Variation of Characteristics of Reading and Writing Difficulties in Japanese Children with Learning Disabilities

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Abstract

There are conflicting hypotheses for the causes of Dyslexia in reading and writing difficulties, such as the phonological deficit hypothesis, double deficit hypothesis, magnocellular deficits hypothesis etc. The cause of the difficulties may vary between individuals. Moreover, most of these hypotheses consider only a single disability, despite the fact that factors related to reading and writing may affect the difficulty in various ways. We conducted this study to identify individual differences in the effect of Dyslexia. The participants were 12 Japanese children who were diagnosed with learning disabilities or suspected to be learning disabled. In this study, we considered how phonological awareness, visual perception, and phonological processing are related to reading and writing abilities in the Japanese language. In addition, we checked "handwriting ability." This study shows that reading and writing difficulties are caused by a variety of factors and that there are individual differences in the difficulties.

Keywords: Reading and writing Difficulties, Dyslexia, Individual differences, Japanese education

Introduction

In Japan, official reports claim that 6.3% of elementary and middle school students enrolled in normal classes experience learning difficulties (MEXT Japan, 2002). This means that each class has two or more students with actual or potential learning problems, making learning disabilities an issue that should be urgently addressed to provide these students with special learning assistance. Students with learning difficulties have more than one problem in reading, writing, listening, communicating, calculating, planning, and memorizing. In particular, support for reading and writing are very important. Difficulty with reading negatively affects all learning domains, thereby hindering academic performance in all subjects. A person's inability to read well can also generate an inferiority complex that results in the loss of his or her motivation to learn, which, in turn, may be linked to symptoms leading to juvenile delinquency (Kimberly & Richard, 2006; Siponmaa, Kristiansson, Jonson, Nyden et al., 2001). The inability to read also influences friendships outside of the classroom (Stanovich, 1986) and children's ability to process feelings of anger (Kazdin, Rodgers, Colbus, & Siegel, 1987; Moffitt & Henry, 1989). All of these factors suggest that addressing reading difficulties should be a priority for helping children with learning difficulties.

To support them, it is important to know the causes of the difficulty. Moreover, there are different manifestations of developmental dyslexia in different languages (Miles, 2000). Researchers (e.g., Landerl, Wimmer & Frith, 1997; Paulesu, McCrory, Fazio, Menoncello et al., 2000; Paulesu, Demonet, Fazio, McCrory, 2001; Wydell & Butterworth, 1999) argue that the discrepancy in the prevalence of reading impairments in different languages might be primarily due to inherent differences in the structure/characteristics of each orthography, specifically the way in which phonology is computed from it. In the alphabetic languages in which a

finer "grain" processing of orthography-to-phonology mapping is required, such as English or Danish, developmental dyslexia forms a large minority group. For these facts, to support Japanese children, it is necessary to know the characteristics of Japanese children's reading and writing difficulties.

There are conflicting hypotheses for developmental dyslexia, reading and writing difficulties, such as the phonological deficit hypothesis (Shaywitz, 2003; Shaywitz & Shaywitz, 2005), double deficit hypothesis (Wolf & Bowers, 1999; Wolf & Bowers, 2000; Faust & Sharfstein-Friedman, 2003), magnocellular deficits hypothesis(Livingstone, Rosen, Drislane, & Galaburda, 1991), and so on. However, most of these hypotheses only consider a single disability. Other studies that discuss the issue with many factors don't consider individual differences (e.g., Uno, Wydell, Haruhara, Kaneko et al., 2009). However, all factors related to reading and writing may affect the difficulty in various ways. This paper hypothesizes the influence of individual differences is suspected to add to the difficulties.

The core ability of reading and writing skills is phonological processing. Phonological processing is the ability to see or hear a word, break it down into discrete sounds, and then associate each sound with letter/s that make up the word. The prerequisite skills for phonological processing are the ability to analyze the phonological structure of sound and the ability to recognize its characters. According to the phonological model, the difficulty results from an impaired ability to segment spoken words into phonologic parts and link each letter to its corresponding sound (Shaywitz, 2003; Shaywitz & Shaywitz, 2005). Phonemes are small units of sound that can be conceptualized as the building blocks of words (for example, the word cat is comprised of three phonemes: k, aaaa, and t). That is the ability to analyze phonological structure. The Japanese language is based on a subsyllabic unit, the mora (Otake, Hatano, Cutler, & Mehler, 1993). According to magnocellular theory, the difficulty results from abnormalities of the magnocellular component of the visual system, which is specialized to quickly process temporal information (Stein & Walsh, 1997). That is the ability to recognize character. Furthermore, not only cognitive ability, but also the ability to correctly produce sound is necessary for reading. And handwriting abilities are necessary for writing letters correctly. Therefore, it is also important to possess these abilities. Moreover, in reading, there are two strategies, one is a lexical strategy based on whole word recognition and another a sub-lexical processing strategy based on a grapheme-to-phoneme conversion (Wydell & Butterworth, 1999). This means that if we want to know the ability of phonological processing in reading, we have to check not only word tests, but also non-word tests.

Additionally, Wydell & Butterworth (1999) established "the Hypothesis of Granularity and Transparency." Through this hypothesis, they maintain that orthographies can be described by two dimensions: "transparency" and "granularity" and argue that: (1) any orthography where the print-to-sound translation is one-to-one or transparent will not produce a high incidence of phonological dyslexia, regardless of the level of translation, i.e., phoneme, syllable, character, etc. This is the "transparency" dimension, and (2) even when this relationship is opaque and not one-to-one, any orthography whose smallest orthographic unit representing sound is coarse, i.e., a whole character or whole word, will not produce a high incidence of phonological dyslexia. This is the "granularity" dimension. Any orthography used in any language can be placed in the transparency-granularity orthogonal dimension described by this hypothesis. This is illustrated in Figure 1. The hypothesis argues that any orthography that falls into the shaded area in Figure 1 should not produce a high incidence of phonological dyslexia. Given the characteristics of Japanese orthography, both Japanese Kana and Kanji can be placed in the shaded area. For example, in Japanese Kana, the granularity of the smallest orthographic unit representing phonology is finer than the whole word, but coarser than the grapheme and its orthography-to-phonology translation relationship is at the level of syllables and one-to-one. For Kanji, on the other hand, the unit of granularity is much coarser, i.e., a character or a whole word and the relationship between orthography and phonology is very opaque, hence Kanji can be placed in the shaded area.

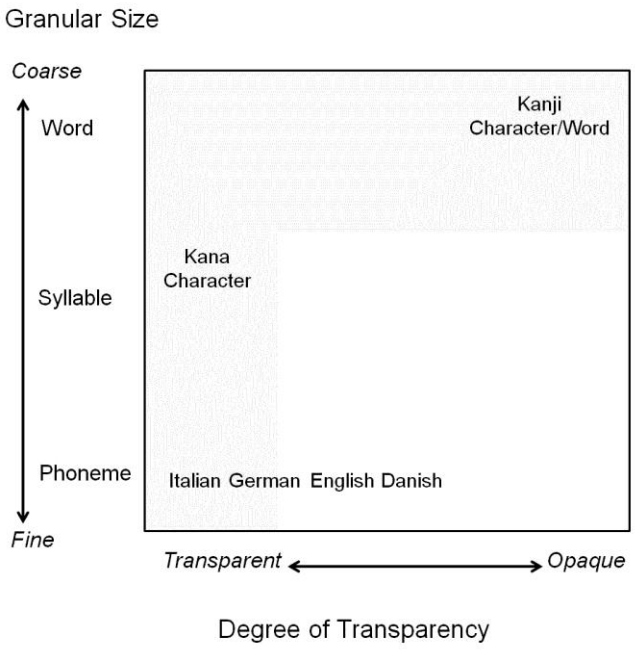

Figure 1: Hypothesis of granularity and transparency and orthography-to-phonology correspondence made by Wydell & Butterworth (1999).

In this study, we targeted the difficulties in Kana (Hiragana and Katakana), the most basic character in Japanese. We considered phonological awareness, visual

perception, and phonological processing which relate to reading and writing abilities in Japanese. In addition, we checked the ability of "expression of handwriting." We conducted this study to bring out the effect of individual differences on the disability.

Method

Participants

The participants were 12 children (eight boys and four girls) who were recruited by the doctor of the Nagoya City Child Welfare Center and Nagoya Central Care Center for Disabled Children. The doctor believed that all had difficulty in reading and writing which harbored the possibility that they had developmental dyslexia. Table 1 presents participant profiles.

Table 1: Participant profiles.

Child	Grade	Gender	Dual diagnosis	
A	6	M	PDD	
B	5	M		AD/HD
C	4	M		
D	4	M	PDD	
E	4	M		AD/HD
F	3	M	PDD	
G	3	F	PDD	
H	3	F	PDD	
I	3	F	PDD	AD/HD
J	3	M		
K	3	M	PDD	AD/HD
L	3	F		

Note. M = Male, F = Female, PDD = Pervasive Developmental Disorder, ADHD = Attention Deficit/Hyperactivity Disorder.

In December 2010, seven children were enrolled in third grade, three in fourth grade, one in fifth grade, and one in sixth grade. All of them were enrolled in regular elementary school classes. Every child was either diagnosed as having learning disabilities or suspected of being learning disabled by the doctor. Five children exhibited symptoms that coexisted with pervasive developmental disorder, two with attention deficit/hyperactivity disorder, and two with both pervasive developmental disorder and attention deficit/hyperactivity disorder. The Wechsler Intelligence Scale for Children-Third Edition (Wisc-III) Full Scale IQ scores ranged from 79 to 112, with a mean IQ score of 97.8. Verbal IQ scores ranged from 72 to 120, with a mean IQ score of 100.7. Performance IQ scores ranged from 80 to 120, with a mean IQ score of 95.1. No children stuttered and all could correctly produce sounds.

Measures

Phonological awareness task: Each participant performed two phonological awareness tests: isolation of unvoiced sounds test and segmentation of choked sound test. Isolation of unvoiced sounds requires recognizing the individual unvoiced sounds in words, for example, **"**Tell me the second sound of the word you hear**."** The experimental stimuli of isolation of unvoiced sounds test were 10 words of five characters like "ka-ta-tsu-mu-ri**,"** in Japanese "かたつむり**."** The participants were asked to identify the second sound in three words, the third sound in four words, and the fourth sound in three words. The achievement scale was above 8/10. Segmentation of choked sound requires recognizing the number of sounds in words, for example, "Tell me how many sounds in the word you hear**."** The experimental stimuli of segmentation of choked sound test were 10 words of six choked sound words and four unvoiced sounds words. These words had three to six characters. We analyzed only the choked sound words. The achievement scale was above 4/6. We performed these tests by checking references from the test performed by Hara (2001).

Visual perception task: Each participant performed three subtests of the Japanese version of the Developmental Test of Visual Perception (DTVP; Frostig, 1977): figure ground, position in space and spatial relations. Perceptual age was determined by the test. Scaled Scores (SS) of each test was determined using the DTVP. If the perceptual age was younger than the calendar age, SS was equal to or less than eight. Individual tests are not sufficiently different to measure separate abilities (Olson, 1968), and all of the tests are thought to be related to visual perception. In this study, participant passed the task if his or her score showed more than eight in every three scores of subtests. Otherwise, the participant failed the task.

Phonological processing task: Each participant performed six reading tests to examine their phonological processing ability. Four tests were subtests of the Screening Test of Reading and Writing for Japanese Primary School Children (STRAW; Uno, Haruhara, Kaneko, & Wydell, 2006): Hiragana character reading test, Katakana character reading test, Hiragana word reading test, and Katakana word reading test. These tests consist of 20 known words. The other two tests were the Hiragana non-word reading test and Katakana non-word reading test. These tests consist of 10 non-words. The achievement scale of each test was more than or equal to 90%. If a child's score of the word reading test was above the achievement scale, but the character reading test or non-word reading test was below the achievement scale for at least one condition of Hiragana or Katakana, he or she can use the lexical strategy based on whole word recognition but

cannot use the sub-lexical processing strategy which is based on a grapheme-to-phoneme conversion. In this case, he or she was assumed to fail the phonological processing task. If a child's score of all the tests was above the achievement scale, he or she was assumed to have passed the phonological processing task.

Handwriting ability task: Each participant performed one subtest of the Japanese version of the Developmental Test of Visual Perception (Frostig, 1977): eye-motor coordination. Perceptual age was determined by the test. SS of the test was determined using the DTVP. If the perceptual age was younger than the calendar age, SS showed equal or less than eight. Participants passed the task if his or her score showed more than eight of the subtests.

Procedure

Participants were tested individually in a quiet room at the Nagoya City Child Welfare Center. Each participant was seen more than five times over one week, each time for approximately 40 minutes. To exclude the factor of PDD or ADHD, we organized the physical environment (e.g., Treatment and Education of Autistic and related Communication handicapped Children). In each test errors were recorded. Also, each child's responses were videotaped for later reviewing. Children were told that these were not academic achievement tests, and that only the investigators would see their results. The data was collected from May 2010 to December 2010.

Results

Phonological awareness task

Every child passed the isolation of unvoiced sounds test. In the segmentation of choked sound test, only one child, F, failed. That means that only one participant had difficulty in phonological awareness.

Visual perception task

Only two children, B and L, passed the task and the other 10 failed. This means that 10 children had problems in the recognition of characters in some way.

Phonological processing task

Four children, A, B, H, and I passed all tests and therefore passed the phonological processing task.

Eight children failed the phonological processing task. Four children, C, D, E, and J failed only the Katakana non-word reading test, while L failed both the Katakana non-word reading test and the Katakana character reading test. They appeared to read the words of Katakana, but seemed to have a weak ability for phoneme-to-grapheme conversion in Katakana. Two children, G and K, failed both the Hiragana and Katakana non-word reading tests. They appeared to read the words of Kana (Hiragana and Katakana), but seemed to have a weak ability for phoneme-to-grapheme conversion in Kana (Hiragana and Katakana). One child, F, passed only the Hiragana character reading test. She appeared to have read the words of Hiragana, but seemed to have a weak ability for phoneme-to-grapheme conversion in Hiragana. In addition, she couldn't complete all of the Katakana tests.

Handwriting ability task

Four children, C, G, K and L, passed the task and eight failed. These eight children's writing movements may be related to their writing difficulties.

Discussion

Table 2 presents the results of each test for each child and the type of characteristics in reading and writing difficulties. One child, F, is type 1 and failed all the tests. Three children, D, E, and J, are type 2 and passed only the phonological awareness test. Three children, C, G, and K, are type 3 and failed in visual perception and phonological processing. Three children, A, H, and I, are type 4 and failed in visual perception and handwriting ability. One child, B, is type 5 and failed only in handwriting ability. One child, L, is type 6 and failed only in phonological processing.

Table 2: Type of characteristics in reading and writing difficulties.

Type	PA	VP	PP	HA	Child	Grade
1	F	F	F	F	F	3
2	P	F	F	F	D	4
2	P	F	F	F	E	4
2	P	F	F	F	J	3
3	P	F	F	P	C	4
3	P	F	F	P	G	3
3	P	F	F	P	K	3
4	P	F	P	F	A	6
4	P	F	P	F	H	3
4	P	F	P	F	I	3
5	P	P	P	F	B	5
6	P	P	F	P	L	3

Note: PA = Phonological awareness, VP = Visual perception, PP = Phonological processing, HA = Handwriting ability, F = Failed, P = Passed

By examining individual levels for the four elements, as shown in Table 2, it becomes apparent that reading and writing difficulties are not caused by a single disability, but

rather by a combination of factors. Furthermore, the combination of individual elements is different. This means that students with learning disabilities need separate support even they have the same symptoms or reading and writing difficulties.

In the four elements, a higher percentage of children were considered to have problems with visual perception. Type 4 children passed the phonological processing task even though they failed the visual perception task. This result may be caused by Japanese education methods. The simultaneous oral spelling method is a good way for dyslexic children to acquire reading and writing skills (Thomson, 1996). Typical Japanese education methods, however, utilize simultaneous oral spelling techniques. Japanese has multiple characters that are similar to each other. Also, there are many strokes in Japanese Kanji. Therefore, we need to study the influence of visual perception on difficulties in reading and writing Japanese in the future.

The groundbreaking discovery of our study was that there were many children who have poor handwriting abilities. Stroke order is believed to very important in Japanese education.

However, if there is difficulty in handwriting, it may be hard for these children to write in handwriting stroke order. When considering the difficulty of writing, handwriting ability wasn't considered. However, from the viewpoint of quality of life, it is necessary to know a child's handwriting ability in an assessment. If a child has poor handwriting ability, he or she should be supported and taught that the stroke order is not necessarily important. In Japan, it is an accepted practice to learn characters from a set of reading and writing lessons. However, this method is not good for children who have poor writing abilities, in particular type 5 children, like child B, who have difficulty only with handwriting. These children need support in the form of separate reading and writing practice.

In this study, only child F failed the phonological awareness task. This supports the granularity dimension of "the Hypothesis of Granularity and Transparency." However, some children failed the phonological processing task because they failed the Katakana test. In particular, child L, a type 6, passed other tasks like the phonological awareness task, visual perception task and handwriting ability task. Why is there difficulty only in the Katakana phonological processing? Kana is a one-to-one from a character standpoint, but not a one-to-one transparent from a sound standpoint. This is illustrated in Figure 2.

Considering this, granularity and transparency and orthography-to-phonology correspondence of KANA will appear as presented in Figure 3.

For type 6 children, like child L, the Japanese syllabary table may be a good education support tool. The Japanese syllabary table may be utilized as a type of location map of phonemes (Seki et al., 2004). If children have already learned Hiragana, using the Katakana syllabary table may help them learn Katakana characters.

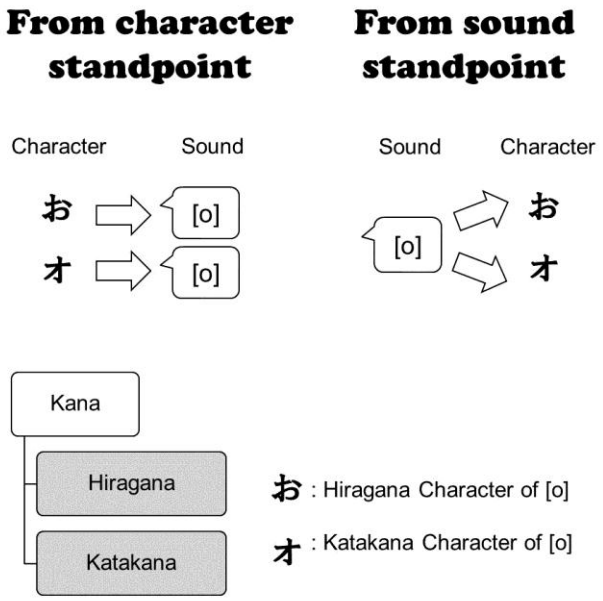

Figure 2: Transparency dimension of Kana from character and sound standpoints.

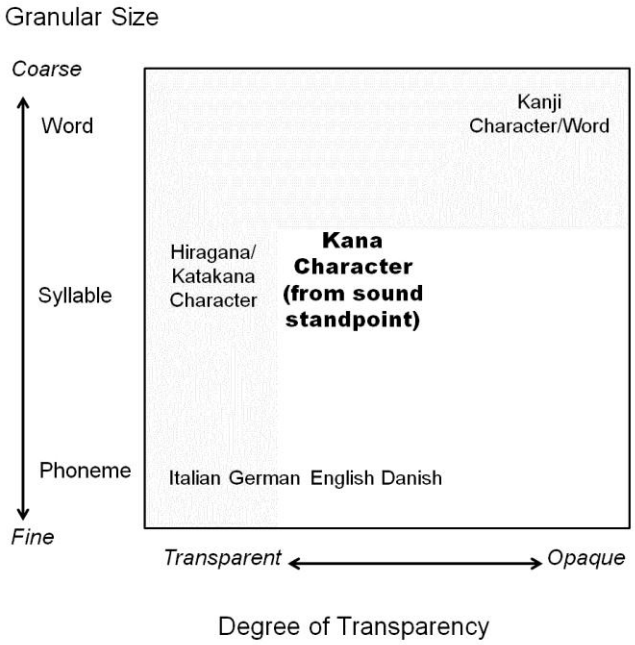

Figure 3: Granularity and transparency and orthography-to-phonology correspondence of KANA

In this study, we demonstrated that reading and writing difficulties in the Japanese language attributed to learning disabilities are caused by variety of factors and that there are individual differences in the difficulties. We also demonstrated that an assessment of handwriting ability is necessary to identify the proper types of support for

problems. Furthermore, we demonstrated that Kana is not one-to-one transparent from a sound standpoint. This research will have a large impact on education methods and techniques in Japan.

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