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Reading and Writing Achievement Tests for Assessing Orthographical and Phonological Impairments of Japanese Children with Developmental Disorders

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1. Introduction

This chapter describes our new reading and writing tests which were designed to evaluate not only the severity of the language-related problem of each child, but also what types of impairments each child is experiencing, namely, whether a given child has an impairment which is mainly in the visual sphere, especially in the orthographical processing or in the phonological processing, on the basis of the psychological models concerning the development of reading and writing abilities. It also includes tentative reports on the experiment that we have conducted in order to ascertain the validity of those tests.

The aim of our study was to design a new set of achievement tests in reading and writing for Japanese-speaking children that will help us identify the specific types of learning problems that some children might be facing and would be useful in determining what types of intervention each child needs. One of the more central goals of our tests was to distinguish dyslexic children and children who are having language-related problems as a result of Attention Deficit Hyperactivity Disorder (ADHD). ADHD and dyslexia, the two most commonly diagnosed psychiatric conditions of childhood, each occur in approximately 5% (ADHD 3-7% and dyslexia 4%) of the population in the United States, according to the Diagnostic and Statistical Manual of Mental Disorders, Forth Edition, Text Revision (DSM-IV-TR) (American Psychiatric Association 2000; Willcutt et al. 2005). Though ADHD and dyslexia are separate and distinct conditions, there is considerable overlap and children with ADHD often display language-related problems similar to those caused by dyslexia (Mason and Reid 2011). In order to give appropriate intervention to children with each disability, we need to be able to distinguish the characteristics of the linguistic problems that each condition entails.

What distinguishes our tests from previous test batteries for diagnosing language-related difficulties among Japanese children ((Uno et al. 2006) among others) is that our tests consist of several distinct categories of questions, so that it will be possible to pinpoint the exact aspects of reading and writing that a given child is having a problem with. Previous achievement tests in reading and writing were designed to detect children having difficulty with reading and writing, and to diagnose the magnitude of the difficulty. Consequently those tests did not allow for construction of a detailed profile of each child's disability.

More specifically, the most important feature of our new tests is that they consist of questions that are more suited to assessing a child's ability in phonological processing and questions that are more suited to assessing a child's ability in orthographic processing. Over the past decade, a growing body of research has shown that reading and writing involve orthographic processing and phonological processing both in alphabetical and in non-alphabetical languages (Afonso and Alvarez 2011; Kandel et al. 2009; Mousikou et al. 2010; Qu et al. 2011). Moreover, a longitudinal developmental study showed that both orthographical and phonological skills accounted for independent variance in later orthographic skills (Sprenger-Charolles et al. 2003). It has been also suggested that both the orthographic and phonological measures contribute to distinguishing various types of dyslexia (Berninger et al. 2008; Coltheart et al. 2001; Hultquist 1997; Plaut et al. 1996); although dyslexia has been strongly associated with a deficit in phonological processing (Ramus et al. 2003; Shaywitz and Shaywitz 2005), reading disabilities may also be linked to problems with orthographic processing. We thus incorporated both orthographical and phonological measures into our reading and writing tests, with the expectation that their inclusion might help us distinguish not only various types of dyslexia but also dyslexia and ADHD.

To state the advantage of our tests in this regard in a more precise fashion, let us go into some details about the way Chinese characters are used in the Japanese language and the way they are taught at Japanese schools. The way Chinese characters are used in Japan is uniquely complicated, even compared to the way they are used in other Asian countries, such as China and Korea (Taylor and Taylor 1995). Whereas the relation between *Kana*, Japanese syllabary, and sounds is relatively transparent, the relation between *Kanji*, Chinese characters used in Japan, and sounds is sometimes opaque and not transparent. While in Chinese each Chinese character corresponds only to one sound in principle, most Chinese characters used in Japanese have two or more pronunciations, which are classified into On/Chinese pronunciations, which reflect the pronunciations that the characters originally had in Chinese, and Kun/Japanese pronunciations, which are sounds representing the Japanese morphemes that are felt to semantically correspond to the meaning of the Chinese characters. The pronunciation of a Chinese character used in a Japanese text often cannot be determined unless the context in which it is used is taken into account.

About a thousand Chinese characters, which are roughly half of the Chinese characters that are commonly used among adults (Jo-yo Kanji), are taught at primary school in Japan, i.e. during Grade 1 through to Grade 6. Children in Grade 1 are taught 80 Chinese characters, those in Grade 2 are taught 160 and those in Grade 3 through to Grade 6 are taught about 200 in each academic year. The average number of strokes of a single character taught at each grade increases from about 5 strokes at Grade 1 to about 11 strokes by Grade 5, which corresponds to almost the same average number of strokes of one character in Jo-yo Kanji used among adults. When Japanese children of each grade are taught a fixed set of Chinese characters, they are typically taught only one of the possible pronunciations of those characters at first; more frequently used, thus more important pronunciations, are taught at earlier grades and other pronunciations are taught at later grades. For example, the Chinese character 言 ('speech, language') is learned in Grade 2 with a Kun/Japanese reading *i*; then it is learned in Grade 3 with a Kun/Japanese reading *koto*; it is also learned in Grade 4 with an On/Chinese reading *gen* and it is learned in Grade 6 with an On/Chinese reading *gon* (Synthetic Research Institute of Elementary Education 2005; Taylor and Taylor 1995). The number of characters which are taught with a new pronunciation increases from about 40 at Grade 1 to about 200 by Grade 6.

Unlike other tests, our tests take advantage of these features of the use and education of Chinese characters in Japan to obtain a detailed profile of the test-taker's ability to read and write. On the one hand, by using both questions involving characters written with a relatively small number of strokes and questions involving characters written with a relatively large number of strokes, we attempted to determine if the test-taker has any difficulty with dealing with visually complex symbols. On the other hand, by using both questions involving characters for which a different pronunciation has been taught before and questions involving characters for which no other pronunciation has been taught before, we attempted to gain insight as to whether the test-taker has any difficulty with phonological processing.

2. Methods

The content of our new tests and the way they were administered to ascertain their validity are presented in this section.

2.1 Material

In this experiment, participants were asked to read and write Chinese characters that were orthographically and phonologically either complex or simple. Orthographically complex characters are ones that are written with a relatively large number of strokes and orthographically simple characters are ones that are written with a relatively small number of strokes. More specifically, in the tests for second and third graders, the test for fourth graders and the tests for fifth and sixth graders, the orthographically complex characters consisted of approximately six strokes, 11 strokes and 12 strokes respectively on average and orthographically simple characters consisted of approximately three strokes, five strokes and six strokes respectively on average. Phonologically complex characters are ones for which the child (the participant) is expected to have already learned at school more than one pronunciation and phonologically simple characters are ones for which the child (the participant) is expected to have already learned at school only one pronunciation. In other words, participants were asked to read and write Chinese characters which fell into one of the following four categories:

i. characters that consist of a small number of strokes and have only one pronunciation,
ii. characters that consist of many strokes and have only one pronunciation,
iii. characters that consist of a small number of strokes and have more than one pronunciation and
iv. characters that consist of many strokes and have more than one pronunciation.

All the words in the achievement tests had been taught at school for at least more than a year before the test, except those used in the tests for Grade 2 children. All the words consist of two to four characters and at least one of the characters is a Chinese character. Words which have potentially problematic homophones were excluded.

Factors such as lexical meaning have been controlled by choosing similar words with respect to frequency, familiarity and imageability (that is, the extent to which the representation of a word's meaning has sensorimotor properties and thus evokes a strong image in any given observer (Strain, Patterson, and Seidenberg 1995)) using some of the standard Japanese corpora for both adults and children (Amano and Kondo 1999; Kai 2005; Sakuma et al. 2005).

2.2 Participants

Twelve Japanese dyslexic children (mean chronological age 10 years 3 months [SD 16.6 months], one female, two lefthanders), nine Japanese ADHD children (mean chronological age 11 years 2 months [SD 11.9 months], two females, one lefthander) and 479 control children participated in the achievement tests.

The children of the diagnostic group had been referred to the National Center Hospital of Neurology and Psychiatry, mostly because of learning, attention and/or behavioural problems. All the children of the diagnostic group in the study underwent clinical evaluations by two professional clinicians (certified paediatric neurologists). Their intelligence as measured by Wechsler Intelligence Test, the third edition (WISC-III) (Japanese WISC-III Publication Committee 1998) was within the normal range (mean FIQ 90.1 [SD 12.7] among dyslexic children and mean FIQ 92.7 [SD 6.3] among ADHD children). With regard to the intelligence scores, there was no significant difference between dyslexic and ADHD children. Other psychological evaluations involved a computerized continuous performance test (Inoue et al. 2008); rapid naming tests developed for the clinics (Kobayashi et al. in press), clinical observations of the child during the evaluation; a review of the child's records including school records from Grade 1 to the present, previous clinical evaluations and the child's developmental history. The psychiatric and paediatric evaluations involved a semi-structured interview with the guardians and with the child (including an assessment of the child's history and current symptoms), clinical observations of the child, a review of records and analysis of the questionnaires completed by the guardians for clinics. The diagnoses of dyslexia and ADHD were based on the criteria in the Diagnostic and Statistical Manual of Mental Disorders, Forth Edition, Text Revision (DSM-IV-TR) (American Psychiatric Association 2000). None of the children had psychosis, autism, bipolar disorder, significant hearing or visual loss, or other neurological impairments (such as cerebral palsy). All the experimental procedures were in accordance with the Helsinki Declaration of 1964, revised in 2002, and approved by the ethics committee in National Center of Neurology and Psychiatry.

The 479 control children, all typically developing Japanese children (mean chronological age 10 years 3 months [SD 17.1 months], 251 females, 35 lefthanders), came from 16 classes of a municipal primary school located in a suburban community of average socioeconomic status in the middle of Japan. They went to regular general education classrooms, had no known learning problems and do not receive special educational support concerning learning disabilities. They have no history of developmental disorders reported by the classroom teachers. The experimental procedure had been approved by the headmaster of the school.

2.3 Procedure

The participants took a reading test and a writing test for 10 and 15 minutes respectively. The children with developmental disorders were allowed to extend the time if needed. The order of the tests was counterbalanced among the participants. Both the tests consisted of 24 words for second and third graders and 32 words for fourth to sixth graders which were formatted on B4-sized paper. The participants were asked to read (i.e. write the syllabic, non-Chinese letters representing the pronunciation of) or write one Chinese character of each word. In the test for writing, ruby characters, i.e. syllabic, non-Chinese letters indicating the way the Chinese character was to be pronounced, were provided.

2.4 Analysis

As the number of items in the achievement tests was not equal among different graders, the correct response rate for each grade was calculated as a proportion and hence the arc sine root transformation was applied to the correct response rates (Sheskin 2007). Since the number of children with developmental disorders was limited at each grade, we abandoned the analysis of variance using two levels of each independent variable. Instead, we created new variables using the four categories of items mentioned above.

Specifically, in order to examine the effect of orthographical demand (i.e. visual complexity), we averaged the correct response rate for (i) characters that consist of a small number of strokes and have only one pronunciation and (iii) characters that consist of a small number of strokes and have more than one pronunciation on one hand to create a variable representing the participants' performance for visually less complex characters, and averaged the correct response rate for (ii) characters that consist of many strokes and have only one pronunciation and (iv) characters that consist of many strokes and have more than one pronunciation on the other hand to create a variable representing the participants' performance for visually more complex characters. Two more variables representing their performance for phonologically less complex characters and their performance for phonologically more complex characters were created in a similar manner.

The mean correct response rate for typically developing children at each grade was further analyzed using the statistical tests according to its distribution after the test for the homogeneity of variance and the test for the normality of distribution. Since the mean correct response rates were not significantly different between the gender groups of typically developing children at each grade according to the Mann Whitney U test, we calculated the mean and the standard deviation of the entire group, containing both girls and boys. Using this mean and the standard deviation as the basis, we then calculated the Z-scores for children with developmental disorders at each grade, although the proportion of males and females was different between typically developing children and children with developmental disorders.

3. Results

The result of the experiment seems to support the following three statements:

a. Overall performance
First, while children with dyslexia had trouble both with writing and with reading, children with ADHD had trouble mainly with writing and not necessarily with reading.

b. Orthographic performance
Second, compared to children with dyslexia, children with ADHD had more trouble writing Chinese characters which consist of many strokes and thus are visually more complex, although both children with ADHD and dyslexia seemed to have less trouble reading visually more complex characters.

c. Phonological performance
Third, compared to children with ADHD, dyslexic children had more trouble reading (if not writing) Chinese characters which have more than one possible pronunciation and are thus arguably phonologically more complex.

3.1 Overall performance

3.1.1 Overall performance by typically developing children

Fig. 1 reports the mean correct response rate of typically developing children at each grade for the reading achievement tests. Error bars indicate one standard deviation of uncertainty. The sampling distribution was similar among different grades, according to the Kruskal-Wallis test (p = .1).

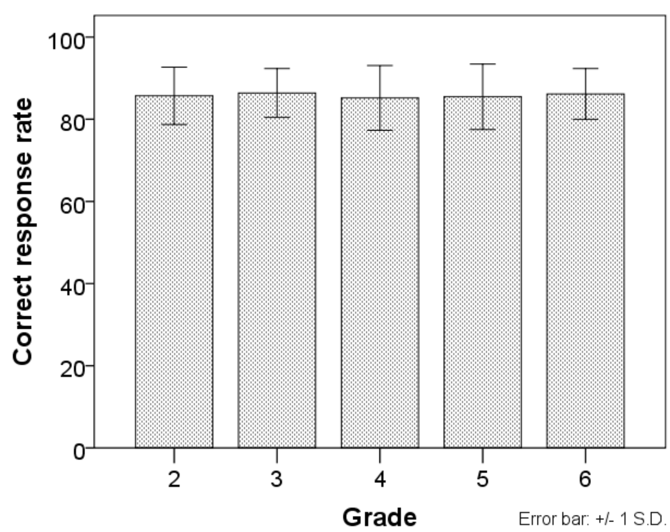

Fig. 1. Overall correct response rate of reading by typically developing children.

Fig. 2 represents the means of the correct response rate of typically developing children at each grade for the entire writing achievement tests. Error bars indicate one standard deviation over sampling distribution. The sampling distribution was significantly different among different grades, according to the Kruskal-Wallis test (p < .0001). The post hoc tests revealed that the mean correct response rate of Grade 4 and 5 was significantly lower than that of Grade 3 (U=3830.5, Z=-3.22, r=-.23; U=3652.0, Z=-4.07, r=-.28, respectively) after Bonferroni corrections.

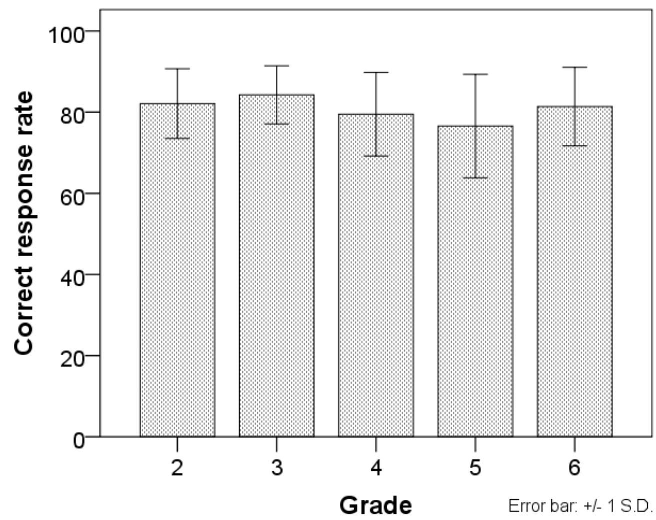

Fig. 2. Overall correct response rate of writing by typically developing children.

3.1.2 Overall performance by children with developmental disorders

Fig. 3 represents the Z scores for the correct response rate of both dyslexics and ADHD patients for the reading and writing achievement tests. The left side column shows the Z scores of the reading tests and the right side column shows those of the writing tests. Each row shows the Z scores of each grade. Filled data points in black represent the cases with dyslexia whereas unfilled data points represent the cases with ADHD.

From those graphs we see that Z scores for writing tend to be low with both developmental disorders, that dyslexics' reading scores likewise tend to be low, but that ADHD patients' Z scores for reading tend to be close to normal (around -1.0 SD or above), suggesting relatively minor impairment of reading abilities.

The pattern of overall performance alone does not necessarily allow us to distinguish ADHD patients and dyslexics. In other words, some ADHD patients and some dyslexics show an indistinguishable pattern of overall performance, as we see with Case 4 (dyslexic) and Case 13 (ADHD) in Grade 3 and Case 12 (dyslexic), Case 16 (ADHD) and Case 17 (ADHD) in Grade 5. Thus, in order to distinguish the two types of disorders on the basis of reading and writing achievement tests, it is necessary to examine not only the overall performance of the children, but also their performance for each of the four (two by two) question types.

3.2 Performance as a function of orthographical complexity

3.2.1 Orthographical performance by typically developing children

Fig. 4 reports the typically developing children at each grade's mean correct response rate for reading achievement tests as a function of orthographical complexity. Error bars indicate standard deviations. There was significant difference between the mean correct response rate for orthographically complex characters and that for orthographically simple characters at Grade 2. The correct response rate was higher when the character was orthographically complex than when the character was orthographically less complex ($Z=2.51$, $p<.01$, $r=.27$). The sampling distribution was similar between the levels of orthographical complexity in other grades, according to Wilcoxon's signed rank test.

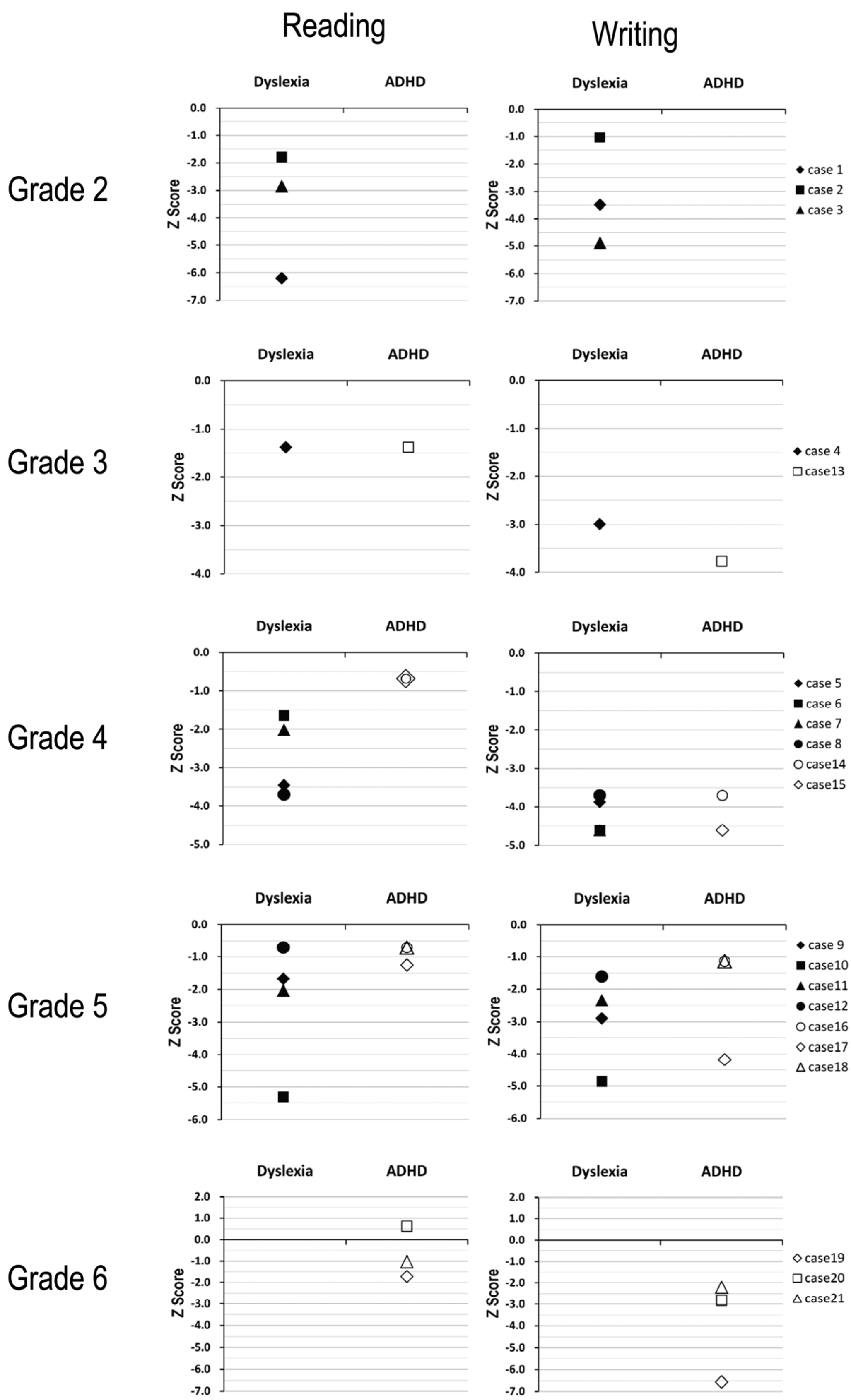

Fig. 3. Overall Z scores of children with developmental disorders.

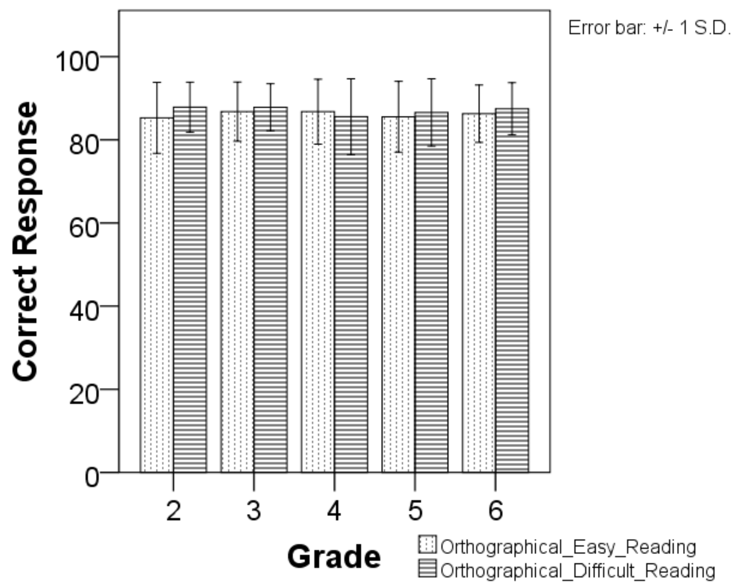

Fig. 4. Correct response rate of reading as a function of orthographical complexity by typically developing children.

Fig. 5 represents the typically developing children at each grade's mean correct response rate for writing achievement tests as a function of orthographical complexity. Error bars indicate standard deviations over sampling distribution. Statistical analysis revealed that the mean correct response rates were different between the levels of orthographic complexity at Grade 5 and at Grade 6. In both grades, the mean correct response rate was significantly lower when the character was orthographically complex than when the character was not ($Z=-4.27$, $p<.0001$, $r=-0.43$; $Z=-2.29$, $p<.05$, $r=-0.23$ respectively). There was no significant difference between the mean correct response rates at different orthographical levels in Grade 2, 3 and 4.

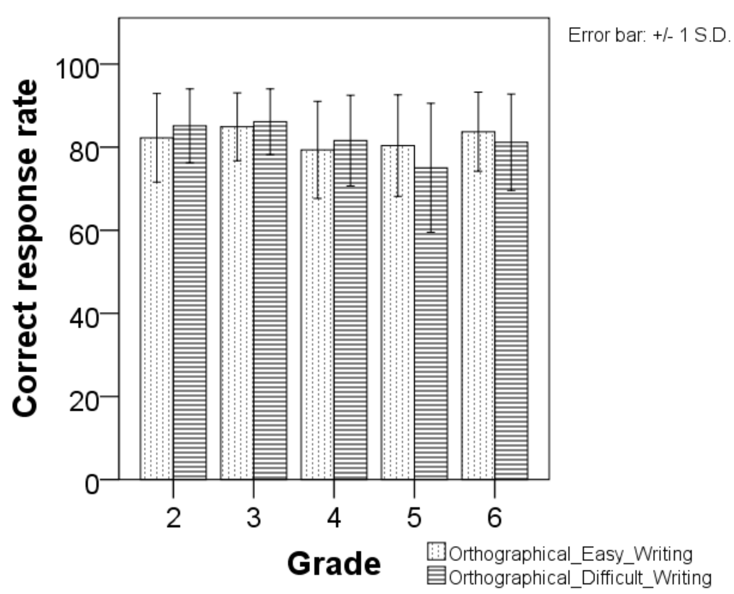

Fig. 5. Correct response rate of writing as a function of orthographical complexity by typically developing children.

3.2.2 Orthographical performance by children with developmental disorders

Fig. 6 represents the Z scores for the correct response rate of both dyslexics and ADHD patients for the reading and writing achievement tests as a function of orthographical complexity. The left side column shows the Z scores of the reading tests and the right side column shows those of the writing tests. Each row shows the Z scores of each grade. Filled data points in black represent the cases with dyslexia whereas unfilled data points represent the cases with ADHD.

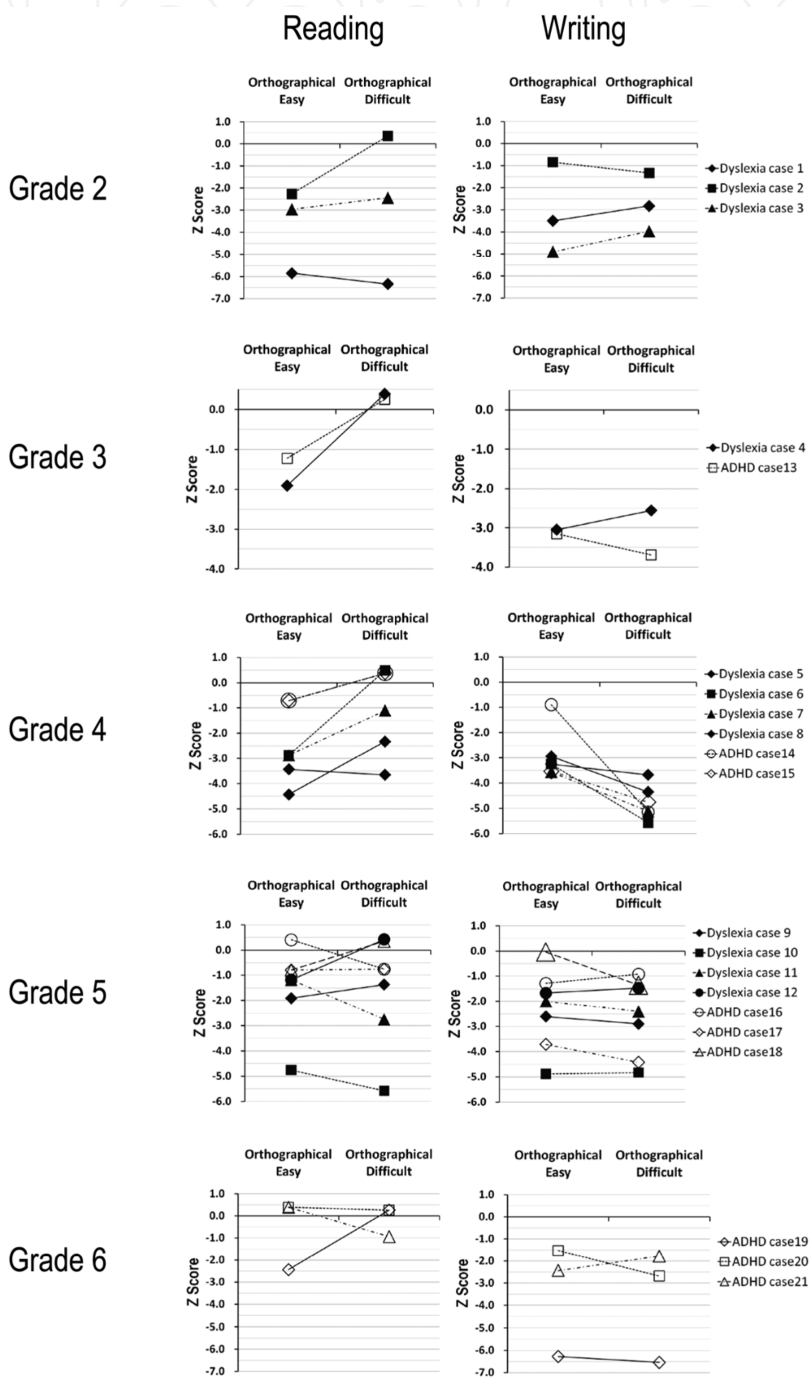

Fig. 6. Z scores as a function of orthographical complexity by the children with developmental disorders.

From those graphs we see that, with both developmental disorders, Z scores for reading tended to be higher when the characters were orthographically complex, whereas Z scores for writing tended to show different patterns for participants with ADHD and for participants with dyslexia. With ADHD, the Z scores tended to decrease when the characters were orthographically complex. With dyslexia, on the other hand, such a tendency was not seen at all in Grade 3 and was less pronounced in Grade 4 and Grade 5, compared to the cases of ADHD patients in the same grades.

Of particular importance in our study was whether the pattern of Z scores as a function of orthographical complexity can distinguish the cases when overall performance alone does not necessarily allow us to distinguish ADHD patients and dyslexics. The pattern of Z scores of Case 4 (dyslexic) and Case 13 (ADHD) in Grade 3 and that of Case 12 (dyslexic) and Case 17 (ADHD) in Grade 5 showed a different pattern in the writing achievement test. Those cases with ADHD showed that the Z scores decreased when the characters were orthographically complex, while this did not agree with the cases with dyslexics.

3.3 Performance as function of phonological complexity

3.3.1 Phonological performance by typically developing children

Fig. 7 reports the means of the correct response rate of reading achievement tests as a function of phonological complexity by typically developing children at each grade. Error bars indicate the standard deviations. The means of correct response for reading were significantly lower in Grade 4 and 6 when the character was phonological complex than when the character was not (Z=2.22, $p<.05$, r=.23; Z=3.18, $p<.01$, $r=.32$ respectively). There was no significant difference between the means of correct response at different orthographical levels in Grade 2, 3 and 5.

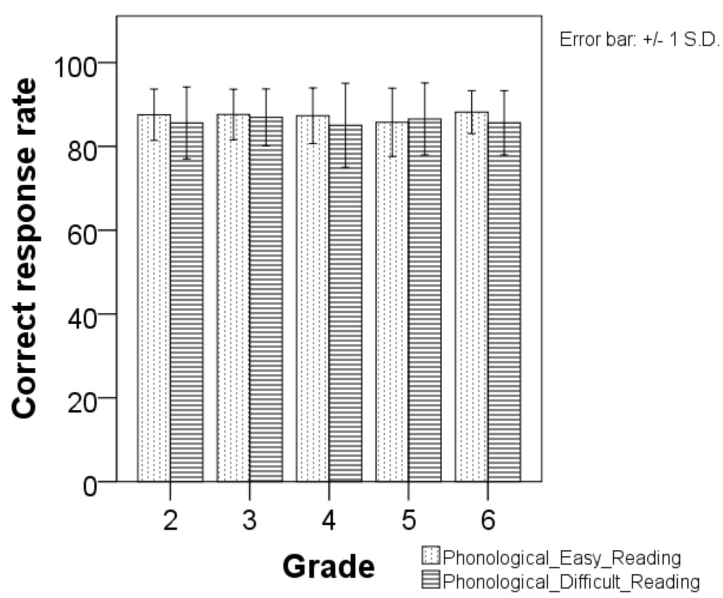

Fig. 7. Correct response rate of reading as a function of phonological complexity by typically developing children.

Fig. 8 reports the means of the correct response rate of spelling achievement tests as a function of phonological complexity by typically developing children at each grade. Error bars indicate standard deviations over sampling distribution. Statistical analysis by

Friedman's test revealed that the mean score of correct response rate was different between the levels of orthographic complexity at Grade 4. The mean of correct response for writing was significantly lower when the character was phonological complex than when the character was not (Z=3.29, p<.001, r=.34). There was no significant difference between the means of correct response at different orthographical levels in Grade 2, 3, 5 and 6.

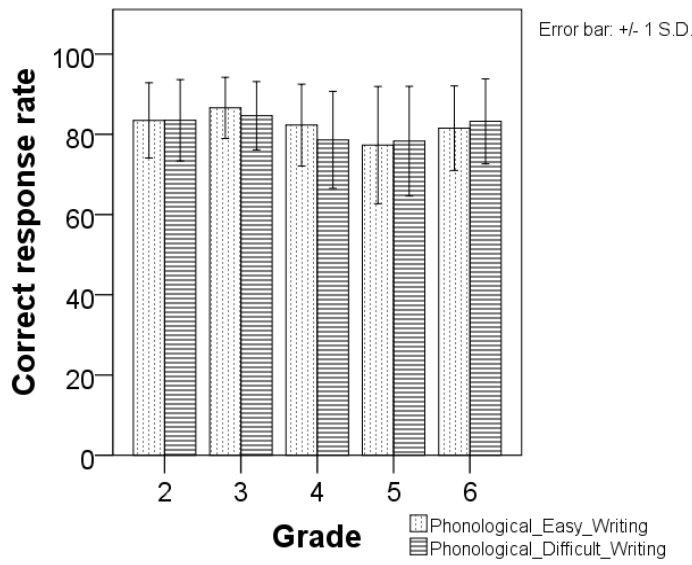

Fig. 8. Correct response rate of writing as a function of phonological complexity by typically developing children.

3.3.2 Phonological performance by children with developmental disorders

Fig. 9 represents the Z scores for the correct response rate of both dyslexics and ADHD patients for the reading and writing achievement tests as a function of phonological complexity. The left side column shows the Z scores of the reading tests and the right side column shows those of the writing tests. Each row shows the Z scores of each grade. Filled data points in black represent the cases with dyslexia whereas unfilled data points represent the cases with ADHD.

As seen in these graphs, the dyslexics tended to do worse in reading phonologically complex characters than in reading phonologically simple characters. Some of the children with ADHD showed a similar tendency, but many of them did not, and even those who did showed the tendency only to a lesser degree, compared to dyslexics. On the other hand, Z scores for writing seemed to be slightly higher for phonologically complex characters than for phonologically simple characters, both for dyslexics and for ADHD patients. This unexpected result might have been due to the control group scoring particularly low for phonologically complex characters.

Since dyslexics, but not ADHD patients, apparently tend to do worse in reading phonologically complex characters than in reading phonologically simple characters, we might be able to use the pattern of Z scores as a function of phonological complexity to differentiate dyslexics and ADHD patients, when overall performance alone does not allow us to. For instance, Case 4 (dyslexic) and Case 13 (ADHD) in Grade 3 showed different patterns of Z scores in the reading achievement test and could have been differentiated on that basis.

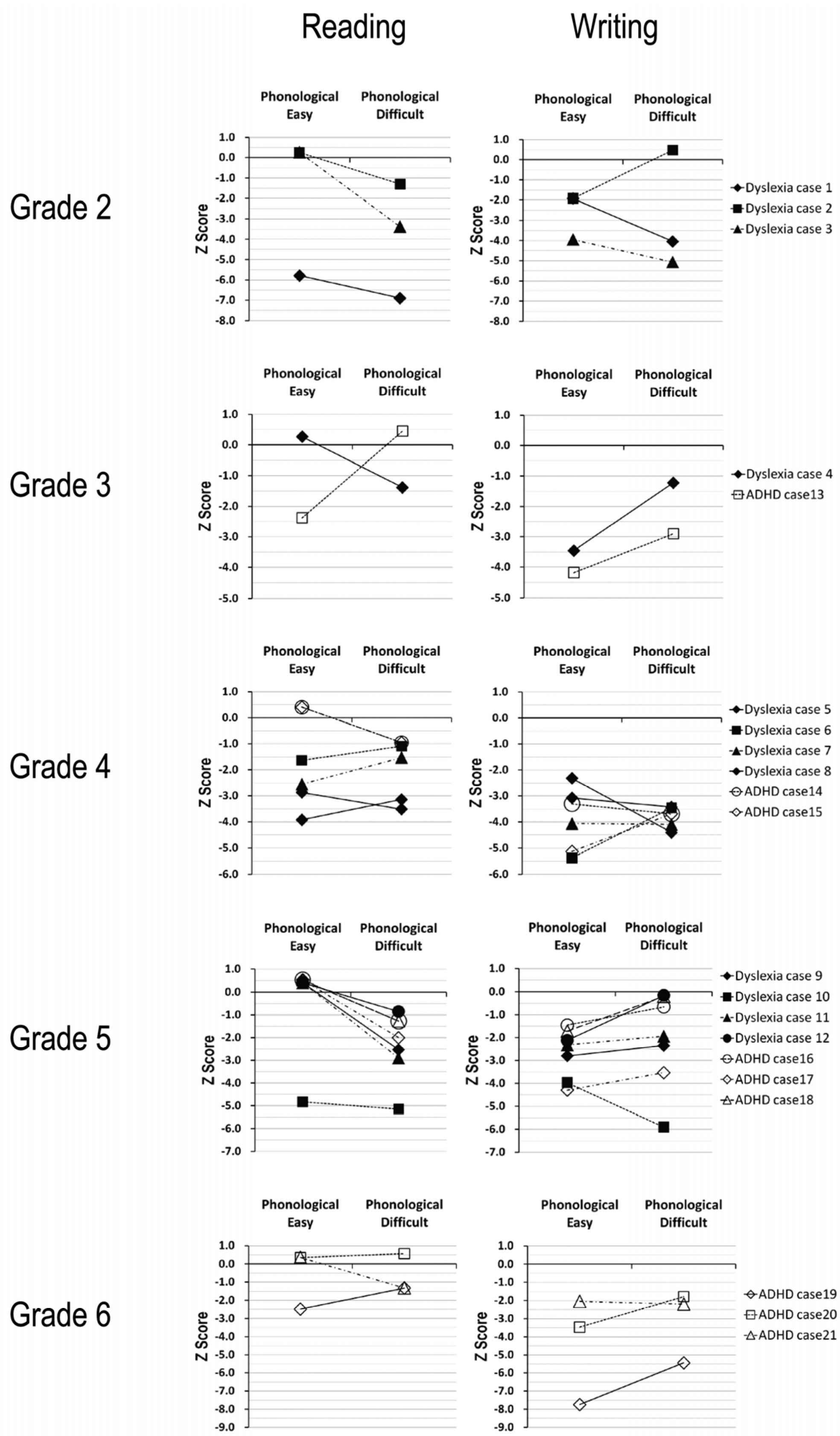

Fig. 9. Z scores as a function of phonological complexity by the children with developmental disorders.

4. Discussion

Now we would like to examine each of the three main observations that we made in the previous section.

4.1 Overall performance

It was found that the children with dyslexia had trouble both with writing and with reading, whereas children with ADHD had trouble mainly with writing and showed little evidence of impaired reading. Our finding about dyslexics seems to accord fairly well with previous findings. On the other hand, our finding about ADHD patients should be treated with caution, given the frequent co-occurrence of ADHD with language-related learning problems. Though ADHD has been reported to co-occur with problems in writing more often than with problems with reading in accordance with our results, several independent studies have reported that ADHD patients have problems not just with writing, but also with both reading and writing when they have any language-related problems (Rucklidge and Tannock 2002; Willcutt et al. 2005). If a further study involving a larger number of ADHD patients confirms our finding, that will constitute new information about ADHD.

As was particularly obvious in the overall performance of children with ADHD and with dyslexia at Grade 3 in Fig. 3, there was not always a difference in performance between ADHD patients and dyslexics, possibly because of the small sample size. At the moment, overall performance does not differentiate ADHD patients and dyslexics as reliably as orthographic performance and phonological performance, to be discussed below.

4.2 Orthographic performance

As noted in the previous section, children with ADHD in our patients seemed to have more trouble writing Chinese characters which consist of many strokes and thus are visually more complex. This may be due to the fact that ADHD patients do not have long attention span (Bellgrove et al. 2006; Manly et al. 2001). This observation may point to a potential cause of literacy learning difficulties among Japanese ADHD children.

Both ADHD patients and dyslexics seemed to have less trouble reading orthographically more complex characters. This may be due to the fact that visually more complex characters tend to have more orthographical subunits which could function as clues as to their pronunciation. The majority of Chinese characters are phonograms which consist of a phonetic subcomponent that provides information about the character's pronunciation and a semantic subcomponent that provides information about the character's meaning, though sometimes the combination between the pronunciation and the orthographic (sub)component is entirely arbitrary as we noted in the example of 言. For example, 時 ('time') has On/Chinese reading *ji,* has the same orthographic unit as its phonetic component 寺 ('temple') which has also the same On/Chinese reading *ji*. Children with ADHD and dyslexia may be resorting to the same method that beginner readers are said to use (Bowey, Vaughan, and Hansen 1998), namely orthographical analogy, whereby components of characters are used as clues as to their pronunciation. In fact, even among typically developing children, Grade 2 children, many of whom can probably be classified as beginner readers, they had less trouble reading orthographically more complex characters in Fig. 4.

4.3 Phonological performance

Compared to children with ADHD, dyslexic children were found to have more trouble reading (if not writing) Chinese characters which have more than one possible pronunciation and are thus arguably phonologically more complex. This is consistent with the previous findings about dyslexia, but it is notable that ADHD patients did not show an analogous tendency. This observation indicates that the learning problems experienced by dyslexics and those experienced by ADHD patients are distinct from each other, possibly reflecting the difference in innate cognitive abilities between the two groups

4.4 Limitations and future directions

Although our tests thus seem to have brought out some differences in performance between ADHD patients and dyslexics, there are obviously a number of issues that are left unresolved. For example, dyslexics' writing performance seemed not to be affected either by phonological complexity or by orthographical complexity. This leaves open the possibility that there are factors other than the above two factors that need to be taken into account, or that the sample size in this study was too small to allow us to detect an effect that is really there.

One purpose of our study was to facilitate intervention for children with ADHD or dyslexia by investigating the nature and magnitude of the learning problems faced by each group of children. The above results arguably have some implications in this regard. For instance, since children with ADHD were found to have difficulty in writing Chinese characters consisting of many strokes, it will probably be advisable, when we teach such children, to show them explicitly how to break visually complex characters into simpler components.

There are some limitations to this study that affect the generalizability of our results. First, the number of children at each grade was limited and consequently we could not ascertain the results using statistical tests. The use of our achievement tests in large groups of patients with developmental disorders in the future is likely to provide stronger evidence and further insight into the nature of learning problems among children with ADHD and dyslexia. Likewise, it will be possible to test the implications of this research more thoroughly if a longitudinal examination of children with developmental disorders is conducted.

Second, the control group was not a reading-level-matched group, but merely an age-matched group with similar socioeconomic status. In order to mitigate the adverse effect of this limitation, we used material which includes only those Chinese characters that the children had learned at school more than a year prior to the experiment, so that we could ensure that the material would not be too difficult even for children with language-related problems, since some previous research has suggested that children with language-related problems may be delayed by as much as two years in a wide range of skills ((Kolb and Whishaw 2008; Wright and Zecker 2004) among others). However, future replications should use a reading-level-matched control group, as the failure to use such a control group in this study may have inflated the group difference between the children with developmental disorders and the typically developing children.

Nevertheless, in light of the fact that each condition affected some individuals in the same diagnostic groups similarly in comparison with the typically developing children, we believe that the results of this initial, exploratory study do give us some indication as to the types of learning problems caused by ADHD and dyslexia.

5. Conclusion

The result of our work suggests that children with dyslexia and children with ADHD have problems mainly with the phonological processing (i.e. conversion between characters and their sounds) and the orthographical processing respectively. Moreover, the fact that the achievement tests allowed us (if not in a statistically significant way at the moment) to discover differences between the two groups of children suggests that our achievement tests are successful in assessing some aspects of each child's cognitive profile and that it can therefore be useful in determining whether and what type of intervention is needed for each child.

6. Acknowledgments

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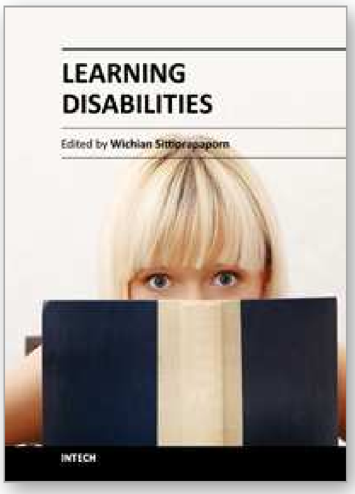

Learning Disabilities

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Learning disability is a classification that includes several disorders in which a person has difficulty learning in a typical manner. Depending on the type and severity of the disability, interventions may be used to help the individual learn strategies that will foster future success. Some interventions can be quite simplistic, while others are intricate and complex. This book deserves a wide audience; it will be beneficial not only for teachers and parents struggling with attachment or behavior issues, but it will also benefit health care professionals and therapists working directly with special needs such as sensory integration dysfunction.