Taiwan Journal of Linguistics
Vol. 3.1, 65-100, 2005
doi:10.6519/TJL.2005.3(1).3

LEARNING TO READ AND SPELL: THE RELATIVE ROLE OF PHONEMIC AWARENESS AND ONSET-RIME AWARENESS

I-Chih Chan
Chieh-Fang Hu
I-Ping Wan

ABSTRACT

It has been assumed that Chinese-speaking children do not have phonemic awareness. This study investigated phonemic awareness of Chinese-speaking children in tandem with onset-rime awareness and their relative roles in learning to read and spell English. The participants were 29 fourth graders with better onset-rime and phonemic awareness, 29 with better onset-rime but poorer phonemic awareness, and 26 with poorer onset-rime and phonemic awareness. The children first took a criterion learning of letter-sound correspondences task and were then tested on their abilities to spell and read English pseudowords. The results showed that most children were able to detect segmental components in a falling diphthong or a VN rime, indicating phonemes were constituents in their phonological awareness. Children with better onset-rime and phonemic awareness performed better in English pseudoword spelling than children with better onset-rime but poorer phonemic awareness, who in turn, performed better than children with poorer onset-rime and phonemic awareness. Similar patterns were observed for pseudoword reading, only that the effect of onset-rime awareness was less conclusive. These findings underscore the role of phonemic awareness in the acquisition of EFL reading and spelling for Chinese-speaking children.

1. INTRODUCTION

There are substantial differences in children's ability to detect and manipulate phonological units. This ability, usually referred to as phonological awareness, is strongly correlated with individual

differences in reading and spelling of an alphabetic language (e.g., Caravolas, Hulme, & Snowling, 2001; Goswami & Bryant, 1990; Wagner & Torgesen, 1987; McBride-Chang and Kail, 2002). Children with difficulties in phonological awareness are usually in the low tails of normal distribution for reading and spelling accuracy. The close relation between phonological awareness and the development of reading and spelling skills has been identified cross-linguistically (Comeau, Cormier, Grandmasion, & Lacroix, 1999; Durgunoglu, Nagy, and Hancin-Bhatt, 1993; Hu, 2003, 2004b). For example, Hu (2004b) found that Chinese-speaking children with better L1 phonological awareness were more likely to be better spellers of English than those with poorer L1 phonological awareness even though these two groups of children were equipped with adequate knowledge in letter-sound correspondence rules. It appears that phonological awareness plays an important role in the acquisition of the reading and spelling skills of an alphabetic language. In our context, the question is then how well phonological awareness has developed in Chinese-speaking children when they learn to read and spell EFL.

Phonological awareness is in fact an umbrella term, which contains the awareness of different phonological units of the oral language, ranging from syllables, to intermediate syllabic units (i.e., onsets and rimes), and finally to phonemes. Onset-rime awareness is considered to be more rudimentary and has been shown to set the stage for the development of phonemic awareness (Adams, 1990). Although onset-rime awareness has been found to be related to the development of reading and spelling in an alphabetic language (Bryant, MacLean, Bradley, & Crossland, 1990; Goswami & Bryant, 1990; Kirtley, Bryant, MacLean, & Bradley, 1989; Stahl & Murray, 1994), more recent studies have suggested that phonemic awareness places more significant constraints on the acquisition of alphabetic literacy skills (Bowey, 1995; Hulme, Hatcher, Nation, Brown, Adams, & Stuart, 2002; Hulme, Muter, & Snowling, 1998; Muter, Hulme, Snowling, & Taylor, 1998). For example, Nation and Hulme (1997) found that a measure of phonemic segmentation accounted for a significant portion of variance in children's spelling performances even after the variance in rhyme/alliteration was controlled for, but not vice versa. Muter et al. (1998) found that their phonemic awareness measures predicted reading success several years later, while their

rime awareness measures failed to be significant predictors.

Given the importance of phonemic awareness in learning to read and spell, there is surprisingly little research on the phonemic awareness of Chinese-speaking EFL children, in contrast to a rich body of research on the onset-rime awareness of Chinese-speaking children (e.g., Ho, Law, & Ng, 2000; Hu, 2004b; Hu & Catts, 1998; Huang & Hanley, 1994). One reason might be the implicit assumption that phonemes are not constituents in Chinese speakers' phonological awareness. This commonly-held view is partly based on the fact that in contrast to English and Dutch, which have a huge number of syllables, Chinese has around 400 syllables with relatively simple syllabic structures. Given that a few hundred syllables could be stored holistically in the mental syllabary (Levelt, Roelofs, & Meyer, 1999), some researchers have suggested that Chinese speakers store most of the syllables in their mental syllabaries without detailed specification in the phonemic units (e.g., Yamada, 2004). Similarly, Wang (1997; see also Cheung & Chen, 2004) suggested that it is adequate for a Chinese syllable to be represented in an onset and a rime because there are only about 400 syllables in Chinese, and this number of syllables should not consume too much memory resources in language processing. This view has been corroborated by several studies, which find that the development of phonological awareness is related to the experience with a particular orthography (Bertelson, de Gelder, van Zon, 1997; Cheung, Chen, Lai, Wong, & Hills, 2001; Ho & Bryant, 1997; Wang & Geva, 2003; Wang, Koda, & Perfetti, 2003). Specifically, the findings of the studies indicate that while the experience with an alphabetic orthography, which represents phonemes in discrete printed units, can trigger the development of phonemic awareness (Bertelson et al., 1997; Cheung & Chen, 2004), the experience with a non-alphabetic orthography may inhibit such development (Ho & Bryant, 1997). Taken together, the above studies have led to the idea that Chinese speakers might have poor or underdeveloped phonemic awareness due to the limited number of syllables in Chinese and/or due to the exposure to a logographic orthography (e.g., Cheung & Chen, 2004; Cheung et al., 2001).

However, the commonly-held view that Chinese speakers do not have phonemic awareness might be too simplistic. Evidence gathered from the theories of syllable structure in Chinese and that from the investigation of speech errors of Chinese speakers (e.g. Ao, 2001;

Duanmu, 2000; Wan & Jaeger, 2003) suggests that syllable representation at the phonemic level might be available in Chinese speakers. For example, in a study of speech errors such as saying *dan-xin wo fan-zi* for *dan-xin wo fang-zi* 'worry about my house', Wan and Jaeger (2003) evaluated several alternative theories and analyzed the error as a case where the segment [n] has substituted for the segment [N], causing a vowel change in *fang*. These errors suggest that phonemes might be the representations, together with the syllabic frame, that Chinese speakers operate on during speech production. The question is whether the phonemes, which sometimes appear in speech production errors, are accessible in our awareness and whether this awareness, if any, predicts individual differences in learning to read and spell in an alphabetic orthography.

In the current study, we examined phonemic awareness among Chinese-speaking children. To the authors' best knowledge, many studies have examined the onset-rime awareness of Chinese-speaking children and have already yielded fruitful results. However, few studies, if any, have specifically looked at phonemic awareness in tandem with onset-rime awareness in Chinese-speaking children. For example, Hu and Catts (1998) adopted a sound categorization task to measure children's phonological awareness by asking them to categorize sounds based on onsets or rimes (e.g., "*bi*, *ban*, *guo*" for onset categorization; "*ta*, *po*, *ma*" for rime categorization). In Hu (2004b), a similar sound categorization was adopted, plus a sound deletion task which required the deletion of an onset from a spoken word. In Ho, Law and Ng (2000; see also Cheung et al., 2001), Cantonese-speaking children were asked to indicate among three syllables which two sounded similar ([sau], [fo], [fung] in onset detection and [gaam], [bing], [daam] in rhyme detection). Huang and Hanley (1994) adopted a "phoneme" deletion task, where the children were asked to delete the first sound of a word, which happened to fall at the onset-rime boundary. In another task which required the deletion of the final sound from a word of CVC, CVV, VV, or CV, some of the items did tap phonemic awareness. However, the data were not analyzed separately for those at the onset-rime boundary and those at the phoneme boundary. It was not clear whether the children had developed phonemic awareness.

This research examined L1 phonological awareness of Chinese-speaking children both at the onset-rime level and at the

phonemic level. The relative roles of these two levels of awareness in learning to read and spell English were also investigated, following a format adopted in the second author's previous study (Hu, 2004b). Phonemic awareness was measured by a sound oddity task, which required the child to break a falling diphthong (e.g., [ow]) or a VN rime (e.g., [an]) into smaller segments. Three groups of Chinese-speaking fourth graders were selected and categorized according to their performances on a set of L1 phonological awareness tests. The first group had good onset-rime awareness and good phonemic awareness, the second group had good onset-rime awareness but poor phonemic awareness, and the third group had poor onset-rime awareness and poor phonemic awareness. Each child participated in a criterion letter-sound learning task, during which the English letter-to-sound and sound-to-letter correspondence rules necessary for successful performances in the subsequent spelling and reading tasks were instructed. Finally, children's abilities to spell and read English words were measured in a pseudoword spelling and a pseudoword reading tasks. Variables related to individual differences in phonological awareness such as digit span and English vocabulary were also measured and used as statistical controls. Note that the first and the second groups differed only in phonemic awareness, while the second and the third groups differed only in onset-rime awareness. If the three groups of children displayed different performances in the spelling and reading tasks, we could attribute them to the different levels of phonological awareness. This study differs from Hu (2004b) in three important aspects. First, phonemic awareness was empirically tested in tandem with onset-rime awareness. Second, the children in Hu's (2004b) study mastered the letter-to-sound conversion rule required for successful performances in a pseudoword spelling task. Yet in order to spell the pseudowords successfully, the children should also master the sound-to-letter conversion rules. In the current work, the children were taught both the letter-to-sound and the sound-to-letter correspondences. Third, in addition to spelling ability, children's ability to read pseudowords was also measured.

This research sought to establish the answer to three questions:

1) Do Chinese-speaking children have the awareness of phonemes in addition to onsets and rimes?
2) Which level of phonological awareness is more related to children's English word spelling ability? Onset-rime awareness or

phonemic awareness?

3) Which level of phonological awareness is more related to children's English word reading ability? Onset-rime awareness or phonemic awareness?

It is hypothesized that the children with better L1 phonemic awareness are more ready to attend to the segmental prototypes of English words and are more able to form fine-grained and complete phonological representations for the English words just encountered, and therefore would be more able to apply their knowledge of letter-sound correspondences to the spelling and reading tasks than those with poorer phonological awareness at either the onset-rime level or the phonemic level. Likewise, with sensitivity to the internal structure of a syllable, children with better L1 onset-rime but poorer phonemic awareness were expected to demonstrate better performances in spelling and reading than those with poorer awareness at both the onset-rime and the phonemic level.

2. METHODS

2.1 Participants

A group of 192 Chinese-speaking fourth graders were recruited from seven classes in Taipei City and Taipei County. According to the classroom teachers' report, the children did not have any obvious language problems that affected their daily communication ability. The children were administered two participant selection tests in groups of 20 to 30. One measured phonological awareness at the onset-rime level; the other at the phonemic level. The children were divided into three groups according to their performances on the two L1 phonological awareness tests. Group A consisted of children with better onset-rime and phonemic awareness, Group B consisted of children with better onset-rime but poorer phonemic awareness, and Group C consisted of children with poorer onset-rime and phonemic awareness. Given that onset-rime awareness is an earlier developing ability than phonemic awareness (Goswami & Bryant, 1990), it is not plausible to find a group of children with better phonemic but poorer onset-rime awareness. Thirty children in Group A, 31 children in Group B, and 39 children in Group C were initially identified.

Following the criterion learning of letter-sound correspondence task, one child from Group A, two children from Group B and 13 children from Group C were excluded from the study because they could not passed the criterion learning task, leaving 29 children in Group A, 29 children in Group B, and 26 children in Group C. The exclusion of these children did not change the grouping characteristics of the participants.

2.2 Materials and procedure

The tasks were given in a fixed order. Two phonological awareness tests were given for participant selection. Participants selected were given measures of digit span and English vocabulary for statistical control. Then they were given criterion learning of letter-sound correspondences to ensure that they were equipped with the requisite letter-sound knowledge for the subsequent spelling and reading tasks. After taking the criterion learning of letter-sound correspondences, the child was given a pseudoword spelling task, followed by a pseudoword reading task.

Participant Selection Tests

The child's awareness of the sound structure of spoken words was assessed by a sound oddity task, which has been widely used to assess children's phonological awareness (e.g., de Jong, Sevek, van Veen, 2000; Ho, Law, & Ng, 2000; Hu & Catts, 1998; Siok & Fletcher, 2001). In a training study, Bryne and Fielding-Barnsley (1989, 1990) found that sound oddity (e.g., the ability to notice that *sun* and *sail* start with the same sound whereas *ham* does not) was more strongly related to reading than were other tasks of phonological awareness such as segmentation (e.g., the ability to say "*s...un*" and "*ha...m*"). A child who can tell that *sun* and *sail* start with the same sound has implicitly parsed the words at the phonemic level and recognized phoneme identity. However, the ability to segment the same phoneme from different words (e.g., to delete *s* from *sun* and *sail*) does not necessarily signify knowledge of the identity of elided sounds. Another reason that the oddity task was adopted in the current work was that unlike other tasks of phonological awareness (e.g., sound deletion, segmentation, spoonerism, etc.), the task did not require overt verbal responses. The variability in articulatory

precision in less familiar, smaller phonological units could cause difficulty in scoring measures that relied on vocalization and was expected to confound the interpretation of the results.

Onset/rime oddity test. This test measured children's onset-rime awareness. The children were given 20 triads of monosyllabic spoken words and were asked to select from the triad the "odd" word that sounded differently from the other two. The monosyllabic words in each triad had the same tone. In half of the triads, the odd word in each triad did not alliterate with the other two (e.g., [lAw51], [li51], [kP51]), and in the other half, the odd word in each triad did not rhyme with the other two (e.g., [tÏP55], [xej55], [kP55]) (*see* Appendix A). Each triad was recorded into a sound file by using the Super MP3 Recorder V2.5 software on a Compaq notebook. The three test words in each triad were presented as a set three times to the children, accompanied by three enlarged versions of numbers, 1, 2, and 3, respectively. While playing the sound file, the experimenter pointed to the corresponding number that represented the test sound. The children were required to circle on an answer sheet the number that represented the odd spoken word according to the onset or the rime designated by the experimenter. One point was awarded for each correct response (Max = 20).

Nucleus/coda oddity test. This test measured children's phonemic awareness. The procedure was identical to that of onset/rime oddity test except that the odd word in each triad was the one differing in nucleus or coda rather than in onset or rime. These words were constructed with an initial consonant combined with a falling diphthong (e.g., [kow]) or a VN rhyme (e.g., [kaN]) (*see* Appendix B). In half of the triads, the odd word in each triad contained a different nucleus (e.g., [laj51], [tÏˇoN51], [kow51]).[1] In the other half, the odd sound contained a different coda (e.g., [tˇaj55], [pej55], [moN55]).[2] One point was given for each correct response (Max = 20).

Control Tests

---

[1] Caution was particularly taken so that the nuclei or the vowels to be compared and contrasted belong to different underlying phonemes (e.g., [a] in [laj] and [o] in [tÏˇoN] belong to /a/ and /W/, respectively).

[2] The triad in which two nasal sounds (alveolar /n/ and velar /N/) are to be compared was not included because comparing the two nasal sounds is more likely to tap the task of perception, rather than phonological awareness.

Digit span. Children's memory capacity was measured by a digit span task, following a standardized procedure in the literature. In this task, the experimenter read a sequence of digits (from 4 to 12 digits) at the rate of one digit per second to the child, and the child was asked to repeat the sequence of digits in the same order in which the digits had just been presented. There were two trials at each sequence length. The task discontinued when the child failed to repeat two trials of the same length consecutively. The scoring was based on the maximum number of digits that the child could recall.

English vocabulary. In this task, 40 three- or four-picture plates were used as the test materials. The children were required to pick out from each plate the picture (illustrating either objects or actions) that best fit the meaning of the stimulus word orally provided by the experimenter. One point was given for each correct response (Max = 40).

Criterion learning of letter-sound correspondence

This task prepared the children with the requisite letter-sound knowledge that they might not have mastered for the pseudoword spelling and reading tasks in the current work. In this task, the child learned the letter-to-sound and the sound-to-letter correspondences of ten English letters, the knowledge of which was necessary for successful performances in the spelling and the reading tasks subsequently administered. The ten English letters included four letters representing vowels (i.e., *a*-/é/, *i*-/ç/, *o*-/O/ and *u*-/U/) and six letters representing consonants (i.e., *p*-/p/, *t*-/t/, *f*-/f/, *s*-/s/, *l*-/l/, and *n*-/n/). The six consonants were subjected to three categories: (a) stops (i.e., /p/ and /t/), (b) fricatives (i.e., /f/ and /s/), and (c) sonorants (i.e., /l/ and /n/). The child began the task by supplying the names of the ten letters, which were presented in a fixed non-alphabetical order. One point was awarded for each correct letter naming (Max = 10). Children's ability to name the letters was scored and used for statistical control because knowledge of letter names is related to the learning of basic letter-sound relation (Share, 2004).

After naming the ten letters, the child was required to say the sound that each of the ten letters represented. The child's first attempt to say the sound (i.e., in the pre-training phase) was scored (Max = 10). One point was awarded for each response if it conformed to the criterion sound for

the subsequent pseudoword spelling and reading tasks. If the sound supplied by the child was a legal alternative but not the same as the criterion sound, the response was not given a credit. For example, /O/ as a response to letter *a* was given one credit but /A/ (as in 'box') was not. This was because, for the purpose of this study, we intended to obtain the measure of the child's *readiness* for the subsequent pseudoword spelling and reading tasks rather than the measure of the child's letter-sound knowledge. Presumably, the child's first response represented the child's most retrievable sound for the letter. If that sound was the criterion sound, the child would find the subsequent spelling and reading tasks easier than would the child who gave a legal but non-criterion sound. There were eight trials of instruction; each trial consisted of the instruction of the ten letter-to-sound correspondences. The instructional procedure stopped at the eighth trial or when the child mastered the letter-to-sound correspondences for two consecutive trials. After the letter-to-sound learning task, the child was administered a sound-to-letter learning task following the same procedure as the letter-to-sound learning task. The child was offered the a letter sound pronounced by the experimenter and was required to write down the letter that represented the sound. The child's first attempt to write the letter was also scored (Max = 10). Children who could not learn the 10 letter-to-sound or the sound-to-letter correspondences in the eight trials did not participate in the pseudoword spelling and reading tasks.

Pseudoword Spelling

The child was asked to spell four types of monosyllabic pseudowords varying in syllable structures, i.e., CVC, CVCC, CCVC, and CCVCC (e.g., *nat*, *nift*, *plat*, *flast*). There were four pseudowords in each type, resulting in a total of 16 pseudowords. The 16 pseudowords were made up of the ten letters the child had encountered in the criterion learning of letter-sound correspondences task. The pseudowords were constructed based on the following stipulations: (a) All of the pseudowords obeyed English phonotactic constraints; (b) the two sonorants /l/ and /n/ did not appear syllable-finally because the child was not taught how the two sonorants were realized phonetically in the syllable-final position in the letter-sound learning task; and (c) the spelling for each pseudoword was regular and consistent, involving no conditional rules.

The child listened to each pseudoword read by the experimenter three times and spelled the pseudoword on an answer sheet, where the ten letters were printed on the top. Children's spelling performances were scored in four different ways: (a) based on the number of correctly spelled pseudowords: one point was given for each correct spelling of the pseudoword (Max = 16); (b) based on the syllable structures – CVC, CVCC, CCVC and CCVCC (Max = 4 for each type); (c) based on the phonological units of the pseudoword irrespective of other parts of spelling: one point was given for each correctly spelled onset (Max = 16) / nucleus (Max = 16) / coda (Max = 16); (d) based on the spelling components of the pseudoword irrespective of other parts of the spelling: one point was given for each correct initial consonant (Max = 16) / final consonant (Max = 16) / initial consonant cluster (Max = 8) / final consonant cluster (Max = 8).

Pseudoword Reading

The child read four types of pseudowords constructed with the ten letters used in the letter-sound learning task. The four types of pseudowords were CVC, CVCC, CCVC, and CCVCC (e.g., *saf, faps, flis, slapt*). Each type had four pseudowords, resulting in a total of 16 pseudowords. These pseudowords were different from those used in the spelling task, but were created with the same stipulations. The test stimuli were displayed with the Microsoft PowerPoint software on a Compaq notebook, with one pseudoword presented on the screen per time. The child was asked to read out loud the pseudoword shown on the computer screen. Their responses were audio recorded for later transcription. Children's reading performances were scored in four different ways similar to those adopted in the spelling task: (a) based on the number of pseudowords correctly read (Max = 16); (b) based on the syllable structures – CVC, CVCC, CCVC and CCVCC (Max = 4 for each structure); (c) based on the phonological units irrespective of other components of the pseudoword (Max = 16 for onset, nucleus, and coda, respectively); (d) based on the reading components irrespective of other components of the reading (Max = 16 for initial and final consonants, respectively; Max = 8 for initial and final consonant clusters, respectively).

3. RESULTS

3.1 Phonological awareness

The first question of this study was whether Chinese-speaking children had phonemic awareness. To answer this question, the data from the original pool of 192 children were examined. As expected, the children performed better on the onset/rime oddity test than on the nucleus/coda oddity test ($t(191) = 16.0$, $p < .001$; $M = 16.1$ for onset/rime oddity and 11.3 for nucleus/coda oddity). About 14.1 % of the participants achieved a perfect score (i.e., the score of 20) in the onset/rime oddity test, in contrast to 0.5% in the nucleus/coda oddity test. About 72% of the participants achieved 75% mastery in the onset/rime oddity test whereas only about 23% of the participants achieved the 75% mastery in the nucleus/coda oddity test. Albeit relatively poor on phonemic awareness, children's performances on the nucleus/coda oddity test were significantly higher than the chance level of 6.7 ($t(191) = 17.2$, $p < .001$). As shown in Figure 1, while only 16 children (out of 192) performed below the chance level in the nucleus/coda oddity test, about 92% of the children performed better than the chance level in the nucleus/coda oddity test, suggesting an awareness of the phonemic constituents among most Chinese-speaking children.

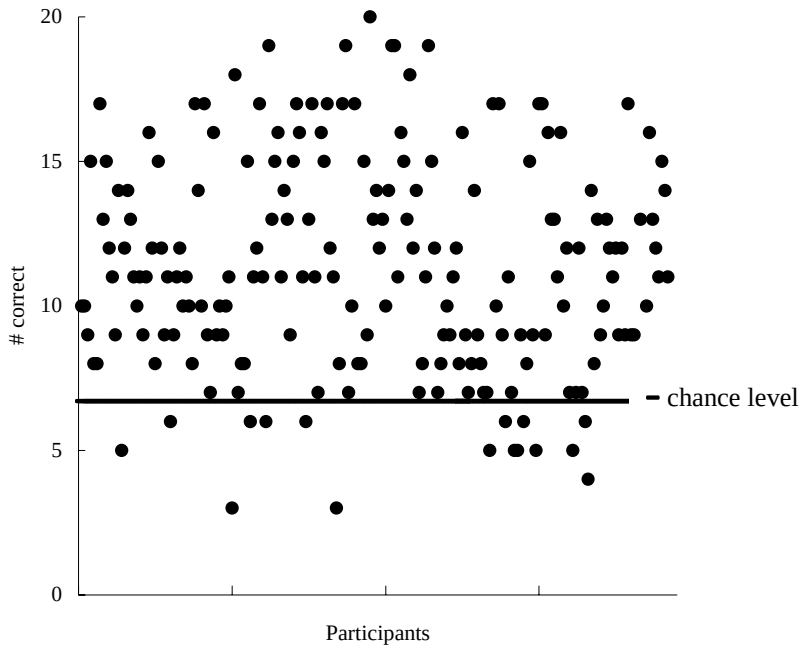

Figure 1. Distribution of the scores of nucleus/coda oddity

3.2 Grouping characteristics of the participants

Grouping characteristics of the participants appear in Table 1, together with the scores for statistical controls. Group A outperformed Group B in nucleus/coda oddity ($t(56) = 17.2$, $p < .001$); yet these two groups did not differ in onset/rime oddity ($t(56) = 1.6$, $p > .05$). Group B outperformed Group C in onset/rime oddity ($t(53) = 15.5$, $p < .001$); yet they did not differ in nucleus/coda oddity ($t(53) = 0.1$, $p > .05$). Thus, the three groups of children differed in terms of the degree of phonological awareness: Group A demonstrated the most advanced phonological awareness (as evidenced by their better performances in both onset/rime and nucleus/coda oddity than the other two groups),

followed by Group B (as evidenced by their better performances in onset/rime oddity than Group C but poorer performances in nucleus/coda oddity than Group A). Group C demonstrated the poorest phonological awareness (as evidenced by their poorer performance in onset/rime oddity and nucleus/coda oddity than the other two groups).

In Table 1, there are two control measures (i.e., digit span and English vocabulary) and three sets of control scores, which were gathered in the criterion learning of letter-sound correspondences task (i.e., letter name, letter-sound readiness, and sound-letter readiness). It can be seen from Table 1 that there were no significant group differences in digit span and in letter naming. However, Group A enjoyed an advantage in English vocabulary and in letter-sound and sound-letter readiness. These differences might complicate the interpretation of the results and thus were controlled statistically in the following analyses.

Table 1
Pairwise Comparisons of the Major Variables for the Three Groups of Participants

		n	*M*	*SD*	*t-value*
L1 onset/rime oddity (Max = 20)	Group A	29	18.9	1.1	1.6
	Group B	29	18.5	1.1	
	Group B	29	18.5	1.1	15.5***
	Group C	26	11.3	2.2	
L1 nucleus/coda oddity (Max = 20)	Group A	29	16.9	1.4	17.2***
	Group B	29	8.7	2.1	
	Group B	29	8.7	2.1	0.1
	Group C	26	8.7	1.9	
Digit span	Group A	29	8.2	1.2	0.3
	Group B	29	8.1	1.2	
	Group B	29	8.1	1.2	0.2
	Group C	26	8.1	1.1	
English vocabulary (Max = 40)	Group A	29	32.1	4.1	2.3*
	Group B	29	28.6	6.8	
	Group B	29	28.6	6.8	1.8
	Group C	26	25.5	6.3	
Letter name (Max = 10)	Group A	29	10.0	0.2	1.2
	Group B	29	9.9	0.4	
	Group B	29	9.9	0.4	0.4
	Group C	26	9.8	0.5	
Letter-sound readiness (Max = 10)	Group A	29	8.5	1.0	2.5*
	Group B	29	7.5	1.8	
	Group B	29	7.5	1.8	1.4
	Group C	26	6.6	2.9	
Sound-letter readiness (Max = 10)	Group A	29	9.7	0.9	2.9**
	Group B	29	8.8	1.4	
	Group B	29	8.8	1.4	1.8
	Group C	26	7.8	2.6	

* $p < .05$ ** $p < .01$ *** $p < .001$

3.3 Pseudoword spelling

Recall that the child's performances on the pseudoword spelling were scored according to four independent criteria, that is, *words correctly spelled*, *types of syllable structure*, *phonological units*, and

spelling components. The raw scores of the pseudoword spelling task were converted into percentages for comparability. Table 2 shows the mean percentages of correct responses in the pseudoword spelling task for the three groups.

Table 2
Mean Percentages of Correct Responses in the Pseudoword Spelling Task for the Three Groups

		n	*M*	*SD*	*t-value*
Words correctly spelled					
Pseudoword spelling	Group A	29	85.3	19.5	5.3***
	Group B	29	48.7	31.7	
	Group B	29	48.7	31.7	2.7**
	Group C	26	26.9	27.5	
Types of syllable structure					
CVC	Group A	29	96.6	11.0	4.9***
	Group B	29	66.4	31.5	
	Group B	29	66.4	31.5	1.9
	Group C	26	48.1	38.7	
CVCC	Group A	29	89.7	17.1	4.9***
	Group B	29	52.6	37.4	
	Group B	29	52.6	37.4	1.6
	Group C	26	35.6	41.9	
CCVC	Group A	29	78.5	30.4	4.1***
	Group B	29	40.5	39.8	
	Group B	29	40.5	39.8	3.0**
	Group C	26	13.5	25.7	
CCVCC	Group A	29	76.7	32.0	4.7***
	Group B	29	35.3	35.1	
	Group B	29	35.3	35.1	3.1**
	Group C	26	10.6	22.6	
Phonological units					
Onset	Group A	29	95.9	7.5	2.9**
	Group B	29	87.7	13.1	
	Group B	29	87.7	13.1	2.5*
	Group C	26	77.9	15.9	
Vowel	Group A	29	89.4	19.8	4.3***
	Group B	29	59.9	30.7	
	Group B	29	59.9	30.7	2.7**
	Group C	26	37.3	30.3	
Coda	Group A	29	98.1	2.9	2.6*
	Group B	29	91.4	13.3	
	Group B	29	91.4	13.3	1.6
	Group C	26	85.6	12.8	

Spelling components					
Initial consonant	Group A	29	100.0	0.0	2.6*
	Group B	29	97.4	5.4	
	Group B	29	97.4	5.4	1.5
	Group C	26	94.2	9.7	
Final consonant	Group A	29	99.6	1.6	2.6*
	Group B	29	96.3	6.6	
	Group B	29	96.3	6.6	2.2*
	Group C	26	91.1	10.9	
Initial cluster	Group A	29	92.2	14.3	2.5*
	Group B	29	79.7	22.3	
	Group B	29	79.7	22.3	2.7*
	Group C	26	63.9	21.6	
Final cluster	Group A	29	96.1	5.9	2.2*
	Group B	29	90.1	13.5	
	Group B	29	90.1	13.5	1.9
	Group C	26	81.7	19.1	

* $p < .05$ ** $p < .01$ *** $p < .001$

As shown in Table 2, Group A correctly spelled more pseudowords than Group B ($t(56) = 5.3$, $p < .001$). Group B, in turn, correctly spelled more pseudowords than Group C ($t(53) = 2.7$, $p < .01$). Although Group A had larger English vocabulary and were more ready to learn the letter-sound correspondences than Group B, the group differences in spelling remained significant after allowing for differences in these variables ($F(1, 53) = 14.4$, $p < .001$).

In terms of syllable structures, Group A outperformed Group B on all types of pseudowords, from the words with the simplest syllabic structure CVC to those with the more complex syllabic structures (CVCC, CCVC, and CCVCC) (all *p*s < .05). Group B had better performances on the items of CCVC and CCVCC than Group C, but not on items of CVC and CVCC structures, though the differences were in the expected direction. Figure 2 illustrates group performances on pseudoword spelling in terms of syllable structures.

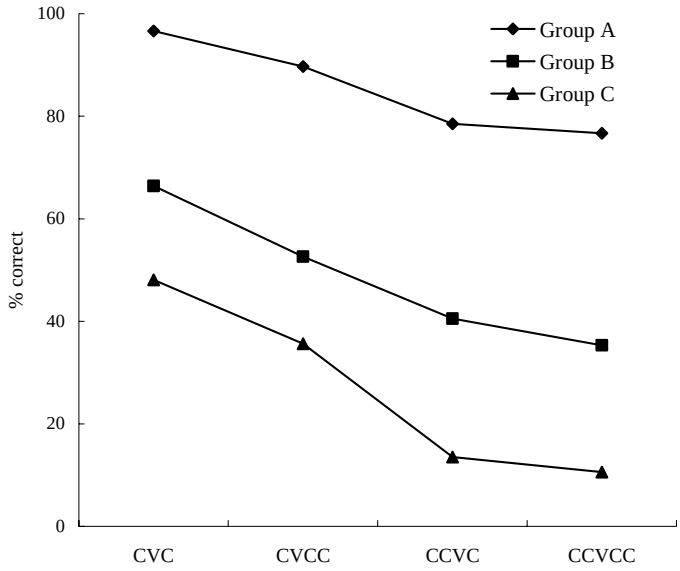

Figure 2. Group performances on pseudoword spelling in terms of syllable structures

Similar to the results obtained from the spelling performances in terms of the syllabic structure, Group A performed significantly better than Group B in dealing with all of the phonological units (i.e., onsets, vowels, and codas) and all of the spelling components (i.e., initial consonants, final consonants, initial clusters, and for final clusters) (all *p*s < .05). Group B performed better than Group C in the spelling of onsets, vowels, final consonants, and initial clusters (all *p*s < .05), but not in the spelling of codas, initial consonants and final clusters, though the differences were in the expected direction. Group performances on pseudoword spelling in terms of the phonological units and spelling components are depicted in Figure 3. One thing worth noticing was that Group B and C had a fairly poor performance on the vowel parts of the pseudowords, as shown by the dips in the performance curves in Figure 3.

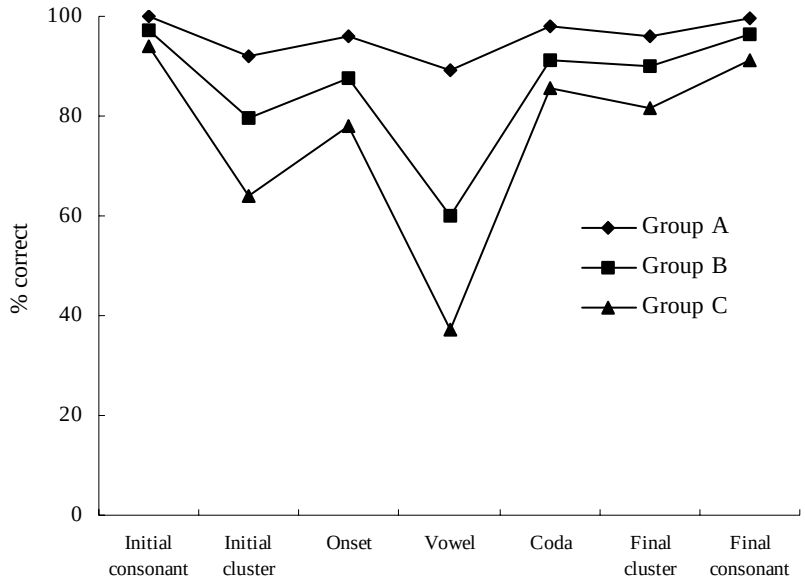

Figure 3. Group performances on pseudoword spelling in terms of the phonological units and spelling components

3.4 Pseudoword reading

Similar to the pseudoword spelling task, children's performances on pseudoword reading were scored based on four independent criteria with each having a different maximum score. The raw scores of the pseudoword reading task were transformed into percentages for comparability. Table 3 presents the mean percentages of correct responses in the pseudoword reading task for the three groups.

Table 3
Mean Percentages of Correct Responses in the Pseudoword Reading Task for the Three Groups

		n	*M*	*SD*	*t-value*
Words correctly read					
Pseudoword reading	Group A	29	78.9	24.6	4.0***
	Group B	29	49.4	31.4	
	Group B	29	49.4	31.4	1.1
	Group C	26	40.1	29.7	
Types of syllable structure					
CVC	Group A	29	87.1	19.6	3.9***
	Group B	29	61.2	30.3	
	Group B	29	61.2	30.3	0.0
	Group C	26	61.5	36.2	
CVCC	Group A	29	75.9	28.7	3.2**
	Group B	29	49.1	35.0	
	Group B	29	49.1	35.0	0.2
	Group C	26	47.1	34.9	
CCVC	Group A	29	77.6	30.1	3.5**
	Group B	29	45.7	39.0	
	Group B	29	45.7	39.0	1.3
	Group C	26	32.7	35.9	
CCVCC	Group A	29	75.0	29.9	3.9***
	Group B	29	41.4	35.5	
	Group B	29	41.4	35.5	2.4*
	Group C	26	19.2	31.9	
Phonological units					
Onset	Group A	29	91.8	13.2	3.7***
	Group B	29	72.6	24.5	
	Group B	29	72.6	24.5	1.6
	Group C	26	60.3	32.1	
Vowel	Group A	29	89.0	16.6	2.6*
	Group B	29	75.2	22.8	
	Group B	29	75.2	22.8	1.4
	Group C	26	66.1	25.4	
Coda	Group A	29	92.0	15.1	3.6**
	Group B	29	70.7	28.6	
	Group B	29	70.7	28.6	1.2
	Group C	26	61.1	31.4	

Reading components					
Initial consonant	Group A	29	96.3	5.9	3.1**
	Group B	29	85.1	18.6	
	Group B	29	85.1	18.6	1.9
	Group C	26	71.9	32.5	
Final consonant	Group A	29	94.6	12.9	3.4**
	Group B	29	77.6	23.3	
	Group B	29	77.6	23.3	1.5
	Group C	26	66.6	31.7	
Initial cluster	Group A	29	88.8	22.0	3.7**
	Group B	29	61.6	33.4	
	Group B	29	61.6	33.4	1.6
	Group C	26	45.7	39.5	
Final cluster	Group A	29	87.9	21.3	3.4**
	Group B	29	61.6	36.4	
	Group B	29	61.6	36.4	1.0
	Group C	26	51.9	36.4	

* $p < .05$ ** $p < .01$ *** $p < .001$

Group A correctly read more English pseudowords than Group B ($t(56) = 4.0$, $p < .001$). The differences in pseudoword reading between the two groups remained significant after controlling for the variance in English vocabulary and the readiness for letter-sound learning ($F(1, 53) = 5.2$, $p < .05$). However, Group B did not perform better in the pseudoword reading task than Group C ($t(53) = 1.1$, $p > .05$), though the differences were in the expected direction.

In terms of syllable structures, Group A performed significantly better than Group B on all types of pseudowords, including the items with the simplest CVC structure and the items with the more complex syllable structures, i.e., CVCC, CCVC, and CCVCC (all *p*s < .05). Group B had better performances in reading than Group C on the items with the most complex syllable structure (i.e., CCVCC), but not on the items of CVC, CVCC, and CCVC. Group performances on pseudoword reading in terms of syllable structures are depicted in Figure 4.

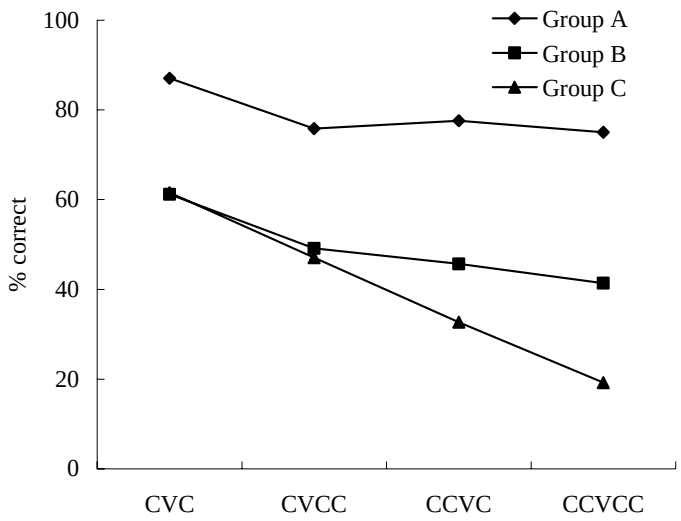

Figure 4. Group performances on pseudoword reading in terms of syllable structures

Group A outperformed Group B in the reading of all of the phonological units (i.e., onsets, vowels, and codas) and all of the reading components (initial consonants, final consonants, initial clusters, and final clusters) (all *p*s < .05). However, there were no differences between Group B and C in the reading of the different phonological units of the pseudowords and the reading components, despite that the differences between the two groups were in the expected direction, as shown in Table 3. Group performances on the pseudoword reading task in terms of the phonological units and the reading components are depicted in Figure 5.

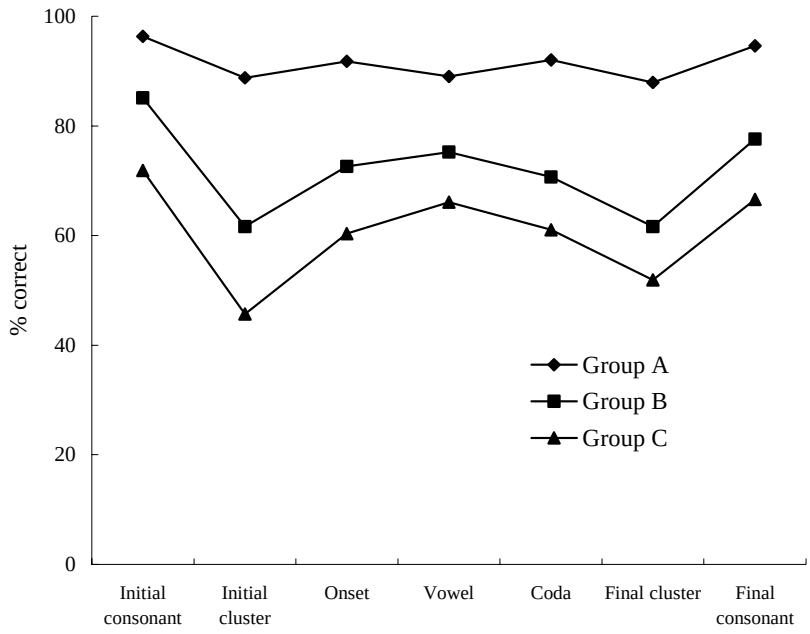

Figure 5. Group performances on pseudoword reading in terms of the phonological units and the reading components

4. DISCUSSION

There are three main findings in the present study. First, some Chinese-speaking children were sensitive to the sound units which are smaller than onsets and rimes. Second, performances on pseudoword spelling varied with the degree of phonological awareness. Children with better onset-rime and phonemic awareness (Group A) performed better in pseudoword spelling than those with better onset-rime but poorer phonemic awareness (Group B), who in turn performed better

than those with poorer onset-rime and phonemic awareness (Group C). Third, in pseudoword reading, children with better onset-rime and phonemic awareness (i.e., Group A) outperformed the other two groups, who were both poor at phonemic awareness (i.e., Group B and C). These results complement and reinforce previous findings based on onset-rime awareness (Hu, 2004b). They provide support for the notion that not only onset-rime awareness but also phonemic awareness supports the acquisition of early English literacy among Chinese-speaking children.

4.1 Phonemic awareness in Chinese-speaking children

The current work is in line with the view that children usually perceive and access larger sound units (e.g., onsets and rimes) in speech more easily than the smaller ones (e.g., phonemes) (Adams, 1990; Goswami & Bryant, 1990). In this study, many Chinese-speaking children were able to perform the onset/rime oddity test (as an index of onset-rime awareness) better than the nucleus/coda oddity test (as an index of phonemic awareness). Even though phonemic awareness appeared to be less well-developed among Chinese-speaking children than onset-rime awareness, it was not non-existent. Approximately 92% of the children performed above the chance level in the nucleus/coda oddity test, suggesting that some Chinese-speaking children were sensitive to the sound units that are smaller than onsets and rimes. The sound oddity test did not require children to segment the syllable into phonemic units. Thus, one may argue that the nucleus/coda oddity test may not reveal children's phonemic awareness because children may have categorized the sounds according to the overall similarity rather than according to common phoneme relations. While this possibility cannot be completely dismissed, we have reasons to believe that children in the current work were more likely to categorize the sounds according to common phoneme relation. First, the children were not instructed to find out the sound that was not similar to the other two. Rather, they were explicitly told to attend to a designated unit and find out the odd sound according to the unit. Second, except for the unit of comparison designated by the test giver, the odd sounds in the nucleus/coda oddity test did not show a systematic difference from the other two in terms of overall similarity.

One may also argue that the nucleus/coda oddity test can be interpreted as a task in detecting diphthongs vs. non-diphthongs rather than by accessing to the phonemes because we constructed the nucleus/coda oddity test largely based on diphthongs and VN rimes. Another reason to suspect that the children might have coped with the nucleus/coda oddity test by detecting diphthongs is the finding that Group A did better than Groups B/C in handling vowels in pseudowords, indicating that the commitment poor performances in the nucleus/coda oddity test and pseudoword spelling and reading might have a root in poor diphthong detection. A detailed examination of the data did not appear to support this contention. First, the nucleus oddity test could not have been achieved by categorizing the three stimuli into diphthongs and non-diphthongs (please see Appendix B). Second, the coda oddity test might seem to be solvable by a strategy with which the three stimuli were categorized into diphthongs and non-diphthongs for all the items, except for item 5. Yet if this is the case, this should be also true for most of the items in the rime oddity test (except for items 2, 6, 9) and children's performances in the coda oddity test should be similar to the performances in the rime oddity test. However, children's performances in the rime oddity test were significantly better than those in the coda oddity test ($t(191) = 9.67$, $p < .001$; $M = 6.25$ for coda oddity; $M = 8.02$ for rime oddity)..

One caveat is put forth here: children's ability to perform the nucleus/coda oddity test should not be over-interpreted as that phonemic awareness arises as a requirement of the processes of the Chinese language because our tasks are meta-linguistic in nature and do not tap the automatic aspect of language processing. As shown in Figure 1, there were children who were placed below the chance level on the nucleus/coda test. These children did not demonstrate any obvious deficiency in their general language ability. If phonemic awareness was required in the speech perception or production of Chinese, we would expect them to demonstrate some problems in language processing that were observable by their classroom teachers. The finding of the study only reflects that some Chinese-speaking children have phonemic awareness of their native language even though Chinese is a syllabic language. The question is how these Chinese-speaking children develop phonemic awareness in the first place, if it is grown out of the demands. It has been suggested that syllable structure constitutes a critical dimension that impacts on the

development of phonological skills (Cheug et al., 2001; Yamada, 2004). Since English syllable patterns (C)(C)(C)V(C)(C)(C)(C) are more complex than the syllable patterns (C)(G)V(C) of Chinese, it might be the experience with the English language that triggers the development of phonemic awareness in these Chinese-speaking children. We calculated the correlation between the scores in nucleus/coda oddity and the scores in English vocabulary and found that these two variables were only moderately related $r = .26$, $p < .05$. A large portion of the variance in phonemic awareness was left unaccountable by English vocabulary. Another factor that might have triggered the development of phonemic awareness is the experience with the alphabetic orthography (e.g., Cheung & Chen, 2004; Hu, 2004a). Since this was not measured in this study, the effect of orthographic experience cannot be determined either. Thus, how phonemic awareness develops in these Chinese-speaking children still remains to be explored. This is important from an educational point of view in terms of developing intervention strategies for children at risk for reading and spelling problems in EFL.

4.2 Pseudoword spelling

Consistent with the hypothesis that children with a higher degree of phonological awareness should be more able to spell in English, the results showed that Group A had better spelling performances than Group B, who in turn had better spelling performances than Group C. The group differences were evident after controlling for differences in the confounding variables, such as English receptive vocabulary and readiness for the letter-sound learning. There is a general belief that once children have mastered letter-sound correspondences, they can successfully apply such knowledge to spelling and reading (Treiman, Berch, & Weatherston, 1993). This view is not supported in this study. In spite of having the letter-sound mapping knowledge necessary for successful performances on pseudoword spelling, children in Group B and C could only spell 49% and 27% of the pseudowords. Though necessary as it is, letter-sound knowledge, in itself, is not sufficient for success in spelling. Children need to be able to break the code to apply letter-sound knowledge.

The finding that Group A correctly spelled more pseudowords not only for the items with more complex syllable structures (i.e.,

CVCC, CCVC and CCVCC) but also for those with simple CVC structure than Group B and Group C further underscored the importance of phonemic awareness in the acquisition of English spelling. As noted earlier, Group B had onset-rime awareness comparable to Group A. Theoretically, Group B should perform comparably well with Group A in spelling the pseudowords that shared a similar syllabic structure with Chinese syllables (i.e., CVC), given that onset-rime awareness, as suggested by Leong and Tan (2002), is sufficient for Chinese-speaking children to read and write in Chinese scripts. However, Group B performed more inferiorly in spelling the CVC words than Group A in spite of having comparable onset-rime awareness. Thus, the onset-rime awareness developed in L1 settings, in itself, did not seem to play a role in English spelling as critically as phonemic awareness.

The analyses of phonological units and spelling components also shed some light as to the effect of different levels of phonological awareness on children's spelling accuracy. For example, Group A had better performances in all types of phonological units and spelling components than Group B and Group C, suggesting that phonemic awareness contributed a great deal to the catching of the phonological nuts and bolts of a pseudoword. In addition to phonemic awareness, onset-rime awareness appeared to be important as well. Compared with Group B, Group C was inferior in spelling most of the phonological units and spelling components, suggesting that onset-rime awareness, though appeared to be less critical in English spelling than phonemic awareness, might still play a facilitative role at the entry level of acquiring English spelling skills.

One thing worth noting is the substantial proportion of vowel errors committed by Group B and Group C, in contrast to the 89% accuracy rate for Group A. Treiman, Berch, and Weatherston (1993) have proposed two views to account for the poor spelling of the middle vowels frequently observed in English L1 learners. The first view asserts that the difficulty in spelling vowels arises from the fact that letter-sound mapping for vowels is less consistent than that for consonants. The second view claims that the difficulty arises from the double hazard in separating the vowel from its preceding phoneme as well as from its following phoneme. The first view is hard to accommodate the data in the current work in that the letter-sound correspondences in the pseudoword spelling task were designed to

have a regular one-to-one relationship, which was learned by the three groups of children prior to the spelling task. The second view appeared to provide a more ready explanation of the poor spelling of the vowels in Group B and Group C. Given their poor sensitivity to the phonemic constituents of a spoken word, they might have found the middle vowel particularly difficult to detect, as its identify was masked by its preceding as well as its following phonemes.

4.3 Pseudoword reading

The results of the pseudoword reading task partially support the hypothesis that children's reading performances vary with the degree of phonological awareness. This was shown in the better reading performances in Group A than group B. However, inconsistent with the hypothesis, there was a lack of group differences between Group B and Group C. The three groups of children all received sufficient instruction in letter-sound correspondences required for successful reading in this study, but only Group A attained nearly 80% reading accuracy, whereas the rate was less than 50% for both Group B and C. Recall that children who participated in the pseudoword reading task were the children who could supply accurate sounds for the letters in the criterion learning of letter-to-sound correspondences task. Thus, it did not seem appropriate to attribute the inferior performance of Group B and C in reading to the articulatory difficulties of the individual phonemes. Whether they had difficulty in coordinating the sequence of sounds remains to be seen. So far, the results supported the critical role of phonemic awareness in EFL reading.

Analyses of reading performances in terms of syllable structures further demonstrated that phonemic awareness played a more crucial role in pseudoword reading than onset-rime awareness. In this study, Group A displayed better reading performances in all types of syllable structures than Group B. However, Group B had better reading performances than Group C only in the most complex syllable structure (CCVCC), but not in other simpler syllable structures. It should be noted that Group B's better performance in reading CCVCC over Group C should not be over-interpreted as that onset-rime awareness was a critical component skill in reading CCVCC words. If that was the case, Group A and Group B should have performed at approximately the same level in the reading of CCVCC words, given

their equivalent level of onset-rime awareness. However, Group B, though with equivalent level of onset-rime awareness as Group A, performed more poorly on words of different syllabic structures, including CCVCC. Thus, it appeared that phonemic awareness is more critical for alphabetic reading, whereas the beneficial effect of onset-rime awareness in reading may be evident only in some restricted situations, i.e., only when compared to children with very limited phonological awareness *and* only when the words to be read are complex in structure.

The analyses of the phonological units and reading components revealed much the same patterns of results. Group A exceeded Group B and Group C in reading all types of the phonological units and reading components. However, in spite of having better onset-rime awareness, Group B did not show better reading performances in the different phonological units and reading components than Group C, suggesting that phonemic awareness is more essential than onset-rime awareness in enhancing children's reading accuracy.

It was not clear why the effect of onset-rime awareness in reading was not evident as predicted. It might be that the onset-rime awareness measured by the sound oddity test in the current work was not sensitive in distinguishing Group B from Group C in reading. To obtain an accurate reading for a word, the child had to appropriately blend the constituent sounds of a pseudoword together. Such a process required synthetic phonological awareness (Wanzek & Haager, 2003), which might not be tapped by the sound oddity test used in this study. Future studies need to include tasks that measure the disparate dimensions of phonological awareness.

In conclusion, the current work showed that some Chinese-speaking children have developed phonemic awareness when they are reaching fourth grade as evidenced by the "above the chance level" scores in the nucleus/coda oddity test. How phonemic awareness develops in these Chinese-speaking children cannot be resolved by this study but is worth further investigation. In the present study, the development of phonemic awareness appears to lag behind that of onset-rime awareness. Yet this later emerging ability places constraints on the acquisition of English reading and spelling skills over those accountable by digit span, English vocabulary knowledge, and the child's readiness in letter-sound correspondences. Although we found support for a specific association between phonemic

awareness and leaning to read and spell English, the role of onset-rime awareness appears to be equivocal. It was found to be important in learning to spell but it did not seem to play a similar role in learning to read. Whether the lack of the effect of onset-rime awareness reflects the true nature of its role in leaning to read English or whether it is a result of the task factors in the current work is a matter for future research. Given that phonemic awareness appears advantageous to the acquisition of literacy skills in English, the present work calls for more studies on the relationship between phonemic awareness of Chinese and English learning as well as training studies on Chinese phonemic awareness. If we are able to show that phonemic awareness can be developed in the Chinese language, then we can find out a way to train the students' phonemic awareness with Chinese with the understanding that if the students are equipped with this ability, their English learning will be made much easier.

REFERENCES

Adams, Marilyn Jager. 1990. *Beginning to read: Thinking and learning about print*. Cambridge, MA: MIT Press.

Ao, Benjamin. 2001. The non-uniqueness condition and the syllable medial in Chinese phonology. *Proceedings of the 7th International and the 19th National Conferences on Chinese Phonology* (pp. 204-217). Taipei: National Cheng-chi University.

Bertelson, Paul, Beatrice de Gelder, and Morvigue van Zon. 1997. Explicit speech segmentation and syllabic onset structure: Developmental trends. *Psychological Research* 60: 183-191.

Bowey, Judith A. 1995. Socioeconomic status differences in preschool phonological sensitivity and first grade reading achievement. *Journal of Educational Psychology* 87: 476-487.

Bryant, Peter E., Moray MacLean, Lynette L. Bradley, and J. Crossland. 1990. Rhyme, alliteration, phoneme detection, and learning to read. *Developmental Psychology* 26: 429-438.

Bryne, Brian, and Ruth Fielding-Barnsley. 1989. Phonemic knowledge and letter knowledge in the child's acquisition of the alphabetic principle. *Journal of Educational Psychology* 81: 313-321.

Bryne, Brian, and Ruth Fielding-Barnsley. 1990. Acquiring the alphabetic principle: A case of teaching recognition of phoneme identity. *Journal of Educational Psychology* 82: 805-812.

Caravolas, Marke0ta, Charles Hulme, and Margaret Snowling. 2001. The foundations of spelling abilities: Evidence from a 3-year longitudinal study. *Journal of Memory and Language* 45: 751-774.

Cheung, Him, and Hsuan-Chih Chen. 2004. Early orthographic experience modifies both phonological awareness and on-line speech processing. *Language and Cognitive Processes* 19: 1-28.

Cheung, Him, Hsuan-Chih Chen, Chun-Yip Lai, On-Chi Wong , and Melanie Hills. 2001. The development of phonological awareness effects of spoken language experience and orthography. *Cognition*, 81: 227-241.

Comeau, Liane, Pierre Comier, Eric Grandmaison, and Diane Lacroix. 1999. A longitudinal study of phonological processing skills in children learning to read in a second language. *Journal of Educational Psychology*, 91(1): 29-34.

de Jong, Peter F., Marie-Jose Seveke, & Marjo van Veen 2000. Phonological sensitivity and the acquisition of new words in children. *Journal of Experimental Child Psychology*, 76: 275-301.

Duanmu, San. 2000. *The phonology of standard Mandarin*. Oxford: Oxford University Press.

Durgunoglu, Aydin Y., William E. Nagy, and Babara Hancin-Bhatt. 1993. Cross-language transfer of phonological awareness. *Journal of Educational Psychology* 89: 453-365.

Goswami, Usha, and Peter E. Bryant. 1990. *Phonological skills and learning to read.* Hillsdale, NJ: Erlbaum.

Ho, Connie. Suk-Han, and Peter E. Bryant. 1997. Development of phonological awareness of Chinese children in Hong Kong. *Journal of Psycholinguistic Research* 26(1): 109-126.

Ho, Connie Suk-Han, Teresa Pui-Sze Law, and Penny Man Ng. 2000. The phonological deficit hypothesis in Chinese developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal*, *13*: 57-79.

Hu, Chieh-Fang. 2003. Phonological memory, phonological awareness, and foreign language word learning. *Language Learning* 53: 429-462.

Hu, Chieh-Fang. 2004a. The development of phonological

representations among Chinese-speaking children. *Taiwan Journal of Linguistics* 2(1): 103-130.

Hu, Chieh-Fang. 2004b. Learning to spell with poor phonological awareness. *English Teaching and Learning* 28(3): 31-52.

Hu, Chieh-Fang, and Hugh W. Catts. 1998. The role of phonological processing in early reading ability: What we can learn from Chinese. *Scientific Studies of Reading* 2(1): 55-79.

Huang, Hsiu-Shuang, and J. Richard Hanely. 1995. Phonological awareness and visual skills in learning to read Chinese and English. *Cognition* 54: 73-98.

Hulme, Charles, Peter J. Hatcher, Kate Nation, Angela Brown, John Adams, and George Stuart. 2002. Phoneme awareness is a better predictor of early reading skill than onset-rime awareness. *Journal of Experimental Child Psychology* 82: 2-28.

Hulme, Charles, Valerie Muter, and Margaret Snowling. 1998. Segmentation does predict early progress in learning to read better than rhyme: A reply to Bryant. *Journal of Experimental Child Psychology* 71: 39-44.

Kirtley, Clare, Peter E. Bryant, Moray MacLean, and Lynette Bradley. 1989. Rhyme, rime and onset of reading. *Journal of Experimental Child Psychology* 48: 224-245.

Leong, Che-Kan, and Li-Hai Tan. 2002. Phonological processing in learning to read Chinese: In search of a framework. In Erland Helmquist, and Curt von Euler (Eds.). *Dyslexia and literacy* (pp. 126-150). London: Whurr Publishers.

Levelt, Willem. J. M., Ardi Roelofs, and Antje S. Meyer. 1999. A theory of lexical access in speech production. *Behavioral and Brain Science* 22: 1-75.

McBride-Chang, Catherine, and Robert V. Kail. 2002. Cross-cultural similarities in the prediction of reading acquisition. *Child Development* 73: 1392-1407.

Muter, Valene, Charles Hulme, Margaret Snowling, and Sara Taylor. 1998. Segmentation, not rhyming, predicts early progress in learning to read. *Journal of Experimental Child Psychology* 71: 3-27.

Nation, Kate, and Charles Hulme. 1997. Phonemic segmentation, not onset-rime segmentation, predicts early reading and spelling skills. *Reading Research Quarterly* 32: 154-167.

Share, David L. 2004. Knowing letter names and learning letter

sounds: A causal connection. *Journal of Experimental Psychology* 88: 213-233.

Siok, W. T., & Fletcher, P. 2001. The role of phonological awareness and visual-orthographic skills in Chinese reading acquisition. *Developmental Psychology* 37: 886-899.

Stahl, Steven A., and Bruce A. Murry. 1994. Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology* 86: 221-234.

Treiman, Rebecca, Denise Berch, and Sarah Weatherston. 1993. Children's use of phoneme-grapheme correspondences in spelling: Roles of position and stress. *Journal of Educational Psychology* 85(3): 466-477.

Wagner, Richard K., and Joseph K. Torgesen. 1987. The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin* 101: 192-212.

Wan, I-Ping, and Jeri Jaeger. 2003. The phonological representation of Taiwan Mandarin vowels: A psycholinguistic study. *Journal of East Asian Linguistics* 12: 205-257.

Wang, Hsu Samuel. 王旭。1997。〈漢語音標謝議〉。第一屆台灣語言發展學術研討會論文講稿。國立新竹師範學院。

Wang, Min, & Esther Geva. 2003. Spelling performance of Chinese children using English as a second language: Lexical and visual-orthographic processes. *Applied Psycholinguistics* 24: 1-25.

Wang, Min, Keiko Koda, and Charles A. Perfetti. 2003. Alphabetic and nonalphabetic L1 effects in English word identification: A comparison of Korean and Chinese English L2 learners. *Cognition* 87: 129-149.

Wanzek, Jeanne, and Diane Haager. 2003. Teaching word recognition with blending and analogizing. *Teaching Exceptional Children* 36(1): 32-38.

Yamada, Jun. 2004. An L1-script-transfer-effect fallacy: A rejoinder to Wang et al. (2003). *Cognition* 93: 127-132.

APPENDIXES

Appendix A

Onset/rime Oddity Test

Onset Oddity	Rime Oddity
1. [kWn55],[kow55],[paj55]	1. [tÏP55],[xej55],[kP55]
2. [tÏa55],[x‹N55],[xej55]	2. [xaj51],[low51],[tÏow51]
3. [Ï‹n51],[taj51],[ÏP51]	3. [mej51],[pej51],[sa51]
4. [lAw51],[li51],[kP51]	4. [tˇoN55],[kAw55],[sAw55]
5. [fej55],[toN55],[fa55]	5. [fej51],[mu51],[pˇej51]
6. [íow51],[nan51],[ni51]	6. [tÏˇoN55],[foN55],[xP55]
7. [ˆˇan51],[sow51],[ˆˇP51]	7. [tow55],[Ïow55],[pˇAN55]
8. [xoN55],[xa55],[ˆ‹n55]	8. [tAw55],[kˇP55],[pAw55]
9. [tˇAw51],[nej51],[n‹n51]	9. [su51],[xan51],[nan51]
10. [kˇu55],[sow55],[kˇP55]	10. [laj51],[pˇaj51],[tÏV51]

Appendix B

Nucleus/coda Oddity Test

Nucleus Oddity

1. [ÏAw51],[mej51],[pAN51]
2. [taj55],[fan55],[tˇow55]
3. [laj51],[tÏˇoN51],[kˇow51]
4. [pˇej51],[fAN51],[kAw51]
5. [tow51],[maj51],[koN51]
6. [tan55],[tÏaj55],[kow55]
7. [tÏow55],[kˇaj55],[toN55]
8. [xej55],[lAw55],[ÏAN55]
9. [saj55],[kan55],[tÏˇow55]
10. [pej55],[fAN55],[tˇAw55]
2. [mAw55],[ˆˇan55],[f‹n55]
3. [pˇAN51],[maj51],[tÏˇoN51]
4. [x‹n51],[tˇAw51],[sow51]
5. [mej51],[naj51],[tÏˇow51]
6. [xow51],[lAN51],[tÏAw51]
7. [kˇan55],[ˆow55],[xAw55]
8. [f‹n55],[pˇan55],[pej55]
9. [ˆˇan51],[nAw51],[m‹n51]
10. [tAN55],[foN55],[Ïaj55]

Coda Oddity

1. [tˇaj55],[pej55],[moN55]

I-Chih Chan
Graduate Institute of Linguistics
National Chengchi University
Taipei, Taiwan 116, ROC
g0555002@alumni.nccu.edu.tw

Chieh-Fang Hu
Department of English Instruction
Taipei Municipal Teachers College
Taipei, Taiwan 100, ROC.
cfhu@mail1.tmtc.edu.tw

I-Ping Wang
Graduate Institute of Linguistics
National Chengchi University
Taipei, Taiwan 116, ROC
ipwan@nccu.edu.tw