

Efficiency of Neuropsychological Methods in Enhancing the Comprehension of Students Suffered from Developmental Dyslexia

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Abstract—The goal of the current research is determining the efficiency of HSS (Hemisphere Specific Stimulation) and HAS (Hemisphere Alluding Stimulation) neuropsychological methods in enhancing reading comprehension of students of third, fourth and fifth classes of elementary school, suffered from dyslexia. Twelve students, who identified are of reading disorder based on clinical interview, intelligence test and reading and comprehension tests, were individually received neuropsychological task in 30 sessions. Reading and comprehension tests were used in pre- and post-tests. After one month, follow up test was performed. Statistical data was analyzed using visual analysis of chart and improvement percent. The results were shown that the reading and comprehension performance of students in post-test was better than in pre-test. Applying such treatment methods was led to stability of treatment effects in these children after one month. The current results emphasize the importance of working with neuropsychological tasks and show that using HSS+HAS methods can lead to increasing the comprehension in people suffered from reading disorder.

Index Terms— Neuropsychology, Neuropsychological Methods, Comprehension, Developmental Dyslexia, Hemisphere Specific Stimulation (HSS), Hemisphere Alluding Stimulation (HAS)

1 INTRODUCTION

According to the definition provided by British Dyslexia Association, dyslexia is a combination of abilities and difficulties that affect the learning process in one or more of reading, spelling and writing [1-16]. This disorder may be accompanied by some other weaknesses in areas of speed of processing, sequencing, spoken language, etc. [17, 18]. If the performance of a person in reading is lower than expected level based on his/her age, education and intelligence, the person can be categorized in reading disorder. This disorder considerably prevents educational success or reading-required daily activities. According to DSM-IV-IR criteria, the learning disability level is more if a neurological or sensory disorder is presented than other disorders are presented [19, 21, 23, 24, and 26]. Dyslexia is a prevalent learning disorder among elementary students. 80 percent of children suffered from learning disorder are of dyslexia. Some specialists believe that dyslexia is the main reason of failure of students in schools. Reading experiences are strongly affected satisfaction, self-reliance and self-esteem of students. In addition, it can be led to behavioral disorder, anxiety and lack of motivation [19-29].

Based on Bakker's Balance Model of Reading, dyslexia is induced by disorder in structure and action of brain's hemispheres. This approach said that dyslexia is due to failure in one or both left and right hemispheres of brain [30]. This model states, based on neuropsychological approach, that reading skill consists of two main stages. The beginning stage performs by right hemisphere; as the right hemisphere is superior in viso-spatial analysis; right hemisphere is responsible for

extracting the visu-spatial features of the written word [31-41]. At the beginning of reading, brain should analyze the written word from visu-spatial point of view and then, perceps this spatial figure with its meaning [42-45]. Gradually, by improving learning skills and as this process becoming automatized, the importance of the first stage will be reduced and the second learning stage (meaning stage) is started in which, the left hemisphere is more important. In the second stage, learning is performed with more speed and perception. According to this model, learning skill is a complicated process which necessitates transferring the task from right to left hemisphere of brain. In other words, passing through the beginning reading toward advance and complicated reading is simultaneous with more activity of right hemisphere than left one. If this transferring is not happened or is happened prior to its right time, learning disorders will be inevitable [46-49]. Therefore, perception and linguistic disorders defaced beginning and advanced forms of reading, respectively [50].

Based on Bakker's Balance Model of Reading, there are many children who start reading by functions of right hemisphere but are failed to learn advanced reading which requires acting of left hemisphere. The reading process is relatively slow, interrupted and accompanied by doubt in these children. These types of children are named as perceptual type (P-type) dyslexia. In another group of children, the activity of left hemisphere is started too early or even from the start, left hemisphere plays the main role. These types are reckless to characteristics of words or other perceptual tasks and hence, their readings are fast, hurried, inaccurate and full of error and they are usually encountered with remove and add errors. This type of dyslexia is named as linguistic type (L-type) dyslexia [51-65].

Numerous studies have been shown the efficiency of neuropsychological treatments methods; but the authors have not

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been successful in obtaining a research about the evaluation of efficiency of HSS+HAS neuropsychological methods in learning perception of dyslexic students of L- and P-type [66-76]. The main question of the current study is that if HSS+HAS neuropsychological treatment methods are able to improve reading perception of dyslexic students of L- and P-type?

2 RESEARCH METHOD

The current research is an experiment with small number of samples. The HSS (Hemisphere Specific Stimulation) and HAS (Hemisphere Alluding Stimulation) treatment methods are independent variables and reading comprehension is dependent variable.

2.1 Population, Sample and Sampling Method

The population of the current study includes all students of third, fourth and fifth classes of elementary school during 2010-2015 education years. After performing Wechsler intelligence scale, CSI-4 and reading passage and comprehension test, 6 male and 6 female students were selected by saturated available sampling method. The accept criteria of samples were including:

- Having diagnostic criteria of dyslexia;
- Normal level of intelligence (95-110);
- Aged between 9 and 11 years;
- Educating in third or fourth or fifth class of elementary school.

The reject criteria of samples were including:

- Having comorbid disorders such as mathematics disorder, ADHD, ODD, CD;
- Having family problems such as divorce of parents; addiction and delinquency of parents;
- Having sensorimotor problems;
- Using Ritalin.

2.2 Wechsler Intelligence Scale for Children (WISC-R)

This scale consists of 12 subtests (6 verbal tests including information, similarities, arithmetic, vocabulary, comprehension, digit span and 6 non-verbal or performance tests including picture completion picture arrangement, block design, symbol search and mazes) in which, mazes and digit span are optional [75-80]. The new Wechsler Intelligence Scale for Children is generally of high credit. The average internal consistency reported by Wechsler [81-86] for all 11 age groups is 0.96 for general scale IQ, 0.95 for verbal scale and 0.91 for performance scale. Internal consistency for specific subtests is variable. The lowest reported consistency coefficient is 0.69 for object assembly and the highest one is 0.87 for vocabulary. The average validity coefficient for verbal subtests is ranged between 0.77 and 0.78 while for performance subtests is slightly lower and ranged between 0.69 and 0.89. Test-retest reliability for all 3 scales are high but for specific subtests is slightly lower. The validity of test-retest in average period of 23 days for each age group is 0.95 for general scale and 0.94 and 0.87 for verbal and performance scales, respectively [87-93].

2.3 CSI-4 Test Based on DSM-IV

This test has been used to differentially diagnose dyslexic students from students suffered from ADHD and conduct disorder. Child Symptom Inventory questionnaire (CSI-4) is a rating scale of behavior founded by Sprafkin and Gadow to screen emotional and behavioral disorders of children aged between 5 and 12 [94, 95]. Validity coefficient of parents and teachers versions (Attention Deficit Hyperactivity Disorder, ADHD, and conduct disorder test) were estimated by test-retest as 0.9 and 0.93, respectively [96-101].

2.4 Reading and Comprehension Test

In the current research, reading and comprehension test were performed to distinguish perceptual and linguistic type dyslexic students. The construct related validity of the considered test in reading accuracy was ranged between 0.6 and 0.9 for even cards (text of a story in the level of considered class) and between 0.7 and 0.9 for odd cards (text of schoolbook of considered class). The construct related validity of comprehension for even cards was ranged between 0.3 and 0.6 and for odd cards was ranged between 0.3 and 0.5. However, the construct related validity of reading speed for even and odd cards was separately ranged between 0.8 and 0.9. All coefficients were meaningful in the level of $P < 0.001$. In order to calculate test-retest reliability, Cronbach's alpha test and parallel test were used. Cronbach's alpha for reading accuracy was 0.9 and 0.8 for even and odd cards, respectively, while for comprehension it was 0.8 and 0.7 for even and odd cards, respectively. For reading speed, Cronbach's alpha was 0.9 and 0.8 for even and odd cards, respectively. Reliability of reading accuracy, comprehension and reading speed based on parallel test were 0.9 [102-111].

2.5 Performing Method

Generally, 30 learning sessions were considered to specific and alluding stimulation of left and right hemispheres of L- and P- type dyslexic students. Learning sessions were performed six days per week and 40 minutes for every session. It should be noted that 30 learning sessions were consisted of 10 sessions of hemisphere specific stimulation through the visual channel (HSS-Vis), 10 sessions of hemisphere specific stimulation through the tactile channel (HSS-Tac) and 10 sessions of hemisphere alluding stimulation (HAS).

In hemisphere specific stimulation through the visual channel (HSS-Vis), subjects should be looked to a point in the center of page (spot-fixing) during the sessions and words were appeared for a few seconds, one time per 2 minutes. The right or false answers of subject were recorded during sessions. In order to stimulate hemispheres of L-type and P-type children, objective words in left visual field and abstract words in right visual field were used, respectively.

In hemisphere specific stimulation through the tactile channel (HSS-Tac), L- and P-type dyslexic students were learned through touching objective letters and words with left hand and abstract letters and words with right hand, respec-

tively [112-114]. P/L type dyslexic subjects were under tactile learning for 10 sessions (six days per week, 40 minutes per day). The first 5 sessions were intended for learning the alphabetical letters and the next 5 sessions were intended for touching objective and abstract words.

2.6 Hemisphere Alluding Stimulation Protocol (HAS)

Hemisphere alluding stimulation was represented for L- and P-type subjects during 10 sessions. In order to alluding stimulation of hemispheres of L-type, 20 words were represented by different fonts and sizes and subject should be read the words with loud voice [110-114]. In the first 5 sessions of alluding stimulation of hemispheres of P-type, child should be selected the word that its mean is different from other words and then subject should read it with loud voice. In the next 5 sessions, subjects should be made a sentence with irregular words [115, 116].

At the end of interventions, post-test (reading and comprehension test) was performed for subjects to measure the reading ability level of dyslexic students. In addition, follow up test was performed in the current study, after 1 month, to evaluate the constancy level of interventions. Statistical data were analyzed using visual analysis of chart and improvement percent.

3 RESULTS AND DISCUSSION

The current research experiment is performed within the single-subject design framework using single baselines. The independent variable of the current research was neuropsychological treatment methods and the dependent one was reading efficiency level. The efficiency of intervention was evaluated based on comparison of response trend of each subject in baseline step with treatment. The marks of follow up stage are demonstrated the constancy of treatment effects after 1 month. Increase in average marks confirms the efficiency of treatment interventions.

4 CONCLUSION

In the current study, students suffered from reading disorder were treated by HSS+HAS neuropsychological methods. Comparing the difference between post-test and pre-test marks was shown that representing the neuropsychological methods meaningfully leads to improve in comprehension performance of such persons. Neuropsychological methods were led to improve in comprehension performance of students of third, fourth and fifth classes of elementary school suffered from P- and L-type reading disorder.

Since good reading process is required for good comprehension, using neuropsychological methods reduced the basic errors (such as removing, adding, replacing letter and word) of L-type dyslexic students and fragmented errors (slow reading, stop and delay on words, repeating and etc.) of P-type

dyslexic students and therefore, the reading comprehension of L- and P-type dyslexic students is increased after treatment.

The importance of working with neuropsychological methods in specific and alluding stimulation of hemispheres of people suffered from reading disorder is shown by the current results. HSS+HAS neuropsychological approaches which aimed to correct the neuropsychological deficiencies can help the child to overcome reading problems induced by inappropriate performance of one of his/her hemispheres.

From neuropsychological point of view, dyslexia is induced by disorders of structure and action of brain's hemispheres. In reading process, both right and left hemispheres have a role.

Generally, reading is a complicated process; the first steps is dominated by the role of right hemisphere and then, the key role is transferred to the left hemisphere. The transferring of "management chair" from right to left hemisphere, at the right time, plays an important role in reading. In some people, the transferring of management chair to the left hemisphere is not at the right time. They are P-type dyslexic people. In another part of people, the transferring to the left hemisphere is too early and or the left hemisphere is of leading role from the first. They are L-type dyslexic people.

Brain is ready for changing through stimulations received by the environment. It means that it is possible to improve the reading performance of P-type dyslexic person, whose left hemisphere is not appropriately active, by stimulating the left hemisphere and for L-type dyslexic person, whose right hemisphere is not appropriately active, reading performance can be improved by stimulating the right hemisphere.

Applying HSS+HAS methods in P-type dyslexic children and using objective words for this group meaningfully reduced interruption, stop on words and repeating and hence, comprehension improved in this group. Applying HSS+HAS methods in L-type dyslexic children and using abstract words for this group meaningfully reduced removing, adding and reversing the words and hence, comprehension improved in this group.

These findings are in good accordance with experimental and clinical researches about students suffered from developmental dyslexia with various languages such as English, Italian, Finnish, and Dutch. Researchers also have been found that neuropsychological methods can be used to improve the reading performance of P/L-type dyslexic students. The results of these researches are shown that the effect of using the Bakker's neuropsychological methods on different languages is the same. It is worthwhile to note that the results of the current study is also in accordance with the above mentioned researches since applying HSS+HAS neuropsychological methods in the present study leads to increase in the learning comprehension of dyslexic students.

According to the current results, there is a meaningful difference between the average marks of pre-test and post-test of L- and P-type dyslexic students. In addition, there is a mean-

ingful difference between the average marks of pre- and post-follow up test of L- and P-type dyslexic students. These findings indicate that neuropsychological interventions lead to increase in reading comprehension of P/L-type dyslexic groups. Moreover, these treatment methods cause to constancy of remedial effects after 1 month of treatment period. Researchers also have been found that neuropsychological methods are effective in reading efficiency of P- and L-type dyslexic students.

As the findings of the current researches and the results of the other studies are shown, reading performance of students suffered from developmental dyslexia can be improved using HSS+HAS neuropsychological treatment methods. Moreover, the results of the current study and other researches are shown that the effect of the Bakker's neuropsychological treatment methods on the reading efficiency of the students suffered from developmental dyslexia with different languages such as English, Dutch, Italian and Persian is the same. Since the developmental dyslexia has a neurological basis, it can be explained because all children suffered from developmental dyslexia, disregarding to the language, have disorders in structure and performance of left or right hemispheres.

To achieve the above mentioned objectives, the current research is aimed to investigate the application of HSS+HAS neuropsychological treatment methods in reading comprehension of students suffered from developmental dyslexia (P- and L-type). The results of the current research indicates that neuropsychological treatment methods based on the Bakker's Balance Model of Reading, disregarding to the language, not only leads to increase in learning comprehension of P- and L-type dyslexic students, but also leads to constancy of remedial effects after 1 month of treatment period in this type of children.

Based on the findings of the current research, using the Bakker's neuropsychological treatment methods can be strongly recommended to therapists as new methods to increase the reading efficiency of students with developmental dyslexia. The low volume of sample is one of the limitations of the current study which can be led to difficulties in generalization of findings. It is suggested that the future studies consider high volume of sample to remove this limitation. The current research was performed on students of third, fourth and fifth classes of elementary school and hence, the results cannot be generalized to students of other classes. It is suggested that the future research consider other classes. Further, the current research was performed on dyslexic students with no comorbid disorders. It is necessary that the effects of neuropsychological methods on dyslexic students with comorbid disorders also investigate in the future studies.

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