

READING DISABILITIES OF CHINESE ELEMENTARY SCHOOL STUDENTS: BEYOND THE PHONOLOGICAL DEFICITS OF SINGLE-CHARACTER IDENTIFICATION**Hua Jin***South China Normal University***Dan Lin***Chinese University of Hong Kong***Dake Zhang***Purdue University***Hongbo Wen****Huohong Zhu****Xianyou He****Lei Mo***South China Normal University*

This study investigated the contributions of single-word identification and compound word categorization to Chinese students' reading achievement among 31 students with reading difficulties and 20 students without reading difficulties. The results suggested that, deficiency in single characters identification is not the primarily reason for dysfunction in reading Chinese. This is different from alphabetic language readers. Chinese students' difficulty in accessing the meaning of compound words in a specific context contributes greatly to students' reading achievement. The results call for researchers' and school teachers' attention to focus on teaching compound words during Chinese instruction. The results also suggested the need for further research on compound words.

Reading is a basic component of language that influences many other areas of academic functioning. Students' problems with reading comprehension may seriously impair their development of cognitive and social skills (Benner, Beaudoin, Kinder, & Mooney, 2005). Although Chinese language is one of the most widely spoken languages in the world, so far little research existed about Chinese students' reading disorders (Penney, Leung, Chan, Meng & McBride-Chang, 2005; Shu, McBride-Chang, Wu, & Liu, 2006; Yin & Weekes, 2004).

There still is not an agreed-upon conclusion of the prevalence of reading disability among Chinese students. One of the reasons is the definition of Chinese reading disabilities is controversial (Shu, McBride-Chang, Wu, & Liu, 2006). In western countries, reading disability is defined as *a specific language-based disorder of constitutional origin characterized by difficulties in single word identification, usually reflecting insufficient phonological processing* (Lyon, 1995, p.9). Consequently, researchers reported that prevalence of Chinese reading disability is as low as 1.92 % (Yin & Weekes, 2004); or as 2.9% (Kuo, 1978), and some researchers doubt the existence of dyslexia in logographic languages (Makita, 1968; Rozin & Gleitman, 1977). However, there is a large proportion of Chinese-speaking children who have an average or above average IQ and have difficulties reading Chinese, even though they do not have special difficulties with identifying single Chinese characters.

Reading disabilities have various manifestations in different languages (Miles, 2000). As the users of a non-alphabetic language, Chinese students with reading disabilities may demonstrate unique problems in learning reading (Ho, Chan, Tsang, Lee, & Luan, 2004). As such, the assertion that the failure in identifying single characters is the main feature for Chinese students who have reading difficulties is subject to dispute. Unfortunately, influenced by the dyslexia research of alphabetic languages, previous studies for Chinese reading emphasis on processing deficits at the single character identification (Ho, Chan, Tsang, & Lee, 2002; Ho et al., 2004; Shu et al. 2006), but little research addressed Chinese

students' difficulties in other areas such as compound word identification and passage comprehension (So & Siegel, 1997; Penny et al., 2005).

The purpose of the present study was to investigate the etiology of reading failure in children who experience difficulties reading, and to provide implications for researchers and educators about what should be the focus of Chinese instruction. Specifically, this study was designed to address the following questions: (1) Does the single-word character identification primarily account for students' difficulty in Chinese reading? (2) What is the role of semantic identification for compound words in difficulties reading Chinese? And (3) What is the relation between word-level processing and passage comprehension in reading Chinese?

Features of Chinese Words

The unique deficits of students with Chinese reading disability are closely relevant to the special features of the Chinese sprits (Shu, et al., 2005, 2006). Therefore, it is critical for researchers to thoroughly consider the characteristics of Chinese written language, which is greatly distinct from alphabetic languages (Ho, et al., 2002).

The first feature of Chinese vocabulary is its great amount of compound words. Similar examples of compound words exist in English, for example, the morpheme [work] occurs in the compound words *workplace*, *homework*, *workforce*, and *overwork* (Shu, et al., 2006). The morpheme in English usually indicates the same semantic meaning in a variety of compound words, which means, if you know word A and B, then it is easy to access to the meaning of compound word AB. However, in Chinese language, even if you can recognize A and B as two single characters, you may have difficulties to understand what the compound word AB means. For example, a single word 花 means flower in Chinese and 生 means *living*, but the compound word 花生 means peanut. Additionally, the same single word A may have different meanings in compound words AB and AC. Therefore, readers need to identify the specific meaning of each character varying with the context. Reading problems may occur when students are unable to identify a particular meaning of a character in a specific compound word (Penny et al., 2005; Shu et al., 2006).

Another feature of written Chinese is that no obvious boundary exists between words. English writing, people use spaces to segment different words; however, there is no visual space between Chinese characters or words within a sentence. Chinese readers have to segment the sentence into several semantic units all by themselves. How to correctly combine the characters into semantic units in a sentence may greatly impact students' reading performance. For example, in the sentence of 这花生长得真好。 (How well the peanut grows.), the character 生 could combine with the preceding character 花 to make a compound word 花生 (peanut, a noun); or combine with the following character 长 to make another compound word 生长 (grow, a verb). Therefore, the way a reader segments a sentence may lead to completely different meanings the sentence conveyed. If a reader regards the 生 and 长 as two independent semantic units (这花 / 生长得真好), the meaning of the sentence is how well the flower grows. In the contrary, if the characters 花 and 生 is grouped as a compound word (这花生 / 长得真好), the meaning is how well the peanut grows. Chinese readers have to decide how to segment the sentences into semantic units appropriately according to the context.

In conclusion, Chinese written language has its own characteristics, and these unique features of Chinese written language may greatly impact Chinese students' reading process. This study is going to explore how Chinese students' identification of compound words contributes to their reading achievement.

Method

Participants

Thirty one children (mean age =9.6, 17 boys, 14 girls) participated in the present study. Written consent forms for children's participation in this study were obtained from each family. These subjects were screened from 1315 students from ten primary schools in the urban area of Guangzhou City. A standardized reading comprehension test was used to select participants. The inclusive criteria involved: (1) the student should demonstrate an achievement of the reading comprehension below 30% of peers of the same age; (2) with normal intelligence, specifically, students should have IQs of 85 or

above, which is considered as the cutoff score for learning disabilities and mental retardation (Frankenberger & Fronzalia, 1991); and (3) without any labeled suspected physical or emotional problems. Subjects who met all of those three criteria were then involved and labeled as Low Achieving Readers (LAR) in this study. The demographic information of the participants was provided in table 1.

Another twenty normally achieving children (10 boys and 10 girls) from primary schools matched in education level served as controls for the poor readers group, the average age was 9.4 years old. All participants in LAR group and control group are native Chinese speakers.

Table 1.
Participating Student Demographic Information

Variable	LAR Group	Control Group
Gender		
Male	17	10
Female	14	10
Grade		
3	31	20
Mean Age in months (SD)	114 (10.25)	112 (11.07)
Race		
Han	31	20
SES		
Low income family	4	1
Classification		
LD	31	0
Remedial class students	24	2
NL	0	17
Other	1 mild visual impaired	1 with emotional disorder
IQ		
Full Scale	89.04	NA
Achievement		
Reading PR(Media)	27%	64%

Note: LD= learning disabilities; NL=not labeled; Han=the mainstream race of the Chinese population; SES=social economic status; IQ scores were obtained from the Wechsler Intelligence Scales for Children-Fourth Edition (Wechsler, 2003); PR=percentile rank.

Measures and Procedures

The reading comprehension test was administered in small groups by four trained graduate research assistants during the after school program. Other tests were administered individually during daytime in a quiet room at school sites. To ensure that all participants could understand the tasks, researchers gave students informal trials before the formal testing.

Reading Comprehension Test. The Evaluation Scale of Reading Ability for Grade Three was employed to estimate the reading achievement of the subjects. This scale was a part of the assessment handbook of reading ability for Chinese elementary school students. It was developed and standardized with a national norm (China Education Bureau, 2005). The internal consistency reliability (α) was 0.701, and the split-half reliability was 0.746. These results from statistical analysis indicated that this scale had a good content validity.

Single Character Identification (SCI) Test. A self-developed rapid naming test was employed to measure students' abilities in single-character-identification. E-Prime (Schneider, Eschmann, & Zuccolotto, 2002) programming software was used in the test. The test consisted of 40 frequently-used single characters chosen from Chinese elementary school textbooks. Each character was tested as a trial. In each trial, a fixation point was first displayed at the center of the screen for 1000 ms. After that, a single word showed up, and children were instructed to name it as fast and as accurately as possible. The computer recorded students' responses and a trial was completed. A reappearance of fixation point indicated another trial would start. The reaction time (RT) of naming was recorded by computers and experimenters record the accuracy.

Compound Word Categorization (CWC) Test. A self-developed semantic categorizing test was employed to measure students' ability to access the meaning to a compound word in a given context. There were forty trials in this task. In each trial, the subjects saw four words presented on the center of the computer screen. Three of them were under the same category, while one of them was not. Three words of the same category provided a semantic context. For example, 铅笔 (pencil), 橡皮 (rubber), 尺子 (ruler) composed a trial, in which pencil, rubber, and ruler are all stationery, whereas ear is not. So the students need to access to the meaning of the four compound words and tell which one differed from others. Computers recorded the RT and accuracy for students' response.

Results

Group Analysis

Investigators analyzed the difference between means of the two tests of the LAR group and the control group (table 2). In the SCI test, the average accuracy of the LAR group was over 95%, but it was still lower than that of control group, $t(49) = 2.596, p < 0.05$. The average RT of SCI test in the LAR group is significant longer than that of control group, $t(49) = 2.722, p < 0.01$. The similar pattern was found on the CWC task: the accuracy of LAR group was lower than that of the control group, $t(49) = 4.883, p < 0.01$. Their RT also appeared longer than that of control group, although no statistically significant difference was found, $t(49) = 0.16, p > 0.05$.

In line with the previous studies on Chinese reading disabilities (e.g., Ho et al., 2002, 2004), the results showed that LAR performed worse than the control group at both single character identification and compound word categorization tasks.

Table 2.
Means and standard deviations of tasks of two groups

	Control group (n=20)	LAR group (n=31)
Reading Achievement	67.55(9.52)	30.08(7.44)**
RT of SCI (ms)	603.54(96.47)	697.61(133.52)*
Accuracy of SCI (%)	98.7 (2.0)	95.9(4.5) **
RT of CWC (ms)	2771.72(617.48)	2743.77(673.95)
Accuracy of CWC (%)	76(8.7)	59.3(13.5) **

Note: SCI=single character identification, CWC=compound word categorizing, RT=responding time, * $p < 0.05$; ** $p < 0.01$.

Individual Analysis

The purpose of individual analysis was to find out at which task certain individual performed poorly, and at which task they performed normally. With the means and standard deviations of the normal achieving students in the three tests, we set up a 95% confidential band (Ramus, 2003) to detect students who did *poorly* comparing to normal achieving students.

Table 3.
The Number of LAR Students with Deficit in SCI or CWC Task

	SCI normally	SCI poorly	Chi Square
CWC normally	5	6	0.22
CWC poorly	9	11	

Note: SCI=single character identification, CWC=compound word categorizing.

The results suggested that single character identification deficits could not primarily account for the comprehension difficulty in Chinese reading. Table 3 showed that five individuals from LAR group performed well in two tasks of word processing, indicating that about 16.1% of poor readers have no problems in single word identification and compound word categorization. In addition, 19.4% (six children) showed only deficit in identifying single words, 29% (nine students) showed only deficit in categorizing compound words, and 35.5% showed deficits in both two tasks.

Correlation Analysis

Table 4 presents a matrix of the correlation coefficients between students' reading achievement and the two tests for character identification and word semantic retrieving respectively. Reading achievements were found to correlate significantly with the recognizing test of single characters ($r=0.509$ for normal achieving group, $p < 0.05$; $r=0.562$ for LAR group, $p < 0.01$), and the compound word categorizing measure ($r=0.60$ for normal achieving group, $p < 0.01$; $r=0.618$ for LAR group, $p < 0.01$), while the correlation between two word level tasks was not significant ($r=0.140$ for normal achieving group, $r=$

0.059 for LAR group). In both groups, compound word categorizing associated stronger with reading achievements, compared with single character identification.

Table 4.
Pearson Correlation Coefficients among Measures Conducted in the Study

	Reading Achievement	Accuracy of SCI	Accuracy of CWC
Control group			
Reading Achievement	1		
Accuracy of SCI	0.509*	1	
Accuracy of CWC	0.605**	0.140	1
LAR group			
Reading Achievement	1		
Accuracy of SCI	0.562**	1	
Accuracy of CWC	0.618**	-0.059	1

Note: SCI=single character identification, CWC=compound word categorizing;

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed)

The investigators had a close look at the contributions of SCI and CWC to the reading achievement. As shown in Table 5, SCI and CWC together explained 54.9% of the variance in normal reading group; whereas these two tasks together explained 74.1% of the variance of reading achievement in LAR group. The results suggested that SCI and CWC are important predictors in identifying developmentally poor readers.

Moreover, when controlling CWC, SCI alone could only explain 18.3% of the variance of students' reading achievement in normal achieving group; whereas it explains 35.9% of all variance of students' reading achievement for the LAR group. This indicates that students' ability in single-character-recognizing is one of the primary predictors for students' reading comprehension achievement; it is especially important among students with reading problems; however, it is not the most vital predictor of Chinese students' reading development as in English.

Table 5.
Contributions of Single-character-identification and Compound-word-categorizing to Students' Reading Achievement

	Variable	Beta	R	R ²	ΔR^2	F
Control	CWC	.54	.605	.366	.366	10.39
	SCI	.43	.741	.549	.183	10.37
LAR	CWC	.65	.618	.382	.382	17.91
		.60	.861	.741	.359	40.09

Note: SCI=single character identification, CWC=compound word categorizing.

Discussion

This study was aimed to investigate the roles of single word identification and compound word identification in Chinese comprehension. Results suggested that, single word identification made certain contributions to Chinese reading comprehension, however, the identification of compound words made greater contribution in Chinese reading. The results indicated that, due to the unique characteristics of Chinese language, the statement that *the basic reading skills are primarily caused by deficits in phonological awareness* (p.54, Lyon, 1996) is subject to much debate.

The Role of Phonological Processing for Single-characters in Reading Chinese

The results found certain contribution of the single-character identification to Chinese reading achievement. Consistent with western researchers, the findings suggested that the identification of single word is important for basic reading skills, and it is prerequisite for comprehending the whole sentence and text (Kail & Hall, 1999). Group analysis showed that the poor readers performed worse in SCI task than normal readers.

However, it seemed that students' comprehension difficulty in Chinese reading should not be attributed primarily to their deficits in single character identification. As shown in Table 3, the individual analysis of the data showed that 14 (45.16%) students performed well in SCI test. It indicated that although these students have difficulties in reading, they do not have problems in identifying a character

phonologically. In addition, single word identification only explains 18.3% of all variance of Chinese students' reading achievement.

The reason why single word identification in reading Chinese is not as important as in English may be due to the large amount of homophones in Chinese. The existence of a great amount of homonym in Chinese languages certainly hinders the access of character meaning by phonology (Li & Yip, 1998; Tan & Perfetti, 1997; Zhou, Huang & Yu, 2002). Only decoding the sound of a single Chinese character could not ensure the reader able to retrieve the meaning of the character, because there are some other characters sharing the same sound. Instead, identifying a character by its visual features appears to be an effective way in reading such homophones (Zhou & Marslen-Wilson, 1996; Zhang, 2005). The meaning of a character could be activated by the visual form of the character, and the ability of character identification could hardly impose on this process. Therefore, the ability of single word identification contributes less in Chinese reading than in English reading.

The Role of Semantic Identification of Compound Words in Chinese Reading

Results suggested that compound-word-identification in Chinese played an important role in reading Chinese. In this study, among 31 low achieving readers, only six students purely displayed deficits in single-character identification, nine students' demonstrated deficits in semantic accession for compound words, and 11 students had problems with both. A larger number of students showed deficit in the semantic access than pure deficit in single-character-identification. Results of the correlation and regression analysis also supported the conclusion that the deficit in semantic identification for compound words is another important reason of students' difficulties in Chinese reading. The results support the hypothesis that compound word identification makes great contribution to Chinese students' reading achievement. As described, there is no visual boundary between Chinese semantic units, and the single word *A* may represent a definitely different meaning in a compound word *AB*, and another different meaning in the compound word *AC*. As thus, it is not surprising the decoding of compound words play an essential role in reading Chinese.

Conclusions and Implications

The present study suggested that, as a specific type of ideographic script, Chinese reading difficulty is not primarily caused by single-word-identification; instead, the semantic identification of compound words largely contributes to students reading achievement. In addition, the comprehension of the context and word-level-processing seem to be closely interrelated to each other, which means, students need to refer to the context to decide how to segment a sentence into semantic units before they can understand the words.

Thus, in teaching and training, educational practitioners should not only emphasise students' single character identification; instead, teaching multiple reading skills is necessary in Chinese literacy instruction, including how to segment sentences, how to identify compound words, and how to visually recognize a single character. In addition, researchers need to thoroughly reconsider how to define the Chinese reading disabilities, as phonological skill is not the primary feature of reading disabilities. As most of previous studies and interventions focus on phonological training for single-word identification, more research is needed on the cognitive mechanism of the compound word identification, as well as interventions to improve students' ability to recognize the compound words.

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