Original Contribution Kitasato Med J 2012; 42: 156-164

A study of reading ability of Japanese kanji among 4th to 6th grade primary school students

Reiko Shiba, Hiroyo Ishida

Department of Rehabilitation, Speech Therapy Course, School of Allied Health Sciences, Kitasato University

Objectives: We aimed to assess the incidence of pediatric dyslexia together with its subtypes, surface dyslexia and phonological dyslexia, in public Japanese primary school students and analyze the effect of the constituent characters of each test word on the reading scores obtained.
Methods: The reading ability of 282, 4th through 6th grade, Japanese public primary school students was investigated using word lists developed for this study comprised of one or two kanji for each word. In addition, the cognitive ability of each participant was separately examined using four different types of test batteries.
Results: Less than 10% of the students examined had a problem in reading ability. Some of the students showing reading difficulty could be classified into the two subtype categories of pediatric dyslexia, reported in previous studies in Western countries.
Conclusion: The incidence of pediatric dyslexia was less than 10% in our study. The word lists used were effective and useful for revealing the two subtypes of dyslexia in 282, 4th through 6th grade, Japanese public primary school students.

Key words: dyslexia, subtype, Japanese kanji, consistency

Introduction

In the past, developmental dyslexia was defined simply as a congenital reading disability found in some populations that never attained reading ability for some reason or other. Through later studies, however, it has proven difficult to provide an exact definition or to draw any firm conclusions about the nature of developmental dyslexia. In English-speaking countries where regular and exceptional patterns of reading coexist, dyslexia is perhaps the most common neurobehavioral disorder affecting children, with prevalence rates ranging from 5% to 17.5%.[1,2] However, in Italy, where only a regular reading pattern exists, the incidence of developmental dyslexia is about half that in English-speaking countries. Furthermore, there has been increasing evidence suggesting that developmental dyslexias do not form a homogenous entity but rather fall into different subgroups.

Castle and Coltheart[3] examined the reading skills of 56 developmental dyslexics through close comparison with the skills of 56 normally developing readers. They found that there were at least two varieties of developmental dyslexia: the first was characterized by a specific difficulty using the lexical procedure, and the second by a difficulty using the sublexical procedure.

The difference between lexical and sublexical procedures is based on a dual-route model of reading aloud.[4] As stated by Coltheart, reading via the lexical procedure involves retrieving, from a mental lexicon, the phonological form appropriate to a particular orthographic stimulus.[4] Since, by definition, the mental lexicon contains only representations of real words which the reader has previously encountered, this procedure does not allow the ability to read nonwords (unreal words). On the other hand, reading via the sublexical procedure involves correspondence rules that specify relationships between submorphemic orthographic and phonological segments. Thus, pronunciations are "assembled" from smaller orthographic components. The problem with this procedure is that it produces incorrect responses for irregular or exception words, as these words disobey the correspondence rules.

There are reports of subjects who can read regular words and nonwords but have difficulty with irregular words.[5,6] In these subjects, irregular words are pronounced according to traditional grapheme-phoneme

Received 7 March 2012, accepted 20 April 2012
Correspondence to: Reiko Shiba, Department of Rehabilitation, Speech Therapy Course, School of Allied Health Sciences, Kitasato University
1-15-1 Kitasato, Minami-ku, Sagamihara, Kanagawa 252-0373, Japan
E-mail: sbaorca@kitasato-u.ac.jp

conversion rules. This pattern of symptoms, referred to as "surface dyslexia," is thought to be based on selective damage to the lexical procedure for reading. In contrast, other subjects have been described who can read both regular and irregular words but cannot read nonwords.[7] This specific difficulty with nonword reading, referred to as "phonological dyslexia," would appear to reflect damage to the sublexical procedure for reading.

Manis et al.[8] also studied whether different subtypes of developmental dyslexia were in evidence in 51 dyslexic children as compared with 51 age-matched normal readers, using methods developed by Castle and Coltheart.[3] They identified two subgroups which fit the profiles commonly termed "surface" and "phonological" dyslexia. Surface subjects were relatively poorer in reading exception words compared to nonwords, while the phonological subjects showed the opposite pattern.

Concerning incidence of developmental dyslexia, it has been reported by researchers in Western countries that up to 10%-20% of children suffer from this type of disability.[9] In Japan, on the other hand, it has often been claimed that the incidence of developmental dyslexia is rather low compared with Western populations. The Japanese reading/writing system is quite different from that of Western countries, in that Japanese orthography consists of two linguistically different script systems: kanji (logographic-morphographic script) and kana (syllabic script which further consist of two types: hiragana and katakana); therefore, the nature of developmental dyslexia is most likely different from that found in Western countries. In particular, each kanji has a morphographic element that cannot be decomposed phonemically in the same way as alphabetic words.

In their recent study, Uno et al.[10] indicated that there is a difference in the incidences of developmental dyslexia found in Japanese primary school students between kanji and kana reading tasks. They tested 495 Japanese primary school students aged between 8 and 12 years old to determine their ability to read and write in hiragana, katakana, and kanji. They reported that percentages of the students whose reading and writing scores fell below the normal range differed according to the type of script. The percentage of students whose reading and writing scores fell below the -1.5 SD cut-off was 0.2% for hiragana, 1.4% for katakana, and 6.9% for kanji. Furthermore, they also stated that the percentage of students whose scores fell below the -2 SD cut-off was 1% for hiragana, 1% for katakana, and 3% for kanji reading, while it was 5% for kanji writing.[11] They postulated that the difference in scores between kana and kanji derived from the fact that different reading strategies are used for kana and kanji in Japanese. They further claimed that for kana, in which orthography-to-phonology mapping is consistent, a simple on-line phonological processing strategy could be used during reading, as reported by Wydell and Butterworth.[12] For kanji, on the other hand, the character-to-sound relationship is often one-to-many and so inconsistent that Japanese readers use a lexical whole-word reading strategy.[13-15]

As described in the report by Fushimi et al.,[16] the pronunciation or "reading" of a single Japanese kanji can be divided into ON (音: オン) and KUN (訓: クン). When kanji characters were imported from China, their pronunciations also entered the Japanese spoken language. An ON reading derives from the pronunciation of the original Chinese character, while a KUN reading derives from the pronunciation of the original Japanese word that has the same meaning as the Chinese character.[14] Usually, there is no phonological similarity between the ON and KUN readings of any given single kanji. Also, during the long history after their original import from China, many Japanese kanji acquired multiple ON readings and occasionally even more than one KUN. Thus, the reading system of Japanese kanji is quite complex.

Several past studies have classified Japanese kanji into different types based on their reading characteristics. Wydell et al.[15] classified a two-character kanji word as consistent if each constituent character has a single ON reading, and inconsistent if both characters take an ON reading in the target word but one or both characters also have KUN readings that are correct readings of these characters in other two-character words. Thus, the correct reading of Japanese, as related to other languages, is relatively complex.

Fushimi et al.[16] counted character-sound correspondences for each kanji using a corpus of approximately 31,000 two-character kanji words in a representative Japanese dictionary. They then classified a word as consistent if the constituent character took the identical pronunciation across all words containing that character at the same position. On the other hand, a word was classified as "inconsistent typical" if each constituent character was an inconsistent character (i.e., a character with more than one legitimate pronunciation across words containing that character at the same position), but both character pronunciations appropriate to this target word were statistically typical. A word was classified as "inconsistent atypical" if both characters had multiple pronunciations at their respective positions and the pronunciation of one or both characters in this target word was statistically atypical.

Japanese kanji can also be classified as high-frequency or low-frequency words depending on their affinity or frequency of use, although the degree of affinity of a given word would not necessarily be the same comparing adults with children.

In the present study, Japanese public primary school students' reading ability of kanji was examined using specially designed test stimuli for children based on the lists used by Fushimi et al.[16] to assess the reading ability of the Japanese adult population. In the process of preparing the test stimuli, the effect of the constituent characters of each test word was taken into consideration. The present study aimed at investigating the incidence of apparently dyslexic 4th through 6th grade Japanese students in regular public primary school classes. It further aimed to study whether those dyslexic students could be classified into previously reported subtypes of developmental dyslexia.

Methods

Participants

A total of 282 Japanese students (142 boys and 140 girls) in the 4th through 6th grades, of a public primary school, participated in the present study. The students, their parents/guardians, and their school teachers were informed of the study, and consent and approval were given by the headmaster of the school.

Test stimuli

Two sets of stimulus word lists were used. Set-1 consisted of relatively familiar words often used in clinical situations (Table 1), and Set-2 was prepared to compare constituent characters of the test words more precisely (Table 2). In preparing the lists, constituent characteristics of the word were taken into consideration, with special reference to those lists used in previous reports.[16,17] Namely, in terms of consistency of the two-character kanji[16] used in Set-2 of the present study, only inconsistent words were used for exploring the effect of the difference between typical and atypical words, while for lexicality, nonwords were added to real words. Furthermore, affinity (frequency of use: high vs. low frequency) was also taken into consideration in the process of preparing these test batteries. The number of test words in each pair of the word classes (typical vs. atypical; high vs. low frequency) was equated as closely as possible. In the studies by Fushimi et al.[16] and Shiba et al.,[17] nonwords were classified as consistent, inconsistent biased, or inconsistent ambiguous according to the degree of pronunciation typicality of its constituent characters in real words. In the present study, correct reading of nonwords was defined according to pronunciation typicality.

Set-1 (standard set) consisted of 13 words including 6 one-character words and 7 high-frequency typical two-character words (Table 1), while Set-2 consisted of 48 two-character words including 7 high-frequency typical words (the same words included in Set-1), 7 low-frequency typical words, 7 high-frequency atypical words, 7 low-frequency atypical words, and 20 nonwords (Table 2).

In addition, a separately prepared list consisting of 9 real and 14 unreal words was prerecorded and used in a dictation task to check the abilities of each participant in perceiving and writing Japanese phonemes (Table 3).

Table 1. List of reading test stimuli (Set-1)

No.	Item	Phonetic spelling	Translation	Consistency	Frequency	No. of characters
1	春	/haru/	spring	Inconsistent typical	High frequency	1
2	雪	/yuki/	snow	〃	〃	1
3	倍	/bai/	double	〃	Low frequency	1
4	海	/umi/	sea	Inconsistent atypical	High frequency	1
5	馬	/uma/	horse	〃	〃	1
6	列	/retsu/	line	〃	Low frequency	1
7	相手	/aite/	partner	Inconsistent typical	High frequency	2
8	天使	/tenshi/	angel	〃	〃	2
9	医学	/igaku/	medicine	〃	〃	2
10	和風	/wafuu/	Japanese style	〃	〃	2
11	全身	/zenshin/	the whole body	〃	〃	2
12	小指	/koyubi/	the little finger	〃	〃	2
13	虫歯	/mushiba/	decayed tooth	〃	〃	2

Table 2. List of reading test stimuli (Set-2)

No.	Item	Phonetic spelling	Translation	Word attribute	Frequency	
1	相手	/aite/	partner	Inconsistent typical	High frequency	
2	天使	/tenshi/	angel	〃	〃	
3	医学	/igaku/	medicine	〃	〃	Same words
4	和風	/wafuu/	Japanese style	〃	〃	as 7〜13
5	全身	/zenshin/	the whole body	〃	〃	in Set-1
6	小指	/koyubi/	the little finger	〃	〃	
7	虫歯	/mushiba/	decayed tooth	〃	〃	
8	配分	/haibun/	distribution	〃	Low frequency	
9	予期	/yoki/	expectation	〃	〃	
10	長屋	/nagaya/	row house	〃	〃	
11	投下	/touka/	drop	〃	〃	
12	足軽	/ashigaru/	common foot soldier	〃	〃	
13	横笛	/yokobue/	flute	〃	〃	
14	名実	/meijitsu/	name and reality	〃	〃	
15	息子	/musuko/	son	Inconsistent atypical	High frequency	
16	大豆	/daizu/	soybeans	〃	〃	
17	様子	/yousu/	state	〃	〃	
18	都合	/tsugou/	convenience	〃	〃	
19	始発	/shihatsu/	first train	〃	〃	
20	上着	/uwagi/	jacket	〃	〃	
21	中身	/nakami/	content	〃	〃	
22	問答	/mondou/	dialogue	〃	Low frequency	
23	物品	/buppin/	article	〃	〃	
24	家路	/ieji/	the way home	〃	〃	
25	油田	/yuden/	oil field	〃	〃	
26	白波	/shiranami/	whitecaps	〃	〃	
27	曲者	/kusemono/	rascal	〃	〃	
28	犬歯	/kenshi/	canine tooth	〃	〃	
1	食同	/shokudou/		Nonword		
2	内合	/naigou/		〃		
3	正半	/seihan/		〃		
4	休算	/kyuusan/		〃		
5	曜食	/youshoku/		〃		
6	校活	/koukatsu/		〃		
7	回交	/kaikou/		〃		
8	番曜	/banyou/		〃		
9	弱天	/jakuten/		〃		
10	刀校	/toukou/		〃		
11	回算	/kaizan/		〃		
12	弱同	/jakudou/		〃		
13	番合	/bangou/		〃		
14	正活	/seikatsu/		〃		
15	曜校	/youkou/		〃		
16	内曜	/naiyou/		〃		
17	食天	/shokuten/		〃		
18	校半	/kouhan/		〃		
19	休交	/kyuukou/		〃		
20	刀食	/toushoku/		〃		

Table 3. List of reading test stimuli (List for dictation test)

No.	Item	Phonetic spelling	Translation	Word attribute	Frequency
1	おにぎり	/onigiri/	rice-ball	Word	High frequency
2	やかん	/yakan/	kettle	〃	〃
3	はさみ	/hasami/	scissors	〃	〃
4	じゃがいも	/jagaimo/	potato	〃	〃
5	あじさい	/ajisai/	hydrangea	〃	〃
6	うさぎ	/usagi/	rabbit	〃	〃
7	にわとり	/niwatori/	chicken	〃	〃
8	りんご	/ringo/	apple	〃	〃
9	たわし	/tawashi/	scrub brush	〃	〃
1	かきふ	/kakifu/		Nonword	
2	みった	/mitta/		〃	
3	にょせき	/nyoseki/		〃	
4	くれみゅ	/kuremyu/		〃	
5	くらが	/kuraga/		〃	
6	とぷか	/topuka/		〃	
7	らげん	/ragen/		〃	
8	ひごちゃに	/higochani/		〃	
9	ひがゆう	/higayuu/		〃	
10	ぱころね	/pakorone/		〃	
11	りゃくしけ	/ryakushike/		〃	
12	ふせざわり	/fusezawari/		〃	
13	きゅらぶっし	/kyurabusshi/		〃	
14	しっつくみ	/shittsukumi/		〃	

Procedures

The participants were divided into small groups consisting of approximately 30 students each. As for the order of the test procedures, cognitive ability test was first given in the order of Rey-Osterrieth complex figure test-copy (RCFC),[18] Raven standard progressive matrices (RSPM),[19] and Wechsler intelligence scale for children (Third Edition: Coding).[20] The dictation test was then performed and the reading task was given finally. The reading task was given to each group by showing the test words of Set-1 and Set-2 written on a board, one by one, for 10 seconds each, and asking the participants to write down the reading of each word in hiragana. The order of showing the test words was from the top to the bottom of each list. The total time required for a series of the tests was an average of 45 minutes.

To check the in abilities in perceiving and writing Japanese phonemes, the dictation test was performed so that the prerecorded word list mentioned above was reproduced and the participants were required to write each dictated word in hiragana.

Assessment of cognitive abilities

The following four test batteries were used in the present study to assess the cognitive ability of the participants: the RSPM C set,[19] RCFC drawing[18] together with its delayed recall version,[18] and Coding.[20]

The present study was approved by the Ethics Committee of Kitasato University School of Allied Health Sciences (Approval Number: 2009-083) on October 27, 2009.

Analysis

Subjects

From the total 282 students (142 boys and 140 girls) who initially participated in the present study, 21 students, whose scores on the cognitive ability and/or dictation test fell below the -1.5 SD cut-off, were excluded from further analysis of reading ability scores. Concerning the dictation test, only scores for the 9 real words in the list were used to exclude participants. As a result, the scores obtained from the remaining 261 students (128 boys and 133 girls) were adopted for further analyses.

Statistics

A three-way mixed analysis of variance (ANOVA) was performed on the obtained data of percentage correctness, with gender, grades and the constituent characteristics of

the word as variables.

Results

Percent of correct responses for reading of Set-1

The mean percent of correct responses for Set-1 among 4th, 5th, and 6th graders are shown in Table 4. The score was >90% for each grade.

Percent of correct responses for reading of Set-2

The mean percent of correct responses for typical, atypical, and nonwords in Set-2 among 4th, 5th, and 6th graders and total subjects are shown in Table 5. As stated above, the correct reading of nonwords was defined according to pronunciation typicality.

The ANOVA revealed significant different main effects of the grade ($F(2,255) = 20.44$, $P < 0.01$) and word attributes ($F(1.76, 451.12) = 565.77$, $P < 0.01$), but there were no significant different main effects of gender ($F(1,255) = 0.42$, $P = 0.51$). There were no significant interactions among gender, grade, or word attribute ($F(3.53, 451.12) = 0.30$, $P = 0.85$), and no significant interactions between gender and word attribute ($F(1.76, 451.12) = 0.85$, $P = 0.89$), or between grade and word attribute ($F(3.53, 451.12) = 1.85$, $P = 0.12$).

Post hoc Bonferroni multiple comparisons revealed that there was a statistically significant difference between the scores of the 4th and 5th graders for typical, atypical, and nonword types ($P < 0.01$), while the difference between the 5th and 6th graders was insignificant ($P = 0.52$). These results indicated that there is an age effect on the ability of character-sound conversion during the period from the 4th to 5th grades ($P < 0.01$). Post hoc Bonferroni multiple comparisons also revealed that typical word scores were higher than nonword scores ($P < 0.01$), and nonword scores were higher than atypical word scores ($P < 0.01$).

Incidence of reading difficulty among the students

For both Set-1 and Set-2, those students whose reading scores fell below the -2 SD cut-off were considered to have reading difficulty (Tables 4 and 5). The numbers and incidence of all participants were 10 (3.5%) for Set-1 and 19 (6.7%) for Set-2.

Subtype classification of students with reading difficulty

With reference to the subtype classification advocated by Castle and Coltheart[3] and supported by Manis et al.,[8] an attempt was made to classify those students showing apparent reading difficulty in the present reading tasks into two subtypes: surface and phonological groups based on the pattern of their error profiles. In the process of the classification, possible "surface" dyslexia was used to refer to those students who exhibited relatively poorer scores (-2 SD below) in reading atypical words compared to nonwords (-2 SD above), while possible "phonological" dyslexia was used to refer to students showing the opposite pattern, i.e., exhibiting relatively better scores in reading atypical words than nonwords (-2 SD above), and poorer scores (-2 SD below) in reading atypical words.

Table 4. Percent of correct responses with SD for Set-1 in each grade

Grade	n	Mean	SD
4th	90	91.4	12.2
5th	77	94.2	9.5
6th	94	94.9	11.4

Table 5. Percent of correct responses with SD for Set-2 in each grade and all cases

Grade	n	Typical		Atypical		Nonword[a]	
		Mean	SD	Mean	SD	Mean	SD
4th	90	69.7	18.1	36.4	16.6	64.6	21.6
5th	77	78.5	15.6	49.4	17.1	74.0	19.6
6th	94	82.2	14.9	49.0	17.3	79.9	16.1
Total	261	76.8	17.2	44.8	18.1	72.9	20.2

*$P < 0.01$

[a]Correct reading for nonwords was defined according to pronunciation typicality.

As shown in Table 6, among 10 students, of 282 whose reading scores fell below the -2 SD cut-off for the reading task using Set-1, 2 students (0.7%), were classified as possible phonological dyslexia, while there were no surface dyslexics in this task. The remaining 8 of those 10 students could not be classified into either of the subtypes. On the other hand, among 19 students of the 282 whose reading scores fell below the -2 SD cut-off for the reading task using Set-2, 6 students (2.1%) were classified as possible surface dyslexia, while 10 (3.5%) were classified as possible phonological dyslexia. The remaining 3 of those 19 students could not be classified into either of the subtypes.

Discussion

In the present study, two specially designed sets were used for detecting possible dyslexic students in so-called regular classes in public primary schools. In designing the reading tasks, the effect of the constituent characters in each test word was taken into special consideration.

Using the two sets of reading tasks revealed that there appeared to be a certain number of dyslexic children in regular classes of public primary schools. In particular, when Set-2, consisting of two-character kanji words selected with special consideration of their constituent characters and appropriate nonwords, was used, 19 of the total 282 students (6.7%) appeared to have reading difficulties. This incidence was higher than that reported by Uno et al.[11]

It had long been believed that dyslexic children show a simple, common type of reading difficulty compared to normal children. However, after the concept of a dual-route model of reading was introduced by many theorists including Coltheart[4] and Morton and Patterson,[21] it has been claimed that the system which skilled readers use to read involves at least two separate procedures. Based on this concept, Castle and Coltheart[3] reported that there appeared to be two subtypes in the population of developmental dyslexia which they called "surface" and "phonological" groups. In the present study, 6 of 19 students showing reading difficulties for Set-2 were classified as the surface type and 10 as the phonological type, while the remaining 3 were unclassifiable into either type.

Uno et al.[22] studied the reading ability of sixth-grade public school children using test words prepared by taking constituent characters into consideration such as consistency, typicality, and affinity, although they did not present substantial word lists in their report. As stated in the introduction of the present paper, they reported that the percentage of the students whose scores fell below the -2SD cut-off was 1% for hiragana, 1% for katakana, and 3% for kanji reading, while it was 5% for kanji writing.[11] The results of the present study for Set-1 (3.5%) appeared to be comparable with their results.

Table 6. Results of subtype classification of students showing a tendency of reading difficulty

1. Subtype classification based on the results of reading Set-1

Subtype	Pattern	n	Incidence
Possible surface dyslexia	Nonwords > atypical	0	0%
Possible phonological dyslexia	Atypical > nonwords	2	0.7%
Unclassified		8	
Total		10	3.5% of total 282

2. Subtype classification based on the results of reading Set-2

Subtype	Pattern	n	Incidence
Possible surface dyslexia	Nonwords > atypical	6	2.1%
Possible phonological dyslexia	Atypical > nonwords	10	3.5%
Unclassified		3	
Total		19	6.7% of total 282

However, they also reported that they could not find any significant differences in the results of reading tasks between meaningful words and nonwords.

The apparent differences between the results of their study and the present study are most likely due to the differences in the criteria of correct answering. In the present study, correct reading of nonwords is defined according to pronunciation typicality. In their study, on the other hand, even atypical reading was taken to be correct for the reading of nonwords. It is also conceivable that the differences could be based on the differences in the criteria of the word selection, although definitive comparison is impossible, because their lists are unobtainable, as stated above. Because no standardized tests to assess reading ability in children have been developed in Japan, it is reasonable that there would be differing results between two independent studies.

In preparing the Set-2 word list, special care was taken to include an appropriate number of two-character kanji words having different types of constituent characters. Use of the Set-2 list revealed that two different subtypes could possibly be classified even for primary school children. These results seem to support the usefulness and validity of the test materials in the present study.

Conclusions

The reading ability of kanji was assessed Japanese 4th through 6th grade public school students using two specially designed sets of test words prepared with special consideration of the constituent characters of Japanese. The results revealed that less than 10% of the students were considered to be dyslexic. Also, the scores of percent correct reading showed significant improvement from 4th to 5th grade for all of the word types: typical, atypical, and nonwords. Some of the students considered to be dyslexic appeared to be classifiable into one of two subtypes, i.e., surface and phonological groups, depending on the pattern of reading errors. We concluded that the test method used in the present study was effective and useful for revealing developmental dyslexia in grade school students.

Acknowledgements

The authors extend their sincere gratitude to the late Prof. Takao Fushimi for his kind guidance throughout the study. We also thank Profs. Hajime Hirose and Toshimasa Matsuhira for their valuable advice in the preparation of the manuscript. We also thank Chika Nakanishi, Yuka Nakamura and Sayaka Noda from the Graduate School of Allied Health Sciences, Kitasato University, and the staff from KNI Kitahara International Hospital, the Green Village Warabi and the Department of Rehabilitation of Taga Hospital, Hitachi, Ltd., for their significant help in data collection and analysis.

References

1. Interagency Committee on Learning Disabilities. Learning disabilities: A report to the U.S. Congress. Government Printing Office, Washington, D.C, 1987.
2. Shaywits S. Current concepts: Dyslexia. *New Engl J Med* 1998; 338: 307-12.
3. Castles A, Coltheart M. Varieties of developmental dyslexia. *Cognition* 1993; 47: 149-80.
4. Coltheart M. Lexical access in simple reading tasks. In: Underwood G, Editor. Strategies of information processing. London: Academic Press; 1978; 151-216.
5. Behrmann M, Bub D. Surface dyslexia and dysgraphia: Dual routes, single lexicon. *Cogn Neuropsychol* 1992; 9: 209-51.
6. Coltheart M, Masterson J, Byng S, et al. Surface dyslexia. *Q J Exp Psychol A* 1983; 35: 469-95.
7. Beauvois MF, Derouesne J. Phonological alexia: Three dissociations. *J Neurol Neurosurg Psych* 1979; 42: 1115-24.
8. Manis FR, Seidenberg MS, Doi LM, et al. On the bases of two subtypes of development dyslexia. *Cognition* 1996; 58: 157-95.
9. Shaywits S, Shaywits B, Feltcher J, et al. Prevalence of reading disability in boys and girls: Results of the Connecticut longitudinal study. *J Am Med Assoc* 1990; 264: 998-1002.
10. Uno A, Wydell TN, Haruhara N, et al. Relationship between reading/writing skills and cognitive abilities among Japanese primary-school children: normal readers versus poor readers (dyslexics). *Read Writ* 2009; 22: 755-89.
11. Uno A. Developmental dyslexia frequency of appearance, cerebrum. In: Sasanuma S, Editor. The new viewpoint and intervention theory of a formative period language communication obstacle. Tokyo: Igakushoin; 2007; 82-92 (in Japanese).
12. Wydell TN, Butterworth B. A case study of an English-Japanese bilingual with monolingual dyslexia. *Cognition* 1999; 70: 273-305.
13. Morton J, Sasanuma S, Patterson K, et al. The organisation of lexicon in Japanese: Single and compound kanji. *Br J Psychol* 1992; 83: 517-31.
14. Wydell TN. What matters in Kanji word naming-Consistency, regularity, or ON/KUN-reading difference? *Read Writ* 1998; 10: 359-73.

15. Wydell T, Butterworth B, Patterson K. The inconsistency of consistency effects in reading: The case of Japanese Kanji. *J Exp Psychol Learn Mem Cogn* 1995; 21: 1155-68.
16. Fushimi T, Ijuin M, Patterson K, et al. Consistency, frequency, and lexicality effect in naming Japanese Kanji. *J Exp Psychol Hum Percept Perform* 1999; 25: 382-402.
17. Shiba R, Fushimi T, Ishida H. Reading ability of Japanese Kanji characters in the upper grade primary school students. *Cogn Neuropsychol Soc* 2008; 11: 36-7 (in Japanese).
18. Spreen O, Strauss E. Memory Rey-Osterrieth complex figure test (CFC). In: A compendium of neuropsychological tests, 2nd ed. New York: Oxford University Press; 1998; 341-63.
19. Raven JC, Court JH, Raven J. Manual for the Raven's colored progressive matrices. (Japanese Raven's colored progressive matrices). Tokyo: Nihon Bunka Kagakusha; 1993 (in Japanese).
20. Japanese WISC-III Publication Committee. Nihonban WISC-III Jisshi Saiten Manual [Japanese Wechsler Intelligence Scale for Children; 3rd ed.]. Tokyo: Nihon Bunka Kagakusha; 2005 (in Japanese).
21. Morton J, Patterson KE. A new attempt at an interpretation or an attempt at a new interpretation. In: Coltheart M, Patterson KE, Marshall JC, editors. Deep dyslexia. London: Routledge & Kegan Paul; 1980; 91-118.
22. Uno A, Suzuki K, Sambai A, et al. Issues in direct application of adult cognitive neuropsychology to developmental dyslexia-surface and/or phonological dyslexia. *Jpn J Logoped Phoniatr* 2009; 50: 276-84 (in Japanese).