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Comparison of Executive Function in Nonverbal Learning Disorders

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This study was designed to examine the existence of deficits of executive function (EF) in children with nonverbal learning disabilities (NVLD).Methods: 20 NVLD students (8 boys and 12 girls) from Tehran, Iran, aged 11 to 14 years (M = 12.7 years, SD = 1.11). The Normal student comparison group consisted of 20 normal students (9 boys and 11 girls), aged 11 to 14 years (M = 11.10 years, SD = 2.1). For assessing NVLD we used the original Wechsler Intelligence Scale (Wechsler, 1949) and EF. The Behavior Rating Inventory of Executive Function (BRIEF), developed by Goya et al. (1996), was used to measure EF in both groups**.** Results: Children with NVLD were less able to recognize the ability to focus, shift, and memorize, organize information and distribute attention. Despite the differences in the development of executive functions, they were robust and virtually identical across the two samples. Conclusion: EF deficits were more broadly defined in nonverbal learning disorder students. The results of this research should help parents and educators understand the learning that students provide outreach services to increase executive functions

Keywords*:* nonverbal learning disability, executive function

Executive functions include such higher level abilities as abstract reasoning, logical analysis, hypothesis testing, and cognitive flexibility, or the ability to "shift gears" mentally. The ability to focus, shift, and distribute attention, organize information in memory to aid learning and remembering; otherwise, regulating thought processes are also examples of executive functions. “Executive functions are those involved in complex cognitions such as solving novel problems, modifying behavior

in the light of new information, generating strategies or sequencing complex actions." (Elliott, 2003). "Executive functions include processes such as goal selection, planning, monitoring, sequencing, and other supervisory processes which permit the individuals to impose organization and structure upon their environment" (Foster, Black, Buck, & Bronskill, 1997). "The executive functions consist of those capacities that enable a person to engage successfully in independent purposive self-serving behavior" (Lezak, 1995).

Nonverbal learning disability (NVLD) has consistently been identified as one type of learning disability in subtype studies (Casey & Rourke, 1991; Fuerst, Fisk, & Rourke, 1990; Koushik, Saunders, & Rourke, 2007) and in clinical reports (Mamen, 2000, 2007). NVLD is a learning disorder that has been proposed to involve basic neuropsychological and cognitive processing deficits that lead to both academic achievement difficulties and psychosocial problems (Rourke, 1989, 1995).

NVLD is a neurodevelopment disorder first defined by Mykelbust (1975) as a social perception disability, and then more extensively researched by Rourke et. al, (1971, 1973, 1993, 1983, 1986, 1993, 1995-1986). It typically impacts three main areas of functioning including visual spatial organizational (the ability to interpret and organize the individual's visual-spatial environment), motored (the ability to master their physical environment and express themselves in written form), and social. It is hypothesized to involve the white matter of the brain (including the right hemisphere and the corpus callosum). NLD is found in approximately 10% of the learning disabled population (approximately 1% of the normal population). However, the most estimated is that 10–15% of all learning disabled students have a nonverbal learning disorder (Ozols & Rourke, 1988).

NVLD is not a learning disability in the traditional sense, but rather a life learning disability. Some researchers do not consider NVLD as a specific learning syndrome. They argue against it even being considered as an "official" diagnosis (Pennington, 2009) while others argue that creating

a formal diagnostic code will aid in the research and treatment of NVLD also it is used for insurance reimbursement of services. Children with NVLD have been found to have deficits in tactile perception and visual-motor coordination or complex psychomotor skills, visual-spatial perception, organization, memory, processing novel stimuli, language pragmatics, and achievement difficulties in the areas of arithmetic or in written language (Harnadek & Rourke, 1994; Mamen, 2000, 2007; Rourke, 1989, 1995). These deficits occur alongside strengths in rote verbal memory, oral language mechanics or form, and word reading (Johnson, 1987; Rourke, 1987, 1989, 1995).

Executive functioning is hypothesized to involve the control and coordination of cognitive operations and it has become an important concept in contemporary neuropsychology. However, there is still little consensus on what executive functioning actually means. Consider the following sample of variables that have been used to assess executive functioning in recent articles: verbal fluency (Bastin & van der Linden, 2003), trail making (e.g., Barnes, Yaffe, Satariano, & Tager, 2003; Bigler et al., 2003), Stroop color word (e.g., Barnes et al., 2003; Bastin & van der Linden, 2003), and digit symbol or symbol digit (e.g. Barnes et al., 2003; Bigler et al., 2003; Verghese et al., 2003).

More recently a clinical model of executive functions involving six components including: (1) initiation and driving (activation or starting of a cognitive system) (2) response inhibition (stopping automatic or proponent rasp tendencies) (3) task persistence (maintaining a behavior until task completion) (4) organization (organizing and sequencing of information) (5) generative thinking (creating multiple solutions to a problem and thinking in a flexible manner) and (6) awareness (monitoring and modifying one's own behavior) was conceptualized. They used this model to guide their observations, assessment, and management plan. The uncertainty about the nature of executive functioning is also apparent in the following characterizations from recent articles and books. "Executive functions cover a variety of skills that allow one to organize behavior in a

purposeful coordinated manner and reflect on or analyze the success of the strategies employed" (Banich, 2004). NVLD students have problems in some components of EF.

Method

Participants

Participants were 20 NVLD students (8 boys and 12 girls) from Tehran, Iran, aged 11 to 14 years (M = 12.7 years, SD = 1.11). They were selected from the Learning Disorder Research Institute and elementary schools in Tehran. 20 normal achieving (NA) children were select based on their age. They were tested at school. The normal student comparison group consisted of 20 normal students (9 boys and 11 girls) aged 11 to 14 years (M = 11.10years, SD = 2.1). The slight differences between the two samples in NA and NVLD distribution were statistically significant. Children in the NA comparison group were volunteer recruited children. The participants' families were from a middle-class population and socioeconomic status (SES). None of them had a primary visual or hearing impairment. All children in the NLD group had known or been suspected of NLD based on results from prior testing participants. They were included in the NLD group, if they met a constellation of cognitive, neuropsychological problem are proposed to be core features of NLD (Harnadek & Rourke, 1994; Pelletier et al., 2001; Petti et al., 2003; Worling et al., 1999). Verbal IQ (VIQ) and Wisc-R Performance IQ (PIQ), in NVLD were assessed. The WISC can be used to show discrepancies between Verbal IQ (VIQ) & Wisc-R Performance IQ (PIQ) for assessing NVLD. In a clinical setting, learning disabilities can be diagnosed through a comparison of intelligence scores and scores on an achievement test (Furest,., Fisk, & Rourk, 1990).

1. *Verbal* IQ (VIQ) was lower than 85 and VIQ was greater than *Performance* IQ (PIQ) about 10 or more points;

2. A scaled score of 7 or less for one or more *Block Design*, *Object Assembly*, or *Coding*; in the NA group included VIQ ≥ 85; a scaled score

of 8 or above for each *Block Design*, *Object Assembly*, and *Coding*; reading, arithmetic, and written language was about or above 30 percent.

Measurements

Wechsler Intelligence Scale. The original WISC (Wechsler, 1949) was an adaption of several subtests which were not only made of the Wechsler–Bellevue Intelligence Scale (Wechsler, 1939) but also featured several subtests designed specifically for it. The subtests were organized into Verbal and Performance scales, and they provided scores for Verbal IQ (VIQ), Performance IQ (PIQ), and Full Scale IQ (FSIQ). A revised edition was published in 1974 as the WISC-R (Wechsler, 1974), featuring the same subtests. However, the age range was changed from 5-15 to 6-16. The third edition was published in 1991 (WISC-III; Wechsler, 1991) and brought with it a new subtest as a measure of processing speed. The current version, the WISC-IV, was produced in 2003 followed by the UK version in 2004. Each successive version has re-normed the test to compensate the Flynn effect, ensuring that the norms do not become outdated. This is suggested to result in inflated scores on intelligence measures and they are also representative of the current population. A number of concurrent studies were conducted to examine the scale's reliability and validity. Evidence of the convergent and discriminant validity of the WISC–IV is provided by correlation studies with the following instruments: WISC–III, WPPSI–III, WAIS–III, WASI, WIAT–II, CMS, GRS, Bar-On EQ, and the ABAS–II. Evidence of construct validity was provided through a series of exploratory and confirmatory factor-analytic studies and mean comparisons using matched samples of clinical and nonclinical children. The number of questions presented depended upon a pre-determined basal and ceiling level. The minimum number of word-pairs presented is four while the highest is twenty-three. The child can receive a raw score between 0-44. The Wechsler Intelligence Scale for Children-Revised was standardized on a representative sample of 1400 children aged 6 to 13 years. The

standardization sample was derived on the basis of the father's occupation, age and sex according to the 1986 census of Iran. Tables for conversion of raw scores to standard scores and IQs were constructed. Test-retest reliability and split-half reliability of the test scores were comparable to the values reported by Wechsler (1974). Split-half reliability coefficients range from .67 -.69 (mean = .68), depending on the age of the child. Test-retest reliability is reported to be .92-.95. Correlations between WISC-R and WPPSI IQs, correlations between WISC-R scaled scores and IQs, the increase of raw scores with age, the relationship between scores and the socioeconomic status of the family, and correlations between IQ and school achievement were interpreted as an index of the validity of the scale (.78-.97). Gender difference in IQs were not significant (Shahim, 1387).

Behavior Rating Inventory of Executive Function (BRIEF). The Behavior Rating Inventory of Executive Function (BRIEF) was developed by Gioia et al. (1996), and used to assess executive function in the sample. The BRIEF is a rating instrument designed to assess impairment of executive function in individuals aged 5-18. Reliability is reported in terms of internal consistency (ranging from .80-.98) and test-retest reliability (ranging from .76–.85).

The BRIEF is easily administered to either parents or teachers and it provides clinical scales on various executive function components. In this study one form was used for parents and teachers. The Meta-Cognition Index is composed of the Initiate, Working Memory, and Plan Organization, Organization of Materials and Monitor scales. The Global Executive Composite score is a composite score incorporating all eight scales of the BRIEF. The scale also contains items. Parents also completed the Brief Betrayal Trauma Scale–Parent version. Their mothers completed this questionnaire (Nesayean & Alizadeh, 1392).

Results

The current study extended previous research on NVLD by examining multiple aspects through the comparison of EF in NVLD and normal achieving children (NA). One major finding in this study makes unique contributions to the literature. First, children with NVLD showed deficits in several aspects of EF compared to normally achieving peers.

Children with NVLD may have difficulty in carrying out or enacting competent solutions, thus these responses have not led to successful outcomes. An alternative account is that children with NVLD may have difficulty generalizing from instances of positive outcomes. That is, they may have difficulties in building a concept corresponding to "responses that lead to positive outcomesof school, comprehension and abstract reasoning difficulties may become more noticeable. For the students with NVLD, and elimination of extraneous stimuli is recommended, because planning, organization and initiation of tasks may be difficult for children with NVLD, the likelihood of shaping or changing behavior through the use of positive reinforcement and consequences will probably not promote desired behavior.

Table 1
Comparison of Intelligence Wisc-R Verbal IQ (VIQ), in NVLD & Normal Groups

	Value	F	Hypothesis df	Error df	Sig.
Pillai's Trace	.973	316.868	5	34	.000
Wilks' Lambda	.027	316.868	5	34	.000
Hotelling's Trace	36.213	316.868	5	34	.000
Roy's Largest Root	36.213	316.868	5	34	.000

Control (n=20) NVLD (n=20)

Table 1 intelligence Wisc-R Verbal IQ (VIQ) include: Information, Similarities, Arithmetic, Vocabulary, Comprehension, and Digit Span. The NVLD group scores higher in Information, Similarities, Arithmetic, Vocabulary and lower in Comprehension. It shows that multivariate statistics test based on MANOVA, all statistics show a significant difference among variables. The output of unilabiate tests are summarized:

Variables	Type III Sum of Squares	df	Mean Square	F	Sig.
Information	181.841	1	181.841	589.721	.000
Similarity	72.131	1	72.131	158.906	.000
Arithmetic	125.013	1	125.013	394.298	.000
Vocabulary	197.390	1	197.390	1.315E3	.000
Comprehension	197.390	1	197.390	1.315E3	.000

Tabel 2
Comparison of Intelligence Wisc-R Performance IQ (PIQ), in NVLD & Normal Groups

	Value	F	Hypothesis df	Error df	Sig.
Pillai's Trace	.986	1331.628	5	34	.000
Wilks' Lambda	.014	1331.628	5	34	.000
Hotelling's Trace	71.980	1331.628	5	34	.000
Roy's Largest Root	71.980	1331.628	5	34	.000

Control (n=20) NVLD (n=20)

Intelligence Wisc-R Performance IQ (PIQ) include: Picture Completion, Picture Arrangement, Coding, Block Design, Object Assembly and the NVLD group scores higher in: Picture Completion,

Picture Arrangement, Coding, Block Design and lower in Object Assembly.

Table 2 shows the significant between the two groups.

Variables	Type III Sum of Squares	df	Mean Square	F	Sig.
Information	181.841	1	181.841	589.721	.000
Similarity	72.131	1	72.131	158.906	.000
Arithmetic	125.013	1	125.013	394.298	.000
Vocabulary	197.390	1	197.390	1.315E3	.000
Comprehension	197.390	1	197.390	1.315E3	.000

Table 3
Comparison of Intelligence Wisc-R VIQ and PIQ, in NVLD & Normal Groups

	Value	F	Hypothesis df	Error df	Sig.
Pillai's Trace	.989	1685.010	2	37	.000
Wilks' Lambda	.011	1685.010	2	37	.000
Hotelling's Trace	91.082	1685.010	2	37	.000
Roy's Largest Root	91.082	1685.010	2	37	.000

Control (n=20) NVLD (n=20)

Table 3 intelligence Wisc-R Verbal IQ (VIQ) include: Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span and NVLD group scores higher in Information, Similarities, Arithmetic, Vocabulary and lower in Comprehension, Digit Span. Intelligence Wisc-R Performance IQ (PIQ) include: Picture Completion, Picture Arrangement, Coding, Block Design, Object Assembly and the NVLD

group scores higher in: Picture Completion, Picture Arrangement, Coding, Block Design and lower in, Object Assembly.

Table 4

Group Differences on the BRIEF

	Value	F	Hypothesis df	Error df	Sig.
Pillai's Trace	.989	783.546	4	34	.000
Wilks' Lambda	.011	783.546	4	34	.000
Hotelling's Trace	92.182	783.546	4	34	.000
Roy's Largest Root	92.182	783.546	4	34	.000

Control (n=20) NVLD (n=20)

Variables	Type III Sum of Squares	df	Mean Square	F	Sig.
Working	178.681	1	178.681	1143.942	.000
Inhabit	200.657	1	200.657	129.084	.000
Metacognition	213.070	1	213.070	2008.675	.000
Regulation	76.157	1	76.157	237.583	.000

Tabel 4: Group means for the 4 BRIEF scales are presented in Table 4. There was a significant multivariate group effect for the five scales (P<.0001). Univariate tests for the two scales were considered to be useful for differentiating the subtypes of NVLD (Working Memory and Inhibit) and three primary index scores revealed significant group differences (P<.0001). There were significant differences between the BRIEF scales or indices between the NVLD and the normal groups. However, in the analyses reported above, there was a difference between the individuals with NVLD and controls on four out of the five BRIEF indices; however,

normal individuals had higher ratings (P<.05) than NVLD participants on the Executive function.

Table5
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Information	40	2.43	8.29	5.4107	2.22779
Codes	40	1.00	2.00	1.5000	.50637
Similarity	40	3.29	8.29	6.2000	1.51386
Arithmaetic	40	2.57	8.57	5.7821	1.87467
Vocabulary	40	2.43	8.29	5.3214	2.28199
Comprehension	40	2.43	8.29	5.3214	2.28199
Completion	40	1.40	8.40	4.5350	2.97697
VIQ	40	2.89	8.34	5.6071	1.99590
Arrangement	40	1.40	8.40	4.5350	2.97697
Block	40	1.40	8.40	4.5350	2.97697
Object	40	1.40	8.40	4.5350	2.97697
PIQ	40	1.40	8.20	4.5350	2.97415
Regulation	40	3.00	7.88	5.5156	1.51837
Metacognition	39	2.18	7.88	4.8815	2.38964
Inhabit	40	.00	8.09	4.6773	2.68238
Working	40	2.21	7.57	4.6518	2.20592
Valid N (listwise)	39				

Conclusion

However, by definition NVLD refers to what in this study consists of one who obtains a Lower score of intelligence Wisc-R Performance IQ (PIQ), at or above a standardized intelligence Wisc-R Verbal IQ (VIQ). Although, executive functioning has been defined by some in such broad

terms as to include almost all human cognition, and by others so narrowly as to over emphasize one area and completely overlook all others, it remains an important construct (Zelazo et al, 1997; Ozanoff et al, 1991). Executive function is defined as 'the ability to maintain an appropriate problem-solving set for the attainment of a future goal' and executive function includes such behaviors as planning, impulse control, inhibition, set maintenance, organized search, and flexibility of thought and action (despite obfuscation in the construct). Although similar etiologies have been proposed to explain both non-verbal learning disability and executive dysfunction (impairments of subcortical white matter), poor performance on measures of executive functioning are not always found in children with NVLD.

Rourke (1995) has also identified deficits in executive functioning among the primary impairments in NVLD (Strang & Rourke, 1985). There is no clear data to indicate how frequently executive functioning deficits occur in the NVLD population. Significant discrepancies between verbal and nonverbal memory are also frequently observed. As with other nonverbal functions, NVLD children frequently demonstrate greater impairments on nonverbal memory tasks as the spatial component of the task increases. NVLD children frequently demonstrate problems with more complex measures of verbal learning and memory (Fletcher et al., 1992). Deficits in executive functions, including working memory, are hypothesized to be responsible for these difficulties on more complex verbal memory measures (Rourke, 1995). Traditional definitions of learning disabilities tend to have a narrow focus on academics and they are generally associated with verbal deficits. NVLD, on the other hand, is more debilitating than those verbal in nature due to the connection between nonverbal experience and the acquisition of meaning (Myklebust, 1975). NLD affects the ability to learn academics and also the acquisition of mental health (Semrud-Clikeman, et al., 2010), self-help (Petti et al., 2003) and psychomotor skills (Rourke, 1995).

Our final question is about comparative executive function in Non-Verbal Learning Disorder and normal children. Despite obvious differences in executive functions of nonverbal learning disorder and normal students.This finding suggests that some of the underlying processes that contribute to the development of students with NVLD are similar to executive functions. This article is an attempt to critically review the empirical findings which tried to shed light on the connection between EF and NVLD. All the analyses were performed on the standardized data conducted on one of the most Characteristics of children with nonverbal learning disorderthe relation between executive skills and NVLD. To meet the goals of our study, we collected data from children using the same relevant tasks. These NVLD children data answering these questions will help inform the relation between executive functioning and NVLD. Further research on EF intervention skills in early childhood seems to be needed.

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