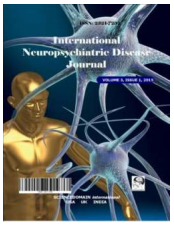

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Analysis of Psycholinguistic and Intelligence Factors in Chinese Children with Dyslexia

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Authors' contributions

This work was carried out in collaboration between both authors. Author FT conceived, designed and performed the experiments. Authors FT and TF analyzed the data. Author TF contributed reagents/ materials/analysis tools. Author FT wrote the paper. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To probe the developing factors for both general intelligence and special linguistic abilities on children with dyslexia.
Study Design: Dyslexia outpatients were screened from The Chinese Capital Institute of Pediatrics following the ICD-10-CM (International Classification of Diseases), and retested in laboratory again after consent form was obtained from participants.
Methodology: To conduct the Chinese psycholinguistic assessment, the WISC-III intelligence test, and the questionnaire survey on early developing factors. The data were input Excel and analyzed with SPSS16.
Results: 1) Unbalanced equilibrium was responsible for the development of phonological score (PS) and orthographic score (OS) of psycholinguistic assessment; 2) Some units of intellectual development delays were at different degrees; 3) With a score of 90 as the boundary value comparison used by full intelligence quotient (FIQ) groups, the receiver operating characteristic (ROC) curve showed significantly on the automatic level and closer processes of psycholinguistic. With a score of 85 as the boundary value comparison used by psycholinguistic groups, most factors

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in the general IQ showed significant positive relationship, but some factors showed a negative relationship regarding the information and arithmetic portion of the verbal intelligence quotient (VIQ), and a significantly negative relationship on the coding of the performance intelligence quotient (PIQ). 4) The early motion development and single syllable pronunciation of children with dyslexia was slightly underdeveloped.

Conclusions: Children with dyslexia should be focused on balance between their abilities relating psycholinguistic factors. The general intelligence factors have alternately relationships with psycholinguistic factors. At the same time, close attention should be paid to early intelligence problems, such as macro motor delays.

Keywords: Chinese children with dyslexia; intelligence factors; psycholinguistic factors; factors relating to early developmental delays.

1. INTRODUTION

Children with developmental dyslexia estimated to affect 5-17% of children and 80% of all individual with a learning disability (LD) is characterized by low reading achievement in them who otherwise have cognitive abilities, motivation, and education necessary for accurate and fluent reading [1-3]. Das, Naglieri and Kirby [4] and Das, Kar and Parrila [5] challenges g-theory (The Planning, Attention-Arousal, Simultaneous and Successive (PASS) theory of intelligence) on the grounds that the brain is made up of interdependent, but separate, functional systems. Neuroimaging studies and clinical studies of individuals with brain lesions make it clear that the brain is modularized; for example, damage to a very specific area of the left temporal lobe will impair the production (but not the comprehension) of spoken and written language. Damage to an adjacent area will have the opposite impact, preserving the individual's ability to produce, but not understand speech and text. Nevertheless, some case-control researches showed the PASS cognitive processes were not strongly related to Chinese dyslexia, and suggested that phonological and orthographic processing represent sources of difficulties in children with dyslexia in Chinese [6]. Developmental dyslexia may also be characterized by the co-existence of phonological and visuospatial disorders in Chinese children [7]. Some phonological processing such as awareness and memory predicted acquisition in both alphabetic [8-10] and non-alphabetic orthographies [11-13]. Chinese phonological processing skills in dyslexia have provided inconsistent finding ether. The dyslexia group performed equally well as the chronological age (CA) control on thyme detection and sound categorization [14].

Early factors, such as motion, were thought as being indicative of early intelligence, which might forecast learning abilities later, allowing for interventions during those key periods [15]. As the meta analysis of Mainland-Chinese children with dyslexia showed about one deviations on general intelligence development to be delayed including fluid and crystallized intelligence [16,17], although there was significant heterogeneity in the full intelligence quotient (FIQ) and the sub-test scales among the screened articles in both the dyslexia and the control groups. These scores were only based on the g-factors. The present study is meant to probe deeply the internal cross-relationship on g-factors and psycholinguistic-factors on mainland Chinese children with dyslexia.

2. METHODS

2.1 Participants

Ethical approval for the study was obtained from Chinese Capital Institute of Pediatrics. According to the diagnostic criteria of ICD-10-CM, 283 cases were screened from thousands of outpatient over 2 years. 50 of them obtained the consent form from their parents, general intelligence and psycholinguistic abilities were retested in a laboratory. Their parents filled the questionnaire on early developmental factors.

2.2 Diagnostic Screening Criteria

1) Through intellectual screening tests, IQ> = 70.
2) Sensory impairments, neuropsychiatric disorders, and somatic diseases, emotional disturbance and also environmental, cultural or economic dis-advantages attention deficit hyperactivity disorder and organic brain disease were excluded.
3) Teacher rating: the average score of core subjects (Chinese, mathematics, English) below 5% of the class score, or head

teacher rating: Having learning disabilities for more than 1 year, or parents rating: Being unable to finish homework independently.

2.3 Retest Tools

The Chinese format of The Psycholinguistic Abilities Test was translated and modified from The Illinois Test of Psycholinguistic Abilities, which including ten subtests comprised of five phonological subtests: Auditory Reception (AR), Auditory Association (AA), Verbal Expression (VE), Auditory Sequential Memory (ASM), Grammar Closure (GC); and five orthographic subtests: Visual Reception (VR), Visual Association (VA), Manual Expression (ME), Visual Sequential Memory (VSM), and Visual Closure (VC). The representative levels involved in the formal three processes are as follows: The decoding process is shown as AR and VR, the organizing process is shown as AA and VA, the encoding process is shown as VE and ME. The automation level is involved in the later two: The closer is shown as GC and VC, and the sequential memory process is shown as ASM and VSM.

The Wechsler Intelligence Scale for Children (WISC-III) includes ten subtests, in addition to the digit span. The verbal intelligence (VIQ) portion involves five subtests: Information, classification, arithmetic, vocabulary, and comprehension. The practice intelligence portion (PIQ) is involved in five subtests: Picture completion, picture arrangement, block design, object assembly, and coding.

2.4 Statistical Analysis

Data were entered in an Excel database, which were then analyzed using SPSS16. This was done in order to conduct scale distribution, boundary value and group comparisons, relationship probes, and ROC curve painting for comparing the psycholinguistic factors with IQ groups and IQ factors with psycholinguistic groups.

3. RESULTS

3.1 General Assessments of the Patients

The clinical ages of the subjects were around the 6-10 years old, which includes two peaks: 6-7 years old (constitutes more than 37.2% of total), and 9-10 years old (constitutes more than 52.6% of total). There were more boys than girls (2.3:1). The average FIQ was crowded mode of 90 score and selected as the boundary of the group later, although mean of which near the median [100.71±11.37 (73~126)]. VIQ [99.31±12.03 (68~128)] and PIQ [103.00±11.49 (80~127)] did not show separation (t test, $p > 0.05$). The distribution of FIQ appeared to a basic normal distribution, but showed significant differences in degrees ($p < 0.01$).

3.2 The Psycholinguistic Factors Evaluation

The average score on both phonological (PS) and orthographic (OS) were about 85, one deviation delayed to the mean (selected as the boundary of the group later). The weakest items related to the verbal expression of phonological subtest, and the visual sequence memory of orthographic subtest. Each subtest score, according to the specific ability of corresponding subgroups on psycholinguistic scores, showed more nuance, which was owed to equilibrium; the higher items correspond opposite to the lower ones (Fig. 1).

3.3 General Intelligence Elements Comparison Following Psycho-linguistic Scores Grouped by 85 Points

The common weaker points of general intelligence were classification, comprehension, and object assembly when phonological and orthographic scores were both under 85 points (Fig. 2). It is still evident that general ability is a controlling force, and that higher IQ scores indicate higher psycholinguistic scores; IQ factors were balanced when phonological and orthographic scores reached 85 points.

3.4 Further Comparing on IQ Factors with Separated Psycholinguistic Groups by 85 Point

With an 85 block boundary value of psycholinguistic scores, the ratio of children with dyslexia from a higher score to a lower one was 2 to 1 on phonological test, and 1 to 1 on orthographic test. IQ factors that showed a similar tendency were: FIQ, VIQ, PIQ; classification and vocabulary comprehension in VIQ, and picture completion, block design, and object assembly in PIQ. It is interesting to note that there were some factors that showed a

negatively related tendency, although without significant differences, such as information and arithmetic in VIQ. Coding in PIQ had a significant negative correlation (Tables 1, 2).

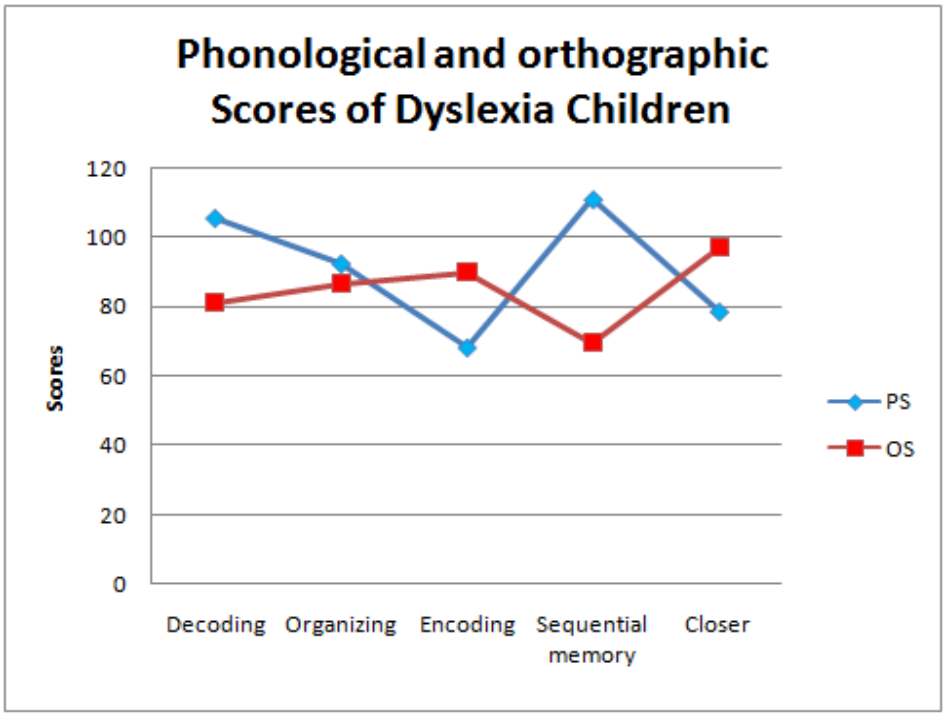

Fig. 1. Factors of corresponding phonological and orthographic scores

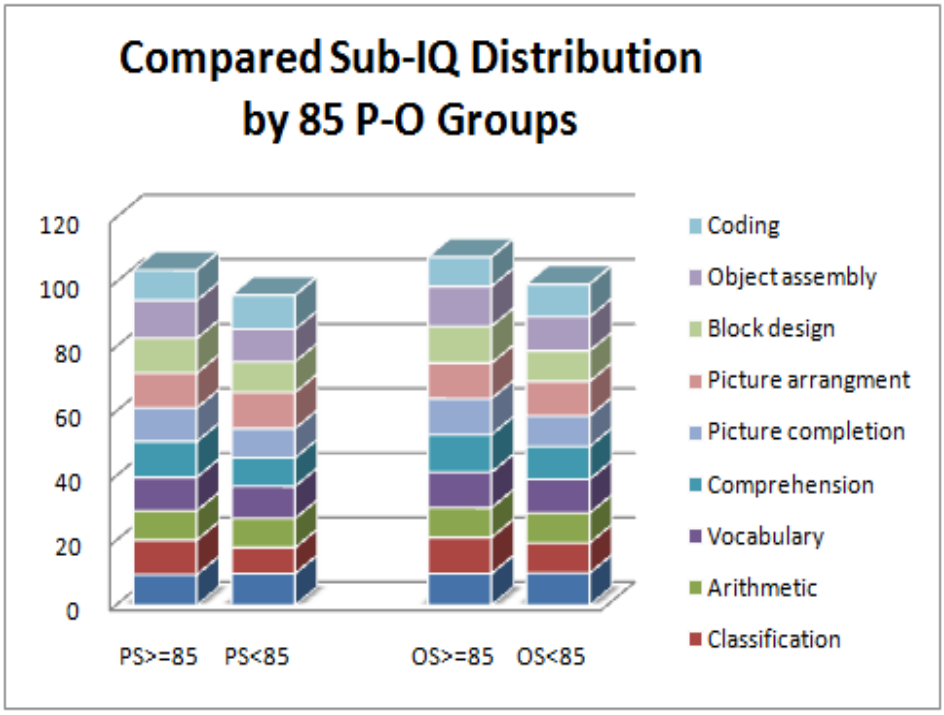

Fig. 2. Compared Sub-IQ distribution by 85 psycholinguistic scores

3.5 ROC Curves of Psycholinguistic Factor Comparisons by 90 FIQ Groups

The automation level, which includes memory and expression, and the closer processes, including PS and OS of psycholinguistic assessment, embody the FIQ index in the ROC curve when children with dyslexia are grouped by FIQ 90 (Figs. 3, 4). There is not significant factor on IQ in ROC curve when grouped by 85 score of psycholinguistic assessment.

ROC curves analysis of automatic level of psycholinguistic ability was the best bound up with general IQ deviating groups by 90 scale (sensitivity=0.81, specificity=0.62).

ROC curves analysis of closer process of psycholinguistic ability was the best bound up with general IQ deviating groups by 90 scale (sensitivity=0.83, specificity=0.68).

3.6 Early Factors of Development

The early motion development and single syllable pronunciation in children with dyslexia were slightly less advanced. Macro-movements, which include climbing, walking, and drinking with a cup, with the combination of voice were more delayed in groups possessing IQ scores below 90 points, although the indexes of laughing, rolling over, sitting and standing developed in corresponding months of normal reference (Fig. 5).

4. DISCUSSION

When comparing children with dyslexia using higher IQ scores (> 110 points) and lower ones as the group boundary (< 90 points), Johnston [18] found that the former were more vulnerable to the wordless reading of pronunciation and intonation. In the present study, the general IQ grouped by 90 score for comparing the factors of psycholinguistic assessment in ROC curves. We found significant different on automation level in both phonologic and orthographic score (Fig. 3). The result supported the idea of Ferrando's study [19], which showed that children's mental development was delayed to some degree, the automation level, including memory and expression, should be considered first. At the same time the closer processes could not be ignored either when dyslexia children with higher IQ score (Fig. 4).

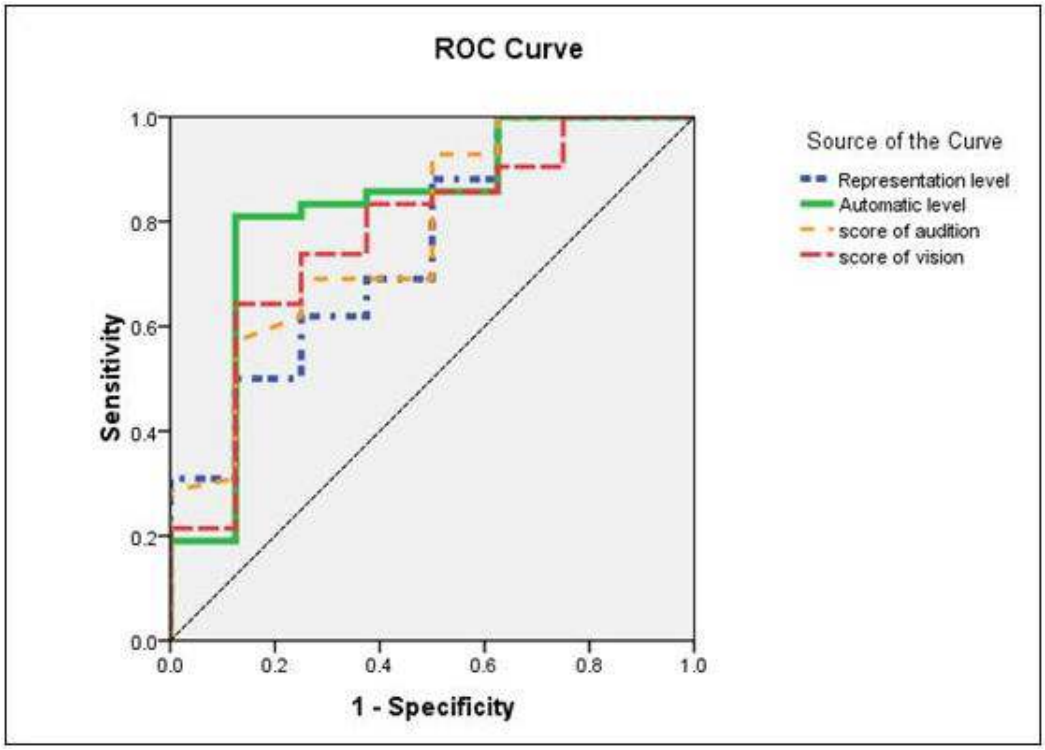

Fig. 3. ROC curves of psycholinguistic levels deviated groups by FIQ 90 score

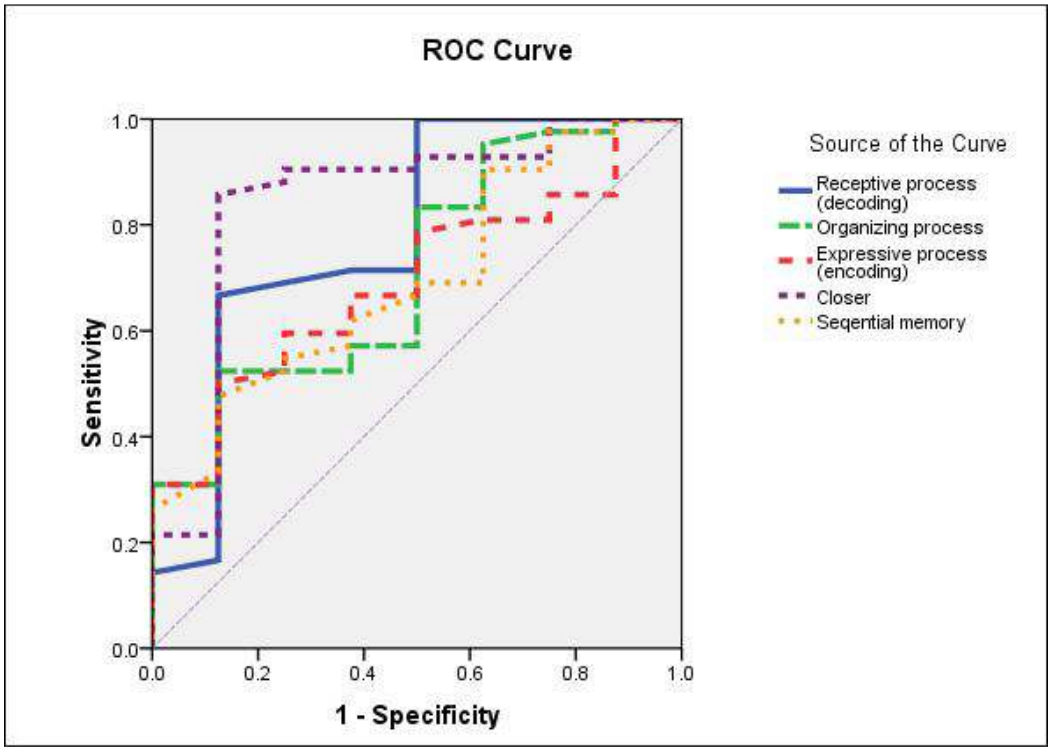

Fig. 4. ROC curves of psycholinguistic processes deviated groups by FIQ 90 scale

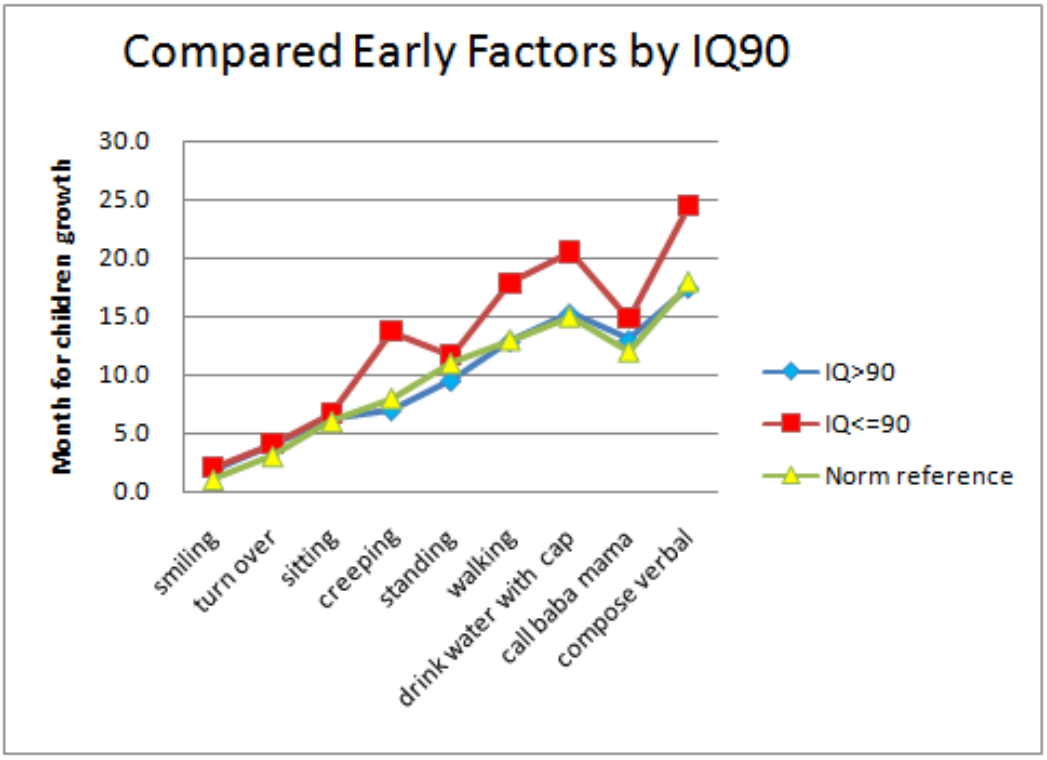

Fig. 5. Compared early development factors by FIQ90

There are little reports on how many scores delayed in Chinese psycholinguistic assessment. Meta-analysis on the fluid IQ showed one deviation score delayed in Chinese children with dyslexia [20]. The mean scores of linguistic learning abilities for this study were centered around a minus deviation of 85 points, and so, were chosen for the block boundary value, meaning groups with scores higher than 85 and lower than 85. It was also showed that the factors correspondence is owed each other between this phonological and orthographic sub-scores, which may be another aspect of the important mental development problems related to Chinese children with dyslexia.

Neurophysiology studies support the theory of brain metastases from right to left, The right half of brain is involved in visual process, and the left half is involved in language skills. Improved recollection is a function of the left hemisphere, while young children use the right hemisphere's visual process to help them start reading [21], and can predict reading ability by measuring this process [22]. Children obtain visual association abilities according the difficulty of degree in the tasks they perform. Western children at 6~7 years can distinguish letters, familiarizing them into words as they become older.

Chinese is flexible; it is strongly constrained by its language-specific properties such as high information density and lack of word spacing [23]. Chinese orthographic processing includes the knowledge of character structure and radical awareness [24], graphic units represent basic units of meaning and characters are monosyllabic. About 90% of Chinese characters are ideophonetic compounds, each comprising a semantic radical and a phonetic radical. The semantic and phonetic radicals give meaning and phonological cues to a reader [14]. There are some other problems, such as homophones, words that sound the same but have different meanings; homographs, words that are spelled the same but have a different sound and meaning; and synonyms, different words that all have similar meanings. Word segmentation occurs in the overlapping of ambiguous strings during Chinese reading [25]. The Chinese component radical portfolio of learning difficulties have differences from the sequential alphabetic component, which proved there were differences in the excitement and transfer of nerve impulse between right and left brain activation [26]. A poor or not fully formed understanding of internal orthographic structure may impede and delay character recognition and make reading a laborious task [26].

Altarac et al. [27] reported about 9.7% children suffer from lifelong dyslexia; this information came from surveying doctors, teachers, and health care workers around America. In China, children with dyslexia were usually found in school-age children, and most studies focusing on the general IQ are measured during the same period. This study found that early factors related to intelligence, especially in children with dyslexia are in the wake of lower IQs, has delayed early action and speech, but their parents had not paid attention to it. Psycholinguistic ability tests on children should also be conducted prior to reaching school age. This study explores and provides an assessment method through specific ability tests on Chinese children with dyslexia.

Table 1. IQ factors comparing of Phonological Score (PS) by 85 point groups

	Mean 1 (PS>=85)	s1	Mean 2 (PS<85)	s2	T (*p*)
FIQ	102.4	9.3	94.8	13.5	10.0**
VIQ	100.9	10.5	94.5	13.6	7.7**
Information	9.5	2.6	9.8	2.9	-1.8
Classification	10.7	2.9	8.0	2.8	13.9**
Arithmetic	9.1	3.0	9.1	3.3	-0.1
Vocabulary	10.4	2.5	9.9	3.0	2.5**
Comprehension	11.1	2.4	8.8	3.2	11.5**
PIQ	103.4	11.2	99.0	11.9	5.6**
Picture completion	10.4	1.9	9.1	2.3	9.3**
Picture arrangment	10.8	2.7	11.2	2.5	-2.1
Block design	10.8	2.5	9.5	3.4	6.1**
Object assembly	11.7	3.0	10.1	2.1	9.2**
Coding	9.4	3.2	10.5	2.2	-6.0**

One start (*) means p<0.05; two starts (**) mean p<0.01

Table 2. IQ factors comparing of Orthographic Score (OS) by 85 point groups

	Mean 1 (OS>=85)	s1	Mean 2 (OS<85)	s2	t (*p*)
FIQ	103.9	9.9	97.6	12.2	11.4**
VIQ	103.6	10.6	99.3	14.9	8.6**
Information	9.8	2.6	10.0	2.8	-1.6
Classification	11.2	2.8	9.3	2.7	17.2**
Arithmetic	9.2	2.5	9.2	3.5	-0.2
Vocabulary	11.0	2.5	10.5	2.8	5.1**
Comprehension	11.6	2.5	10.2	3.6	12.3**
PIQ	106.0	11.6	99.7	10.7	11.5**
Picture completion	11.2	2.3	9.5	2.0	15.9**
Picture arrangment	11.0	2.3	10.7	2.9	2.6**
Block design	11.4	2.6	9.5	2.6	15.1**
Object assembly	12.3	2.7	10.5	2.6	13.9
Coding	9.1	3.1	10.1	2.6	-7.3**

One start (*) means p<0.05; two starts (**) mean p<0.01

5. CONCLUSION

Chinese children with dyslexia have unbalanced and delayed factors relating to psycholinguistic assessment. There is interactive relationship among the factors on both general intelligence and special psycholinguistic assessment scores. Early development factors related to general intelligence should also be considered.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lyon GR. Toward a definition of dyslexia. Annals of Dyslexia. 1995;45:3-27.
2. Shaywitz SE. Dyslexia. N Engl J Med. 1998;338(05):307-312.
3. Shaywitz SE, Shaywitz BA. Dyslexia (specific reading disability). Pediatr Rev. 2003;24(5):147-53.
4. Das JP, Naglieri JA, Kirby JR. Assessment of cognitive processes. The PASS theory of intelligence. Massachussets: Allyn & Bacon, Inc; 1994.
5. Das JP, Kar R, Parrila RK. Cognitive planning. The psychological basis of intelligent behavior. London: Sage Publications Ltd; 1996.
6. Wang X, Georgiou G, Das JP, Qing L. Cognitive processing skills and developmental dyslexia in Chinese. Journal of Learning Disabilities. 2012;45: 526-537.
7. Siok WT, Spinks JA, Jin Z, Tan LH. Developmental dyslexia is characterized by the co-existence of visuospatial and phonological disorders in Chinese children. Curr Biol. 2009;19(19):R890-2.
   DOI: 10.1016/j.cub.2009.08.014.
8. De Jong PF, Van Der Leij A. Specific contributions of phonological abilities to early reading acquisition: Results from a Dutch latent variable longitudinal study. Journal of Educational Psychology. 1999; 91:450-476.
9. Geogiou GK, Parrila R, Papadopoulos TC. Predictors of word decoding and reading fluency in English and Greek: Across-linguistic comparison. Journal of Educational Psychology. 2008;100:566-580.
10. Schatschneider C, Carlson CD, Francis DJ, Foorman BR, Fletcher JM. Relationship of rapid automatized naming and phonological awareness in early reading development: Implications for the double deficit hypothesis. Journal of Learning Disabilities. 2002;35:245-256.
11. Ho CS, Bryyant P. Phonological skills are important in learning to read Chinese.

Developmental Psychology. 1997;33:946-951.
12. McBride-Chang C, Ho CS. Predictors of beginning reading in Chinese and English: A 2-year longitudinal study of Chinese kindergartners. Scientific Studies of Reading. 2005;9:117-144.
13. McB ride-Chang C, Kail R. Cross-cultural similarities in the predictors of reading acquisition. Child Development. 2002;73: 1392-1407.
14. Ho CS, Chan DWO, Tsang SM, Lee SH. The cognitive profile and multiple-deficit hypothesis in Chinese developmental dyslexia. Developmental Psychology. 2002; 38(4):543-53. PMID: 12090484.
15. Friedman R. Using the family school in treatment of learning disorders. Journal of Learning Disabilities. 1978;11:378-382.
16. Tong F, Fu T. Meta-analysis of fluid intelligence tests of children from the chinese mainland with learning difficulties. Plos One. 2013;8(11):e78311. DOI: 10.1371/journal.pone.0078311.
17. Tong F, Fu T, Sun J. Wechsler intelligence scale for children testing among chinese children with learning difficulties: A meta-analysis. Chinese Journal of Evidence-Based Pediatrics. 2012;7(5):364-372.
18. Johnston RS, Morrison M. Toward a resolution of inconsistencies in the phonological deficit theory of reading disorders: Phonological reading difficulties are more severe in high-IQ poor readers. J Learn Disabil. 2007;40(1):60-79.
19. Ferrando-Lucas MT, Banus-Gomez P, Hoz-Rosales AG. Written language and intellectual disability. Rev Neurol. 2005;40 (Suppl1):S91-96.
20. Critchley M. The dyslexicchild. Springfield, IL: Charles C. Thomas; 1970.
21. Bakker DJ. Hemispheric specialization and specific reading retardation. In M. Rutter (ed.), Developmental Neuropsychiatry. New York: Guilford Press; 1983.
22. Bakker DJ, Licht R. Learning to read: Changing horses in mid-stream. In Pavlidis G. Th & Fisher DF. (eds.), Dyslexia: Its neuropsychology and treatment. Now York: John Wiley & Sons; 1986.
23. Yan M, Zhou W, Shu H, Kliegl R. Perceptual span depends on font size during the reading of Chinese sentences. Journal of Experimental Psychology, Learning, Memory and Cognition. 2015; 41(1):209-19. PMID: 25329081.
24. Chan DW, Ho CS, Tsang S, Lee S, Chung KKH. Reading related behavioral characteristics of Chinese children with dyslexia: The use of the teachers' behavior checklist in Hong Kong. Annals of Dyslexia. 2003;53:300-323.
25. Ma GJ, Li XS, Rayner K. Word segmentation of overlapping ambiguous strings during Chinese reading. Journal of Experimental Psychology, Human Perception and Performance. 2014;40(3): 1046-59.
26. Yeh SL, Li J. Role of structure and component in judgments of visual similarity of Chinese characters. Journal of Experimental Psychology: Human Perception and Performance. 2002;28: 933-947.
27. Altarac M, Saroha E. Lifetime prevalence of learning disability among US children. Pediatrics. 2007;119(Suppl 1):S77-83.

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