Disability of Phonological versus Visual Information Processes in Japanese Dyslexic Children

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ABSTRACT
We analyzed phonological and visual information processes of four Japanese dyslexic children between 7-10 years of age. None of them had disability in word retrieval and/or auditory memory. Two of them manifested lower score in phonological awareness tests while the others showed normal score. All children showed subnormal score in a visual cognitive test, a visuo-spatial constructional test, and a visual long-term memory test. 90% of their errors were formal ones. As results, these four Japanese dyslexic children are thought to have disabilities in visual information processes and are thought to be of a different type from those reported as phonological dyslexia.

1. INTRODUCTION
Tallal reported twenty years ago that the phonological ability may take a role in reading and writing development as well as in language development. In recent years, the importance of the auditory cognitive ability for verbal sounds is emphasized for the development of the language function. Most of recent papers and reports discuss about their phonological impairments. While it may be reasonable to postulate that the auditory cognitive disorders prevent the development of normal language, it is not commonly recognized that the auditory cognitive disorders may prevent the development of writing and/or reading abilities.

It is also known that there exists a group of dyslexic children who manifested formally resembled errors: [ŋ] and [㇯] and [ŋa] and [ŋ] and [m]. They are thought to have a problem in visual information processes.

In this present study, we analyzed four Japanese developmental dyslexic children from two viewpoints: phonological information processes and visual ones.

2. METHOD
2.1. Subjects
Subjects were four boys (7-10 years old), who manifested reading and writing disorders in both Kana and Kanji. They had no spoken language disorders and no intellectual disorders (Table 1). Their MRI and CT findings were normal. They showed reduction of rCBF (regional Cerebral Blood Flow) in common in left temporal and parietal lobes. Their verbal and performance IQ were 103 and 86 (case 1), 89 and 96 (case 2), 69 and 88 (case 3), 120 and 104 (case 4), respectively. 90% of their errors in reading and writing were formal errors.

Table 1. Developmental dyslexic children

<table>
<thead>
<tr>
<th>Case</th>
<th>Kana 1 mora</th>
<th>age</th>
<th>VIQ</th>
<th>PIQ</th>
<th>Reading</th>
<th>Writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>10</td>
<td>103</td>
<td>86</td>
<td>92 (99.3±3.85)</td>
<td>75 (98.5±3.6)</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>8</td>
<td>89</td>
<td>96</td>
<td>63 (98.3±3.95)</td>
<td>58 (96.6±5.6)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>10</td>
<td>69</td>
<td>88</td>
<td>73 (99.3±3.85)</td>
<td>10 (98.5±3.6)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>7</td>
<td>120</td>
<td>104</td>
<td>79 (98.3±3.95)</td>
<td>30 (96.6±5.6)</td>
</tr>
</tbody>
</table>

(average of normal children ±SD)

2.2. Tests
Several neuropsychological tests were administered as follows: WISC-R or III, ITPA, K-ABC, SLTA (Standard Language Test of Aphasia), AVLT (Auditory Verbal Learning Test), RCFT (Rey’s Complex Figure Test), repetition of 4- and 5-mora words in reverse order, identification of the second, third or forth mora of words. Confrontation naming, word fluency tests of a semantic (ex. animal) and a phonological (ex. initial mora is [a]) category, MFFT (Matching Familiar Figure Test), which required pointing of a picture to identify the target line drawing among five distracters.
2.3 Therapy

All four children were trained, using serial sounds and letters of Japanese syllabary (Kana). First they taught only serial sounds of Japanese syllabary. After they could say 45 serial moras, they were taught to write them voluntarily while saying them simultaneously. Then they were taught to write them to dictation by analyzing and retrieving a mora from Japanese syllabary. After three months, the percentage of their correct performance in writing and reading aloud of moras increased significantly.

3. RESULT

3.1. Phonological awareness

In repetition of words in reverse order, and identification of a mora in words, case 1 and 2 showed normal ability. The performance of case 3 and 4 was significantly lower than that of normal children.

3.2. Word retrieval

All children showed good performance within a normal range.

3.3. Long-term memory for verbal sounds

In AVLT, all four children could memorize at least 12 words after five sessions and could reproduce 11 words after 30 minutes. There was no significant correlation between the score of digit span in WISC and that of the first and the fifth trial, and the reproduction after 30 minutes in AVLT (p < 0.1). On the other hand, the score of the fifth trial and the reproduction after 30 minutes showed significantly higher correlation.

3.4. Visual information process

Case 1, 2, and 3 showed significantly lower score than normal children in all tasks in RCFT: copy drawing, immediate reproduction and reproduction after 30 minutes. All cases manifested significantly lower scores than normal children in MFFT.

4. DISCUSSION

4.1. Phonological disorders theory in developmental dyslexia

There are phenomena that cannot be explained by the theory of phonological disorders in dyslexia at least in three ways. One is the theory of working memory, using the digit span test. The memory of sounds which correspond to letters or pictures (meanings) is
not all that is required for reading aloud words and sentences. Our data showed no significant correlation between digit span in WISC-R or III and memorized words after the fifth trial and trials after 30 minutes in AVLT. These results suggest that the ability of digit span and that of learning verbal sounds is only partially related. Actually, our four cases manifested no disorders for long-term memory of verbal sounds.

The second is the theory of naming disorders, which also derives from the disorder of logical correspondence of sound memory and letters. If this theory is correct, all developmental dyslexic children should have disorders in naming in addition to reading and writing. It makes difference between dyslexia and specific learning impairment unclear. We found no disorders in naming ability with our subjects.

The last theory is, as we mentioned above already, that of cognitive disorders of verbal sounds. These four children showed no disorders in repetition of words and single moras. We do not discuss further more about the phonological cognitive disorders in this paper, because we could not examine reported cases precisely in our experimental method.

4.2. Phonological disorders and disorders in the visual information process

It is widely known in developmental psychology that the ability of learning Kana and the development of the ability in identification of a mora in a word is closely related: a child with Kana dyslexia manifested the delayed development in identification of moras from a word. While two of our cases showed low correct percentage in these tasks, the others showed no problems in repetition of 4- and 5-mora words in reverse order and identification of the second, the third or the forth mora of words. In RCFT and MFFT, which detect the ability of visual cognitive functions, constructional ability, long-term memory of figures, all four children manifested significantly lower score than normal children. 90% of their errors were formal in reading aloud and writing tests, excluding no responses. Taken together, these four Japanese dyslexic children are thought to have a disability of visual information processes.

It is possible to say that two of four children had a disorder both in phonological and visual information processes, because they had a problem in identifying a mora from a word. However, their ability of Kana reading and writing improved by our training method, which needed the ability of identifying a mora from serial sounds of Japanese syllabary. These data suggest that their disorders of visual information processes are more likely to be at the base of their dyslexia than phonological disorders.

Most of recent papers on underlying mechanisms of dyslexia, especially in USA and Europe, discuss about disability of phonological information processes with dyslexic children. In case of these four Japanese dyslexic children, however, there thought to be the disorders of visual information.

5. REFFERENCE

Tallal P: Rapid auditory processing in normal and disordered language development. Journal of Speech and Hearing Research, 19, 561-571, 1976


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