERIAL AND METHOD

The EEGs from 44 children, aged between 10 and 14 years old, with LD were evaluated, of which 23 presented LCI and 21 did not. EEGs from younger children were not used, due to possible confusion concerning maturation aspects of EEGs.

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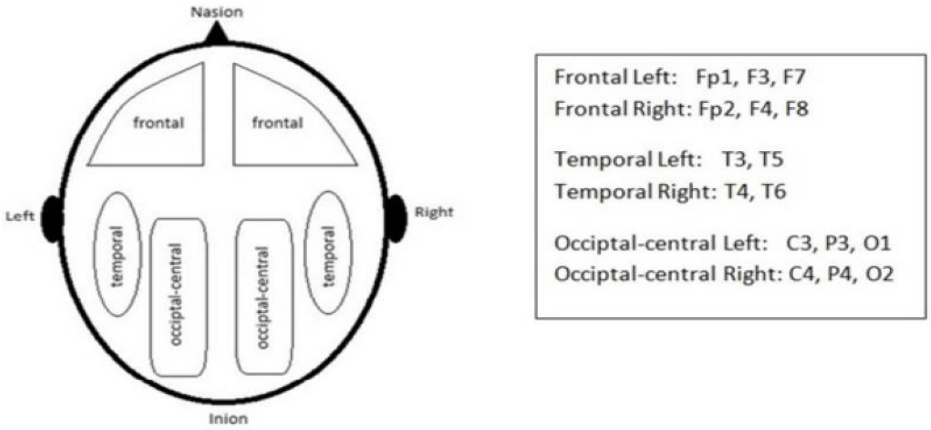
EEGs from children with epilepsy and structural brain damage were also disregarded by the possibility of interference in the EEG cortical basal activity, resulting from these pathologies. The EEGs were obtained through records made in the electroencephalography sector from the Hospital das Clínicas of the Federal University of Uberlândia (UFU), using the Brainet36 apparatus from the company ENSA, and records were made with the electrodes arranged according to the international placement system Electrodes 10-20 (4). For each EEG analyzed, 8 times of 1-second were selected, since the EEG stretches selected were among awakened, rested and closed eyes children, in addition, the selected sections were free from pathological elements and artifacts, visible to visual analysis. After selecting the times, the Fast Fourier transform (FFT) was used for each of the following electrodes F7, T3, T5, Fp1, F3, C3, P3, O1 and F8, T4, T6, Fp2, F4, C4, P4, O2 in order to calculate the AF from each one. After calculating the AF from each electrode, these were grouped into six sets, according to their topographies in such a way that with each group of electrodes, a specific area of the scalp was represented. Figure 1 shows the sets' arrangement formed by each group of electrodes.

Figure 1. Disposition of the electrode sets on the scalp.



For each set of electrodes, their AF were compared between the two groups, in which group 1 regards EEGs from patients with LD and LCI and group 2 the EEGs from patients with LD and without LCI. The study was approved by the human research ethics committee from UFU.

Statistical analysis:

For statistical analysis, the data package from Bio-Estat program 5.3 was used.

Initially, a data's descriptive statistic aiming the characteristics' evaluation obtained was performed. After which, each data set was analyzed for its normality and variance using the Shapiro-Wilk test. For the hypothesis test and average's comparison between the two groups, t-test was used, and the level of significance was considered 0.05.

3. RESULTS

The EEGs from 44 LD children were analyzed, of which 23 presented LCI (group 1) and 21 without LCI (group 2). For both groups a predominance of males was observed, with the same mean age in both groups. Table 1 shows the general characteristics from the two study groups.

Table 1: General characteristics of patients who is EEGs were analyzed

	LD + LCI	LD	Total
No of EEG	23	21	44
Male	14	16	30
Female	9	5	14
Average age	12.5	12.8	12.6

Figure 2. Mean of the AF of each set of electrodes of the two groups.

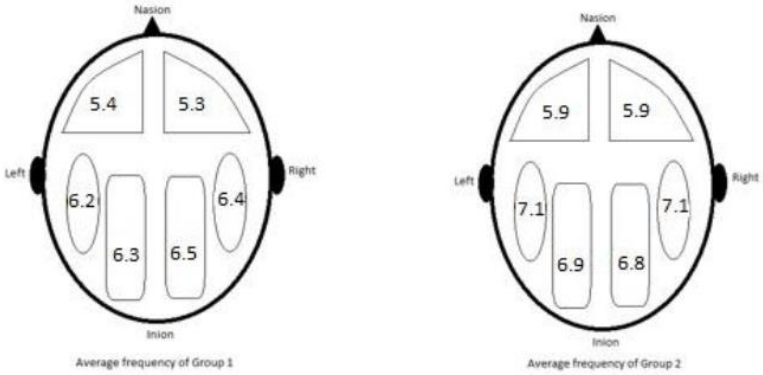


Figure 2: shows the AF's mean for each of the electrodes sets from the two groups.

Figure 3. This figure shows the boxplot of the average frequencies of the two groups.

The group 1 represent the children with cognitive impairment and the group two, the control group.

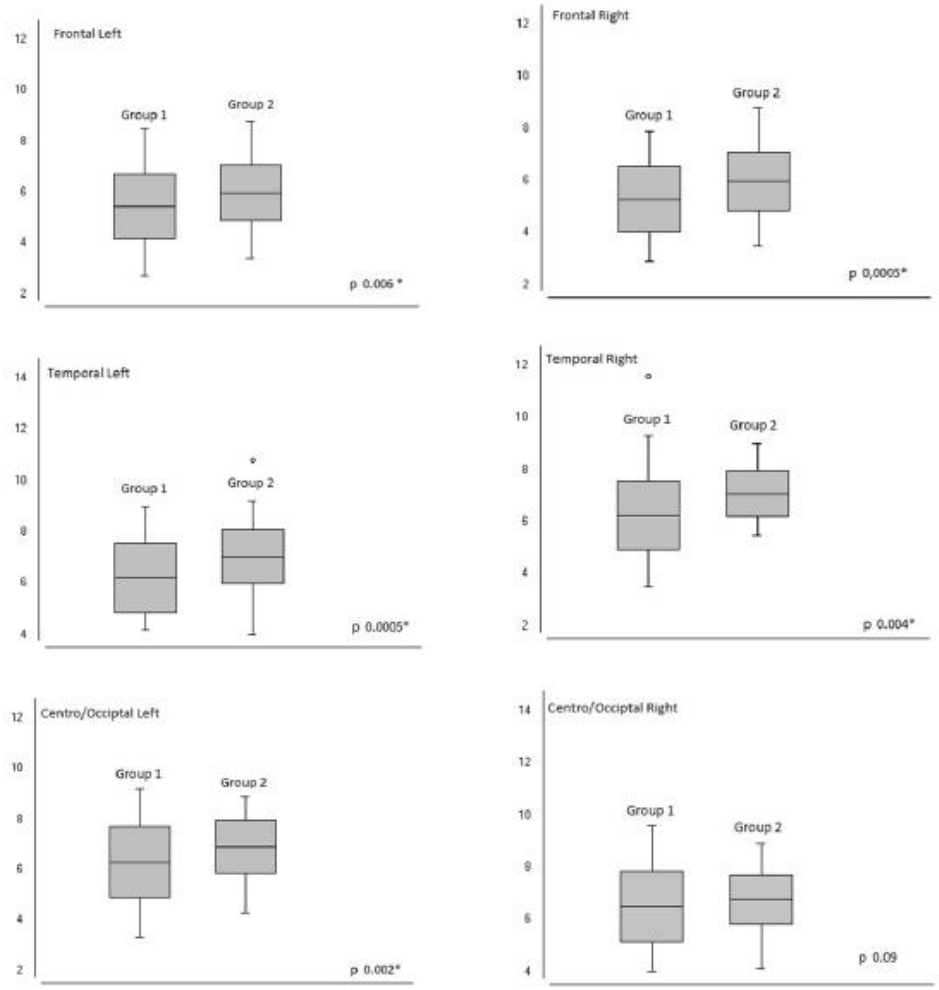


Figure 3: shows the comparison of the average difference between the two groups as well as the statistical significance between the differences.

4. DISCUSSION

The results obtained allow discarding the null hypothesis H0, and therefore, the non-null hypothesis H1 was accepted as a result of the study, ie, the AF's means for the group with LD/LCI were slower in all scalp regions evaluated. Thus, for the frontal right, frontal left, temporal right, temporal left and central occipital left we observed a statistically significant difference. Although central occipital right regions did not present a statistically significant difference, they had lower significant differences in the topographic mean frequencies between LD/LCI and LD non-LCI children. Thereby, lower mean frequencies are associated to the symptomatic group, leading to a probable lower metabolism and lower cortical bioelectrical activity in those children. These findings coincide with the concept of "diffuse slowing of cortical basal activity with more evident attenuation at the frontal/temporal regions", discussed by Plomin and Kovas theory in 2005 (5). This finding may point out a diffuse decrease regarding the dendritic tree. Moreover, these results are somehow compatible with additional findings of the EEG taken on children with mental deficiency (6, 7). This fact is reinforced by the findings of Schmid's and Scherb's 2002 work, where the authors observed a significant difference in alpha activity's frequency among individuals with higher scores on intelligence tests when compared to individuals with lower scores on these tests, indicating that a faster alpha activity is related to a higher intellectual capability (8).

It is important to reinforce that, although several studies have shown less activity in the cerebral cortex among children with cognitive deficits (9), the average frequencies calculation, an easy-to-execute quantification tool, was not used at any time. Thus its use is much easier and acceptable.

5. CONCLUSION

Therefore, it has been concluded that: 1) Signal processing by AF calculation allowed us to observe differences between EEG tests among LD children with LCI, and LD children without LCI, not visible to the visual analysis, discarding the null hypothesis H0. 2) We have demonstrated that the use of the mean frequency calculus is a useful and powerful tool in order to distinguish children with LD and LCI from children with LD without LCI. 3) LD Children with LCI presented lower EEGs frequencies than LD children without LCI. The EEGs were analyzed, along the scalp, among awakened, rested and with closed eyes children.

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