

The Effect of Neurofeedback on Iranian EFL Dyslexic Students

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Abstract

This research was designed to investigate the effects of neurofeedback on dyslexic students. Dyslexia is one of the most common psychiatric disorders of reading between children in schools. This research includes pre-test and post-test of Persian and English passages with a group of seven Persian dyslexic students with IQ between 95 to 105 were randomly selected from 25 dyslexic students (7 to 12 years old) which has been performed at Nima Ushij primary school in Tehran. The research tools were four English and Persian reading passages and neurofeedback system. After a six months treatment course by neurofeedback, finally t-test was used to analyze the results of pre and post-test to find whether neurofeedback was effective on their reading disability. Dyslexic children performed perfectly (except two brothers called maybe for genetic reason) on reading after neurophysiology treatment and a significant difference was statistically observed between their pre and post-test reading performance. At last, an oral interview was administered with parents to identify their children's improvement. Most parents were satisfied with the treatment and even expressed the neurofeedback effects on their children's self-confidence in personal life. With respect to the results of the research, neurotherapy is highly efficient and it will increase intelligence and mental capabilities and even self-confidence and reduces difficulties for reading of dyslexic students.

1. Introduction

The present study investigates the effect of neurofeedback training on dyslexic students on children in Persian and English between 7 to 12 years. Reading is apparently one of the most fundamental issues in language learning and teaching. Therefore, it occupies a key function in almost every language teaching and learning pattern. Yet, in many foreign language learning and teaching texts, little attempt is delivered to the elements that facilitate or delay the difficulties in reading. Therefore, a large number of Persian and English learners as a Foreign Language (EFL) learners are not able to conquer their reading's difficulty even though they expend vast amounts of time in order to master it. Scientists called the difficulty of reading "dyslexia". The origin of the term dyslexia suggests that it is a difficulty associated with reading, in fact most definitions describe dyslexia as a difficulty with accurate and fluent word recognitions. Dyslexia can cause difficulties with spelling and processing spoken information, but it is not just a difficulty in reading, it also has an effect on other aspects of producing and using language. It is going to influence not only the student's academic progress and performance but also other areas of life.

As dyslexia can cause problems in reading on students' first language, it is also effective on another languages. Students might mix up letters, misread words, read more slowly and have difficulties understanding meaning of text. They might have problems reading a text aloud and pay attention to what they are reading at the same time. The other difficulty is problems with spelling words correctly and difficulties with memorizing new vocabulary.

1.1. Significance of study

This topic of study is new and attempt to look at reading's disability when children are reading. In previous studies just proceed more in reading comprehension difficulties. But this study will proceed dyslexia as a difficulty with accurate and fluent word recognitions. It is expected that the findings of this research will help teachers. The results of the study are intended to create beneficial information for teachers, designers, and students by applying new facilities and also to arise their awareness of the importance of being more thoughtful and more careful on their around. To dominate these solicitudes authors must pay more attention to contents, applied topics, and the strategies which use in reading. Designers must be careful in designing and how represent the aims of authors in order to show the most interesting and beneficial strategies. Teachers must be intelligent in exploiting of facilities and must be aware how to extract all available strategies in their treatment.

1.2. Statement of the Problem

Every language learner has a couple of abilities and disabilities in learning. Effective communication skills of Persian and English language are necessary for the people of all professions. Hence, if you want to maintain both ways of communication better, that is, you need to gain mastery over all language skills. One of the skills is reading which is very important to achieve language learning's goals. Reading in Persian and English language will aid you in gaining effective communication skills. Here is a reading's challenge in language learners which is called "dyslexia" that unfortunately less was concerned about. Lots of article were written about reading, but there is a little about the most critical problem of reading (dyslexia).

1.3. Purpose of the Study

This study tries to examine children with the symptom of dyslexia may improve their reading by the use of neurofeedback system and compare the students of L1 and L2 reading improvement. The main purpose of this research is generally to explore and study the reading's disability in order to find its function between children and even adults, and to get the most effective solution in reading, and also if the readers have been successful in representing their purposes. The participants who are children between 7to 12 will be precisely analyzed in order to figure how neurofeedback system is effective in their reading that learners need to succeed in their daily lives. The study uses real language, real people, real places to connect learners of English and Persian to the world. In order to find out if the learners succeed to read more fluent during their special age, this paper notices to the neurofeedback system and its effects on kids in their reading process. Aim

of all teachers is, in particular, improve and guide their students in all levels, and also communication skill is highly essential and prominent for learners. So it is not really important in teaching field how old the learners are.

1.4. Research Question and hypothesis

This study tries to answer the following question and hypothesis:

- Can the use of neurofeedback help dyslexic students of Persian and English language as their second language read better?
- The use of neurofeedback can be helpful for dyslexic students of Persian and English language as their second language read better.

2. Method

2.1. Participants

The participants who are seven Persian children between 7 to 12 years old who all of them were boys with IQ between 95 to 105 were randomly selected from 25 dyslexic students in an elementary school (Nima Ushij) in Tehran. The dyslexic children were precisely analyzed in order to figure out how the neurofeedback system is effective on improvement of their disability of reading (with an almost similar degree of dyslexia) that children need to succeed in their daily lives. The matter of gender was not considered. The study uses real language, real people, real places to connect children of Persian to the world. In order to find out if the learners succeed to read more fluent during their special age, this research focuses on dyslexic children and its influences on kids in their reading process.

2.2. Study materials

2.2.1. Dyslexia test: the present research applied dyslexia test to assess reading ability and diagnose dyslexic students. The test includes three categories as following:

a) Reading errors: five types of current errors were considered to measure this category. The types are included: omission, addition, transposition, replacing, and reversing.

1) Omission: it means not hearing one or more letters in a word for example; این ها ← این (in Persian), called → call (in English).

2) Addition: it means adding one or more letters to a word, for example; خان ← خانه (in Persian), real →really (in English).

3) Transposition: it means moving letter order in a word without deletion and addition of any letter, for example; ببخشید ← ببشخید (in Persian), provide → prodiver (in English).

4) Replacing: it means deletion one or more letters and adding another letters instead of them, for example; طلافروشان ← طلافروشها (in Persian), prisoners → prisonerz (in English).

5) Reversing: it means reading a word from end to beginning, for example روز ← زور (in Persian), five → vife (in English).

2.2.2. Neurofeedback: "Neurofeedback is one of the applications of Brain—computer interface (BCI) in rehabilitation and behavioral medicine" (Torgesen, 2001, p. 55). Neurofeedback is reportedly applied to treat associated impairments in children with reading disability (Weeks, 2007) and also some of other psychiatric disorders. Some studies reported improvements in the reading ability and phonological awareness deficit, as well as changes in the EEG in children with reading disabilities as a result of neurofeedback in a single-subject study (Nachman-Katz & Friedmann, 2007). It was applied to improve dyslexic student during six months. Neuro-feedback (EEG Biofeedback) is typically provided by mental health professionals such as psychologists, family therapists, and counselors. These professions usually work with clients one-on-one. The training may also be provided by nurses, clinical social workers, rehabilitation specialists, and educators.

2.3. Procedure

The study was conducted in six months one treatment session (lasted about 1 hour) per week. After speaking with their teachers and parents and analyzing the students' marks the subjects were randomly selected from different classes, then they were tested through mentioned tests (Kids' WISC-R test, Phonological working memory test, Dyslexia test, Naming test, and Phonological awareness test) and their errors were carefully written down. The subjects were all Persian boys (because their family have asked privacy we cannot name the student). Both Persian and English texts were applied in order to reading test.

2.3.1. How dyslexic test was performed?

The test was performed individually so that they were sent to laboratory one by one. Then their age and gender were recorded. Next, the tests were started as bellow:

1. First of all, a friendly communication was created with the mentioned students.
2. The researcher said to the kids "I want to give you a text, please read it carefully and try to do that speedily without any stop, and learn the material you read. Because I will ask you about the text.
3. A text was presented to the kid. He was asked to start. We turned on a timer without absorbing his attention. Next the time was recorded.
4. During his reading, his errors were written down in an answer sheet.
5. When he finished, he was requested some questions clearly. Then his answers were recorded in answer sheet.
6. At last we appreciated their participation.

2.3.2. How neurofeedback was used to improve dyslexic students?

Through this device we applied electrodes to the scalp to listen in on brainwave activity. They process the signal by computer, and we also extract information about certain key brainwave frequencies (All brainwave frequencies are equal, but some are more equal than others...). It showed the ebb and flow of this activity back to the student, who tried to change the activity level. Some frequencies we wished to promote. Others we wished to diminish. Then, we presented this information to the student in the form of a video game. The student was effectively playing the video game with his brain.

Eventually the brainwave activity was "shaped" toward more desirable, more regulated performance. The frequencies we targeted, and the specific locations on the scalp where we listened in on the brain, were specific to the conditions we were trying to address, and specific to the individual. All forms of Biofeedback employ some type of computer or monitoring device along with electronic sensors to give information about what is going on in the body.

2.4. Data analysis

This research includes pre-test and post-test with a group of seven students having attention deficit disorder at the primary school has been performed. The research tools, were included four reading passages (English & Persian) to find out dyslexic students' reading errors (transposition, replacing, omission, addition, reversing errors), and neurofeedback system to improve their reading more fluent and accurate. Data analysis was performed in two pre-test (to record errors before working with neurofeedback) and post-test (to record errors after treatment with neurofeedback system) to figure out the effects of neurofeedback system. At last a t-test was applied to compare the results of two tests.

3. Results

3.1. Reliability Statistics

To do the pilot study, 7 students (7 to 12 aged) being the same as the main population of this study took part in it. Table 4.1 shows the reliability of the pre dyslexic participants' test were estimated in table 4.1. The result of dyslexic pre-test phases in the experimental group were gathered. A Persian reading (including 400 words) was presented to the dyslexic students to find their errors. Their errors at five types of current errors were recorded (table 4.1) in order to compare them after Neurofeedback treatment.

Table 3.1 *The result of dyslexic pre-test (Persian)*

Dyslexic test					IQ 95-105	
Experimental Group	Age	Transposition errors	Addition errors	Omission error	Replacing errors	Reversing errors
Student 1	12	9	7	3	5	6
Student 2	9	7	3	6	10	5
Student 3	12	10	6	12	6	9
Student 4	10	6	9	5	11	9
Student 5	8	8	5	3	7	2
Student 6	7	5	7	6	5	4
Student 7	7	5	4	7	9	7

The result of dyslexic pre-test phases in the experimental group were gathered. An English reading (about 400 including words) was presented to the dyslexic students to find their errors. Their errors at five types of current errors were recorded (table 4.2) in order to compare them after Neurofeedback treatment.

Table 3.2

The result of dyslexic pre-test (English)

Dyslexic test					IQ 95-105	
Experimental Group	Age	Transposition errors	Addition errors	Omission error	Replacing errors	Reversing errors
Student 1	12	6	12	3	8	8
Student 2	9	9	7	6	12	9
Student 3	12	13	8	12	9	9
Student 4	10	11	14	5	12	10
Student 5	8	9	7	3	10	12
Student 6	7	8	10	6	8	9
Student 7	7	9	8	7	11	10

As it can be seen in table 4.1 and 4.2, dyslexic students made more errors in English reading in compared with Persian reading. Probably it happened because they study English as a foreign language.

The researcher applied neurofeedback system to improve dyslexic students at elementary school. She worked on the students during 6 months course (about 24 session, one session per week, each session 1 hour). Through this device she applied electrodes to the scalp to listen in on brainwave activity. The electrodes process the signal by computer, and she also extract information about certain key brainwave frequencies (All brainwave frequencies are equal, but some are more equal than others). It showed the ebb and flow of this activity back to the student, who tried to change the activity level. Some frequencies researcher wished to promote and others diminish. Then, the researcher presented this information to the student in the form of a video game. The student was effectively playing the video game with his brain.

After treatment through neurofeedback, a reading post-test was administered to investigate the effects of Neurofeedback treatment. Post-test like pre-test was included two English and Persian

reading passages. Dyslexic students were asked to read the passages at as the same condition as pre-test.

Their errors were recorded and are illustrated in the following tables.

Table 3.3

The result of dyslexic post-test (Persian)

Dyslexic test					IQ 95-105	
Experimental Group	Age	Transposition errors	Addition errors	Omission error	Replacing errors	Reversing errors
Student 1	12	5	4	1	3	4
Student 2	9	6	3	5	9	4
Student 3	12	9	4	10	5	7
Student 4	10	3	4	2	6	5
Student 5	8	4	2	0	3	0
Student 6	7	2	2	3	2	1
Student 7	7	3	2	5	4	3

The result of dyslexic pre-test phases in the experimental group were gathered. An English reading (about 400 including words) was presented to the dyslexic students to find their errors. Their errors at five types of current errors were recorded (table 4.2) in order to compare them after Neurofeedback treatment.

Table 3.4

The result of dyslexic post-test (English)

Dyslexic test					IQ 95-105	
Experimental Group	Age	Transposition errors	Addition errors	Omission error	Replacing errors	Reversing errors
Student 1	12	2	7	1	4	5
Student 2	9	8	6	4	10	8
Student 3	12	11	7	10	8	8
Student 4	10	7	10	3	7	5
Student 5	8	5	5	1	8	7
Student 6	7	5	6	3	6	5
Student 7	7	6	4	5	8	6

As it can be easily realized at table 4.3 and 4.4, dyslexic students' improvement. In order to analyze pre-test and post-test, the researcher applied t-test

Table 3.5

T-test results

T- test results	Number	Mean	SD	SD error
Pre-test of dyslexic students	7	22/5	6/93	3/12
Pre-test of dyslexic students	7	43	5/58	2/52

Based on table 4.5, results showed that neurofeedback was an effective method in improving reading performance of students suffered from dyslexia disorder. According to the significant level of paired t test ($P < 0.003$), which is reduced 0.05. So we claimed that neurotherapy was effective on children's reading disorder who has dyslexia disorder. Considering the significant level of paired t test ($P < 0.005$), which is lower than 0.05, therefore the present research can claim after performing neurotherapy the difference level among variable children with reading disorder in pretest and post-test has increased and research hypothesis was confirmed. It can be reported that after performing neurotherapy the capability of reading of students significantly has improved.

3.2. Summary of results

With respect to the results, of the present research, neurotherapy will increase intelligence and mental capabilities and reduces difficulties for reading for students with dyslexia (deficit disorder) is useful and suitable. The present research also found out that the treatment was effective on the participants' reading comprehension. As their difficulties in reading were reduced, their reading comprehension ability was improved. After the treatment course, an oral interview was performed with their parents to find their satisfaction degree. Except Amirali and Amirmohammad's (they are brothers) parent, other parents were satisfied with the course. They also stated that the effects of neurofeedback treatment course are seen in their real lives, particularly in making communication with their peers and classmates. Connecting with others was difficult for some children before treatment.

To answer research question, it was realized that research hypothesis was confirmed because the results of T-test illustrated a significant difference between pre-test and post-test results.

4. Discussion

In this research, the researcher tried to develop participants' reading performance specially reading comprehension and investigate the effects of neurotherapy on their reading performance. This

Research question attempted to answer the question of whether neurofeedback system has any significant impact on the reading performance of Iranian dyslexic elementary students or not. During the period of the treatment, the participants in the experimental group were asked and encouraged to participate in treatment sessions completely. Their parents were also informed about the significant influences in previous research which has been carried out in Iran and all around the world. After comparing the results of the post-test they came to the conclusion that there was a significant difference between children's performance before and after treatment course of the study.

Over the last twenty years, there has been a large number of research focused on investigating the most influential methods or treating reading disability (dyslexia). We have had the opportunity to assess not only the effect of specific interventions on reading skill but also to devise

technologies which make it possible to study the way in which the brain shows reactions to these interventions.

This body of knowledge is complex, because although all individuals with dyslexia have a similar problem, namely, difficulty reading, they have heterogeneous characteristics, and depending on the child's developmental level, the demands of reading and the required skills are quite different (Torgesen, 2001).

The importance of neurophysiology has recently been attracted much attention as a pivotal feature in dyslexia. Several researchers have carried out on the impacts of neurofeedback system and received different results, but most of them gained the highly impacts of the device on reading comprehension.

There is a general agreement that 'earlier intervention to ameliorate reading is better than late intervention' (Forman & Moats, 2004; Nicolson, Fawcett, Moss, Nicolson, & Reason, 1999). However, it is not clear if this recommendation is important to prevent side effects on school motivation and achievement, so the present research achieved the similar results children have a better capacity for improving their reading level through neurofeedback system because of an assumed better plasticity of their neurobiological condition (see as secondary resources Draganski, Gaser, Busch, Schuierer, Bogdahn, & May, 2004; Green & Bavelier, 2003).

The present research is agreed with Nobr and McCarthy's study (1995) which reviewed evoked potential studies in normal word recognition. Word recognition is often impaired in dyslexia, and evoked potential studies are only used for studying discrete events.

Flynn, Deering, Goldstein, and Rahbar (1995) failed to confirm the theta activation but found reduced beta activity bilaterally in the dyslexic children and decreased right parietal/occipital beta activity in the dysphonetic children through neurophysiology. So the present research is not accord with their study.

The research confirmed the significant effects of neurophysiology as Shaywitz SE, Fletcher's study (1994) who mentioned that modern electro physiologic and brain imaging technologies have applied to increase diagnostic precision and demonstrate the neurobiological underlying of learning disorders. They also believe that electroencephalography (EEG) presents methods by which human brain activity can be measured during recognition procedures. Sally Shywitz introduces "computerized EEG studies" as a treatment which including evoked potentials (EP) or event-related potentials (ERP), spectral EEG analysis, and topographic EEG brain mapping have also identified a number of brain irregularities in individuals with learning disabilities.

Such an association problem could be the consequence of a slow and inefficient phonological lexicon (Snowling, 2000) or of a more general neurological timing problem preventing visual and phonological areas from being activated at the same time (Breznitz, 2002; Breznitz & Lauren Berman, 2003; Paulesu et al., 1996; Wolf & Bowers, 1999). According to this hypothesis, dysfluent readers have a deficit in storing words or parts of words in the orthographic

lexicon as a consequence of a lack of multiple, redundant associations between the single graphemes and grapheme clusters of word spelling and the single phonemes or larger morphophonological segments (e.g. syllables, morphemes, onsets, rimes) of word phonology. If this explanation is correct, then it should be possible to help poor readers to build up orthographic representations by highlighting the correspondences between the segments and the phonemic and phonological elements within words. This can be possible through using neurofeedback system. To improve dyslexic children Breznitz (2002) administered a neurophysiology course. After treatment course he found that if the suitable treatment is performed, participants with dyslexia will improve in reading performance. Therefore, the present research is highly according to Breznitz's study.

The research is also accord with Wolf & Bowers's study, 1999 which demonstrated that through this device they apply electrodes to the scalp to listen in on brainwave activity. They process the signal by computer, and they also extract information about certain key brainwave frequencies It shows the ebb and flow of this activity back to the person, who attempts to change the activity level.

In the case of organic brain disorders, the present research proves Green and Baveleir's study. They believe that it can only be a matter of getting the brain to function better rather than of curing the condition. When it comes to problems of dis-regulation, we would say that there is not a disease to be cured. Where dis-regulation is the problem, neurophysiology may very well be the remedy (Green & Bavelier, 2003).

4.1. Conclusion

Reviewing the studies in the second chapter of this research reveals the fact that the majority of the studies that caused significant improvements in dyslexic participants allocated much more time to their treatment period than this research did and more importantly, the points that were common in the most of those studies that helped the participants to increase their fluency and accuracy in reading proficiency level.

With all these sayings, we can conclude that training dyslexic kids with suitable treatment of umbrella neurophysiology like neurofeedback system and encouraging them to pay attention to different roles of neurophysiology is a life time process that should be considered from the very beginning of every academic year for dyslexic children and in every course both explicitly and implicitly. As this study illustrated us it is found out that neurofeedback roles not only are really significant and helpful in the field of Iranian dyslexic learners' reading comprehension but also it helps teachers in training of reading comprehension of the students with reading deficit disorder and how they encourage learners and guide their parents to pay attention all aspects of neurophysiology, in particular, neurofeedback.

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