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Dyslexia and the Pattern of Strengths and Weaknesses: Wechsler Intellectual Profile of Students with Dyslexia

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This study aimed to identify the pattern of strengths and weaknesses of students with dyslexia based on their Wechsler intellectual profiles. We obtained 119 Wechsler intelligence test results of male and female students with dyslexia from SLD centers. The data from four primary index scores (VCI, PRI, WMI, and PSI) were extracted and analyzed. The highest scores belonged to PRI (98.22), comprising block design (10.45), matrix reasoning (9.7), and picture concepts (8.6). The lowest means were observed on WMI (78.2), with the highest and lowest average in digit span (8.24) and number-letter sequencing (4.12), respectively. The performance of these students in overall perception, general visualization, visual-spatial information processing, discovery of nonverbal relationships, and fluid reasoning was superior to their other cognitive features, e.g., digit span and letter-number sequencing.

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Dyslexia is a specific deficit impacting the reading ability in the presence of an average intelligence quotient (IQ) and in the absence of any apparent sensory or neurological damage or poor educational opportunities (Alfons & Flanagan, 2018; Kapp, Gillespie-Lynch, Sherman & Hutman, 2013). With a prevalence of about 17% (Schultz, Simpson & Lynch, 2012), dyslexia is one of the most thoroughly studied types of specific learning disabilities (SLDs), affecting more than 80% of all individuals identified as learning disabled (Adubasim, 2018).

The evolution of reading requires coordination in various cognitive functions, especially in basic reading skills, e.g., decoding and comprehension (Foy & Mann, 2013), visual processing (Semrud-Clikeman, 2005), and visual-spatial working memory (Baddeley, 2012).

Different approaches have explained dyslexia differently. These approaches can be divided into two primary groups; the medical model is a deficit-oriented approach emphasizing the existence of a deficit/damage in the brain of dyslexic people (Swain, French & Cameron, 2003; Honeybourne, 2018). On the other hand, neurodiversity emphasizes dyslexic people's capabilities and strengths (Harris, 2017).

A neurodiversity-related theory is the pattern of strengths and weaknesses (PSW) in one's cognitive abilities (Lichtenstein, as cited in Phipps & Beaujean, 2016). Studies demonstrate the efficiency of the PSW for diagnosis and identification purposes. With precise and comprehensive tests, appropriate assessment, and identification of strengths and weaknesses, the PSW distinguishes SLDs from other disorders, identifies the type and

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severity of the disorder, and offers suitable treatments based on the strengths and weaknesses profile (Mohammadzadeh & Qamarani, 2017).

The PSW assumes that students with dyslexia have cognitive processing strengths and weaknesses detected and measured by standard tests (Phipps & Beaujean, 2016). When data are collected, they should be analyzed to demonstrate potential patterns of strengths and weaknesses characterizing the person. This is performed in different steps. The first step is examining the reliability of the data by judging the trustworthiness of the source and process of data acquisition; the second step is data collection, and the final step is data analysis and plotting the diagram of strengths and weaknesses (Schultz et al., 2012; Alfons & Flanagan, 2018).

One of the tests used for SLD evaluation and identification is the Wechsler Intelligence Scale for Children (WISC- IV), administered based on standard methods to estimate children's cognitive ability (Lecerf, Bovet-Boone, Peiffer, Kieng, & Geistlich, 2016). The version normed in Iran presents four primary indices of verbal comprehension index (VCI), perceptual reasoning index (PRI), working memory index (WMI), and processing speed index (PSI).

The VCI deals with verbal conceptualization, verbal reasoning, and language development. Deficits in verbal conceptualization and reasoning can complicate language development, and below-average scores indicate the severity of the problem (Afrooz, Kamkari, Shokrzadeh & Hellat, 2013). PRI shows fluid reasoning ability and is assessed via the subtests of arithmetic, matrix reasoning, and picture concept. Fluid reasoning involves the abilities put to use in new situations

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(Asiaee & Yamini, 2018). Taddei, Contena, Caria, Venturini, and Venditti (2011) concluded that students with SLDs have good performance compared to the controls only on the visual-spatial scale. Manshaei et al. (2014) reported that students with SLDs have slightly better performance than their non-dyslexic peers on PSI and VCI, despite having a weakness in WMI and PSI.

Working memory is a cognitive system in charge of temporary information storage and manipulation. It is a comprehensive system integrating the functions of long- and short-term memory (Holmes, Gathercole & Dunning, 2009). Swanson and Berninger (1996) showed that a deficit in working memory capacity distinguishes children with and without dyslexia. Swanson and Jerman (2006) examined the effects of working memory in the reading development of students with dyslexia; they found that, compared to phonemic awareness, working memory is more strongly correlated with the development of reading comprehension and speed. Studies by Alipour et al. (2014), Smith-Spark and Fisk (2007), Taroyan, Nicolson, and Fawcett (2007), Jeffries and Everatt (2008), and Parhoon, Alizadeh, Hasanabadi, and Dastjerdi Kazemi (2019) also showed that students with dyslexia have lower performance than non-dyslexic students in terms of working memory. De Clercq-Cuaegebeur et al. (2010) studied the intelligence profile of children with dyslexia; they demonstrated that the WMI is lower than the other indices, and this deficit is observed in 70% of these children.

McInnes, Humphries, Hogg-Johnson, and Tannock (2009) also reported that processing speed is one of the problems faced by students with SLDs. Processing speed comprises five smaller cognitive abilities (perception speed, test response speed,

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numeric ability, reading and writing speed and fluency). It is defined as the ability to automatically perform simple cognitive and repetitive tasks, especially when a high level of mental efficiency and persistent attention and concentration is demanded (Poletti, 2016). Toffalini, Giofrè, and Cornoldi (2017) examined the intelligence profiles of 1049 children with different types of SLDs (reading, spelling, mathematics, and writing) and found that all the SLD sub-groups showed similar weaknesses in working memory and processing speed. According to Oberauer and Lin (2017), a deficit in working memory and visual-spatial memory of students with SLDs causes problems in calculation, short-term memory, and processing speed.

Cognitive scales can predict children with SLDs' response to intervention, and are better predictors compared to academic achievement and personal information (Campton, as cited in Toffalini et al., 2017). The analysis of WISC indices and weaknesses helps clinicians, teachers, and parents to understand why students do not respond to curriculum-based interventions (Christo & Ponzuric, 2017). The identification and analysis of strengths are also essential to the normal development and acquisition of skills required by children with dyslexia (Everatt, Weeks & Brooks, 2008). Some evidence (West, 1997; Eide & Eide, 2006; Davis, 2010; Akhavan Tafti, 2019) also suggests that dyslexia is associated with some visual-spatial abilities. In their theory, Geschwind and Galaburda (1987) noted that the functioning of the lower-left hemisphere and the neurological features of the right hemisphere lead to linguistic deficits and non-verbal abilities. Moreover, studies by von Károlyi, Winner, Gray, and Sherman (2003) indicate a relationship between

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dyslexia and visual abilities. People with dyslexia reportedly have good artistic abilities and visual-spatial imagination (Rentenbach, Prislovsky & Gabrie, 2017).

Based on a review of the literature, very few studies have been conducted on the PSW of students with dyslexia. The difference between this and previous studies lies in its more focus on the identification of cognitive strengths as well as weaknesses based on a neurodiversity approach. The findings of this study and the identification of these students' cognitive profiles can help therapists and teachers design appropriate educational and interventional programs. Moreover, attention to the cognitive profiles and designing educational programs based on the strengths of students with dyslexia can promote their motivation to learn. Accordingly, this study aimed to identify the strengths and weaknesses of students with dyslexia based on their WISC-IV profile.

Research Questions

RQ1. What are the strengths and weaknesses of students with dyslexia based on WISC-IV subscales?

RQ2. What are the strengths and weaknesses of students with dyslexia based on the four primary WISC-IV scales?

Method

In this descriptive-analytical study, we obtained the WISC-IV scores of 119 elementary-school students that had already been diagnosed with dyslexia, had an age range of 7-13 years, and an average age of 8.11 years. The sample included the case files of 75 boys (62.5%) and 44 girls (36.7%) selected via convenience sampling.

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The data were collected from three SLD centers in Babol, Iran, which were willing to cooperate, in the academic year of 2020-2021. A total of 119 accessible WISC-IV (Persian version) case files were obtained from their archives. The data of four primary index scores (VCI, PRI, WMI, and PSI) were extracted for further analyses.

Ethical Considerations

The Education Department of Babol approved this study, which acts in lieu of IRB approval. Sampling was performed with the permission and cooperation of the SLD centers. We obtained anonymous WISC reports, containing only demographic information. We ensured these centers that the data would be used for research purposes only.

We used the Persian adaptation of the WISC-IV (Afrooz et al., 2013), which is an individually administered test of intelligence for children aged 6 years, 0 months through 16 years, 11 months. It contains 10 core subtests and five supplemental subtests. We examined the scores obtained in the 10 core subtests which allowed us to calculate the FSIQ and the four primary indices. The VCI was calculated from the sum of three subtests' scores: similarities, vocabulary, and comprehension. The PRI was calculated from the sum of three subtests' scores: block design, matrix reasoning, and picture concepts. The WMI was computed from the sum of two subtests' scores: digit span and letter-number sequencing. The PSI was computed from the sum of two subtests' scores: coding and symbol search. The GAI was calculated from VCI and PRI, and the CPI was obtained from WMI and PSI.

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The data were analyzed in SPSS 21 by using descriptive statistics (arithmetical mean and standard deviation). To analyze the scales, subtests, and IQs, the analysis of intra-group variance with Bonferroni post-hoc test was performed. The significance level was $p < .05$.

Results

Table 1 presents the descriptive data on RQ1, i.e. What are the strengths and weaknesses of students with dyslexia based on WISC-IV subscales?

Table 1
Means and SDs of the WISC-IV Subtests of Students with Dyslexia

Subtests	M	S. D
Similarities	6.54	2.65
Vocabulary	8.32	5.00
Comprehension	6.78	2.54
Block design	10.45	2.75
Picture concepts	8.59	2.35
Matrix reasoning	9.70	2.17
Digit Span	8.24	2.32
Letter-Number Sequencing	4.13	2.41
Coding	7.84	2.80
Symbol Search	9.17	2.27

The mean of the vocabulary subtest (M = 8.28) was higher than the similarities subtest (M = 6.54). Block design and matrix reasoning had a higher average than picture concepts (M = 8.6), respectively. The digit span had a higher average (M = 8.24) than the letter-number sequencing score (M = 4.13). Moreover, the mean of the symbol search subtest was higher (M= 9.16) than the coding subtest (M = 7.84).

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Table 2
ANOVA of WISC-IV Subtests

Source	SS	df	MS	F	P	Eta
Subtest	3473.12	9	385.9	52.77	.001	.31
Error	99.76	1053	7			

Table 2 shows that the statistically significant F value explains about 52.77% of the total variance. And there is a difference between the averages of the sub-components

Table 3
Mauchly's Test for Subtests

Within Subjects Effect	Mauchly's W	Chi-Square	df	Sig.
Subtest	.164	205.52	44	.000

An analysis of variance (ANOVA) for correlated samples was also performed. For the homogeneity assumption, Mauchly's test was run, which was significant. The F ratio was then computed using the Greenhouse-Geisser correction method for sphericity aberration (Table 3). In all research variables, using Greenhouse-Geisser ($p < .05$), the assumption for the equality of variances was established. Therefore, intra-group variables were statistically significant on Greenwich-Geisser correction, $F = (52.77, 790.70) = 844.32$, $p < .05$, $\eta = .31$. Due to the significant differences in the mean of subtests, Bonferroni

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correction was used to adjust probability values for the results of pairwise comparisons.

Figure 1 indicates the average scores of the students' WISC-IV subtests, showing the highest mean for block design and the lowest for the letter-number sequencing subtest.

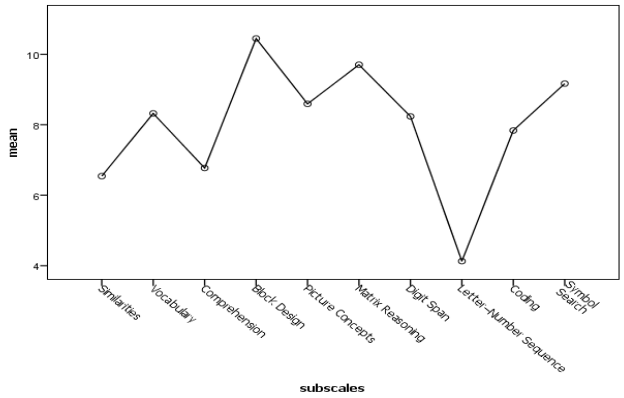


Figure 1. The average scores of the WISC-IV subtest in students with dyslexia

Table 4 presents the descriptive data on RQ2, i.e., What are the strengths and weaknesses of students with dyslexia based on the four primary WISC-IV scales?

Table 4
Means and SDs of the WISC-IV Indexes of Students with Dyslexia

Indexes	M	S.D.
Verbal Comprehension Index	83.08	10.88
Perceptual Reasoning Index	98.22	9.33
Working Memory Index	78.2	10.92
Processing Speed Index	90.94	12.45

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Evidently, PRI (M = 98.22) had the highest, whereas WMI (M = 78.2) had the lowest mean.

Table 5
Analysis of Correlated Variables of Intelligence

Source	SS	df	MS	F	P	Eta
Subscales	2769.53	3	9230.18	87.27	.001	.425
Error	37438.46	354	105.75			

Table 6
Mauchly's Test for Indices

Within Subjects Effect	Mauchly's W	Chi-Square	df	Sig.
Indexes	.906	11.464	5	.043

Table 5 shows that the statistically significant F value explains about 87.27% of the total variance. There is a difference between the criteria.

The homogeneity assumption was assessed via Mauchly's test which turned out to be significant. Based on the Greenhouse-Geisser correction for sphericity and the assumption of the equality of variances, a significant difference was observed between intra-group averages, F= (2.8,330.64) = 339.51, $p < .05$, $\eta = .425$. The Bonferroni correction was used to adjust probability values for the results of pairwise comparisons. By maintaining the alpha level of .05, there was a significant difference between the four indices. Figure 2 displays that the highest and lowest means belong to PRI and WMI, respectively.

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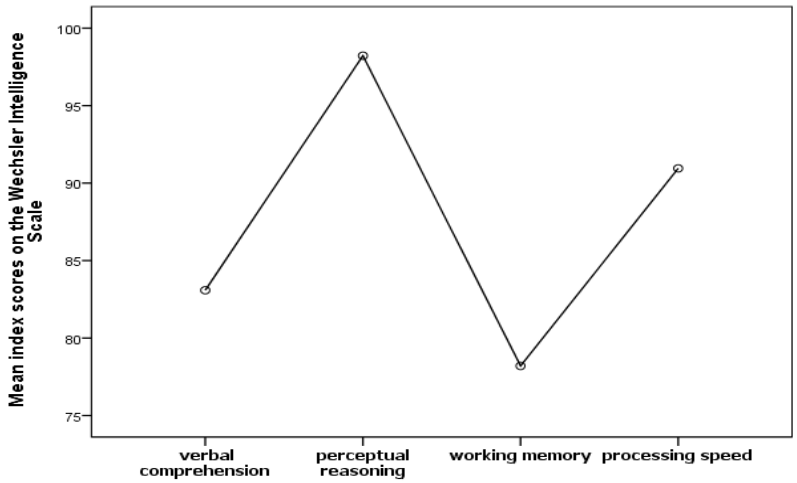


Figure 2. The average scores of the WISC-IV indexes in students with dyslexia

Discussion

A review of relevant research shows that people with dyslexia have different neuropsychological and developmental patterns, accounting for their poor academic achievement and cognitive abilities. However, some studies have emphasized the existence of visual-spatial abilities in these individuals (Akhavan Tafti, 2019; Davis, 2010; Eide & Eide, 2006; Taroyan et al., 2007; West, 1997), albeit with inconsistent empirical evidence. To provide further evidence, the present study identified the PSW of students with dyslexia based on their WISC-IV cognitive profile.

RQ1: What are the strengths and weaknesses of students with dyslexia based on WISC-IV subscales*?*

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To answer the first research question, the performance of students with dyslexia on WISC-IV subscales was analyzed. The findings revealed a significant difference between the WISC-IV subscales of these students. Students with dyslexia had a better performance on the subscales of arithmetic, matrix reasoning, and symbol search, respectively. This result was consistent with that of De Clercq-Cuaegebeur et al. (2010) and Manshaei *et al.* (2014), but inconsistent with that of Alipour et al. (2014). Arithmetic and matrix reasoning are subscales of perceptual reasoning, providing a precise index for visual-spatial processing and fluid reasoning. PSI is a language-free test in which linguistic functions are not involved, and shows fluid intelligence and abstract reasoning about non-verbal concepts. Symbol search is a subscale of the PSI associated with rapid decision-making, visual perception, and visual screening. Precise, or accurate, visual perception is a psychological process requiring quick and optimal decision-making about and reaction to a stimulus (Afrooz et al., 2013). In this study, the students with dyslexia had better performance in symbol search than coding; this finding is in line with that of De Clercq-Cuaegebeur et al. (2010) and Manshaei et al. (2014), but inconsistent with that of Alipour et al. (2014), Parhoon et al. (2019), and McInnes et al. (2009) who expressed that students with SLDs and dyslexia have a poor performance on PSI subscales (symbol search and coding).

The lowest mean among the WISC-IV subscales belonged to letter-number sequencing. This finding is consistent with that of Smith-Spark and Fisk (2007), Taroyan et al. (2007), Alipour et al. (2014), and Parhoon et al. (2019). Sequencing is an achievement of working memory that enables information

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manipulation after its recording and storage. The sequencing ability is a fundamental cognitive process effective in students' reading comprehension. According to Miller (as cited in Afrooz et al., 2013), if students achieve the sequencing ability, they can easily create a logical system for reading and comprehension, segment a story, and retell its beginning, middle, and ending. In this case, a logical system is developed for reading, through which comprehension is accomplished in a logical and structured manner. A weakness in sequencing disrupts the prediction of a situation and causal thinking, and threatens verbal and non-verbal comprehension.

RQ2: What are the strengths and weaknesses of students with dyslexia based on the four primary WISC-IV scales?

To answer this question, the performance of students with dyslexia on the four primary WISC-IV scales was analyzed. Among these primary scales, the highest mean belonged to PRI, followed by PSI, VCI, and WMI, respectively. Thus, their perceptual reasoning was higher than the other indices and showed a remarkable performance compared to the other scales. This finding was consistent with that of De Clercq-Cuaegebeur et al. (2010) and Manshaei et al. (2014), but inconsistent with that of Alipour et al. (2014). According to von Károlyi, Winner, Gray, and Sherman (2003), people with dyslexia have better visual-spatial abilities. Moreover, Rentenbach et al. (2017) showed that individuals with dyslexia have good visual-spatial imagination. Perceptual reasoning is lower in other SLDs, e.g., dyscalculia, compared to dyslexia (Lecerf et al., 2016). The PSI provides considerable clinical information. This scale has also been effective in the conceptualization of intelligence as spatial intelligence, context and text perception, mental visualization, and engineering reasoning, and is introduced as perceptual

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organization in WISC-III (Afrooz et al., 2013). This finding is also in line with that of Taddei et al. (2011) who concluded that students with SLDs have good performance compared to the controls only on the visual-spatial scale. Manshaei et al. (2014) also reported that students with SLDs have a better performance compared to their peers on PRI, despite a weakness in WMI and PSI

This study also revealed that, in students with dyslexia, the lowest mean belonged to WMI among the four primary scales. This finding is in line with that of Jeffries and Everatt (2008) who expressed that students with dyslexia have a lower performance in working memory than non-dyslexic students. This result is also in line with the findings of De Clercq-Cuaegebeur et al. (2010) on the intelligence profile of children with dyslexia, showing that WMI was lower than the other indices, and this deficiency was observed in 70% of these children. The finding is also consistent with that of Toffalini et al. (2017) who examined the intelligence profiles of 1049 children with SLDs and concluded that all SLD groups show similar weaknesses in working memory.

As for VCI, the performance of the students with dyslexia was much lower than the average in all the sub-components, which necessitates timely intervention. This finding is in line with that of Manshaei et al. (2014), Alipour et al. (2014), and Oberauer and Lin (2017).

The means of PRI (98.22) and PSI (90.94) were average, but the means of VCI (83.08) and WMI (78.2) were below average. According to Alfons and Flanagan (2018), a cognitive ability score of 85-89 denotes weakness, but a score of <85 (1 SD below the mean) indicates deficiency or deficit in that ability.

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The use of suitable diagnostic instruments can lead to significant findings. The identification of cognitive processing patterns helps identify students with dyslexia and elucidate how they learn. The findings of the present study showed that WISC profile analysis can provide reliable, valid, and practical information about these students' cognitive processing for educational and interventional program development.

The use of PSW theory to identify the strengths and weaknesses of students with dyslexia has several benefits. It provides a comprehensive assessment of their cognitive, processing, and academic skills. With a robust research and theoretical framework, this theory also eliminates the necessity of multiple measurements to identify strengths and weaknesses in the target group.

Based on the results of this study, the PRI was higher than the other indices of the WISC-IV in the students with dyslexia. This index shows that, in students with dyslexia, visual-spatial processing is superior to their other cognitive features; therefore, their learning style is mostly visual-spatial, and they often think in terms of mental images. As these children's processing and learning are non-linear and visual, they can learn better when the educational material is presented in a visual-spatial format. The use of multi-sensory instruments with highlighted visual-spatial elements that are compatible with these students' strengths will make the process of learning enjoyable for them.

Despite its significant theoretical and clinical implications, this study had several limitations that should be addressed in future research. We relied on post-hoc data collection and analysis on both the diagnosis and testing of students with dyslexia, already made by different clinicians in the selected SLD centers. Moreover, the new version of the Wechsler scale,

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the WISC-V, is now available in other countries, although it is still in the process of normalizing and customization in Iran. Changes in the contents of subtests and new indices such as VSI allow for a greater understanding of the specific strengths and weaknesses of each case, which is especially important in planning an intervention program.

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