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Research Paper

The Effectiveness of Montessori Method of Education on Neuropsychological Functions of Students with NVLD

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Abstract

The purpose of this study was to investigate the effect of Montessori method of education on the neuropsychological functions of students with nonverbal learning disorders. Four first grade students diagnosed with nonverbal learning disorders based on the researcher-made neuropsychological test for the diagnosis of non-verbal learning disorders (Movahedipour et al., 2020) were selected from Nabi Akram Elementary School in Bonab in 2020. The selected students received Montessori method of education for ten separate sessions by using a single subject study design with multiple baselines (ABA). They were followed up three weeks after the intervention. Finally, the data obtained at the baseline, intervention and follow-up stages were analyzed by visual diagram analysis, percentage of all non-overlapping data (PAND), effect size and recovery percentage. The results showed that Montessori method of education improved the neuropsychological functions of students with nonverbal learning disorders.

Keywords: *Montessori method, Nonverbal learning disorder, Neuropsychological functions.*

Introduction

Children with nonverbal learning disorders (NVLD) often have impaired math skills, executive functions, and fine motor control, which may occur due to visual processing defects (Bunker et al., 2020). People with NVLD are more likely to be weak and unable to perform tasks that require skills related to their left body. A large proportion of these cognitive, behavioral, and motor functions, which are impaired in the functioning of individuals with NVLD, appear to be associated with brain damage in neuropsychological assessments, which is evidence of learning disabilities in early childhood (Rezaei Kouchaksarai et al., 2014). Introduced by Johnson and Michaelbast (1967), NVLD is a type of neuropsychological dysfunction that arises from the right hemisphere of the brain and causes defects in visual-spatial processing, organization and evaluation (Abdullah, 2019). Typically, NVLD affects three specific areas: 1- Motor problems 2- Problems related to visual-spatial organization 3- Social interaction and communication problems (Hash Marcus, 2019). Movahedipour et al. (2019) introduced the following nine components as NVLD neuropsychological functions in the neuropsychological test: visual attention and visual memory, tactile attention and tactile memory, tactile perception, processing and spatial visual perception, functions Performance, coordination and perceptual-motor integration, coarse and fine motor skills, nonverbal reasoning, and spatial orientation and orientation.

The Montessori training program provides an effective opportunity to strengthen the five senses (Yildizbach and Eshlyuksek, 2016). Many Montessori activities are designed to help children control their muscles and movements. These activities strengthen children's finger muscles (Kaya and Yildiz, 2019).

Now, the main question of the present study is whether teaching Montessori method is effective in increasing the neuropsychological functions of students with non-verbal learning disorders?

Methodology

The present study used a single baseline multi-baseline (ABA) design. Accordingly, in the first stage, the baseline of the desired behavior was determined using a neuropsychological test to diagnose NVLD for all the participants. In the second stage of the treatment protocol, Montessori method training was initially performed only for the first student. After a few sessions, treatment protocol proved effective in changing the behavior of the first student in the predicted direction. Then an independent variable was applied to the second student. After the effectiveness of the independent variable for the first and the second students, therapeutic sessions were

performed for the third and the fourth students. Finally, the effects of the intervention were determined by comparing their behavior at the baseline and their behavior after the intervention.

The subjects of the study included four male students of the first grade of elementary school who were diagnosed with NVLD based on the researcher-made test: Psychological diagnosis of nonverbal learning disorders by Movahedipour et al. (2020). They were selected by convenience sampling according to the inclusion criteria and participated in the training program.

The tool used in this study was a neuropsychological test for the diagnosis of NVLD. This test consists of nine subtests with a total of 29 questions. The highest score in this test is 60 and the response time for nine subtests is 30 minutes. If a child scores less than 18.5, they are diagnosed with NVLD. The components of this test were significantly correlated with the components of the IQ subtest of perceptual reasoning on the Wechsler scale in the four students at the 0.01 level. This result confirms the simultaneous validity of the test. The total reliability of the test was confirmed through Cronbach's alpha of 0.81 and split half method of 0.78.

Results

The research hypothesis was "Montessori method training increases the neuropsychological functions of students with NVLD." Table 1 shows the students' scores and recovery percentage.

Table 1: Students' scores at baseline, intervention and follow-up stages.

Fourth student	**Third student**	**Second student**	**First student**	**Assessment stage**
First baseline	16	17	16	18
Second baseline	17	17	17	17
Third baseline	16	16	17	17
Fourth baseline	15	14	16	16
Fifth baseline	14	15	16	15
Sixth baseline	14	15	15	15
Seventh baseline	15	14	15	16
The first intervention session	17	16	17	15
The second intervention session	17	17	16	16
The third intervention session	18	19	18	16
The fourth intervention session	19	18	18	17
The fifth intervention session	18	17	19	19
The sixth intervention session	19	19	20	20
The seventh intervention session	20	19	19	21
The eighth intervention session	21	20	21	21
The ninth intervention session	21	21	20	20
The tenth intervention session	20	21	19	20

Fourth student	Third student	Second student	First student	Assessment stage
Percentage of recovery	24	21	16	33
Overall improvement	23	23	23	23
The first follow-up	17	18	17	17
The second follow-up	18	19	20	19
The third follow-up	20	17	19	20
The fourth follow-up	18	20	18	21
The fifth follow-up	19	18	20	20
The sixth follow-up	19	19	18	18
The seventh follow-up	20	19	20	19
Percentage of recovery	22	20	17	38
Overall improvement	24	24	24	24

Figures 3-6 also show the students' data on the amount of neuropsychological functions at baseline, intervention and follow-up stages. Then PAND index, phi coefficient and Cohen d are reported for each student and then for the whole group. As seen in Figures 2, 3, 4 and 5 of the midline, the stability envelope and the trend line for each student are shown in three stages: baseline, intervention and follow-up. According to the figures, all the data related to the students at the baseline, intervention and follow-up stages are within the stability envelope. According to Table 6, the trend of changes at the baseline stage is decreasing for the students and increasing in the intervention stage.

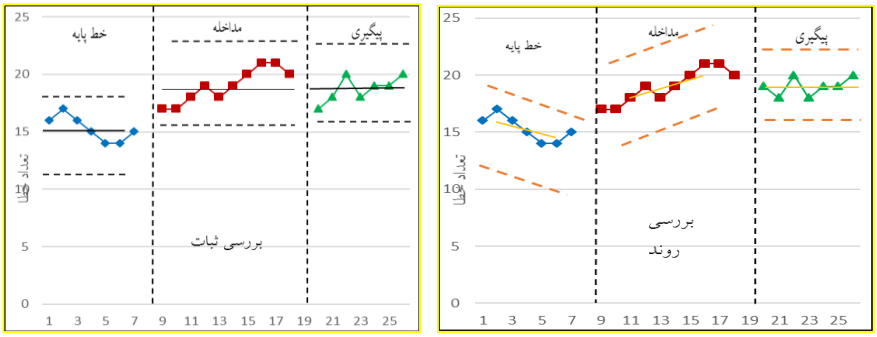

Figure 2: Examining the stability and trend of data for the first student.

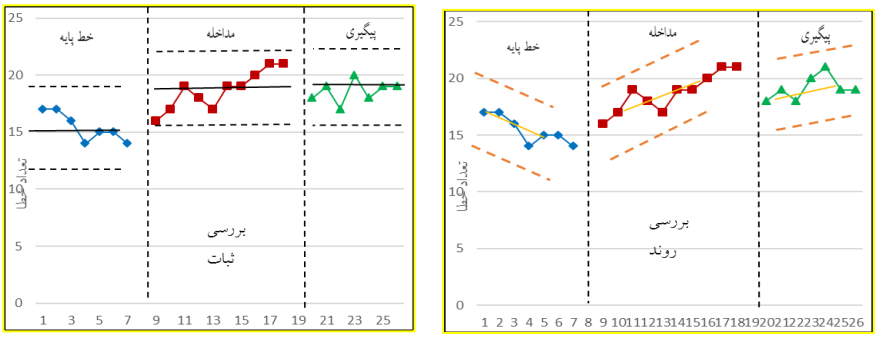

Figure 3: Examining the stability and trend of data for the second student.

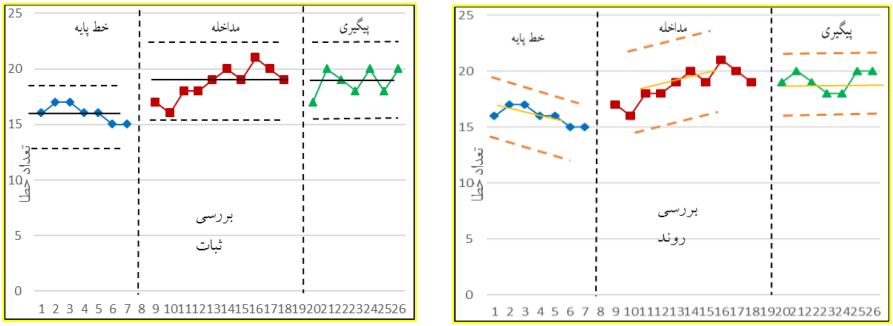

Figure 4: Examining the stability and trend of data for the third student.

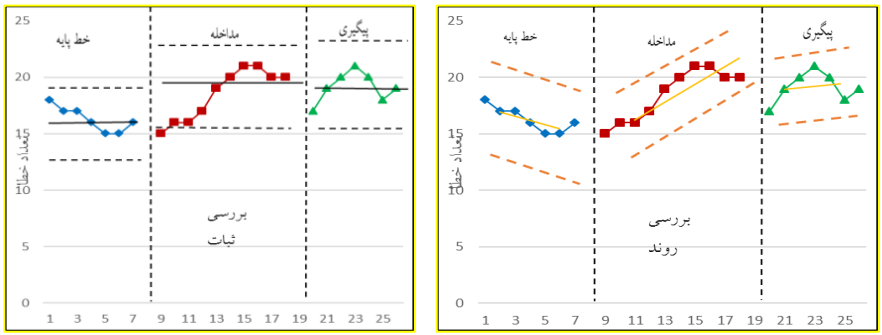

Figure 5: Examining the stability and trend of data for the fourth student.

Table 6: Results of in-situ visual analysis

Position sequence	**Baseline**				**Intervention**			
Level								
Student	First	Second	Third	Fourth	First	Second	Third	Fourth
Median	15	15	16	16	19	19	19	5.19
Mean	15.28	15.42	16	13.85	19	18.7	18.7	18.5
Rang	+3	3+	2+	3+	4+	5+	5+	6+
Stability	18.2	18.2	19.2	19.2	22.8	22.8	22.8	23.4
envelope	11.8	11.8	12.8	12.8	15.2	15.2	15.2	15.6
Percentage of stability envelope data	100	100	100	100	100	100	100	90
Rang of stability envelope	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
Level of change								
Relative level change	-2	-1.5	-1.5	-2	+2	+3	+2	+4
Absolute level Change	-1	-3	-1	-2	+3	+5	+2	+4
Trend								
Direction	Descend	Descend	Descend	Descend	Ascendant	Ascendant	Ascendant	Ascendant
Stability	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
Percentage of stability envelope data	100	100	100	100	100	100	100	100

To evaluate the effect of Montessori method training on all the students, the percentage of PAND overlapping data method was used. This index was also converted to phi coefficient and then Cohen d statistic. The sum of overlapping observations is 11. According to these numbers, the percentage of total overlapping observations is 16.17. The PAND index is obtained by subtracting the percentage of overlap from 100, the value of which is 83.83. The resulting phi coefficient was 0.67. Cohen d statistic was also obtained as 1.81. This number is part of the size of large effects. According to these findings, Montessori method training had a high effect on increasing neuropsychological functions of all the students.

Discussion and conclusion

The aim of this study was to investigate the effect of teaching Montessori method on neuropsychological functions of students with NVLD. The results of visual analysis of the graphs, PAND method, effect size and percentage of recovery of the subjects showed that Montessori method training increased the neuropsychological functions of students with NVLD.

The effectiveness of Montessori method of education on increasing neuropsychological functions of children with NVLD can be explained as enriching the learning environment supports brain development, promotes learning and acts as an effective stimulus in children's psychological development (Di Garbo et al., 2011). Alamian Rad and Shafipour Motlagh (2015) reported a significant relationship between the four components of

Montessori education (educational goals, educational methods, educational tools and equipment and educational activities) and enriching the learning environment. Furthermore, Moradi and Movahedi (2017) examined the effect of enriching the learning environment on improving neurocognitive functions of attention in children with developmental coordination disorder, and concluded that perceptual-motor exercises can be used as an interventional method for improving neurocognitive functions of attention in children with developmental coordination disorder. To scientifically confirm this, animal studies have reported that a rich learning environment affects the child's brain and can even extend the period of brain flexibility sensitivity (Di Garbo et al., 2011).

One of the limitations of the present study was that in single-subject studies, repeated measurements may cause subjects to learn, and therefore scores may decrease or increase. It is suggested that future research examine the effectiveness of computer-assisted cognitive rehabilitation on the neuropsychological functions of children with NVLD.

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