The Efficacy of Multisensory Method and Cognitive Skills Training on Perceptual Performance and Reading Ability in Learning and Non-Learning Based Tests of Male Dyslexic Students in Tehran Iran

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ABSTRACT

The purpose of this research was to examine the effects of multisensory method and cognitive skill training interventions on performance and reading ability of dyslexic students in Iran. 60 dyslexic students participated in this study that were divided into three experimental groups including 20 dyslexic students as first experimental group (E1), 20 dyslexic students as second experimental group (E2), and 20 dyslexic students as control group (C). The effectiveness of the sixteen-weeks and 16 sessions for both of E1 and E2 groups' intervention was measured by the employment of Reading and Dyslexia Test (RDT) and then Bender Visual Motor Gestalt Test (BVMGT) as learning-based tests and Rorschach as non-learning based test. The results were analyzed by analysis of variance (ANOVA) and paired t-test to compare mean scores at tree groups at pre and post interventions. Findings demonstrated that both of two groups (E1 and E2) improved from pre to post intervention; however two groups significantly improved by get better perceptual performances in direction of RDT, BVMGT, and R subscale of Rorschach test and indicated no significant differences in W%,D%,andDd% Results could be argue that the interventions improved subjects motor performance more than their perceptual ability; however the difference accrued the tests which need to learning and this is considered that the current perceptual tests which have been attempted to appraise the abilities which originated from learning aspects cannot actually evaluate perceptual ability of children with dyslexia.

Keywords: Cognitive skills training, sensory-perceptual skills training, non-learning based test, learning based test, dyslexia

INTRODUCTION

dyslexiais the most common learning disability and affecting 10–15% of school age children (Vellutino, Fletcher, Snowling, & Scanlon, 2004). The disability defined asdifficulty with accurate and/or fluent word recognition by poor spelling and decoding ability.Nearly 40% of the general school population experience difficulty in reading (National Center for Education Statistics, 2005). Readers who struggle with dyslexia do not enjoy academic achievement and educational inadequacy in which leads to poor negative consequences, low self-concept, emotional disorder such as isolation, depression, loneliness, and even suicide (Mercer & Pullen, 2005),motivational and social cognition problems, and also behavioral disorders (McNamara, 2007).According toICD-10 & DSM-IV the common reading problems in dyslexiaoriginate from visual perception. The deficit creates confused similar-looking letters and words, difficulty recognizing and remembering "sight" words, frequently losing place when reading, reversing words, poor memory for printed words, trouble for finding letters in words, poor comprehension of themes and main ideas, and also number sequences, diagrams, illustrations and so on.

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To determine accurate methods to diagnosis and remediate learning difficulties, several theories have been advanced. Amongst many theories, cognitive and developmental approaches are used to answer problems related to learning disabilities.

In the basis of the cognitive approach the existence of one or more basic cognitive processing and meta-cognitive deficits causes LD, so that they cannot easily learn how to learn, how to control, and how to direct their thoughts in order to learn (Lerner & Kline, 2006). According to Piaget (1959)cited by Lerner & Kline, 2006), the child needs to have time, to perform motor activities. Thus, the development of motor-perceptual activities depends on age and dyslexic students need more time to develop these abilities. As research has indicated, children with dyslexia have different problems in different stages of information processing such as difficulties with tasks involving processing of visual-spatial information (Weiler, Bernstein, Bellinger, & Waber, 2002; Menghini et al., 2011), more cognitive inhibition (Wang, Tasi, & Yang, 2012), difficulties in higher-order processing or executive control processes (Braiard, 2005;Mercer & Pullen, 2009), deficits in visual attention span (Talcott et al., 2000; Bosse, Tainturier, &Valdois, 2007), difficulties in perceptual processing speed (Tallal, Miller, & Fitch, 1995; Stenneken et al., 2011) and memory deficits (Thomson, 1984). Accordingly, a considerable amount ofliterature has been focused on improving attention span and memories strategies in children with dyslexia,practicing to retain abstract information (Vaughn & Roberts, 2007); increasing phonological awareness and skills (Schneider et al., 2000; Vadasy et al., 2002); and training decoding, and word reading, writing exercises, and also practicing comprehension strategies while reading texts (Scammacca et al., 2007).

However, developmental theory assumes immaturity is a serious cause of LD. One of the earliest single-factor theories which were developed by Orton (1937) attributed reading disability to an incomplete cerebral dominance. Orton suggested that the disorder is caused by a neurological-maturational lag resulting in delayed lateral dominance for language which leads to disruptions in perceptual functioning (Olitsky& Nelson, 2006). Orton-Gillingham methodology uses visual, auditory, and kinesthetic associations to help students learn sound-symbol relationships (Donah, 2012; Falzona, Callejab, &Muscatc, 2011; Hazoury, Oweini, &Bahous, 2009; Joshi, Dahlgren, &Boulware, 2002; Oakland, Black, Stanford, Nussbaum, &Balise, 1998; Shaywitz et al., 2004; Torgesen et al., 1999; Thorton, Jones, and Toohey, 1982; Foorman et al. 1997; Mihandoost and Elias, 2011; Dev, Doyle, Valente, 2002). A study conducted by Thorton, Jones, and Toohey (1982) implemented a multi-sensory teaching program incorporating visual learning with oral prompts and finger-tracing, for students' grades two through six. Findings indicated all of the grade levels - except grade two - showed marked improvement from the pretest to posttest. Another study by Foorman et al. (1997) compared three types of reading interventions for students with poor reading in 2ndand 3rdgrades in 13 different schools. Mihandoost and Elias (2011) in a research in Iran investigated the differences in reading attitude and reading comprehension among dyslexic students following the Barton intervention multi-sensory program. Results of the study showed a significant difference between the control and experimental groups following the Barton intervention program. They concluded that multi-sensory methods such as the Barton intervention program, can improve the dyslexic children's reading comprehension. Dev, Doyle, and Valente (2002) used the Orton-Gillingham technique, which involves visual, auditory, and kinesthetic modalities, with first grade children at the special education level. These children improved enough in their reading abilities to advance them out of the special education level.

In comparison to other countries, there are not many available studies on dyslexia in Iran (Fallahchai 1995; Seif-e-Naraghy&Nadery 2005; Ghonsooly, 2009; Narimani et al., 2009; Sedaghati et al., 2010). The problem in this research is related to the challenges in providing efficient interventions to modify the perceptual abilities of children with dyslexia. Therefore, the study aims to compare the effectiveness of multisensory method adopted from the Orton-Gillingham program based on maturational lag theory (developmental approach) and cognitive skills training based on information processing theory (cognitive approach) on reading and perceptual abilities of third grade students with dyslexia in Iran.Therefore, the critical issue in explanation, prediction, and management of perceptual abilities in students with dyslexia is whether cognitive deficiencies lead to dyslexia as supposed by information processing theory (cognitive approach) or developmental lag and immaturity as supposed by maturational lag theory (developmental approach).The study hypothesizes that the scores in Reading and Dyslexic test (RTD), Bender Visual Motor Gestalt Test (BVMGT) as based learning test and Rorschach test as non-based learning test are different for multisensory method, cognitive skill training, and control groups after intervention. It is expected to observe different test scores among the groups after intervention as each intervention is based on a different underlying theory and the study aims to compare the effectiveness of the developmental and cognitive theories.

METHOD

Primary 3rd grade students with dyslexia who were referred to two Specific Learning Disability Centers in Tehran (Iran) participated in the study. Participants were selected from referrals by ordinary school to public Specific Learning Disability Centers in Tehran, Iran. Criteria for participation in the study were that the dyslexic children: (1) did not have a prior history of treatment for dyslexia, (2) had a confirmed clinical diagnosis of dyslexia using Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria by experienced psychologists in the field of exceptional children who were working in the centers, including (a) difficulty with accurate or fluent word recognition, or both, (b) deficit in word decoding, (c) problem in reading rate, (d) weakness in prosody (oral reading with expression), and (e) reading comprehension (Reading disorder, DSM-IV codes: F81.0/315.00), and finally, (3) met T score of 70 or above on average for five subscales in scale of RDT (Iranian version). From these students, 60 participants were matched by statistical indicators in RDT and they were divided into three groups (two experimental groups and one control group) using random assignment.

The study compares the effectiveness of multisensory method and cognitive skills training on reading and perceptual abilities of students with dyslexia. Multisensory method focused on three sensory modalities simultaneously (visual, auditory, and tactile) provided in seven lessons in 16 sessions/ week. The seven lessons include visual perception skills, auditory perception skills, visual tracking skills, alphabet tracking skills in reading, alphabet track, spell tracking skills in reading, and word tracking skills in reading. Developmental intervention was administered on the E1 group and cognitive intervention was administered on the E2 group, while no related intervention was received by the control group. On the other hand, Cognitive strategies, administered on the E2 group, comprised multiple and flexible strategies, self-monitoring, and meta-cognition to help the participants enhance their perceptual performance and reading skills. The cognitive interventional program was adopted from Swanson (1993), Lerner and Kline (2006), and Christo et al. (2009). The intervention used in this study provided five lessons in 16 sessions/ week. The lessons included Memory strategies, Word recognition skills, Reading accuracy and fluency, Self-questioning strategy followed by visual imagery, and Meta-cognition strategies.

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This research examined three respective tests including Reading and Dyslexic test (RTD), Bender Visual Motor Gestalt Test (BVMGT), and Rorschach test. Reading and Dyslexia Test (RDT) was standardized in Iran and is an individually administered test for diagnosing reading ability in dyslexic students. The test contains five subtests which evaluate reading abilities including Word Reading, Word Chains Reading, Word Comprehension, Phoneme Deletion, and Pseudo-Word Reading. Each response in these subtests is considered as one score and total scores are computed using standard score. The BVMGT as a maturational test which implies a close relationship between the ability to perceive process and reproduce designs was used as a perceptual tool of the study. In this test the examinee had to reproduce on a blank piece of paper one figure at a time. The test provides developmental data on child perceptual maturity and has been recognized as one of the most useful tools in the assessment of neurological functioning (Lerner & Kline, 2006). Scoring is based on drawn difficulties. These difficulties may indicate poor visual-motor abilities that include: angular difficulty, bizarre doodling, closure difficulty, cohesion, collision and so on (Groth-Marnat, 2003). Taylor and Sennott(1984) found that the test as a visual perceptual test is a standard instrument for diagnosis and prescription among LDs, and even the test has long been used in the diagnosis of LDs within the school boards. The Bender-Gestalt test with young children reveals inter-scorer reliability to be very high with correlations of .90 and above. Rorschach test basically is a projective test and creates and organizes constructed responses from examinee and requests him/her to respond to inkblot cards. The test yields data about cognition (perception) and personality variables such as motivation, response tendencies, cognitive operations, affectivity, and personal/interpreted perceptions. The inkblots consist of various configurations and examinee sees, realizes, and expresses them and examiner records their responses. This test has three features categories including location, determinants, and content, and also popular or original. Each category contains subcategories (Marnat, 2003). In this research only the location is considered for administration and for scoring the Exner comprehensive scoring system was used. Location determines which details or part of the inkblots triggered the response and includes the whole inkblot (W), common detail (D),uncommon detail (Dd), and use of white space (S). After administration and receive some responses, scoring will be performed. In this stage the examiner performs a series of calculations producing a structural summary of the test data. The results of the structural summary are interpreted using existing Exner normative data on normal children's perception that have been demonstrated to be associated with different kinds of responses.

RESULTS

In experimental research it is assumed that there is no significant different between experimental group and control group at pre intervention. Here, prior to test the research hypotheses this assumption is investigated using a series of one-way ANOVA. The results are indicatedthatA one-way ANOVA was used to test RDT difference among three groups. As expected, the result of pre-intervention among three dyslexic groups did not differ significantly, [F (2.57) = .178, P = .837]. The result revealed that null hypothesis related to means differences in RDT among dyslexics at pre-intervention was accepted. Also a one-way ANOVA was used to test BVMGT difference among three groups. As expected, the result of pre-test among three groups did not differ significantly, [F (2.57) = .662, P = .520]. The result showed null hypothesis related to means differences in BVMGT at pre intervention was accepted. Also a one-way ANOVA was used to test Rorschach (R subscale) difference among three groups. As expected, results at pre-intervention among three groups did not differ significantly, [F (2.57) = 1.681, P = .195]. Result revealed that null hypothesis of significant of difference in R subscale of Rorschach test at pre-intervention was accepted. As

well a one-way ANOVA was used to test the ratio of mean scores in *W%* of Rorschach test difference among three dyslexic groups. As expected, the results among three groups revealed that they did not differ significantly, [F (2.57) = .289, P = .750]. As expected the result showed that null hypothesis of significant of difference in *W%* among dyslexic groups at pre-intervention was accepted. Furthermore, a one-way ANOVA was used to test the difference of ratio in *D* subscale to total responses of Rorschach test among three dyslexic groups. As expected, the result of this variable among three groups did not differ significantly, [F (2.57) = .343, P = .711]. As expected the result showed that null hypothesis of *D%* among dyslexic groups at pre-intervention was accepted. Finally, a one-way ANOVA was used to test difference ratio of mean scores in *Dd%* subscale to total responses (Dd/R) of Rorschach test among three dyslexic groups. As expected, the result among three groups' responses pattern did not differ significantly, [F (2.57) = 1.1, P = .341]. As expected the result showed null hypothesis of *Dd%* among dyslexia at pre-intervention was accepted and there is not significant differences between dyslexic groups at pre intervention. Table 1 reports the assumption of experimental groups and control group at pre intervention.

Table 1. The assumption of different between experimental groups and control group at pre intervention

Variables	*Group*	*N*	*Mean*	*SD*	*F*	*P*
RDT	C	20	63.84	10.75	.178	.837
	E1	20	62.31	11.63		
	E2	20	64.54	13.63		
BVMGT	C	20	1.74	1.05	.662	.520
	E1	20	1.43	1.35		
	E2	20	1.85	1.18		
R (subscale of Rorschach)	C	20	13.70	2.20	1.681	.195
	E1	20	15.20	2.53		
	E2	20	14.70	3.10		
W%(symbol of Rorschach)	C	20	.27	.15	.289	.750
	E1	20	.28	.10		
	E2	20	.30	.17		
D%(symbol of Rorschach)	C	20	.65	.12	.343	.711
	E1	20	.61	.13		
	E2	20	.66	.23		
Dd%(symbol of Rorschach)	C	20	.06	.01	1.1	.341
	E1	20	.10	.02		
	E2	20	.06	.03		

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A one-way between groups ANOVA was performed to compare the effect of interventions on RDT score of E1, E2 and control groups. As presented in Table 2, the result revealed that the RDT scores of the three dyslexic groups after intervention was significantly different [F (2, 57) = 8.55, P < .05)]. The post hoc comparison using the tukey test indicated that the mean score of RDT for E1 group (Mean=83.38, SD=9.15) was significantly different from control group (Mean=65.98, SD=13, 63). However, E2 group (Mean = 75.09, SD = 16.19) did not differ significantly from that of the control group.

Table 2.Test scores differences in experimental groups and control group after intervention

Variable	*Groups*						*P value*
	Control group (n=20)		*E1 group (n=20)*		*E2 group (n=20)*		
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	
RDT	65.98	13.63	83.4	9.15	75.1	16.19	.001**
BVMGT	1.36	.75	.6	1.16	.89	.82	.0.05*
R symbol (Rorschach test)	14.4	2.95	21.4	4.31	16.6	3.14	.001**
W% symbol (Rorschach test)	.31	.15	.23	.16	.28	.12	.729
D% symbol(Rorschach test)	.59	.16	.68	.14	.66	.11	.642
Dd% symbol (Rorschach test)	.06	.06	.1	.08	29	.06	.05

*: Significant

The second ANOVA was conducted to investigate BVMGT score difference among the three dyslexic groups. There was a significant difference between BVMGT score of control group, the group receiving developmental intervention (E1), and the group under cognitive intervention (E2) at the p<.05 level [F(2, 57) = 0.04, p < .05]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for E1 group (Mean=.6, SD=1.16) was significantly less than that of control group (Mean=1.36, SD=.75). In contrast, there was no significant difference between E2 group's mean scores (Mean=.89, SD =.82) compared to those of the control group. Therefore, developmental interventions decreased the mean score error in the dyslexic group under the intervention compared to the control group.

A one-way ANOVA was used to test R subscale (total responses) of Rorschach test difference among three dyslexic groups. Result of post-intervention among three groups revealed significant difference, [F (2.57) = 20.43 P ≤ .001]. The *Post hoc* (tukey) indicated that the mean scores in R subscale of Rorschach test for E1 group (Mean=21.35, SD=4.31) was significantly different from that of the control group (Mean=14.4, SD=2.95). However, E2 group's performances in this item (Mean=16.6, SD=3.13) was not significantly different from that of the control group.

A one-way ANOVA was used to test mean score ratio in *W%* subscale of Rorschach test to total responses (*W/R*) among three dyslexic groups. The result of post-intervention among three groups was not significantly different [F (2.57) = 11.95, P ≤. 729]. The *Post hoc* (tukey) indicated that the mean scores in R subscale of Rorschach test for E1 group (Mean=21.35, SD=4.31) was significantly different from that of the control group (Mean=14.4, SD=2.95).

However, E2 group's performances in this item (Mean=16.6, SD=3.13) was not significantly different from that of the control group.

A one-way ANOVA was used to test mean scores ratio in D subscale to total responses (D/R) of Rorschach test among three dyslexic groups. The results at post-intervention among three groups was not significantly different [F (2.57) = 12.17, P ≤ .642]. The *Post hoc* (tukey) indicated that the mean scores ratio in this item for both experimental groups for E1 group (Mean =.68, SD =.14) and E2 group (Mean =.66, SD =.11) as compared to control group (Mean =.59, SD =.16); was not significantly different from the control group.

For Dd symbol to total responses (Dd/R) of Rorschach test among three dyslexic groups a one-way ANOVA was used to detect difference ratio mean scores. Result at post intervention revealed there was significant difference in *Dd%* among control, E1, and E2 groups the alpha level of 0.05 [F (2.57) = 3.33, P ≤ .05]. The *Post hoc* (tukey) indicated that the mean scores ratio in this item for both experimental groups for E1 group (Mean =.68, SD =.14) and E2 group (Mean =.66, SD =.11) as compared to control group (Mean =.59, SD =.16); was not significantly different from the control group.

DISCUSSION

The critical issue in explanation, prediction, and management of perceptual abilities in students with dyslexia is whether perceptual disabilities lead to dyslexia as supposed by cognitive impairment or developmental lag and immaturity lead to dyslexia. This study examined the effectiveness of two types of intervention (developmental and cognitive) on the perception and sequential reading ability of dyslexic students. In the present research, comparing the influences of multisensory and cognitive skills interventions on the perceptual performance (in learning and non-learning based tests) and reading ability of dyslexic students indicated students who experienced multisensory intervention, demonstrated significant difference in some variables including RDT, BVMGT and total responses (R) subscales of Rorschach test. However, there were no significant differences in *W%, D%,* and *Dd%* symbols of the location of Rorschach responses. As well, students who experienced cognitive skills training revealed significant difference in some variables including RDT, BVMGT, and R subscale of Rorschach test, while they did not show any significant difference on *W%, D%,* and*Dd%* symbols of Rorschach test. Thus, the significant test's results comparing pre and post-intervention demonstrated the effectiveness of two intervention methods (multisensory and cognitive skills interventions).

Findings showed the performances of dyslexic students who participated in this research, in all scales and subscales of RDT and BVMGT were significantly less than average. Meanwhile, the performances of dyslexic students in Rorschach test only in total response (R) were less than average, and there were no realized significant differences in *W%*, *D%,* and *Dd%* as symbols of location of perception in Rorschach. Accordingly, the present results indicated dyslexic children have deficit in visual-motor performances (as showed in learning based tests); not necessarily in perceptual functioning (as showed in non-learning based test, means Rorschach). As Ayres (1985) and Murray et al. (1990) indicated visual-motor deficits are main characteristic of children with developmental dyspraxia.

As this case, dyslexic students treating by occupational therapists ordinary focus on visual-motor difficulties and motor incoordination and in similarity with Hulme et al. (1982), dyslexia could not be result of perceptual functioning deficits in which create visual-motor performances deficits or difficulties in motor performance (skills) which originate difficulties on some drawing and pencil-paper test including BVMGT as visual-motor performances. As it can be observed, although a traditional instructional approach is sufficient for many

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children to become competent reading by 6 or 7 years of age, handwriting difficulties are common among children in both regular and special education classrooms (Guskey, 1988). As a result, remediation of handwriting difficulties is one of the most important areas of school occupational therapy cited by (O'Brien, Cermak, & Murray, 1988).

The mentioned above differences (between visual-motor performances and perceptual functioning) could be the result of inefficiency of current instruments which are not able to assess their children's intellectual ability and just measure the abilities that are required for achievement, learning, and verbal aspects(Shaywitz, 2005). For this reason, more study need to be done to identify the alternative instruments to assess the intellectual abilities such as perceptual functioning of dyslexic children, instead of abilities which are dependent to learning experiences.

Moreover, findings indicated both multisensory intervention (that originated in developmental lag theory) and cognitive skills training (that originated in information processing model and cognitive theory) can improve the performances of dyslexic children in learning based tests (RDT and BVMGT), however the interventions were not significantly effective on performances of dyslexic children in non-learning based test (Rorschach). This result reveals that both interventions could improve reading abilities and visual-perception performances of dyslexic children, not necessarily their perceptual functioning. Finally, findings displayed the influence of multisensory intervention on reading abilities and visual-perception performance of dyslexic children was more than cognitive intervention. Therefore, the findings of present research are more consistent with developmental lag theory. It should be noted that developmental lag theory emphasized neurodevelopmental delays in several areas of maturation which is the major cause of dyslexia (Lerner & Kline, 2006). According to this approach, learning problems occur when children are pushed into performing academic tasks before they are able to do so. Therefore, the demand of schooling can cause failure by requiring students to perform beyond their readiness, or ability, at a given stage of maturation (Bender, 1957, cited by Lerner & Kline, 2006). These children need more time to learn and to grow up. Therefore, the findings are consistent with the developmental lag theory that considers children who are dyslexia are not so different from other children.

Findings highlighted that the mean score in the group following cognitive intervention (E2 group) was not significantly different from the control group in most of the variables. Therefore, the effect of multisensory method on performance of learning-based tests was more than cognitive skills training. An explanation for more effectiveness of multisensory method is that the multisensory training builds many visual-auditory associations in learning grapheme-phoneme correspondences through kinesthetic activities, develops attention span to details within letters or words that help in word retrieval from long-term memory, reduces boredom, increases the student's involvement time in learning and finally, it provides more feedback to the instructors (Hazoury et al., 2009; Uhry & Clark, 2005). Consistent with the findings of this research, O'Brien, Cermak, and Murray (1988) showed that interventions can improve visual conditions and for this reason motor performance would be improved. Murray, Cermak, and O'Brien (1990) emphasized that visual-perceptual deficits are the main characteristic of children with developmental dyspraxia. For this reason many occupational therapists treating dyslexic students focus on the visual-perceptual problem, visual-motor difficulties, and motor incoordination. Geschwind and Galaburda(1985) pointed out that dyslexic children have average visual-perceptual skills (cited by O'Brien, et al., 1988). Further investigation goals comprising duration of more than six months, follow up tests to study effectiveness of the intervention across time and replication of the research in other populations are recommended.

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