Training in visual skills improves a dyslexic Philippine child's ability in reading and writing Japanese Kanji –characters.

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ABSTRACT

Using the case of a non-Japanese child showing severe difficulties in *Kanji* acquisition, this study empirically (1) investigated the cognitive properties hypothesized to be causing the child's difficulties, by examining various potential cognitive disorders, and (2) developed and evaluated a support method, that is, the "Training in visual skills," for learning *Kanji* based on the child's cognitive properties. The results suggest that a foreign dyslexic child with difficulties in learning Japanese *Kanji* -characters can benefit from training in visual skills.

1. INTRODUCTION

The number of alien registrations in Japan is currently over 2 million. One in 29 children born in Japan has at least one parent of foreign nationality, and one in 15 children living in Tokyo is a foreigner (Ministry of Health, Labour, and Welfare, 2008). Due to their underdeveloped Japanese language skills, these foreign children face many difficulties in school, including delayed academic achievement and problems with peer relationships. They also have difficulties entering high school and college, and obtaining a job of their choice. Accordingly, many cases of truancy, permanent part-time employment, and NEET (not in employment, education, or training) status have been reported. Given this situation, developing support for Japanese language acquisition for these students is an important agenda item.

One of the challenges foreign children find difficult is learning *Kanji*.[1] Some children from countries where *Kanji* are not typically used can barely read or write them even after two or three years of residence in Japan, yet they may become proficient enough in everyday

1 In the Japanese language, there are two written syllabaries of about 50 characters each based on indigenous spoken sounds: *Katakana*, and *Hiragana*. In addition, Japanese uses Chinese ideogrammatic characters, called *Kanji* in Japanese, which were introduced into the Japanese language by the 6th century.

conversational Japanese to attend regular primary and middle school education. Problems in the learning environment, experience in using *Kanji*, student motivation and attitude, and teacher's instructional technique are considered to be among the factors contributing to difficulties in reading and writing *Kanji*. However, even without problems in these areas, major difficulties in learning *Kanji* have been reported. These foreign children have typically been overlooked and not provided with appropriate support to read and write *Kanji*. It is also assumed that some children have major difficulties in learning *Kanji* due to developmental disorders in reading and writing (hereafter "dyslexia"[2]). Therefore, investigating the cognitive properties (or disorders) of children who have major difficulties in learning *Kanji* and providing them with appropriate special support is thought to be critically important.

Most previous studies on dyslexia have focused on languages with alphabet writing systems, and have advanced many hypotheses about what type of cognitive disorders cause dyslexia (Ho, Chan, Tsang, & Lee, 2002; Snowing, 2008). Among them, the phonological disorder hypothesis (e.g., Ackerman & Dykman, 1993; Badian, 1995; Bowers, Steffy, & Tate, 1988; Hulme & Snowling, 1992; McDougall, Hulme, Ellis, & Monk, 1994; Morris , Stuebing, Fletcher, Shaywitz, Lyon, & Shankweilere, 1988; Olson, Rack, & Forsberg, 1990; Wolf, 1991) is regarded as the most influential theory to explain dyslexia's central cognitive impairment. Other hypotheses include the double deficit hypothesis (Wolf & Bower, 1999), which suggests that disorders of naming speed in addition to a phonological disorder cause dyslexia, the triple deficit hypothesis (Badian, 1997), which suggests that an orthographic disorder (Holtquist, 1997; Roberts & Mather, 1997) in addition to phonological and naming speed disorders is the central cause of dyslexia, and the multiple deficit hypothesis (e.g., Rayner & Pollatsek, 1989; Watson & Willows, 1993; Willows, 1991), which suggests that a visual processing disorder in addition to phonological, naming speed, and orthographic disorders causes dyslexia, and a combination of more than two disorders will induce dyslexia.

In recent years, some studies on dyslexia in the Japanese language have been conducted and have accumulated insights in the following areas; studies of cognitive properties (e.g., Uno, Kaneko, Haruhara, Matsuda, Kato, & Kasahara, 2002; Uno, Haruhara, Kaneko, & Awaya, 2007; Sugimoto & Enomoto, 2010a, 2010b), studies of assessment methods (e.g., Ishii, Kumoi, & Koike, 2003; Kabutomori & Takeda, 2008; Kaneko, Uno, Haruhara, & Awaya, 2007), studies of training methods (e.g., Haruhara, Uno, & Kaneko, 2004, 2005), and studies of educational practices (e.g., Kawamura, Niitsuma, Masuda, Nakayama, & Maekawa, 2007; Beppu, Kumada, Takada, & Fujita, 2004; Matumto, 2005). However, comprehensive empirical studies to elucidate what types of cognitive impairments underlie dyslexia in the Japanese

2 Dyslexia is defined in many ways, such as in the definition by the International Dyslexia Association (2003), and the definition of the developmental disorder of reading and writing in Japanese (Uno, 2006). While there are differences depending on the language, dyslexia can be defined as the following: "Despite the absence of mental retardation, sensory or motor disorders, attention or aspiration deficits, familial or social barriers, difficulties are manifest with reading and writing acquisition due to neurologically-based developmental disorders" (Ishii, 2004).

language context have rarely been conducted. Consequently, diagnostic methods to objectively detect children with dyslexia in Japanese have not yet been established, and methods to support effective learning have not been developed.

In an attempt to identify the cognitive properties (disorders) of dyslexic children who show particular difficulties in *Kanji* learning and investigate effective learning support, we present the case of a foreign child who had extreme difficulties in learning *Kanji* in order to illustrate the study aims of: (1) undertaking a comprehensive examination of potential cognitive disorders to identify cognitive properties causing the difficulties; and (2) developing and evaluating a support method to learn *Kanji* based on the child's cognitive properties.

2. METHODS

2.1. Participant Child

The participant was a foreign child M (male, 12 years old) who was enrolled in the 6th grade in a Japanese primary school. M came to Japan from Philippine when he was 10 years old and was enrolled in the 4th grade in a regular classroom. M had acquired spoken Japanese language smoothly and achieved daily conversation proficiency with no problems participating in school activities and socializing with his friends. Nevertheless, his *Kanji* study did not progress well, and the only *Kanji* he could write by the end of the 5th grade were the name of his school, his own name, and several easy characters (e.g., "一" [one], "二" [two], and "十" [ten]). When he became a 6th grader (after two years of residence in Japan), he became a recipient of visiting consultation services we provided, with difficulties in reading and writing *Kanji* as the main complaint. We obtained his and his parents' agreement to participate in this study and we started to provide supportive services.

2.2. Assessment Tasks and Procedures

In this study, pre- and post- tests with tasks[3] in the following 5 domains were administered; (1) assessment of intelligence, (2) assessment of reading and writing skills, (3) assessment of visual-perceptual skills, (4) assessment of *Kanji* orthography, and (5) assessment of phonological skills in Japanese. As M showed idiosyncratic difficulties in reading and writing *Kanji*, the pre-test was administered in order to have a comprehensive understanding of his cognitive properties, and the post-test was to examine the effects of the *Kanji* learning support services delivered.

(1) Assessment of Intelligence: Performance test of the Wechsler Intelligence Scale for Children - Third Edition (WISC-III) was administered to assess M's intelligence level.

3 While the assessment of reading and writing skills (2) included a "Reading sentence task" and a "Writing short sentence task," results of these tasks are omitted from this report due to space issues. The assessment tasks in (4) and (5) were developed by the authors.

(2) Assessment of Reading and Writing Skills: Tests for 5th and 6th graders from "The Screening Test of Reading and Writing for Japanese Primary School Children" (Uno, Haruhara, Kaneko & Wydell, 2006), developed for identifying dyslexic children, were administered.

(3) Assessment of Visual-Perceptual Skills:

The Frostig Developmental Test of Visual Perception: In order to assess the development level of visual perception, this test was administered and graded using standard interpretations.

The Ray-Osterrieth Complex Figure: This is a test to assess many abilities, such as visual configuration ability and visual memory, by copying a complicated line drawing (cf. Figure 1).

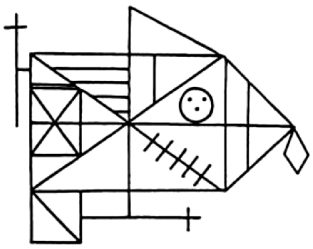


Figure 1. Sample Figure of the Ray-Osterrieth Complex Figure Test

In this study, the procedure in Kubota and Kuboshima (2007), who applied the test to assess dyslexia, was used. The procedure is as follows: (1) copying a sample figure while looking at it (copying), (2) removing the sample figure from view and reproducing the figure by recollection (immediate reproduction), then (3) reproducing the figure by recollection after a 30 minute wait (after-30 min reproduction).

(4) Assessment of *Kanji* Orthography:

For the purpose of assessing cognitive ability around *Kanji* composition such as copying and form-distinguishing abilities, 4 types of tasks were assigned. Example characters used in each task are shown in Table 1.

Right/Left Radical Positioning and Direction Identifying Task: Seeing 30 *Kanji* (10 real characters, 10 pseudo characters with right and left switched radicals, and 10 mirror-reversed pseudo characters), M was asked to judge correct or incorrect characters by marking each with a circle or a cross. The *Kanji* used in the tasks were developed based on standard characters that are usually learned in the six years of primary school.

Judging Unknown Character and Reading Task: For the judging task, M was shown 10 real but infrequently-used *Kanji* and 10 pseudo characters with right/left or top/bottom radicals

Table 1. Materials for Assessment of Kanji Orthography

Tasks	Examples of Kanji and Radicals			
Right/Left Radical Positioning and Direction Identifying Task	吸 Real Character	虧 Mirror-Reversed Pseudo Characters	翕 Pseudo Characters with Right and Left Switched Radicals	
Judging Unknown Character and Reading Task	俟 Judging: Correct	舛 Judging: Wrong	蝟 Reading: Infrequently-Used Character	屮 Reading: Pseudo Character
Judging Radical Position Task	氵 Left	竹 Top	灬 Bottom	斗 Right
Copying and Reproducing Pseudo Character Task	屮 3 strokes	玄 5 strokes	湯 12 strokes	

switched, and asked to judge the real or pseudo characters by marking each with a circle or a cross. For the real but infrequently-used Kanji, we used characters that were not included in official lists of *Kanji* in common use and that whose components (whole or partial) were of the same form and reading as the officially allotted characters for primary school education. For the reading task, we showed M 10 real and 10 pseudo Kanji that were selected in the same way, and then asked him to read them (e.g., 蝟 [*i*, or *chu*], 汪 [*ou*], 迂 [*kou*, or *seki*]).

Judging Radical Position Task: Showing M 11 radicals (right, left, top, and bottom parts), we asked him to describe the correct position of each radical in a *Kanji*.

Copying and Reproducing Pseudo Character Task: (1) Showing M 1- to 15-stroke pseudo *Kanji* that contain parts of real characters (a total of 30 characters with two characters for each stroke count), we (2) instructed him to copy the characters while looking at them, then, (3) immediately hid the sample characters and instructed him to reproduce them by memory. The numbers of right and wrong answers were used as indicators for evaluating the tasks in the "assessment of *Kanji* orthography."

(5) Assessment of Phonological Skills:

Sound Distinguishing Task: The purpose of this task is to examine the ability to identify sound differences of simple words. Presenting two drawings of each word to M, and playing the recorded sound of one word, we asked him to point to the corresponding word. This task (20 questions) comprised 10 questions to distinguish the first-mora sounds (e.g., *kuri* [chestnut] and *ari* [ant]) and 10 questions to distinguish the last-mora sounds (e.g., *hachi* [bee] and *hana* [flower]).

Phonological Awareness Task: The purpose of this task is to measure the phonological awareness of mora. Playing the recorded sounds of three simple three-mora words, we asked M to find the two words with similar sounds. This task (20 questions) comprised 10 questions (alliteration judging task) with two identical first-mora sounds (e.g., *kitsune* [fox], *kirin* [giraffe], *hitsuji* [sheep]) and 10 questions (rhyme judging task) with two identical last-mora sounds (e.g., *yakan* [kettle], *mikan* [orange], *remon* [lemon]).

Phonological Memory Task: The purpose of this task is to measure phonological memory ability. Playing the recorded sounds of three- to seven-mora words, we instructed M to repeat the words. This task (total of 30 questions) comprised 10 questions with words in common use (real words in highly frequent use) (e.g., *kamera* [camera], *suberidai* [slide]), 10 questions with words supposedly unfamiliar (real but infrequently-used words) such as technical terms and academic terms (e.g., *ninchi* [recognition], *kyapitarugein* [capital gain]), and 10 questions with pseudo words that were created by modifying mora orders or inserting partially different mora (e.g., *dausetoi*, *sankukagyoji*).

Rapid Naming Task: The purpose of this task is to measure rapid flow of reading based on levels of phonological representation and an automatized naming process. Based on "the rapid naming speed task" (Ho, Chan, Tsang, & Lee, 2002), we developed a chart on an A4 sheet of paper consisting of numbers (2, 4, 6, 7, and 9), colors (red, blue, yellow, green, and black), and objects (flower, shoes, hands, books, and dogs) placed at random in a 7 x 5 matrix. Showing the chart to M, we asked him to name them in order from the top left as rapidly as possible. While the number of correct answers was used as an evaluative indicator for all five tasks in the assessment of phonological skills, the elapsed time from the beginning to the end was also added to the evaluation indicator for the rapid naming task.

2.3. Support of *Kanji* Learning

Results of the pre-test (see the Results section) demonstrated that (1) M was capable of recognizing and memorizing events in his daily life and simple figures, and showed no difficulty in distinguishing sounds, phonological awareness, and name recollection, but that (2) he showed extreme difficulties in recognizing and reproducing details of a complicated figure and the relations of its parts to the whole. These cognitive properties were thought to

make it difficult for him to recognize, copy, and memorize detailed and accurate forms, numbers, angles, and positions of lines composing complicated *Kanji*, which is causing his serious problems in learning *Kanji*. Hence, the following learning support, the "Training in visual skills," was provided to him.

(1) Training to analytically recognize and copy complicated figures (cf. Figure 2), (2) training to distinguish similar-formed *Kanji* and explain their differences (e.g., 皿 and 皿, 由 and 曲, 丸 and 九) (cf. Figure 3), (3) training to break down *Kanji* and copy them while paying attention to their component parts (cf. Figure 4), and (4) training to write *Kanji* in context. *Kanji* allotted for grade 3 learning were used for training. In addition, training in special subsets of the *Hiragana* and *Katakana* syllabaries was also offered. The learning support session (45 minutes, private instruction) was provided once a week for six months.

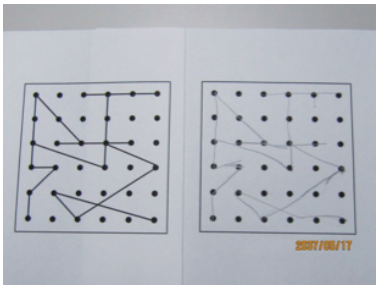


Figure 2. Training to analytically recognize and copy complicated figures

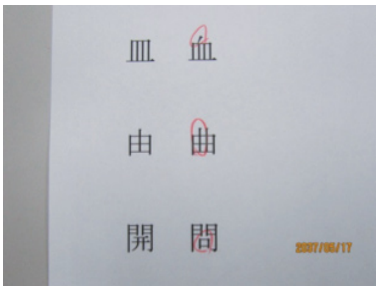


Figure 3. Training to distinguish similar-formed Kanji and explain their differences

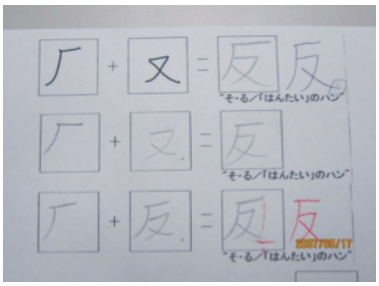


Figure 4. Training to break down Kanji and copy them while paying attention to their component parts

3. RESULTS

3.1. Assessment of Intelligence

Results of the WISC-III Performance Tests (pre and post) demonstrated that while slight improvement was observed in IQ performance (PIQ), perceptional organization (PO), processing speed (PS), completion, codes, arrangement, blocks, and symbols, M's performance remained more or less the same overall (cf. Table 2). That is, (1) the average performance in completion, codes, arrangement, and mazes suggested that he was capable of recognizing characteristics of common objects and simple figures, and understanding procedures of everyday events and routes of mazes. On the other hand, (2) the extremely low scores in the block and assembly tasks suggested that M bordered on severe cognitive weaknesses in observing the detailed parts and wholes of complicated figures and the relations of their parts to the whole, and in reproducing them. While these cognitive deficits might have led to the difficulties in accurate recognition and learning of complicated *Kanji*, results demonstrated that it was difficult to improve the cognitive processes in these areas.

Table 2. Results of Performance Test of WISC-III, Pre- and Post-Tests

Pre-Test	Post-Test
PIQ:75, PO:74, PS:83	PIQ:82 PO:80 PS:94
Completion: 8, Codes: 8, Arrangement: 9, Blocks: 1, Assembly: 6, Symbols: 6, Maze:11	Completion: 9, Codes: 9, Arrangement: 10, Blocks:4, Assembly: 5, Symbols: 9, Maze: 10

3. 2. Assessment of Reading and Writing Skills

Results of the pre-tests (both for the 5th and 6th graders) showed that M performed below the 5th percentile in all the tasks of the *Kanji* reading and writing, and the *Hiragana* and *Katakana* writing; in fact he could not write any *Kanji* at all (cf. Table 3). The *Kanji* used in this test for the 5th graders were actually selected from the officially allotted lists for 3rd graders. Therefore, M's performance indicated that he had not mastered *Kanji* at the 3rd grade and beyond level. It also indicated that he had also not mastered the special moras of *Hiragana* and *Katakana* (doubled consonant, syllabic nasal, prolonged, contracted, contracted and prolonged, voiced consonant). Results of the post-tests demonstrated that while M's performance in writing 5th and 6th grade level *Hiragana* and *Katakana* words and writing and reading 5th grade level *Kanji* improved, no improvement was observed at the 6th grade level *Kanji* tasks.

The improvement in M's performance in reading and writing of 3rd grade level Kanji (the 5th graders in these tests) (cf. Figure 5), which was the focus of the learning support services in this study, suggested that learning support based on the learner's cognitive properties helped a dyslexic child enhance the learning of Kanji. However, no improvement was observed in 6th grade level Kanji tasks, which suggested that it is unlikely for learners to

Table 3. Results of the Screening Tests of Reading and Writing, Pre- and Post-tests [Score, 20 at full score (% tile)]

	Pre-Test	Post-Test
5th grade	*Hiragana* word reading: 20, *Katakana* word reading: 20, *Kanji* reading: 10 (<5%) *Hiragana* word writing: 15 (<5%) *Katakana* word writing: 12 (<5%) *Kanji* writing: 0 (<5%)	*Hiragana* word reading: 20, *Katakana* word reading: 20, *Kanji* reading: 14 (<5%) *Hiragana* word writing: 19 (25<50%) *Katakana* word writing: 16 (5%<10%) *Kanji* writing: 4 (<5%)
6th grade	*Hiragana* word reading: 20, *Katakana* word reading: 20, *Kanji* reading: 10 (<5%) *Hiragana* word writing: 15 (<5%) *Katakana* word writing: 12 (<5%) *Kanji* writing: 0 (<5%)	*Hiragana* word reading: 19, *Katakana* word reading: 20, *Kanji* reading: 10 (<5%) *Hiragana* word writing: 19 (<5%) *Katakana* word writing: 14 (<5%) *Kanji* writing: 0 (<5%)

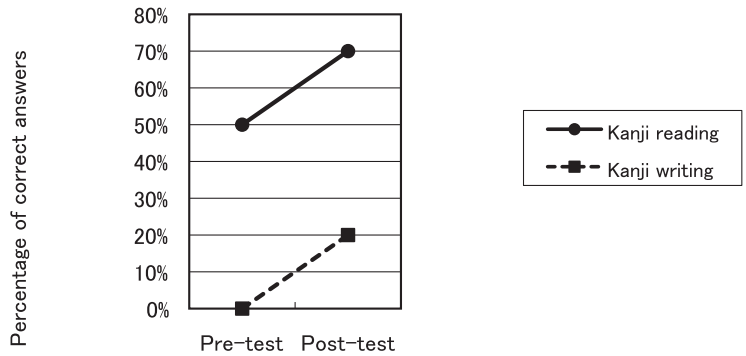


Figure 5. Results of Kanji-reading and Kanji-writing in 5th grade Pre- and Post-tests

learn specific characters by him or herself unless directly coached.

3.3. Assessment of Visual Cognition

For the Frostig Developmental Test of Visual Perception, M's performance in the pre-test demonstrated that, compared to children of the same chronological age, he was delayed in the areas of eye-motor coordination (I), constancy of shape (III), and spatial relationships (V). However, slight improvement was observed in the post-test in the areas of eye-motor coordination (I), figure ground (II), and spatial relationships (V) (cf. Table 4).

For the Ray-Osterrieth Complex Figure test, M's performance on the pre-test demonstrated that while he was capable of reproducing a crude idea of the figure, he had extreme difficulties in paying close-enough attention to perceive detailed parts and to copy precise forms and positions of lines and spaces. The pre-test result also demonstrated that while M was capable of memorizing rough forms and distinctive parts, he easily overlooked precise details. His performance in the post-test showed that while there were no significant changes in overall attention to detailed parts and reproduction tasks, slight improvements were ob-

Table 4. Results of Assessment of Visual Perception, Pre and Post-tests

		Pre-Test	Post-Test
Frostig Developmental Test of Visual Perception		I. Eye-motor coordination: 19 points II. Figure ground: 15 points III. Constancy of shape: 10 points IV. Position in space: 8 points V. Spatial relationships: 7 points	I. Eye-motor coordination: 21 points II. Figure ground: 20 points III. Constancy of shape: 10 points IV. Position in space: 7 points V. Spatial relationships: 8 points
Ray-Osterrieth Complex Figure	Copying	Total time: 100 sec.	Total time: 90 sec.
	Reproducing immediately	Total time: 100 sec.	Total time: 88 sec.
	Reproducing 30 min later	Total time: 109 sec.	Total time: 100 sec.

served in parallel relationships of lines, size of the figure, and the overall form in the reproduction after 30 minutes task (cf. Figure 6, Figure 7).

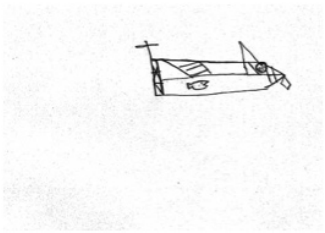


Figure 6. Reproduction after 30 min in the Ray-Osterrieth Complex Figure (Pre-Test)

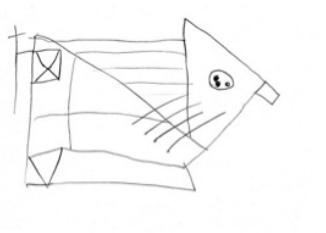


Figure 7. Reproduction after 30 min in the Ray-Osterrieth Complex Figure (Post-Test)

These findings suggested that M had extreme difficulties in perceiving precise forms, numbers, angles, and positioning of lines that compose complicated figures, as well as copying and memorizing them. These visual cognitive properties (disorders) may be considered to be a major factor for M's difficulties in learning *Kanji*. While these cognitive properties are difficult to change, the results suggest that continuous sessions of appropriate training may help a learner to improve his or her skill in conscious perception of spatial figure positional relationships.

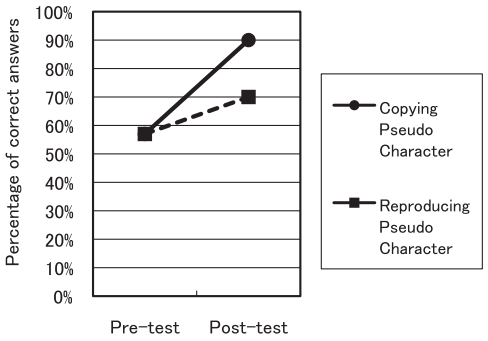
3.4. Assessment of *Kanji* Orthography

Table5 shows the results of Assessment of *Kanji* Orthography in the pre- and post-tests. In the right/left radical positioning and direction identifying task, the judging unknown character and reading task, and the judging radical position task, M provided correct answers on all pre-test items, and almost all post-test items as well. On the other hand, in the reading unknown character task, he had only one correct answer on the low-frequency-use real char-

acter task, and erroneous answers on the other 19 characters, both in the pre- and post-tests. In the copying and reproducing pseudo character pre-test task, M had 17 correct answers out of 30 questions in both copying and reproducing by memory (immediately after copying) tasks, and no correct answers regarding pseudo characters with more than 12 strokes in these tasks. However, in the post-test, M's performance improved, and he became capable of accurately copying pseudo characters with more than 12 strokes (cf. Figure 8).

Table 5. Results of Assessment of *Kanji* Orthography, Pre- and Post-Tests

		Pre-Test	Post-Test
Right/Left Radical Positioning and Direction Identifying Task		Real Characters: 10/10, Pseudo Characters with Right and Left Switched Radicals: 10/10, Mirror-Reversed Pseudo Characters: 10/10	Real Characters: 10/10, Pseudo Characters with Right and Left Switched Radicals: 8/10, Mirror-Reversed Pseudo Characters: 10/10
Judging Unknown Character and Reading Task	Judging	Real but Infrequently-Used Characters: 10/10, Pseudo Characters: 10/10	Real but Infrequently-Used Characters: 9/10, Pseudo Characters: 9/10
	Reading	Real but Infrequently-Used Characters: 1/10, Pseudo Characters: 0/10	Real but Infrequently-Used Characters: 1/10, Pseudo Characters: 0/10
Judging Radical Position Task		Left: 3/3, Top: 2/2, Bottom: 3/3, Right: 3/3	Left: 3/3, Top: 2/2, Bottom: 3/3, Right: 2/3
Copying and Reproducing Pseudo Character Task		Copying: 17/30, Immediate Reproducing: 17/30	Copying: 27/30, Immediate Reproducing: 21/30



Fiure 8. Results of Copying and Reproducing Pseudo-characters in Pre- and Post-tests

These results suggested that while M was capable of understanding overall characteristics of *Kanji* forms, including right and left radical position and direction, and other radical positions, along with judging whether characters were real or not real, he rarely understood the

relationships between character forms and their reading (regularity), which made it difficult for him to speculate how to read both real and pseudo characters. In addition, he had shown extreme difficulties in copying and reproducing complicated characters with many strokes, but his copying and memorizing skills concerning complicated characters appeared to improve after the *Kanji* learning support.

3.5. Assessment of Phonological Skills

Table 6. Results of Assessment of Phonological Skills, Pre and Post-tests

		Pre-Test	Post-Test
Sound Distinguishing Task	Alliteration Distinguishing	10/10	9/10
	Rhyme Distinguishing	10/10	10/10
Phonological Awareness Task	Alliteration Judging	10/10	10/10
	Rhyme Judging	9/10	9/10
Phonological Memory Task	Repeating Words in Highly Frequent Use	9/10	10/10
	Repeating Words in Less Frequent Use	8/10	7/10
	Repeating Pseudo Words	3/10	4/10
Rapid Naming Task		35/35 Time Elapsed to Complete: 23.5 sec.	35/35 Time Elapsed to Complete: 36 sec.

M showed similar performance on all the tasks in the phonological ability assessment in both pre- and post-tests (cf. Table 6). From the observation that M performed almost perfectly in both the sound distinguishing and phonological awareness tasks, we can understand that his ability to distinguish sounds accurately is well developed, and he has no problems in phonological awareness. In addition, his capability of naming accurately and rapidly in the rapid naming task indicated that M has no problems in understanding visually presented information and rapidly responding to name them, and no particular problems in rapid flow of reading based on levels of phonological representation and automatized naming process, either. However, in contrast to his good performance in repeating real words in frequent use in the phonological memory task, his performance regarding less-frequently-used words

and pseudo words gradually declined by difficulty of task. These findings suggest that memorizing unknown words that are composed of randomly arranged phonemes is difficult due to the heavy load of processing phonemes separately, which is in contrast to known words that one can easily memorize because the phonemes are processed as a group (lighter loading). In the case of M, while he has no notable phonological impairments, there might be a possibility of problems in short-term memory.

4. DISCUSSION

Using the case of a non-Japanese child showing severe difficulties in *Kanji* acquisition, this study empirically (1) investigated the cognitive properties hypothesized to be causing the child's difficulties, by examining various potential cognitive disorders, and (2) developed and evaluated a support method, that is, the "Training in visual skills," for learning *Kanji* based on the child's cognitive properties.

In previous studies on dyslexia in alphabet-based languages, phonological information processing disorders have been regarded as the most primary cognitive impairments associated with dyslexia. However, the results of this study on the cognitive properties of a foreign child with dyslexia revealed that in Japanese language learning, dyslexia could occur even in the case of an absence of phonological disorder but in the presence of visual information processing disorder. Previous studies on dyslexia in the Japanese language have rarely examined a wide range of potential disorders in order to elucidate cognitive impairments associated with dyslexia. Hence, this study—which used various types of tasks and tests to detect different root disorders, including phonological, naming, orthographic, and visual perception—identified visual cognitive disorder as a single disorder in the subtype of dyslexia in learning *Kanji*, and can therefore be considered to have made an insightful and significant contribution.

In addition, the learning support services based on the learner's cognitive properties helped enhance M's learning of *Kanji* that were covered in the sessions; he demonstrated improvement in copying and memorizing new characters. However, the findings suggest that it would be difficult to demonstrate improvement in his independent learning of *Kanji* that were not specifically targeted in support sessions, and improving his cognitive properties of having problems in accurately perceiving, reproducing, and memorizing complicated figures was not easy.

Given the complex writing system of the Japanese language, reading and writing acquisition requires a range of cognitive abilities. Accordingly, cognitive impairments in dyslexic children in the Japanese language are not limited to one type; rather, many subtypes are likely to exist. In order to provide appropriate support to children with difficulties in learning to read and write in Japanese, additional empirical studies should be conducted to further investigate assessment methods that can objectively diagnose dyslexic children, and to develop effective learning support programs by identifying subtypes of their cognitive impairments.

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