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Research Article

A Brief Study on EEG Signals of Dysgraphia Children in Different Conditions: Relaxing and Writing Moods

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Abstract

Background: Electroencephalography (EEG) is the one of the important tools to study the brain behavior. Therefore, we have investigated the brain signals function of children with learning disabilities (LD) in order to compare the EEG signals during writing and after relaxing with eyes open.
Aims: The aim of this work is comparing the brain electrical activity of dysgraphia children during writing task with their signals during the rest condition.
Materials and Methods: The used method in this work is based on power spectral density (PSD) proposed with Welch. Participants in this study were included 6 girls and 10 boys with age of 9.2±0.64 who have dysgraphia disorder.
Results: The results show that a frequency ratio of writhing mode is more than the resting mode. It is also indicated that the brain signals during writhing are more complex for dysgraphia children.
Conclusion: Our results reveal that insufficient maturity of the brain increase during writing rather than relaxing mode. Finally, to overcome the LD situation neurofeedback can be proposed.
Keywords: Electroencephalography, Power Spectral Density; Frequency ratios; Learning disabilities

1. Introduction

Learning disorders are one of the most common problems in school which many children grapple with today[1]. Dysgraphia is one of the learning disorders involved problems with handwriting. Handwriting is a complex, overlearned motor skill in which biomechanical and cognitive processes contribute to the spatial form and the kinematic features of the handwritten product[2,3]. Handwriting difficulties or dysgraphia have a profound impact on children's psychosocial development, and yet, 10–30% of school-aged children are reported to experience difficulties mastering this skill[4]. It occurs regardless of the ability to read and is not due to intellectual impairments[5].

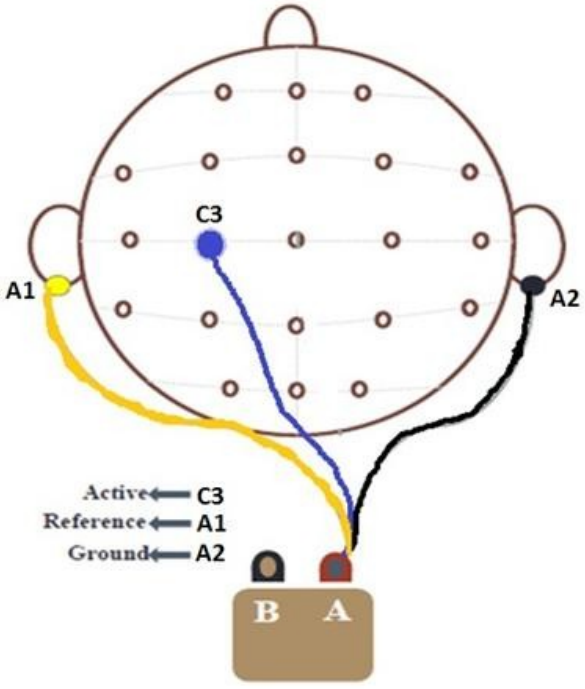
The EEG is defined as electrical activity of an alternating type recorded from the scalp surface after being picked up by metal electrodes and conductive media[6]. The common classification of EEG frequency is listed as follows[7,8]: delta waves at 0.5 to 4 Hz with variable amplitude are closely linked to deep sleep. Theta waves which arise from emotional frustration or disappointment ranged at 4 to 8 Hz. The frequency of alpha wave is set in the range of 8 to 13 Hz. Alpha is the most dominant wave in the brain region which linked to relaxed awareness, reflecting and inattention. Beta waves exhibit at the range of 13 to 30 Hz and are always associated to active thinking, alert and busy state. Meanwhile Gamma waves have the highest frequency range of 30 to 40 Hz. In most studies, which use quantitative EEG analysis, the properties of

measured EEG are computed by applying PSD estimation for selected representative EEG samples. The sample for which the PSD is calculated is assumed to be stationary[9]. In this study, changes in the EEG of dysgraphia children during writing were documented with PSD measurements, which were compared with the relaxing mood. Investigation of the PSD in both relaxing and writing EEG signals can help to understand how the brain works in these children.

2. Materials and Methods

Participants in the experiments were included 16 dysgraphia children (containing 6 girls and 10 boys aged 9.2±0.64), who had been introduced by some nonprofit elementary schools in Mashhad, Iran. All the patients had been studying in third grade and were selected among 154 students by some simple interviews and questionnaires. Parents about their child condition commented on the Colorado learning difficulties questionnaire (CLDQ)[10] and parents' Canners rating scale[11]. Also, parents were asked to fill out a consent form and they accept all the risks. All children have a learning disability in writing and the LD was confirmed by a psychiatrist. The equipment used in the experiments included a ProComp-5 Infiniti which was coupled with BioGraph Infiniti software constructed by company of Thought Technology in Canada. The International 10-20 System of Electrode Placement was used for EEG recording. Based on the Butlers suggestion, we set our EEG protocol in electrode position C3[12]. Active electrode was placed on C3, reference on the left ear and the other ear was connected to the ground electrode. Each child was asked to seat on the comfortable chair and after electrode placing they were wanted to listen to a dictation then write anything they heard. Brain signals were recorded simultaneously during the dictation task. In addition to the signals recorded during writing, EEG was recorded during relaxing mood with eyes open. The time has elapsed for each record was almost 4 and 2 minutes to the writing and relaxing moods respectively. Figure 1 shows the electrode position of EEG recording of LD children in both resting and writing.

Fig 1Electrode position of EEG recording of LD children in both resting and writing.



Motion artifacts and 50 Hz noise along with EOG and EMG noises were removed from obtained data by Butterworth filters. PSD was calculated via Welch's averaged, modified periodogram method by MATLAB software. It uses a Hamming window with the overlap of 50% and 1024 FFT points for default. After the extraction of theta (3-6 Hz), beta (15-20 Hz) and alpha (8-10 Hz) bands as well as the absolute power of these frequency bands from EEG denoised signal, the power ratios of theta/beta and theta/alpha of the signals were determined. Figure 2 illustrates the theta, beta and alpha extraction from clear EEG signal. Also, Figure 3 shows the PSD via Welch's method for alpha, beta and theta signals.

Fig 2 Theta, beta and alpha extraction from clear EEG signal

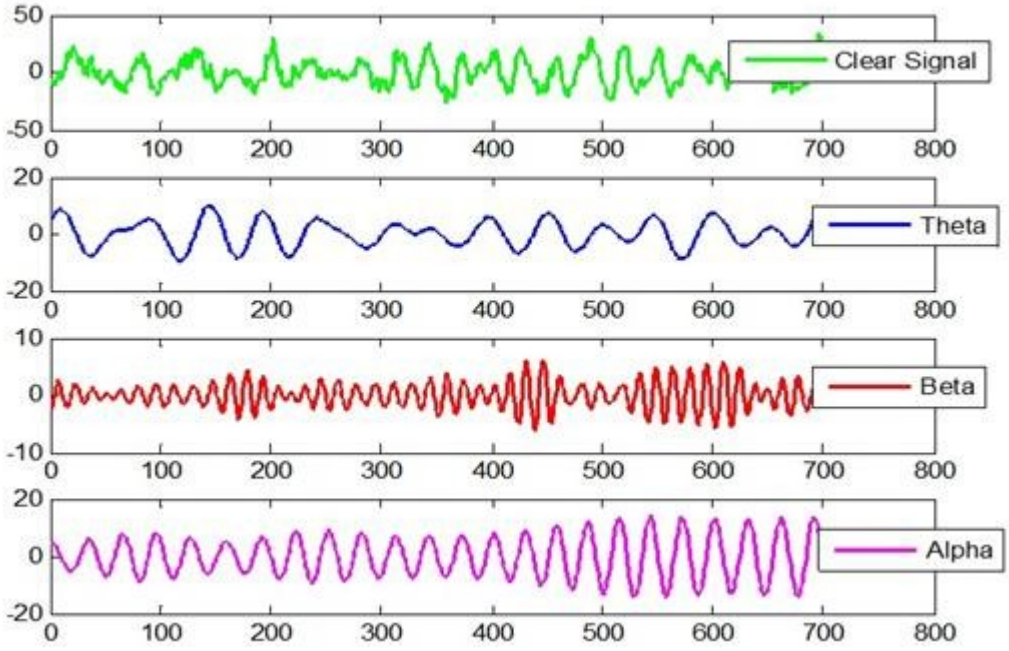
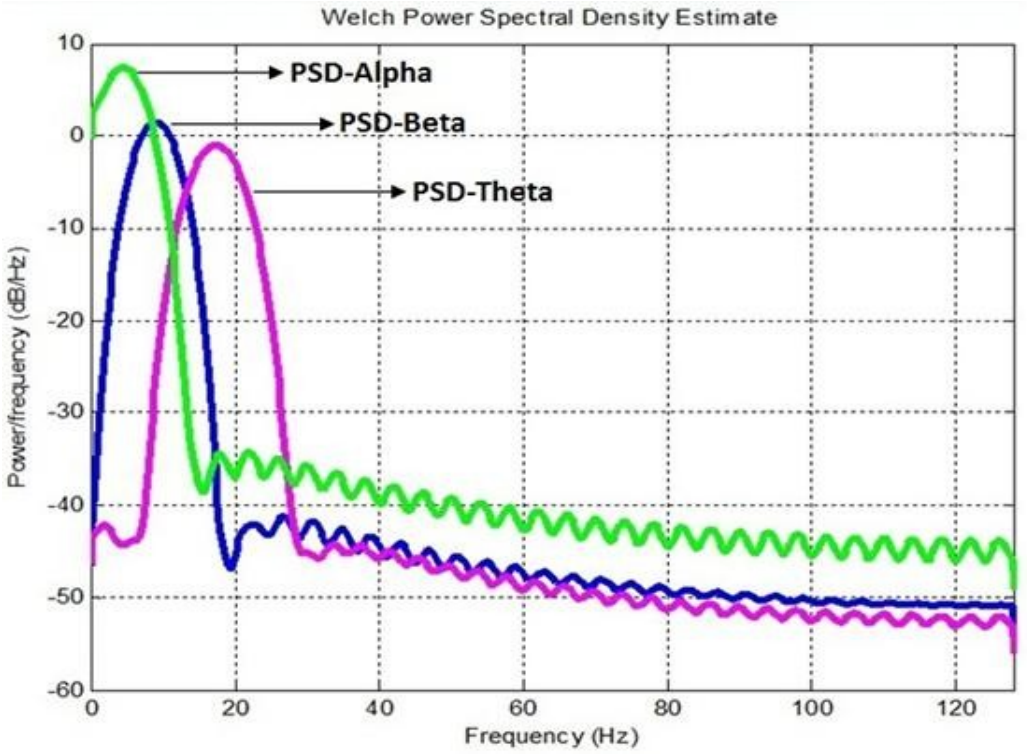


Fig 3PSD via Welch's method for alpha, beta and theta signals



3. Results

The average of PSD from EEG signal of dysgraphia children is depicted in figure 4. As it is seen in this figure, the PSD after removing noises and artifacts in the rest condition has lower values than the other mood.

Fig 4 The average of PSD from EEG signal of dysgraphia children in rest and writing

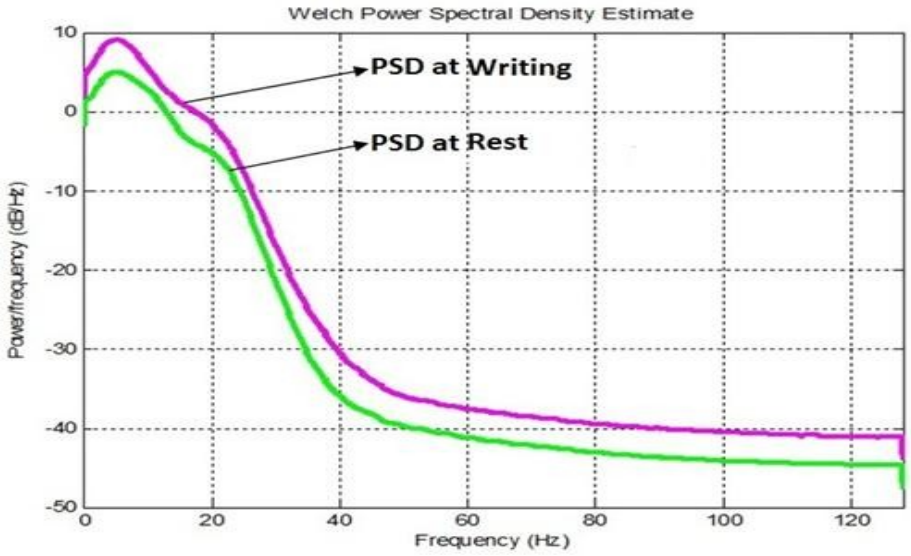
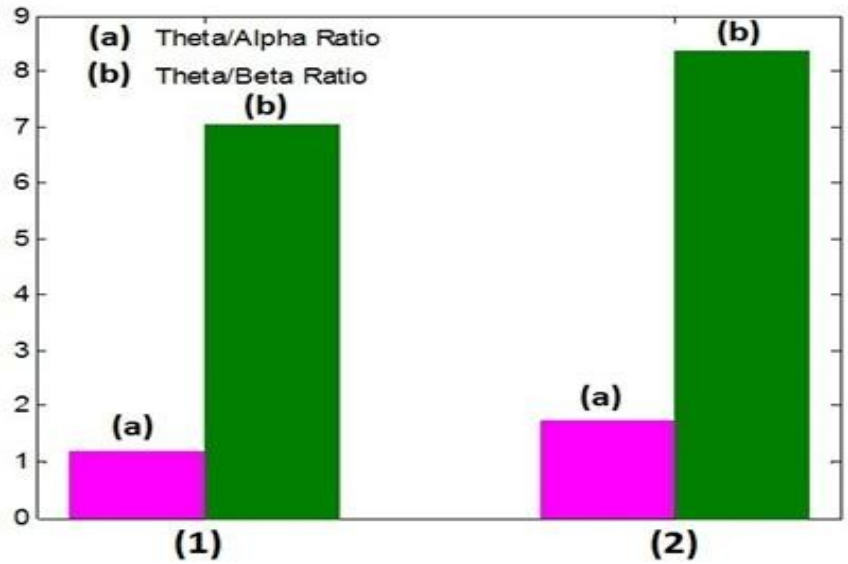


Figure 5 demonstrates the theta/beta and theta/alpha ratios which calculated in rest and writing moods for LD children. As expected, experimental results illustrate that LD children's brain in writing had more theta/beta and theta/alpha ratios than relaxing. The average of theta/beta ratio in writing task is 8.37 in contrast to 7.06 for the relaxing mood. Also, 1.726 and 1.197 are the average of theta/alpha ratios for writing and resting respectively. This meaningful differences show more immaturity in the brain when LD children write, so to overcome the situation, neurofeedback training can be suggested[13-17].

Fig 5 Theta/beta and theta/alpha ratios in rest (1) and writing (2) moods for LD children



4. Discussion

Although in the past years, several studies have been done on EEG signals of children with LD by nonlinear methods[18-21] but in all of these studies, the results have been compared with brain signals of normal children and almost no studies are available on analyzing the EEG signals of dysgraphia children in writing mood compare to the rest condition. Because of this lack of knowledge, in this study, analyzing EEG signals in children with dysgraphia in these two moods by PSD method were investigated in order to evaluate the differences between them in writing and relaxing moods. The results of PSD analysis by Welch method demonstrated that the existence of high amounts of theta/beta and theta/alpha ratios in writing in contrast to the rest condition which this indicates more brains failure during performing writing task by dysgraphia children.

5. Conclusion

This paper describes the PSD analysis of EEG signals obtained in LD children. The results of PSD analysis indicated that the frequency ratio in writing mood is higher than the rest mood. It has been shown that brain signals are more complicated for Dysgraphia children. The present results demonstrate that the quantitative EEG findings in these children have an evident relation with psychological measurements and could be because of the insufficient maturity of the brain. Neurofeedback is an operant conditioning procedure, by which the subject learns to control his/her EEG activity, therefore to overcome the LD situation it can be recommended strongly.

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