

Original Article

## Occupational therapy interventions effect on mathematical problems in students with special learning disorders (Dyscalculia)

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**Objectives:** Dyscalculia is specific learning disability affecting the acquisition of mathematic skills in an otherwise normal child. The aim of this study was investigation of occupational therapy interventions effect on mathematical problems in students with special learning disorders.

**Method:** 40 students with dyscalculia (2-5 grades) were selected and divided through randomized permuted blocks method into two groups; 20 persons as intervention group and the others as the control group. Initially both of groups were administered by the "Iran Key math Test". Then intervention group received occupational therapy interventions for 20 sessions individually and two groups were administered by the Test again. Data was analyzed by using Paired and Independent T tests.

**Results:** By the paired sample t-test the mean of total marks of Iran Key math Test demonstrated statistically significant difference in both of groups ( $P<0/05$ ), but the measure of difference in intervention group was more than control group. The mean of marks of Basic Concepts, Operations and Applications demonstrated statistically significant difference at intervention group.

**Conclusion:** Occupational therapy interventions had clinical effect on mathematical problems in students with special learning disorders.

**Key words:** OT interventions, Mathematical Problems, Learning Disorders, Dyscalculia

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### Introduction

Dyscalculia is a basic disability in doing expected arithmetic skills according to intelligence ability and educational level of a child. It prevents educational performance or daily life activities, and the resulted problems are beyond the disorders related to each kind of sensory or nervous deficits. At present most of the students in different educational levels, have problems in learning math, and however they try as much as the others of the same age but do not have the expected progress. Estimating its prevalence, when it is not accompanied by other special learning disorder is nearly one case of five children who have learning disorders. This disorder is usually accompanied by dyslexia or dysgraphia and accompanies by some complications such as educational problems, shame, weak self-image, disappointment and depression that lead to escaping

from school and finally disappointment about educational success. Mathematic is one of the most known human knowledge. It has been used to solve the problems and issues of human being since long time ago. It is considered among pure sciences from one side and a part of applied sciences from the other side. Disability in learning mathematics (dyscalculia) is observed in two shapes, primary and secondary. In primary mathematics learning disability (LD), the affected people have problems in perceiving the basic concepts of math, basic operations and applying math.

These skills deficits can generate problems in recognizing the shape and size, sets and figures, one by one congruence, counting, visual-auditory constancy, locus value accounting skills, measurement, money value, time, quantity language and problem solving ability (1). Sodabeh Malekpoor

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(1993), preparing math specifying test and comparing the performance of normal students to the students with math learning disorder, showed that there is a significant difference between the performance of two groups in total score, recognizing geometric shapes, size, one by one congruence concept, counting, recognizing sets and figures, visual-auditory constancy, locus value, four basic operations and problem solving(2). In secondary math learning disability, the basic problem is language fundamental structures weakness, visual and auditory perception skills, motion, memory and attention, It prevents the students to do mathematical operations (3,4). Adinezadeh (1995), comparing the visual perception of the students with dyscalculia to normal students showed that there is a statistical significant difference in visual perception, spatial relationship, distinguishing position in space, form constancy and figure ground discrimination and on the whole the visual perception of the students with dyscalculia is significantly less than normal students (5). Rosenburgh (1989) mentions the existence of perceptual-motor and attention deficits in the children with dyscalculia (6). Hetch and et al. state that some math disorders are the results of auditory-verbal deficits and cause dyslexia too, whereas some others may be the product of spatial-visual performance deficit (7). In fact it is possible to state that the primal mathematical disorder can arise from the secondary disability. With due attention to the importance of mathematical basic concepts perception and doing calculating operations and the application of these cases in daily life in dyscalculia and different complications that they may generate, it is necessary to use proper methods to correct and eliminate them. During late 20 years special educations have been suggested for the children with learning disorders .Occupational therapists duty is treatment the children with learning disorders using different methods and integrated approach of existent methods(8). Therefore the following questions were propounded whether occupational therapy (OT) intervention will be effective to improve mathematical problems of the students with dyscalculia such as mathematical basic concepts, operations and applications or not.

In previous studies, the effect of occupational therapy intervention in mathematical disorder has not been considered so much so, the goal of this study is effect of OT interventions in mathematical problems improvement such as math basic concepts, operations and application on affected primary school students with dyscalculia.

### **Method:**

This study was an empirical kind. The studied people were 40, second to fifth grade students with special dyscalculia. They were chosen in an available way among those who had come to Ardabil learning disorders centre in 2008-2009. Then they were divided into two groups; intervention ( $n=20$ ) and control group ( $n=20$ ) by randomized permuted blocks.

Dyscalculia had been discriminated in their educational files and their intelligence quotient(IQ) score was more than 85 in (WISC-R) scale. They had normal physical motion, normal behavior and visual-auditory health and did not use a special drug at the time. The mathematical problems of these people were evaluated by Iran-Key math standard test.

This test has first been norm sought by Connolly (1988) and then by Mohamad Esmaiel (1997) in exceptional children research institute between the students who were 6 years and 6 month old to 11 years and 9 month in 11 provinces of the country. It has three areas math basic concepts, operations and application. Its validity has been calculated by content, separating and predictor validities and its simultaneous validity has been gained between 0.55 to 0.67. Its reliability has also been reported by Cronbach's Alpha between 0.80 to 0.84 (9). At first, both groups took Iran-Key math test. Scoring base of this test was zero-one and the scores less than 85 that 3 standard deviation lower than the mean score (100) in each area was an indicator of problem existence in that area. Then in intervention group, determined OT interventions were exerted during 20 sessions each 45 minutes. They were taken place twice a week for four months individually by the researcher. Then two groups were evaluated once more by Iran-Key math test. The interventions were determined and Organized on the basis of visual perception, auditory perception, memory, Attention and motor skills and they performed in intervention group. It should be mentioned that whole interventions and exercises have been organized from simple to complicated and have been performed in equal intervals and certain sessions among all the people of intervention group as follows :

In visual perception: It includes spatial-visual perception, shape perception and figure ground discrimination by puzzle, form board and Kohs cubes.

In auditory perception: It includes auditory memory and voice perception by verbal commands of exercises performance, copying and remaking Kohs' cubes according to verbal pattern.

Intervention in motor skills, include: Gross motor, fine motor and Balance such as walking on ladder board and balance beam, standing on a balance beam, throwing a ball to the target and thread and dice.

Intervention in memory include: Using visual memory in matching the form board or puzzle and copying the lines on a checked paper; Using verbal patterns and auditory memory in typing and number of motor exercises.

Intervention in attention includes: This factor has been considered in all exercises specially in drawing Mazes and copying compound shapes with details.

The results of pre test and post test were analyzed by spss16 and independent t test, Mann Whitney U, paired t test and ANCOVA methods.

Following the study behavioral considerations were taken into account: student and parent's satisfaction, secret- keeping personal information, preventing physical and mental damages, non-interference of intervention sessions with educational sessions, enjoying educational services by both groups during the study.

## Results:

Evaluating sex and class equality between two groups showed no significant difference respectively with possibilities of ( $p=0.337$ ) and ( $p=0.605$ ) and both groups were the same from this point of view (table1).

**Table 1.** Sex and class characteristics in two groups

variable	Control		Intervention		P value
	%N	%N			
Male	7	35	10	50	0/337
female	13	65	10	50	
2 class	5	25	7	35	0/605
3 class	5	25	4	20	
4 class	4	20	6	30	
5 class	6	30	3	15	

Comparing age and IQ mean in both groups showed no significant difference respectively with these possibilities ( $p=0.377$ ), ( $p=0.541$ ). Thus both groups were equal from age and IQ point of view (table2).

**Table 2.** Age and IQ characteristics in two groups

variable	Control		Intervention		P value
	mean	SD	mean	SD	
age	8/80	1/36	8/45	1/09	0/337
IQ	91/90	7/46	90/50	6/87	0/541

Independent t test between two groups did not show a significant difference in none of variables in pretest and post test ( $p > 0.05$ ). Mann Whitney U test did not show a significant difference in basic concepts variable in post tests ( $p=0.849$ ) either (table3).

**Table 3.** Variables in two groups (before & after intervention)

variable		Control		Intervention		P value
		mean	SD	mean	SD	
basic concepts	before	93/75	8/44	88/65	10/38	0/097
	after	98/75	10/33	97/55	7/57	0/849
operations	before	74/85	9/45	70/90	9/47	0/195
	after	75/70	18/50	81/45	13/16	0/265
application	before	85/35	20/11	85/45	9/56	0/984
	after	93/60	8/81	93/75	7/89	0/955
total	before	84/80	5/97	79/95	9/99	0/072
	after	89/25	9/78	90/00	8/17	0/794

Paired t test in intervention group has shown a significant difference in all variables in pretest and post test ( $p < 0.05$ ). In control group, the difference was specified in math total score in pretest and post test ( $p=0.020$ ). But no significant difference was seen in other variables ( $p > 0.05$ ) (table 4).

**Table 4.** Variables before & after intervention in groups

variable		before		after		P value
		mean	SD	mean	SD	
basic concepts	Intervention	88/65	10/38	97/55	7/57	0/002
	Control	93/75	8/44	98/75	10/33	0/080
operations	Intervention	70/90	9/47	81/45	13/16	0/000
	Control	74/85	9/45	75/70	18/50	0/816
application	Intervention	85/45	9/56	93/75	7/89	0/001
	Control	85/35	20/11	93/60	8/81	0/102
total	Intervention	79/95	9/99	90/00	8/17	0/000
	Control	84/80	5/97	89/25	9/78	0/020

The mean of mathematical total score and subsets did not have a specific difference in post test with adjusting age and IQ effects in two groups ( $p > 0.05$ ) (table 5).

**Table 5.** ANCOVA of variables after intervention in groups

source	basic concepts		operations		application		total	
	Mean square	P value	Mean square	P value	Mean square	P value	Mean square	P value
intercept	23/39	0/529	53/60	0/608	43/67	0/430	98/96	0/186
group	43/42	0/392	107/29	0/469	0/18	0/959	4/39	0/778
age	8/03	0/712	77/93	0/536	10/66	0/696	71/23	0/260
IQ	1/64	0867	195/52	0/329	1/10	0/900	17/30	0/576
age* IQ	3/36	0/811	129/23	0/427	6/86	0/754	53/68	0/327
group*age *IQ	50/28	0/358	155/36	0/384	0/126	0/966	2/75	0/823

**Discussion:**

Dyscalculia is a developmental disorder that is specified with low ability of a person in math contrary to normal intelligence and considering calendar age and educations' proportional with a person's age (10). These people have usually problems in discriminating shape and size, sets and number, one by one congruence, counting, visual-auditory constancy local value, accounting skills, measurement, money value, time, quantity language and problem solving ability (1). Considering different titles of math education, the existent problems in dyscalculia can be divided into three areas: Basic concepts perception, operations and mathematical application. The goal of occupational therapy interventions in this study has been improving and decreasing problems in these areas.

The results showed that occupational therapy interventions have been clinically effective on mathematical basic concepts perception, operations and application. Behnia and et al (2008) had studies the quality of perceptual motor skills effect on educational achievement in affected students to learning disorder and had performed OT programs to increase coordination of these skills. They suggested that OT interventions can be effective in treatment these children, obtaining a normal life and educational achievement (11).

Humphries and et al (1992) have also compared the effect of both sensory integration therapy (SI), and perceptual-motor training (PM). On the performance of children with LD and SI dysfunction, PM-treatment subjects showed significant gains over the other group primarily in gross motor performance. SI treated subjects showed an advantage in motor planning. Perceptual-motor therapy provided motor training to remediate specific motor skills weakness (e.g. Catching or throwing a ball or holding a pencil). SI therapy was designed to provide a sensory motor foundation on which motor skills, reinforcement of social emotion responses (tactile and vestibular experiences and proprioceptive input to made

adaptive responses (12).

In our study, OT interventions have been designed and performed based on composition of existent methods in OT. The main methods are perceptual-motor training, Frostig visual perception, sensory integration, attention increase and memory reinforcement methods. Thus it seems that the obtained results from the present study have had concordance with the results of Behnia and et al and Humphries and et al studies. Mandani's study (2006) has also reported OT interventions were effective on visual-motor skills of children with special LD (13). It seems that performed exercises in our study have been able to affect spatial-visual perception skills that are required in learning math and consequently improve mathematical problems.

Sheikh et al (2006) found significant relationship between perceptual motor abilities and mental development in normal students (14).

With due attention to the results of the present study it looks that this relationship has existed among students with learning disorders, and perceptual-motor abilities reinforcement have been effective in educational achievement specially in math.

The most important and fundamental factors which have had a role in getting the findings of our study and clinically mathematical progress in intervention group, are neurological processes. Some of recent studies have shown that there is a relationship between brain function recovery and cortical plasticity in brain. In neuro rehabilitation try to interfere in structural and functional organizations of the brain according such relationship and the existent potentials in the brain become active for reparation and the function of the brain damaged person is recovered (15).

The result of the electroencephalography studies shows that function of parietal cortex organization in children with dyscalculia is abnormal (16). These children have problems in variable sensory information processes.

These disorganized brain processes, are the base of

dyscalculia. So the treatment and rehabilitation interventions that performed in intervention group have been done to increase plasticity and flexibility of brain neurons. On the other hand, Zelazo and et al (2002) said that dyscalculia come from brain executive functions that is related to function of frontal cortex and includes a large number of cognitive and infra cognitive processes like self-regulation of behavior and development of cognition and social skills which form during child's developing period (17). Belayer, Zelazo & Greenberg (2005) have shown that education and developing of these executive functions have basic roles in social ability extension and academical abilities (18). The obtained results from mirmehdi and et al's research (2009) also showed that education and executive functions' reinforcement like functions with neurological foundation can be propounded as a modern procedure for treating special learning disorders (19). It is inferred that the finding of our research due to intervention memory and constant attention had reinforces neural synapses in brain functions and improves math problems in these students by using goal-directed activities.

Other psychological factors in getting the results of the study can be the style of interventions individually in form of play and completely different circumstances from a normal class such as sitting behind the bench for along time, motivation and consequently self-respect and self confidence increase and also the style of learning.

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The results of Narimani and Rajabi 's study (2005) show that the students with learning disorders use one style of learning more instead of using two styles (visual and auditory) compared to normal students (20). It seems that in our study with different dimensions that have been considered in intervention designing specially auditory and visual perception, that both auditory and visual learning styles have been used and it has caused improvement and decrease in mathematical problems of these students.

But it seems that individual math education services by teacher in LD center at the same time of interventions execution in intervention group had increased the mean of math total score and in control group.

## Conclusion:

Occupational therapy interventions have clinically effect on math problems improvement such as basic concepts, operations and mathematical application of students with dyscalculia.

We offer that due to gain significant and complete effect on them, the future studies will be done with large sample and more treatment sessions.

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