Cognitive Development in Children With Language Impairment, and Correlation Between Language and Intelligence Development in Kindergarten Children With Developmental Delay

Su-Fen Liao, MD1,2, Jui-Ching Liu, MSc3, Chun-Ling Hsu, MSc4, Ming-Yuh Chang, MD5, Tung-Ming Chang, MD5, and Helen Cheng, MD4,6

Abstract
We performed a retrospective review of 65 children with developmental delay. The male-to-female ratio was 2.25 : 1, and the mean age was 5.8 years; performance IQ was 94.8, verbal IQ was 83, and full-scale IQ was 87.4. Twenty-three (35%) children had normal language development, 13 (20%) had below average language development, and 29 (45%) had developmental language disorder. Performance IQ was significantly better than verbal IQ in all children ($P < .001$), and there was no difference within the 3 language groups. The performance IQ ($P = .007$) of children with developmental language disorder and specific language impairment was significantly lower than that of children with normal language development. Performance IQ was found to be correlated with language score ($r = .309, P = .012$). The children with language impairment were associated with lower IQ scores. The discrepancy between performance IQ and verbal IQ persisted in children with developmental delay, not only in children with language disorder.

Keywords
language, developmental language disorder, intelligence

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Developmental delay is defined as the occurrence of significant delay in one of the developmental domains (gross/fine motor, speech/language, social/personal, cognition, and activities of daily living). Among these domains, speech and language disorders are common developmental problems in childhood.1 The term developmental language disorder refers to a predominance of language problems, primarily due to factors other than hearing loss, intelligence impairment, obvious neurologic disorders, autism, and orofacial anomalies.2 The clinical picture of developmental language disorder is quite varied; and the prevalence of developmental language disorder ranges from 1.3% to 7.4%, depending on the definition used.3-5 It was reported to be 4.36% among preschool children (from 4 to 6 years) in Taiwan.6 Developmental language disorder is one of the major developmental delay problems in Taiwan. Tsai et al7 reported a 58.4% delay in language development in developmental delay. Specific language impairment, in addition to developmental language disorder criteria, is also characterized by a normal nonverbal cognitive function in which performance IQ is greater than 85.8,9 However, evidence shows that specific language impairment is associated with a range of impairments in other developmental domains.10 Despite the requirement of normal nonverbal cognitive functioning, nonverbal cognitive impairments have been reported in school-age children with a history of language impairment diagnosed at the preschool age.11 Evaluation of cognitive strengths and weaknesses is an essential part of the evaluation of children with developmental delay. Stothard et al12 found those who had

1 Department of Physical Medicine and Rehabilitation, Changhua Christian Hospital, Changhua, Taiwan
2 School of Medicine, Chung Shan Medical University, Taichung, Taiwan
3 Division of Speech-Language Pathology, Department of Physical Medicine and Rehabilitation, Changhua Christian Hospital, Changhua, Taiwan
4 Child Development Center, Changhua Christian Hospital, Changhua, Taiwan
5 Division of Pediatric Neurology, Department of Pediatrics, Changhua Christian Hospital, Changhua, Taiwan
6 Department of Psychiatry, Changhua Christian Hospital, Changhua, Taiwan

Corresponding Author:
Su-Fen Liao, MD, Department of Physical Medicine and Rehabilitation, Changhua Christian Hospital, No.135 Nanxiao Street, Changhua, 500 Taiwan. Email: sueliao3@gmail.com
specific language impairment at age 5 to 6 had significant impairments in all aspects of spoken and written language functioning at outcome. Yang concluded that there can be an overlap in symptomatology of cognition among autism, other communication disorders, and global mental retardation in very young children. Based on this, intelligence and language assessment cannot reveal a definite result until children are older than 5 years. The knowledge of a child’s cognitive status can facilitate the planning of education and interventions, and provide information about prognosis in children with developmental delay. The aim of this study was to explore intelligence and language development in 5-year-old children with developmental delay. We further assessed the cognitive development of developmental language disorder and specific language impairment, and the correlation between language and intelligence development.

Methods

Patients and Study Design

After obtaining institutional review board approval, we performed a retrospective review of kindergarten-age children who were referred to the Child Development Center and Department of Physical Medicine and Rehabilitation, Changhua Christian Hospital, Changhua. To identify the child’s cognitive and language development, a cognitive and speech-language evaluation was performed between September 2011 and May 2012. All children with developmental delay received regular follow-up in our Development Center every year. The children with a diagnosis of developmental delay were first screened with the 0 to 6 years developmental screening test, then confirmed by physical, occupational, and speech therapists, psychologists, and Development Center physicians (including a pediatric physiatrist, child and adolescent psychiatrist, and pediatric neurologist). The diagnosis of major disease was also made by Development Center physicians. The Peabody Developmental Motor Scales II was used to assess gross and fine motor skills. Speech-language evaluation was assessed with the Revised Preschool Language Assessment (2008) and Revised Primary School Language Assessment (2010). The Wechsler Preschool and Primary School Language Assessment is for preschool children aged between 3 and 6 years; and the Revised Primary School Language Assessment is for children aged between 6 and 12 years. In the study, the receptive and expressive language parts and total scores were used to determine language ability. A score below 1.5 standard deviations on either the receptive or expressive language part was classified as delayed language development or developmental language disorder, and scores between 1.0 and 1.5 standard deviations were classified as below average language development. On the basis of Bishop and Edmundson’s finding that a pure phonological disorder is less serious, the children with an articulation problem only were not defined as having a language disorder.

Statistical Analysis

Descriptive statistics (including mean, range, frequency, and percent) were used for demographic and clinical/treatment factors of interest. Categorical variables were analyzed by one-way analysis of variance and the nonparametric test. When a P value was <.05, a pairwise comparison was carried out using the Kruskal-Wallis test. The correlation between the performance IQ and language scores was identified by Pearson correlation. All analyses were performed using SPSS software version 20.0 for Windows (SPSS Inc, Chicago, IL). A P value ≤.05 was considered statistically significant.

Results

Sixty-five children (45 males and 20 females) who completed the Wechsler Preschool and Primary Scale of Intelligence–Revised–Chinese version and Composite Speech/Language Test participated in this study. The mean age was 5.8 years (standard deviation, 0.3), performance IQ was 94.8 (standard deviation, 13.5), verbal IQ was 83 (standard deviation, 12.3), and full-scaled IQ was 87.4 (standard deviation, 11.9) (Table 1). Twenty-three (35%) children had normal language development, 13 (20%) had below average language development, and 29 (45%, 6, pure receptive disorder; 7, pure expressive disorder; and 16, mixed receptive-expressive disorder) had developmental language disorder as assessed on the speech/language evaluation (Table 2). The male-to-female ratio was 1.6 : 1 in the developmental language disorder group.

Performance IQ was significantly higher than verbal IQ for all children (P < .001), and the difference between performance IQ and verbal IQ was 11.7 (standard deviation, 12.5) (Table 1). After univariate analysis using Pearson correlation, performance IQ was found to be correlated with the language score (r = .309, P = .012, Table 1), but there was no significant correlation of performance IQ and language score within the 3 language groups. The performance IQ and verbal IQ discrepancy
Table 1. Demographic, Clinical Characteristics and Correlation Between Language and Intelligence of Study Participants and Children With Performance IQ ≥85.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Whole group</th>
<th>Children with performance IQ ≥85</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>65</td>
<td>49</td>
</tr>
<tr>
<td>Sex (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>20 (31)</td>
<td>16 (33)</td>
</tr>
<tr>
<td>Male</td>
<td>45 (69)</td>
<td>33 (67)</td>
</tr>
<tr>
<td>Age, y</td>
<td>5.8 (0.3)</td>
<td>5.8 (0.4)</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>94.8 (13.5)</td>
<td>100 (11.1)</td>
</tr>
<tr>
<td>Pearson correlation</td>
<td>r = .309</td>
<td>r = .173</td>
</tr>
<tr>
<td></td>
<td>P = .012c</td>
<td>P = .236c</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>83 (12.3)</td>
<td>85.6 (11.8)</td>
</tr>
<tr>
<td>Full-scaled IQ</td>
<td>87.4 (11.9)</td>
<td>91.2 (10.8)</td>
</tr>
<tr>
<td>Performance IQ–verbal IQ</td>
<td>11.7 (12.5)</td>
<td>14.4 (12)</td>
</tr>
</tbody>
</table>

*Values are mean (standard deviation) unless otherwise indicated.

*p < .001 when compared with verbal IQ.

*p < .05.

The performance IQ and verbal IQ discrepancy persisted in all 3 speech/language groups, and there was no difference within the 3 groups (P = .983). Because the performance IQ and verbal IQ discrepancy, full-scaled IQ was not used in the final statistical analysis. In the nonparametric test, the performance IQ (P = .007) of the children with developmental language disorder was significantly lower than that of the children with normal language development (Figure 1). The results were the same when analyzing only the children with either receptive or expressive delayed development; that is, the children with delayed receptive or expressive development had significantly lower performance IQ than the children with normal language development.

The performance IQ subtests, and the scores of block design, matrix reasoning, and picture completion were significantly lower in children with developmental language disorder than in children with normal language development (Table 3). Although the performance IQ difference was predominant, delayed fine motor development was noted in only 8 children, and there was no difference in fine motor development in the Peabody Developmental Motor Scales II.

Forty-nine children (33 males and 16 females) with above average intelligence (performance IQ ≥85) participated in further analysis. The mean age was 5.8 years (standard deviation, 0.4), performance IQ was 100 (standard deviation, 11.1), verbal IQ was 85.6 (standard deviation, 11.8), and full-scaled IQ was 91.2 (standard deviation, 10.8). Nineteen (39%) children had normal language development, 12 (24%) had below average language development, and 18 (37%) had specific language impairment (Table 1). The main results for the children with average intelligence were the same as for the whole group. Performance IQ was also significantly better than verbal IQ for all children (P < .001), and the difference between the 2 measures was 14.4 (standard deviation, 12) (Table 1). There was no significant correlation of performance IQ and language score in children with average intelligence (r = .173, P = .236).

Discussion

The Wechsler Preschool and Primary Scale of Intelligence was chosen for the psychological evaluation of our subjects. It was reported to be able to assess the intelligence of children between 3 and 7 years well, and the stability of preschool IQ evaluation in children with developmental delay has been reported. Nonverbal intelligence tests are used rather than full-scaled IQ to determine intelligence because children with developmental language disorder perform below their age level on verbally oriented subtests.

Performance IQ was significantly lower in children with developmental language disorder than in children without this disorder, and this was also true in children with specific language impairment. We found their language score was significantly correlated with performance IQ. Our results proved that the delayed development of language abilities can partially account for the delay in development of mental ability, even when the delay is considered to be within the normal range of IQ.

Similar to our findings, Selassie et al reported that children with expressive-receptive disorders were linked to a lower general IQ level. Webster et al indicated the heterogeneity of language disorder, and that nonverbal cognitive impairments have been reported in school-age children with a diagnosis of specific language impairment made at preschool age. Cheng et al reported that children with developmental language disorder had lower nonverbal intelligence scores (by 17 points, performance IQ) than children without this disorder. Miller et al also reported that children with language impairment have been found to have a slower processing speed than their typically developing peers. As in our study, matrix reasoning, picture completion, and block design were the weaknesses in children with delayed language development. These reflect the weak visuospatial processing function in children with language disorder. Cheng et al observed that children with developmental language disorder tended to demonstrate poorer manual dexterity skill in the Movement Assessment Battery for Children.
Table 2. Demographic and Clinical Characteristics of Study Participants in 3-Language Groups.\(^a\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Normal language</th>
<th>Below average language</th>
<th>Developmental language disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>23 (35)</td>
<td>13 (20)</td>
<td>29 (45)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>7 (30)</td>
<td>2 (15)</td>
<td>11 (38)</td>
</tr>
<tr>
<td>Female</td>
<td>16 (70)</td>
<td>11 (85)</td>
<td>18 (62)</td>
</tr>
<tr>
<td>Age, y</td>
<td>5.7 (0.4)</td>
<td>6 (0.3)</td>
<td>5.9 (0.3)</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>101.2 (15.4)</td>
<td>96.5 (8.9)</td>
<td>88.9 (11.2)(^b)</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>89.1 (10.3)(^c)</td>
<td>85.1 (12.8)(^c)</td>
<td>77.3 (11.2)(^b,c)</td>
</tr>
<tr>
<td>Full-scaled IQ</td>
<td>94 (12.3)</td>
<td>89.2 (10)</td>
<td>81.4 (9.4)(^b)</td>
</tr>
<tr>
<td>Performance IQ–verbal IQ</td>
<td>12.1 (12.3)</td>
<td>11.3 (13.3)</td>
<td>11.7 (12.7)</td>
</tr>
</tbody>
</table>

\(^a\)Values are mean (standard deviation) unless otherwise indicated.
\(^b\)P < .01 when compared with normal language group.
\(^c\)P < .001 when verbal IQ compared with performance IQ.

Figure 1. The performance IQ and verbal IQ scores of 3 language groups in study participants (Language_N, Language_B, DLD) and in children with performance IQ \(\geq 85\) (85_N, 85_B, SLI).

Abbreviations: Language_N, normal language development; Language_B, below average language development; DLD, developmental language disorder; 85_N, normal language development in performance IQ \(\geq 85\); 85_B, below average language development in performance IQ \(\geq 85\); SLI, specific language impairment in performance IQ \(\geq 85\).

Table 3. Subscale of Performance IQ in 3 Language Groups on Participants and Children With Performance IQ \(\geq 85\).\(^a\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Normal language</th>
<th>Below average language</th>
<th>Developmental language disorder</th>
<th>Normal language in performance IQ (\geq 85)</th>
<th>Below average language in performance IQ (\geq 85)</th>
<th>Specific language impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object assembly</td>
<td>8.9 (2.7)</td>
<td>9.6 (3.4)</td>
<td>8 (2.5)</td>
<td>9.5 (2.5)</td>
<td>10.1 (3.3)</td>
<td>8.8 (2)</td>
</tr>
<tr>
<td>Geometric design</td>
<td>9.9 (2.8)</td>
<td>9.3 (2.2)</td>
<td>8.6 (2.6)</td>
<td>10.3 (2.7)</td>
<td>8.9 (2)</td>
<td>9.9 (2.1)</td>
</tr>
<tr>
<td>Block design</td>
<td>10.4 (2.9)</td>
<td>8.6 (3.1)</td>
<td>8.2 (2.9)(^b)</td>
<td>10.9 (2.8)</td>
<td>9.4 (2.2)</td>
<td>10 (2.2)</td>
</tr>
<tr>
<td>Matrix reasoning</td>
<td>11.1 (2.9)</td>
<td>9.3 (2.1)</td>
<td>9 (2.1)(^b)</td>
<td>11.7 (2.7)</td>
<td>9.6 (2.1)</td>
<td>10 (2)(^b)</td>
</tr>
<tr>
<td>Picture completion</td>
<td>10.8 (2.8)</td>
<td>8.9 (2.2)</td>
<td>9.1 (2.2)(^b)</td>
<td>11.5 (2.3)</td>
<td>8.6 (2.2)(^b)</td>
<td>9.3 (2.2)(^b)</td>
</tr>
</tbody>
</table>

\(^a\)Values are mean (standard deviation).
\(^b\)P < .05 when compared with normal language in all participants or normal language in performance IQ \(\geq 85\).
A number of studies have found that children with developmental language disorder are not only impaired in speech and language but some of them also have difficulties in non-linguistic tasks, such as attention, perception, working memory, and motor skills. In neurophysiology, a study by Meister et al using transcranial magnetic stimulation noted a strong correlation of the excitability of the hand motor area, but not the leg motor area, with the speech event. This indicated a specific functional connection between the hand motor area and the cortical language network. However, our result revealed there was no difference in fine motor development in the 3 language groups using the Peabody Developmental Motor Scales II. This could indicate that the Peabody Developmental Motor Scales is not as sensitive as the Movement Assessment Battery for Children in identifying developmental coordination disorder or manual dexterity skills; also, the sample size of this study was not large enough to identify differences in fine motor skills.

A lower verbal IQ than performance IQ is expected in children with developmental language disorder. Specific language impairment is characterized by a discrepancy criterion: lower verbal IQ than performance IQ, or higher performance IQ compared to the results on some language tests. In our study, the discrepancy was present, but the result revealed that the difference between performance IQ and verbal IQ in developmental language disorder children was not greater than in developmental delay children with normal language development. The same result was also found in children with specific language impairment. There was no difference in language development among children with different levels of performance IQ and verbal IQ discrepancy. This reflected that the performance IQ and verbal IQ discrepancy was common in children with developmental delay, not only in children with developmental language disorder or specific language impairment. Stanovich and Siegel reported that children with and without an IQ achievement discrepancy showed similar patterns of deficits on measures of word recognition and phonological processing. Yang et al also found a correlation \( r = .4 \) between repeated cognitive measures of developmental language disorder children lower than those of children with autism and mental retardation. Selassie et al reported lower verbal IQ levels than nonverbal IQ levels were almost as common as equal levels, but lower nonverbal IQ than verbal IQ was also found in developmental language disorder. All of these revealed the high heterogeneity in children with developmental language disorder, and that the discrepancy in standard deviation IQ-performance IQ is not an indicator for specific language impairment.

Our results showed that among children with developmental delay, both with and without language disorder, males were more prevalent. Tsai et al reported that developmental language disorder is one of the major developmental delays in Taiwan, and that the male-to-female ratio was 2.3:1 among children with developmental delay. In Western countries, speech delay was approximately 1.5 times more prevalent in boys (4.5%) than girls (3.1%).

The Wechsler Preschool and Primary Scale of Intelligence was chosen for the psychological evaluation of our subjects. However, speedy responses and verbal instruction are rewarded on this test, which can hinder the performance of children with language impairment. As Miller and Gilbert concluded, there is no one test that is a “better” measure of nonverbal intelligence for all individuals, especially children with developmental language disorder. If nonverbal IQ is assessed, the choice of test should be informed by a good understanding of the available options as well as the limitations of such testing.

Further follow-up is merited to evaluate the academic learning, social adaptation, and other comorbidities of children with developmental language disorder identified at kindergarten age. This is important because Webster et al reported that only 26% of children met current research criteria for specific language impairment, 57% of specific language impairment children had language impairment but had cognitive scores more than 1 standard deviation below normative means, and only 10% had normal language and cognitive skills when reevaluated at 10 years old.

The limitations of our study are that (a) our participants were limited to 1 developmental center, and the sample size was small, (b) it was a retrospective cohort study, and (c) the chosen test was not sensitive enough to detect motor competence and manual dexterity.

In conclusion, this study provides provisional evidence that children with language impairment are associated with a delay in the development of mental ability, and both were significantly correlated. The discrepancy between performance IQ and verbal IQ persisted in children with developmental delay—not only in children with language disorder; thus, the verbal IQ-performance IQ discrepancy cannot be an appropriate indicator for specific language impairment.

**Author Contributions**

SFL wrote and revised the manuscript and performed data analysis. JCL and CLH contributed to the acquisition and interpretation of data. MYC, TMC, and HC performed the study.

**Declaration of Conflicting Interests**

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**Ethics Approval**

The study was approved by the Changhua Christian Hospital Institutional Review Board Committee (#121106).

**References**


