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Effectiveness of Neurofeedback Therapy with Cognitive-Behavioral (Play Therapy) in Improving Attention and Cognitive Function in Children with Learning Disorder in Primary School

Zahra Hajmohammadi, M.A.
Kobra Haji Alizadeh, Ph.D.
Roghayeh Arteshdar, M.A.
Department of Psychology, Bandar Abbas Branch, Islamic Azad University, Bandar Abbas, Iran.

Abstract

This study aimed to evaluate the effect of Neurofeedback (NFB) Therapy with Play Therapy in improving attention and cognitive function in students with Learning Disorder (LD). This study adopted a quasi-experimental research with a pre-test and post-test design. The statistical population of the research was about 600 elementary school students with LD in Lar in 2017 (N=212). A sample of 60 LD children who were identified in schools was selected by multistage cluster random sampling and randomly divided into three experimental groups and one control group. The tools used in the study were the Wechsler Intelligence Scale for Children (WISC-R) (Wechsler, 2003) and integrated visual and auditory continuous performance (IVA) (Sandford & Turner, 1995). NFB training was done according to Monastra et al. (2005) and play therapy cognitive performance and attention therapy were based on Drewes (2009) in 20 sessions while no intervention was performed in the control group. Data were analyzed using the covariance analysis method. The results showed that NFB and play therapy were effective in increasing cognitive performance ($p<0.01$) and attention ($p<0.01$) compared to the control group. The combination of play therapy and NFB intervention was more effective on cognitive performance and attention rather than the two interventions separately. According to the results, it is recommended that therapists and clinical psychologists use NFB and play therapy to increase the sustained attention and working memory of students with LD.

Keywords: Attention, Cognitive function, Learning Disorder, Neurofeedback, Play therapy

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Corresponding Author: Kobra Haji Alizadeh
Email: ph_alizadeh@yahoo.com

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Introduction

Learning Disorder (LD) is not a psychiatric disorder but it is closely related to psychiatric and medical situations and developmental disorders (Thurm et al., 2019). LD refers to a sorely inharmonious clinical group defined as significant tribulation in acquiring or using arithmetic, writing, or reading skills (NJCLD, 1987). In the Diagnostic and Statistical Manual of Mental Disorders (DSM–5), LD is common in all functional areas such as writing, reading, and math (APA 2013). LD in children can lead to failure in school activities (Ouherrou1 et al.,

2019). It affects between 5% and 15% of school-age children with different languages and cultures (APA, 2013; Karande et al., 2009). Lack of attention is one of the main issues of this disorder on the academic performance of students. Attention means having a focused and purposeful mind on a specific object, subject, or several things at a time (Grigorenko et, 2020). New findings show that children with LD have abnormal brain activity, mostly in the theta and alpha domains and the brain disorders of this group of students do not allow them to learn well and this leads to their escape from learning environments (Becerra et al., 2006). These children usually show low mental function due to abnormal brain activity (Jones & Bender, 1993).

NFB is an effective method where a person can learn to correct the electrical activity of their brain. The goal of NFB is to redress any EEG abnormality, resulting in an attendant improvement in cognitive and/or behavioral efficiency (Vernon et al., 2004). The EEG of LD children is determined by more slow activity, principally in the alpha range, and theta less than normal children of the same age (Chiarenza, 2021); therefore, a sufficient NFB protocol could be to reward the decrease of alpha-theta ratio in the area with highest ratio (Becerra et al., 2006). Some research revealed the profits of utilizing NFB using games in the treatment of attention disorders or improving cognitive skills (Yildirim & Varol, 2013).

Another method used to improve children's LD is 'play therapy'. This therapy involves the therapist using play therapy techniques to help people cope with psychological and social problems and to grow and develop in the environment they are exploring and experimenting with (Chan, 2020). Play is necessary to achieve therapeutic goals and communicate with a therapeutic room in the environment. In the game room, the choice of game is not limited, as long as it takes into account the interest of the customer (Rathnakumar, 2020). This technique helps children with problems solve their problems, and at the same time, 'play' is a natural tool for the child. A set of games can be used to stimulate parts of the brain involved in LD which will help to treat or prevent this disorder. There is no exactly similar research on the role of this treatment on the memory and social skills of children with LD but some studies have shown the effectiveness of other techniques of this treatment on children. Behavioral and psychological problems were examined and it was reported that this method is effective in improving the cognitive problems of children with cognitive disorders (Landreth et al., 2009). It can improve the child's level of adaptation to the class and promotes communication and social skills in students (Esmaili et al., 2019). In this regard, researchers showed that group play therapy is an effective way to improve interpersonal relationships and reduce negative emotions in children with LD (Heshmati et al., 2016). Also, it was found that play therapy sessions were sufficient for improving social skills, socialization and communication with peers in children (Ansari et al., 2014).

Another factor that this technique can affect in children with LD is memory function. Previous investigations have shown that memory impairment is an important feature of children with LD (Soriano-Ferrer et al., 2014; Ziereis & Jansen, 2015). Working memory and play training can enhance children's working memory performance through cognitive rehabilitation programs. For example, play therapy significantly improved processing speed, cognitive flexibility, and predictive memory scores as well as verbal and memory scores (Pirabasi & Safarzadeh, 2020). Due to neurological problems as well as insufficient treatment methods for LD (Fernandez et al., 2003) and side effects of therapeutic drugs, the development of non-pharmacological methods has become very important (Healey et al., 2011), thus, this study sought to examine the effects of play therapy on improving neurological disorders and prevention of drug side effects in students with LD.

Much research has been done to investigate the effect of NFB on improving symptoms of attention-deficit/hyperactivity disorder and some functional components in children with this disorder. For example, Nourizade et al. (2015) investigated the effect of NFB training on the cognitive processing of children with attention-deficit/hyperactivity disorder. After receiving NFB sessions, cognitive processing increased in children. In another study, Seilsepour et al (2013) showed that NFB can improve the symptoms of attention-deficit/hyperactivity disorder. Oraki et al. (2015) investigated the effect of NFB on improving working memory in children with attention-deficit/hyperactivity disorder. The results of their research showed that the increase in alpha waves as a result of NFB can increase working memory in children. Bakhshayesh et al. (2011) concluded that NFB can reduce the initial symptoms of attention-deficit/hyperactivity disorder. Also, Alvarez et al (2013) investigated the effectiveness of NFB in reducing cognitive damage caused by cancer and showed that NFB can reduce cognitive damage in these patients. To add to the literature, the current study aimed to examine the effectiveness of NFB therapy with cognitive-behavioral (play therapy) in improving attention and cognitive function in children with LD in primary school.

Method

This study adopted a quasi-experimental design with pre-test and post-test. The study was conducted according to the standards of Iranian society in 4 months in Lar in 2016.

Participants

The present study was conducted with 60 male and female students with LD in primary school. Children were divided into 4 groups, three experimental groups (NFB, play therapy, NFB and play therapy) and a control group. The researcher randomly selected an area and then the students who had LD were selected. They were evaluated with cognitive performance and attention tests, and 60 students with the weakest performance were randomly selected into four groups. All groups were homogeneous in terms of normal intelligence (Wechsler IQ test). Further, 15 students were placed in each group. The inclusion criteria were as follows: not being in the group of mentally retarded people and not receiving medical or psychological treatment to reduce cognitive problems.

Instruments

Computer Audio-Audio Continuous Performance Test (IVA)

This test was created by Sandford and Turner in 1995. This test is a computerized method that consists of two parts, visual and auditory. Moreover, the four parts of the test include warm-up, practice, main performance, and relaxation. Further, during the test, the person is told to press a key when they hear or see the number one. If it responds to the number 2, which is not the target, it indicates impulsivity, and if it responds less to the number 1, which is the target, it indicates a lack of attention. This test has a sensitivity (0.92) and a positive predictive power (0.89) for use in measuring ADHD (Sandford & Turner, 1995). In research, the children's attention scale, and 50 ADHD rating scales were calculated, and the percentage of agreement was between 90 and 100%. They reported a coefficient of 0.75, which indicates the optimal reliability of this test. To assess validity, this test was performed on people with and without ADHD. In 92% of cases, this test can correctly diagnose the disorder and the reported coefficient indicates the optimal validity of this test (Hamidi, 2013). In another study, the retest coefficient was 0.89; the validity coefficient with the neurological set tool is reported to be 0.60 (Madani et al., 2015).

Wechsler Intelligence Test for Children Form 4

One of the most prestigious intelligence tests is the Wechsler Intelligence Test, which is designed for three age groups: adults, children, and preschool. In 1991 the Wechsler Children's Scale 3 was published and in 2003 the Wechsler IQ Scale 4. All Wechsler scales provide three types of intelligence, while Wechsler children derive four or five types of intelligence: verbal comprehension intelligence, perceptual intelligence, working memory intelligence, processing speed intelligence, and total intelligence. This test has an average of 100 and a standard deviation of 15. The Wechsler Form IV intelligence test is administered to children aged 6 to 16 (Wechsler, 2003). This test was standardized in 20 by Abedi et al. (2015). The reliability coefficient of micro-tests through Cronbach's alpha is reported between 65 and 91.

Electroencephalography (EEG)

Electroencephalography is a device that records brain waves using electrodes attached to the head. Brain waves from specific points on the head are recorded for an hour using a special cap worn over the head.

Procedure

After performing the IVA and The Fourth Wechsler Intelligence Test, and the inspection of the inclusion and exclusion criteria, sixty children were selected as the sample. Participants were then randomly assigned to experimental NFB (N=15), PT (N=15), NFB + PT (N=15), and the control group (N=15) after filling out the consent forms. Then the experimental groups experienced quantitative electroencephalography (QEEG) for treatment protocol. NFB, play therapy, and a combination of NFB and play therapy was performed on the experimental groups for 30 sessions of 45 minutes. In the meantime, no treatment was performed in the control group. In each session, the participant sat on a chair and standard electrodes were attached to the participant's head at specific points of CZ, C3, and C4. In the first session, the QEEG patient was recorded and the NFB function was explained to the participants for better results. In the treatment sessions, the participant's efforts were accompanied by the therapist's encouragement, and each participant's protocol was written according to his or her own QEEG. In this study, NFB was unipolar. It included the status NFB device and NeXus-4 software, and participants were treated with the first alpha/theta protocol in the Cz region and the second protocol in the C3 and C4 regions of the SMR protocol.

NFB Protocol

NFB training was provided to the corresponding experimental group during 20 sessions of 45 minutes (twice a week) using the NFB device. Completion of 20 sessions of NFB training was done according to the guidelines recommended by Monastra et al. (2005).

Alpha/theta protocol: protocols have been used that increase the first alpha/theta protocol in the Cz region and the goal was to reduce alpha to levels 8 to 12 and theta 4 to 8.

SMR protocol: This method was used to increase the concentration of participants and was implemented in areas C3 and c4 in this beta protocol. The SMR boosted 12 to 15 Hz and theta 4 to 7 Hz, and the high beta suppressed 22 to 30 Hz.

Table 1.
The NFB protocol in 20 Sessions

Session	Increase Accuracy and Attention (Cz)	Increase Accuracy (F3)	Reduce Tension And Increase Concentration (T3)
Session 1-3	15	10	10
Session 4-10	15	15	5
Session 11-20	15	10	10

Play Therapy

These games were aimed at increasing the coordination of eye and hand movements and strengthening mental functions, including visual and auditory memory, as well as increasing concentration and attention (Schaefer, 1993). Treatment guide was presented to the first and second experimental groups individually during a one-hour session three times a week for eight weeks, as follows (Drewes, 2009):

Table 2.
The Play Therapy Protocol in 20 Sessions

sessions	Program	Aim
Session 1	Child and therapist introduction session Practice frosting and mazes	Provide a safe and appropriate environment, encourage and strengthen relationships
Session 2	Remember: show the card to the child and ask for the picture details	Boost visual memory and short-term memory
Session 3	Memorize and repeat the words heard	Enhance auditory and short-term memory
Session 4	One-sided crawl 5 minutes to the right and 5 minutes to the left	Reorganization of the nervous system
Session 5	Practice sandbags and throw the ball with both hands and the top hand into the basket	Strengthen brain processes and flourish learning skills
Session 6	Practice frosting and more complex mazes Practice sandbags and throw the ball with your left and right hands	Eye-hand coordination, strengthening brain processes, and increasing accuracy and attention
Session 7	Hitting the Bells: Repeat kicks after the therapist	Coordinate eye and hand movements, enhance auditory memory and short-term memory
Session 8	Read the story to the child and ask questions about the story and Sandbags and balls	Strengthen learning and auditory memory skills
Session 9	Practice frosting and more complex mazes and Practice sandbags and throwing the ball by the therapist Receiving the ball by the child with the hand chosen by the therapist	Eye-hand coordination, strengthening brain processes, and increasing accuracy and attention
Session 10	One-sided crawling and memorizing words and repeating words after the therapist	Strengthens the nervous system and auditory memory and short-term memory
Session 11-20	Repetition and practice of games in which the child continued to perform poorly	Coordinating eye and hand movements and strengthening memory and mental processes

Data Analysis

After collecting the data and converting some of them into the required data, SPSS 20 software was used. Then, the data were analyzed in two sections: descriptive and inferential statistics. In the descriptive statistics section, indicators such as mean, standard deviation, frequency, frequency percentage, and graph were examined. In the inferential statistics section, using multivariate analysis of covariance, the effect of the intervention on post-test

scores was controlled by controlling pre-tests. Before analysis of covariance, assumptions of analysis of covariances such as normal data distribution and homogeneity of variance were examined.

Results

Sixty students with specific LD participated in this research. The mean and standard deviation of age in four groups were as follows: NFB combined with PT 9.67±1.05, NFB group 9.93±1.67, PT group 9.27±1.62 and control group 8.87±1.12. In addition, the minimum age of the participants was 7 years and their maximum was 12 years.

Descriptive indicators related to pre-test and post-test components of attention are presented in Table 3.

Table 3

Descriptive Indicators of the Pre-Test and Post-Test Components of Attention

Variable	Group	Level	Mean	SD
Visual attention	NFB and play therapy	Pre-test	65	12.82
		Post-test	91.67	14.55
	Play therapy	Pre-test	66.87	11.87
		Post-test	76.47	6.79
	NFB	Pre-test	64.87	12.20
		Post-test	85.87	16.92
	Control group	Pre-test	65.33	8.93
		Post-test	63.13	10.81
Auditory attention	NFB and play therapy	Pre-test	60.67	9.09
		Post-test	85.67	14.64
	Play therapy	Pre-test	60.4	5.91
		Post-test	75.67	14.32
	NFB	Pre-test	60.93	10.45
		Post-test	70.73	20.88
	Control group	Pre-test	60.33	9.90
		Post-test	65.60	10.20
Total attention	NFB and play therapy	Pre-test	125.67	12.63
		Post-test	177.33	26.93
	Play therapy	Pre-test	127.27	14.13
		Post-test	152.13	17.16
	NFB	Pre-test	125.80	17.88
		Post-test	156.60	34.86
	Control group	Pre-test	125.67	15.11
		Post-test	128.73	11.92
Verbal intelligence	NFB and play therapy	Pre-test	56.6	9.95
		Post-test	68.40	9.09
	Play therapy	Pre-test	55.40	15.27
		Post-test	65.73	4.59
	NFB	Pre-test	57.47	19.95
		Post-test	68.67	11.59
	Control group	Pre-test	55.93	12.18
		Post-test	53.33	11.18
Practical intelligence	NFB and play therapy	Pre-test	60.60	7.72
		Post-test	77.60	11.76
	Play therapy	Pre-test	61.13	7.63
		Post-test	75	10.92
	NFB	Pre-test	63.20	6.72
		Post-test	70.53	9.66
	Control group	Pre-test	60.07	6.86
		Post-test	61.13	7.92
General Intelligence	NFB and play therapy	Pre-test	117.20	10.23
		Post-test	146	11.83
	play therapy	Pre-test	116.53	12.52
		Post-test	140.73	8.16

Variable	Group	Level	Mean	SD
	NFB	Pre-test	120.67	14.78
		Post-test	139.20	15.17
	Control group	Pre-test	116	12.50
		Post-test	114.47	10.08

The results showed the factors of visual attention, auditory attention, and total attention, as well as the components of verbal intelligence, practical intelligence, and general intelligence in the post-test, has increased compared to the pre-test. However, these components are not much different in the control group.

Table 4

Results of Kolmogorov-Smirnov Statistic to Evaluate the Normality of Data Distribution in Post-Test of Dependent Variables

Variable	Statistical index	NFB and play therapy	play therapy	NFB	Control group
Visual attention	Statistic	0.52	0.72	0.48	0.54
	Level	0.95	0.68	0.97	0.93
Auditory attention	Statistic	0.55	0.66	0.69	0.61
	Level	0.92	0.76	0.72	0.85
Total attention	Statistic	0.45	0.65	0.62	0.41
	Level	0.99	0.80	0.83	0.99
Verbal intelligence	Statistic	0.58	0.66	0.61	0.59
	Level	0.89	0.78	0.85	0.87
Practical intelligence	Statistic	0.84	0.67	0.84	0.62
	Level	0.48	0.74	0.48	0.84
General Intelligence	Statistic	0.57	0.63	0.42	0.53
	Level	0.90	0.83	0.99	0.94

Normality of Data Distribution

To check the normality of data distribution, the one-sample climograph-Smirnov test was used, which is one of the most widely used tests for this purpose. In this test, the similarity of the form of data distribution with the normal distribution was investigated and unlike most statistical tests based on the researcher's significance, it sought to confirm the null hypothesis. As seen in Table 4, the test statistic in all variables in all groups was not significant at the level of 0.05; therefore, it can be concluded that the distribution of scores is normal.

Homogeneity of Post-Test Variance

Table 5

The Hypothesis of Homogeneity of Post-Test Variances of Attention

variable	F	DF1	DF2	SD
visual attention	0.93	28	1	0.34
auditory attention	0.02	28	1	0.89
total	1.23	28	1	0.32

The hypothesis of homogeneity of post-test variances of visual attention, auditory attention, and total attention as well as verbal intelligence, practical intelligence, and general intelligence is examined by the Leven test in Table 5 because it is necessary to establish it before performing univariate analysis of covariance. Statistical F in visual attention, auditory attention, and total attention as well as verbal intelligence, practical intelligence, and general intelligence was not significant at the level of 0.05 Therefore, the null hypothesis is confirmed; That is, the post-test variance of attention components in the two groups were not significantly different and were the same.

Results of Multivariate Covariance Analysis

Table 6

Test Results of Effects Between Subjects on the Components of Attention and Cognitive Functions

Variable	Variables	SS	DF	MS	F	P-value	Effect Size
Visual attention	Group	6091.98	1	6091.98	34.92	0.0001	0.57
	Error	4536.27	26	174.47			
	Total	190432	30				
Auditory attention	Group	2980.77	1	2980.77	23.51	0.0001	0.47
	Error	3296.74	26	126.80			
	Total	179087	30				
Total attention	Group	17595.37	1	17595.37	44.13	0.0001	0.63
	Error	10366.96	26	398.73			
	Total	732437	30				
Verbal intelligence	Group	1674.26	1	1674.26	16.03	0.0001	0.38
	Error	2715.46	26	86.85			
	Total	115752	30				
Practical intelligence	Group	1918.66	3	1918.66	22.09	0.0001	0.50
	Error	2258.008	26	86.85			
	Total	149201	30				
General Intelligence	Group	7177.52	1	7177.52	56.08	0.0001	0.68
	Error	3327.81	26	127.99			
	Total	520379	30				

According to the results obtained in Table 6, the F statistic of the post-test scores of the attention and intelligence components in the NFB groups along with play therapy and the control group has become significant at the level of 0.01. Therefore, taking into account the initial differences of the participants, it can be said that NFB combined with cognitive-behavioral play therapy has improved children's cognitive performance.

Table 7

The Results of the Analysis of the Effects Between the Subjects of the NFB Group on the Components of Attention and Cognitive Functions

Variable	Variables	SS	DF	MS	F	P-value	Effect Size
Visual attention	Group	3843.51	1	3843.51	17.84	0.0001	0.41
	Error	5600.54	26	230.72			
	Total	176029	30				
Auditory attention	Group	151.65	1	151.65	0.66	0.42	0.02
	Error	2998.61	26	230.72			
	Total	147159	30				
Total attention	Group	5522.06	1	5522.06	8.43	0.007	0.24
	Error	18028.90	26	654.96			
	Total	635442	30				
Verbal intelligence	Group	1325.52	1	1325.52	11.25	0.002	0.30
	Error	3126.63	26	120.25			
	Total	117028	30				
Practical intelligence	Group	513.99	1	513.99	7.64	0.01	0.23
	Error	1749.81	26	67.3			
	Total	132869	30				
General Intelligence	Group	3534.08	1	3534.08	32.81	0.0001	0.56
	Error	2800.85	26	107.72			
	Total	491835	30				

In Table 7, the results revealed that the components of cognitive performance in the two NFB and control groups are significant in visual attention and total attention, but not significant in auditory attention, and

the findings also show that cognitive performance in intelligence components is at level 0.01 is significant.

Table 8.
The Results of the Analysis of the Effects between the Subjects of the Play Therapy Group on the Components of Attention and Cognitive Functions

Variable	Variables	SS	DF	MS	F	P-value	Effect Size
Visual attention	Group	1212.18	1	1212.18	17.28	0.0001	0.40
	Error	1823.48	26	133.17			
	Total	149778	30				
Auditory attention	Group	750.28	1	750.28	5.63	0.02	0.18
	Error	3462.37	26	133.17			
	Total	154759	30				
Total attention	Group	5067.83	1	5067.83	19.85	0.0001	0.43
	Error	5067.81	26	194.92			
	Total	601867	30				
Verbal intelligence	Group	1116.27	1	1116.27	14.42	0.001	0.36
	Error	2012.13	26	79.39			
	Total	109526	30				
Practical intelligence	Group	1503.81	3	1503.81	16.30	0.0001	0.38
	Error	2397.98	26	92.23			
	Total	142986	30				
General Intelligence	Group	5211.33	1	5211.33	58.99	0.0001	0.69
	Error	2296.63	26	88.33			
	Total	495982	30				

According to the findings of Table 8, cognitive performance in the two groups of play therapy and control is significant in the components of attention, and the results of cognitive performance in the components of intelligence in the two groups of play therapy and control are significant.

Table 9
Tukey Post Hoc Test Results for Binary Comparison of Attention Components and Cognitive Function

Variable	Group	Difference of mean	Error	P-Value
Visual attention	NFB+ play therapy and play therapy	15.20	4.92	0.01
	NFB+ play therapy and NFB	5.80	4.92	0.47
	NFB and play therapy	9.40	4.92	0.15
Auditory attention	NFB+ play therapy and play therapy	10	6.16	0.25
	NFB+ play therapy and NFB	14.93	6.17	0.05
	NFB and play therapy	4.93	6.16	0.70
Total attention	NFB+ play therapy and play therapy	25.20	9.96	0.04
	NFB+ play therapy and NFB	20.73	9.96	0.11
	NFB and play therapy	4.46	9.97	0.89
Verbal intelligence	NFB+ play therapy and play therapy	2.66	3.25	0.69
	NFB + play therapy and NFB	0.27	3.25	0.99
	NFB and play therapy	2.93	3.25	0.64
Practical intelligence	NFB + play therapy and play therapy	2.60	3.94	0.79
	NFB + play therapy and NFB	7.07	3.95	0.19
	NFB and play therapy	4.47	3.94	0.50
General Intelligence	NFB + play therapy and play therapy	5.27	4.66	0.50
	NFB + play therapy and NFB	6.80	4.66	0.32
	NFB and play therapy	1.53	4.66	0.94

Based on the results of Table 9, visual attention and total attention in two groups under NFB training with play therapy and play therapy are significantly higher and the average of the group under NFB training with

play therapy is significantly higher. In other variables, there is no significant difference between the groups, but in the components of cognitive function, it is not significant in the three experimental groups.

Table 10

The results of the Analysis of the Effects Between the Groups of the Play Therapy Group on the Components of Attention and Cognitive Functions

Variable	Between Sum of Squares- SSB	Within the sum of squares- SSW	F	P-Value
Visual attention	1765.20	7618.80	4.86	0.01
Auditory attention	1736.71	11975.60	3.04	0.05
Total attention	5241.31	31292.67	3.64	0.03
Verbal intelligence	78.93	3333.87	0.50	0.61
Practical intelligence	383.24	4913.33	1.64	0.21
General Intelligence	381.64	6835.33	1.17	0.32

According to the results in Table 10, the findings make it clear that the difference in the post-test scores of visual attention, auditory attention, and total attention in the three groups has become significant, and no significant difference in the post-test scores of intelligence components has been shown in any of the three groups.

Discussion

The results of the current study showed that NFB improved visual and total attention as well as cognitive function in children with LD. The outcomes of the current study are consistent with the results of Naimian et al. (2022) who compared the efficacy of cognitive rehabilitation and NFB on specific LD among primary school children. The results of the study showed that NFB and cognitive rehabilitation are impressive in increasing the quality of specific LD in primary school children. Besides, the study performed by Khaghani et al. (2022) showed that NFB therapy has been effective in sustainable attention. Also, NFB has been effective in sustaining the attention of dyslexic elementary students in post-test and follow-up. Concerning attention, this findings are consistent with the results of the other research (Fernandez et al. 2016; Jacobs, 2006; Kim et al. 2014) proposing that, after the NFB treatment sessions, the participants showed significant growth in their concentration.

In terms of cognitive function, the findings are consistent with the results of research by Fernandez et al. (2007), Fernandez et al. (2008), and Linden et al. (1996). In explaining these findings, it can be pointed out that the auditory reinforcer was more impressive in decreasing the theta/alpha ratio, and it improved the cognitive abilities more than the visual reinforcer. Also, repeated exercises improve cognitive operations related to attention. Because these types of exercises create an adaptation of anatomical neural networks associated with these processes, most attention training programs based on theories of psychological neurology believe that stimulation of attention-related structures improves the ability to pay attention (Hill & Castro, 2002). It can be argued that changes in the level of behavior are a reflection of changes in the level of the brain. NFB as a therapeutic method focuses directly on brain waves and changes in behavior can be considered a consequence of changes in brain waves. In the current study, increasing beta waves in the frontal lobe increase the functions of this lobe. NFB activates the prefrontal cortex and produces a beta wave, resulting in increased frontal lobe function and attention function.

The results of this study showed that cognitive-behavioral play therapy has improved visual, auditory, and total attention as well as cognitive function (verbal intelligence, practical intelligence, and general intelligence). In confirmation of the findings of the present research, Karami and Lorestani (2022) showed that play therapy can be used as a convenient way to reduce emotional, alexithymia and its components and academic problems in children. In the other study, Jubhar et al. (2022) found that play therapy resulted in children with disabilities managing to play traditional Japanese children's games, including improving their fine motor skills, cognitive abilities, and creativity.

Play therapy in the form of games gives the child more self-awareness of environmental stimuli and consequently a higher sense of control. In play therapy, Games such as pantomime of emotions, two-way storytelling, and puppetry help children release emotions and feelings as well as recognize their facial and physical symptoms. In the same way, empathy and companionship with the child's emotions are done during this process. In this method, by reducing special emotions such as the child's anxiety and fear, the ground for entering the stage of cognitive intervention is provided. At this stage, the dysfunctional and irrational thoughts of the child are intervened and desirable and appropriate thoughts are replaced by unpleasant thoughts to adapt to anxious situations. For this purpose,

solutions are provided by the child and the therapist. Then these strategies and positive self-talk are practiced and learned in the form of puppet shows and role-playing games. Finally, writing and drawing strategies and creating a book will help in reviewing and remembering the learned material. The results showed that there was a significant difference in the attention only between the group under NFB with play therapy and the group under play therapy, and the mean of the group under NFB with play therapy was higher. Explaining this finding, we can point to the interactive role of play therapy and NFB in improving the attention problems of children with LD.

In explaining the present findings, it can be said that NFB training changes the frontal lobe, in a way that affects three parts of the motor cortex, sensory-motor, and cingulate. The action of the sensorimotor cortex is more than just directing the sensorimotor functions; this part helps the cerebral cortex in decoding cognitive and physical activities. Therefore, people who have problems with cognitive tasks can benefit from the effects of NFB in the left sensorimotor cortex (Madani et.al, 2014). NFB also increases beta waves and decreases theta waves , which in turn, improves the symptoms of the disorder. Improving the symptoms of the disorder can lead to better cognitive performance. On the other hand, the increase of beta waves by increasing alertness, concentration, and metabolism can improve cognitive functions (Madani et.al, 2014). Theta waves are associated with distraction, inattention, and anxiety. In NFB, the computer game is controlled without hands and only with brain waves. The person notices his/her abnormal brain waves and tries to correct his/her brain waves by keeping the game and getting reinforcement. A person consciously notices the connection between external processes and his/her brain waves. At the unconscious level, the brain learns how to put its waves in a certain state. Gradually, conscious and unconscious skills are learned, transferred to real life, and affect the performance of the person.

NFB can contribute to the proper functioning of the brain through the changes it creates in the brain wave profile. This abnormal compensation helps the person be more alert and able to increase his attention and as a result show better cognitive performance (Seilsepour et.al., 2013). In addition, neuropsychological research has shown that people with attention-deficit/hyperactivity disorder develop synapses and neural connections show deficits. Therefore, proper stimulation of the brain can help the expand their synapses, establish normal activities, and improve their cognitive functions (Nourizade et.al, 2015).

This research does not include the follow-up phase. This research was conducted on a limited sample and one should be cautious in generalizing its results. It is suggested to investigate the effectiveness of other NFB treatment programs in future research. Also, the research should be done with a larger sample and with a follow-up period.

Conclusion

The results of this study showed NFB and play therapy as effective methods to increase the ability of sustained attention and working memory can be used in educational and medical centers. According to the results, it is recommended that therapists and clinical psychologists use NFB and play therapy to increase the sustained attention and working memory of students with LD. With the cooperation of clients and the use of this treatment, the hope is that attention and stable working memory of people with LD improves.

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Conflicts of Interest

No conflicts of interest declared.

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