Second-Language Reading Difficulties Among Native Chinese-Speaking Students Learning to Read English: The Roles of Native- and Second-Language Skills

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ABSTRACT

The authors report two studies that examined how native- and second-language skills were related to second-language reading difficulties for native Chinese-speaking fourth graders learning to read English. In study 1, 50 poor English readers with Chinese-reading difficulties (the PB group) and 34 poor English readers without Chinese-reading difficulties (the PE group) were compared with 53 typically developing controls on phonological awareness, rapid naming, and phonological memory. Results showed that both groups of poor English readers showed English phonemic awareness and rapid naming deficits in both languages and that the PB group had additional skill deficits in English onset-rime awareness and phonological memory in both languages.

In study 2, 69 poor English readers (25 in the PE group) trained on English phonological skills were compared with 43 typically developing controls before the training, right after, and one year later. Results showed that poor English readers caught up with their typically developing peers on English phonemic awareness irrespective of their Chinese-reading status and that the PE group also caught up on English pseudoword reading and retained their gains one year later. After one year, about one third of the PE group performed comparably to their typically developing peers not only on English reading performance but also on bilingual language skills. However, the majority of the poor English readers persistently showed poor performance in English reading and phonemic awareness, as well as in Chinese and English rapid naming. Findings highlight both language-universal and specific skill deficits contributing to second-language reading difficulties.

A large number of people in the world strive to master a second language for personal and societal success (Nunan, 2003). In mainland China alone, there are more than 390 million people learning English as a second language (ESL; Wei & Su, 2012). The profiles of poor second-language readers may be different from those of poor native-language readers (Manis & Lindsey, 2010; McBride-Chang et al., 2013; McBride-Chang, Liu, Wong, Wong, & Shu, 2012; Tong, Tong, & McBride-Chang, 2015). Nevertheless, the nature of the relations between native- and second-language reading difficulties remains unclear, especially when two languages are in sharp contrast, such as Chinese as a native language with English as a second language. This study examined how native- and second-language skills contributed to second-language reading difficulties among Chinese ESL students. We first compared two groups of second-language (English) poor readers with or without native-language (Chinese) reading difficulties in various reading-related skills. Then, we examined the poor second-language readers’ language skills and reading...
profiles right after a short-term intensive intervention on second-language phonological skills and one year later.

The Relation Between Native- and Second-Language Reading Difficulties

According to the linguistic interdependence hypothesis (Cummins, 1979), the development of native and second languages can be interdependent, yet native-language development can affect the development of a second language. Sparks, Ganschow, and Pohlman (1989) further proposed the linguistic coding differences hypothesis specifically for explaining the relation between native- and second-language reading difficulties. According to this hypothesis, children who have reading difficulties in their native language will also have second-language reading problems and similar skill deficits because both native- and second-language reading may depend on the same set of linguistic skills. Several studies have found that poor second-language readers displayed phonological awareness, syntactic, and semantic skill deficits (e.g., Ganschow & Sparks, 1995; Sparks, Patton, Ganschow, Humbach, & Javorsky, 2006) and phonological memory skill deficits (Swanson, Sáez, Gerber, & Leafstedt, 2004) in their native language. Further, poor readers in their native language also exhibited difficulties in second-language phonological awareness, rapid naming (van der Leij & Morfidi, 2006), phonological memory, and word identification (Da Fontoura & Siegel, 1995). However, most previous studies only focused on reading difficulties in two alphabetic languages. These findings may not be true when native and second languages are very different, such as Chinese (nonalphabetic) and English (alphabetic).

Another explanation emphasizes that both common and specific skills may underlie learning to read different orthographies (Geva & Siegel, 2000; McBride & Wang, 2015; Shum, Ho, Siegel, & Au, 2016; M. Wang, Koda, & Perfetti, 2003). For example, although phonological awareness, phonological memory, and rapid naming may be universally important for learning to read any orthography (Caravolas et al., 2012; Ziegler et al., 2010), the associations between reading and subcomponents of phonological awareness may vary across orthographies (for a review, see Ziegler & Goswami, 2005). Rapid naming may be more important for learning to read in transparent rather than opaque orthographies (de Jong & van der Leij, 2003). Therefore, there may be both dissociations and associations between reading difficulties in both the native and second language. Also, second-language reading may involve different underlying language skills from native-language reading given the different cognitive demands and orthographic features of the two languages (McBride-Chang et al., 2012, 2013).

Language Skill Deficits Underlying Chinese- and English-Reading Difficulties

Chinese is a nonalphabetic language used widely as a first language around the world, whereas English is an alphabetic language widely learned as a second language (Yang, 2006). The two language systems differ substantially in both orthographic consistency and grain size of the orthography–phonology correspondences (Ziegler & Goswami, 2005). Although each grapheme often represents a sound at the phonemic level in English, there is no grapheme–phoneme correspondence in Chinese (DeFrancis, 1984). Reading in Chinese and English may require different language skills or employ certain language skills to different extents. Thus, the question arises as to the common and specific roles that various language skills may serve the dissociation and association between native- and second-language reading difficulties for native Chinese ESL learners. Studies have revealed both associations and dissociations between native- and second-language reading difficulties for native Chinese ESL learners (Ho & Fong, 2005; McBride-Chang et al., 2012, 2013; Tong et al., 2015). However, previous studies only examined poor native Chinese readers’ difficulties in English reading (Chung & Ho, 2010) or poor English readers’ skill profiles in Chinese (McBride-Chang et al., 2012, 2013; Tong et al., 2015). The present study aimed to examine both Chinese and English phonological awareness, rapid naming, and phonological memory for poor English readers with or without Chinese-reading difficulties.

Phonological Awareness

It has been well established that phonemic awareness (i.e., the knowledge that spoken words are made up of individual sounds; Wagner & Torgesen, 1987) is a strong predictor of English word reading (Melby-Lervåg, Lyster, & Hulme, 2012). Failure to develop phonemic awareness may result in reading difficulties in English (Snowling, Gallagher, & Frith, 2003). In contrast, there is no grapheme–phoneme correspondence in Chinese character reading, and each Chinese character usually represents a syllable; moreover, lexical tone, which is not present in English, is critical for differentiating the large number of Chinese homophones (DeFrancis, 1984). Problems in onset-rime awareness (Ho, Chan, Lee, Tsang, & Luan, 2004; Ho, Law, & Ng, 2000) and tone awareness (Li & Ho, 2011; McBride-Chang, Lam,
et al., 2008) have been significantly associated with Chinese-reading difficulties.

It remains unclear how deficits in certain subcomponents of Chinese and English phonological awareness may contribute to English-reading difficulties for native Chinese-speaking students. Poor English readers in Hong Kong performed significantly worse than their typically developing peers on Chinese phonological awareness as measured by mixing syllable and phoneme tasks together (McBride-Chang et al., 2012; Tong et al., 2015), and on tone awareness (Tong et al., 2015). However, such Chinese phonological awareness deficits were not found among poor English readers in mainland China (McBride-Chang et al., 2013). The aforementioned studies neither measured English phonological awareness nor differentiated subcomponents of phonological awareness. Therefore, this study aimed to examine how the subcomponents of phonological awareness in native and second languages may contribute to second-language reading difficulties for native Chinese English learners. As predicted by the psycholinguistic grain size theory (Ziegler & Goswami, 2005), phonemic awareness deficit may be specifically related to reading difficulties in English, and tone awareness deficit may be specifically related to reading difficulties in Chinese for native Chinese English learners.

**Rapid Naming**

The double-deficit hypothesis of dyslexia proposed rapid naming as important as phonological awareness for reading acquisition (Wolf & Bowers, 1999). Rapid naming of both letters and digits has been found to significantly predict reading development in English beyond phonological awareness (Cutting & Denckla, 2001; Wolf et al., 2002), and rapid digit naming has been found to significantly predict Chinese-reading development (Liao, Georgiou, & Parrila, 2008). Further, Chinese rapid digit naming at age 5 significantly predicted English word reading at ages 8 and 10 among native Chinese-speaking students (Pan et al., 2011). Native Chinese ESL students with Chinese-reading difficulties demonstrated weaker English rapid letter naming (Chung & Ho, 2010), and poor English readers showed Chinese rapid digit-naming deficits despite their adequate Chinese-reading performance (McBride-Chang et al., 2013). Therefore, rapid letter/digit naming deficits may be common for both native- and second-language reading difficulties. In this study, we examined not only the roles of native- and second-language rapid naming skills in second-language reading difficulties but also how rapid naming skill problems in both languages may contribute to the persistence of second-language difficulties by delivering a phonological skill training to poor second-language readers and following them for one year.

**Phonological Memory**

Because the efficient operation of phonological codes in working memory is necessary for learning to read (Baddeley, 1986; Wagner & Torgesen, 1987), phonological memory may be a universal skill in reading acquisition (Gathercole & Baddeley, 1993). Students with poor phonological memory are prone to reading difficulties in both English (e.g., Siegel & Ryan, 1988) and Chinese (Ho et al., 2000; Ho & Lai, 1999). When both first and second languages were alphabetic, phonological memory in the native language significantly predicted second-language reading development (Geva & Siegel, 2000; Swanson, Sáez, & Gerber, 2006), and at-risk second-language learners showed weak phonological memory in their native language (Swanson et al., 2004). Because previous studies about second-language reading difficulties for Chinese ESL students did not measure phonological memory (McBride-Chang et al., 2012, 2013), empirical studies are needed to examine whether poor Chinese ESL readers may also show phonological memory deficit in their native language.

**Intervention as an Important Approach for Examining Second-Language Reading Difficulties**

In addition to skill deficits, inadequate instruction and experience may be associated with reading difficulties (Vellutino, Fletcher, Snowling, & Scanlon, 2004), which may be the case particularly for learning to read in a second language (Elbro, Daugaard, & Gellert, 2012). Intervention studies may help better explain the nature of second-language reading difficulties by providing evidence-based instruction for second-language reading. However, to our knowledge, very few studies have adopted an intervention approach to examine skill profiles for second-language reading difficulties. Thus, in addition to group comparisons, this study employed an intervention approach to investigate Chinese- and English-reading skill profiles for persistent or remediable English-reading difficulties with different Chinese-reading performance.

A number of studies have shown that explicit phonological awareness and letter sound knowledge training can significantly improve word reading for young readers and poor readers (e.g., Bradley & Bryant, 1983; Hulme, Bowyer-Crane, Carroll, Duff, & Snowling, 2012; National Institute of Child Health and Human Development [NICHD], 2000). ESL students with diverse native-language backgrounds, including Chinese, in North America performed as well as native English speakers in reading after one year of English
phonological awareness instruction in kindergarten (Lesaux & Siegel, 2003). More recently, Yeung, Siegel, and Chan (2013) reported that an English phonological awareness intervention significantly improved Hong Kong ESL students’ English phonological awareness, word reading, and spelling. As recommended by the National Reading Panel (NICHD, 2000), we applied explicit phonological awareness and letter knowledge training to poor readers in English who did or did not have problem in reading Chinese.

Methodological Considerations for Group Comparisons
First, group comparisons would be facilitated by matching the reading status in either the native or second language. On the one hand, matched native-language reading performance will help group comparisons between poor second-language readers without native reading problems and typically developing peers (McBride-Chang et al., 2012). On the other hand, matched reading performance in the second language may help the group comparisons between the poor second-language readers with and without reading problems in their native language (McBride-Chang et al., 2013). Therefore, this study matched reading performance in one language to facilitate group comparisons relevant to reading status in the other language.

Second, the buffer method may be better than a mere cut-off point to define reading status. It helps prevent assigning individuals’ scoring just around a cut-off point into different groups (Shankweiler et al., 1999). The buffer method has been used in many studies about learning disabilities (e.g., Cirino, Fuchs, Elias, Powell, & Schumacher, 2015; Fuchs, Fuchs, & Prentice, 2004). However, previous studies about second-language reading difficulties have seldom used such a method to define reading status. To avoid assigning students with similar reading performance into different groups, this study used a buffer zone method to define the reading groups.

The Present Study
We report two studies. In study 1, two groups of native Chinese-speaking students who were poor in English word reading with or without Chinese-reading difficulties were compared with their typically developing peers on phonological awareness, rapid naming, and phonological memory of two languages. In study 2, poor readers in English were trained on English phonological awareness and letter knowledge and were followed for one year to further examine how native- and second-language skills contributed to the persistency of second-language reading difficulties, and the impact of native-language reading abilities.

Study 1
Study 1 examined how various native- and second-language skills were related to second-language reading difficulties. Two groups of poor English readers with (the PB group) and without (the PE group) Chinese-reading difficulties were compared with the typically developing controls (the C group) on phonological awareness, rapid naming, and phonological memory of the two languages. We hypothesized that the PE group might show weaker English phonemic awareness in particular and that the PB group might show additional deficits in Chinese rime and tone awareness as predicted by the psycholinguistic grain size theory (Ziegler & Goswami, 2005). Moreover, the PE and PB groups might show similar rapid naming and phonological memory deficits in the two languages because the two skills are universal for learning to read in any language.

Method
Participants
Participants were selected from 962 fourth graders in six community-based public elementary schools in Beijing, China. These schools were medium-sized, with approximately 30–40 students in each class and approximately 600–1,000 students in total in grades 1–6 in each school. All students were native Mandarin speakers, and about 49% of the children had mothers who had college education and above. All students started to learn English at school from grade 1 and had three English classes (40 minutes each) every week at school. The schools followed the national curriculum and used the same version of textbooks. The national curriculum requires students at the end of primary school (grade 6) to be able to “read aloud simple words; know 600–700 vocabulary and 50 or so common expressions; know the difference between the main pronouns; understand information and viewpoints from talk about familiar topics” (Ministry of Education, China, 2011, p. 11), and does not require explicit instruction in letter sound knowledge or phonological awareness.

Nonverbal cognitive abilities, English word recognition, and Chinese character recognition were assessed in a group setting for the initial screening. We requested nominations from teachers for students with low English- and Chinese-reading achievement. School English examination scores were also collected from school records, and parents reported their children’s demographic information on a questionnaire. We also followed ethics guidelines and obtained permission from school principals, teachers, parents, and children. The consent was obtained first from school principals and
teachers. Then, parents offered their consent by signing a form distributed at parent meetings or brought home by their children. Before each testing session, oral permission was obtained from each child by asking, “Do you want to work with me on this activity?”

Among the 962 students, 48 who scored below the fifth percentile on the nonverbal cognitive ability test were excluded from the study. Among the remaining 914 students, 197 scored below the 25th percentile on English word recognition and either were nominated by teachers as being in the bottom third of students in English reading or had scored below the 25th percentile on the school’s English examination. Among these 197 students, 85 who also scored below the 25th percentile on Chinese character recognition and either were nominated by teachers as being in the bottom third of students in Chinese reading or had scored below the 25th percentile on the school’s Chinese examination were classified as poor readers in both Chinese and English (the PB group), and 63 who scored above the 30th percentile on the Chinese character recognition task, were not nominated by teachers as being in the bottom third of students in Chinese reading, and had scored higher than the 30th percentile on the school’s Chinese examination were classified as poor readers in English only (the PE group). For further individual testing, we obtained permissions from 95 poor readers and 55 typically developing controls (the C group) and their parents. Finally, 84 poor readers (50 poor readers of both languages and 34 poor readers in English only) and 53 typical readers who completed all the tests were included in the analysis (see Figure 1).

As Table 1 shows, the PB group scored significantly worse than the C group on English word recognition and worse than the other two groups on Chinese character recognition (ps < .001). The PE group performed significantly worse on English word recognition than the typically developing readers (p < .001) and comparable on Chinese character recognition (p > .10). The two groups of poor English readers were similar in age, nonverbal cognitive ability, mother’s education level, and English word recognition (ps > .10). Because the poor readers in both Chinese and English had mothers with significantly lower education levels than the typical readers (ps < .01), mother’s education level was controlled in the subsequent analyses.

**Measures**

**NONVERBAL COGNITIVE ABILITY TEST.** We used the Chinese version of Raven’s Standard Progressive Matrices (Zhang & Wang, 1985) to measure students’ nonverbal cognitive ability in the present study. Participants were required to choose the best fit for completing the missing part of a matrix. The test consists of 60 items, and the total number of correct responses was

![Flowchart About Participant Classification](image)
the final score. The internal consistency reliability coefficient (Cronbach’s alpha) was .83.

MOTHERS’ EDUCATION LEVELS. Mothers’ education levels were rated on a 6-point scale: 1 = attended primary school, 2 = attended junior middle school, 3 = attended senior middle school, 4 = attended three-year college, 5 = attended four-year university, and 6 = attended graduate school.

CHINESE CHARACTER RECOGNITION. The Primary School Students’ Chinese Literacy Scale (X.L. Wang & Tao, 1996), which has been used in previous studies (e.g., Peng, Sun, Li, & Tao, 2012; Shu, Meng, & Lai, 2003), was administered to students to measure their Chinese character recognition. Participants were asked to generate words or phrases using 206 different characters. The total number of correct responses was the final score, and the internal consistency reliability coefficient (Cronbach’s alpha) was .93. This task is strongly correlated with the Chinese character reading aloud task (Meng, Zhou, & Shu, 2000; reliability = .77, p < .001).

ENGLISH WORD RECOGNITION. We randomly selected 120 words from English textbooks used by the participants. Students were asked to choose one word from four Chinese words that best matched the meaning of an English word. The total number of correct responses was the final score, and the internal consistency reliability coefficient (Cronbach’s alpha) was .82.

ENGLISH AND CHINESE PHONOLOGICAL AWARENESS. Onset-rime and phoneme deletion tasks were administered to measure English and Chinese phonological awareness. Students were asked to sound out what was left after deleting the onset, rime, or phoneme of a syllable presented aurally. A Chinese tone switch task was also administered, in which participants were asked to listen to and repeat two Chinese syllables and then say the first syllable with the tone of the second syllable. For example, students were asked to listen to and repeat /ba1/ and /ma3/ and then say /ba3/.

For onset-rime deletion, there were 15 items in English and five items in Chinese. The internal consistency reliability coefficient was .85 and .73, respectively. For phoneme deletion, there were 15 items in English and 10 in Chinese. The internal consistency reliability coefficient (Cronbach’s alpha) was .86 and .75, respectively. Among the 30 items on the English phonological awareness test, 16 were chosen from the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999), and the other 14 included consonant clusters because native Chinese students have difficulty in manipulating consonant clusters (Tao, Huang, & Li, 2005). The Chinese tone awareness task comprised five items. The internal reliability coefficient (Cronbach’s alpha) was .73. Because of the different item numbers for measuring onset-rime and phonemic and tone awareness, we used percentages of correct responses as the scores for further analyses.

RAPID ENGLISH LETTER/CHINESE DIGIT NAMING. English letters were used for the English task, and digits were used for the Chinese task, as in previous studies (e.g., Keung & Ho, 2009; Shum et al., 2016). Students were presented with a sheet of a 10 × 5 array of lowercase letters or digits (a, d, o, p, and s in English; 2, 4, 5, 6, and 9 in Chinese) in random order and were asked to name the letters or digits one by one as quickly as possible. Each task was repeated twice, and the averaged time was the score. The test–retest reliability was .84 for the English task and .83 for the Chinese task.

ENGLISH AND CHINESE PHONOLOGICAL MEMORY. Students were asked to listen to and repeat nonsense syllables in order, based on previous studies (Peng et al., 2012). The total number of correct responses

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**TABLE 1**

Demographic Characteristics of the Study 1 Participants by Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>PE (n = 34)</th>
<th>PB (n = 50)</th>
<th>C (n = 53)</th>
<th>F(2, 134)</th>
<th>η²</th>
<th>Post hoc comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>121.26</td>
<td>120.22</td>
<td>120.04</td>
<td>1.83</td>
<td>.03</td>
<td>PB = PE = C</td>
</tr>
<tr>
<td>Nonverbal IQ</td>
<td>43.56</td>
<td>41.20</td>
<td>42.79</td>
<td>1.39</td>
<td>.02</td>
<td>PB = PE = C</td>
</tr>
<tr>
<td>Mothers’ education level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College level and above</td>
<td>38%</td>
<td>24%</td>
<td>47%</td>
<td>χ²(2) = 6.02∗ —</td>
<td>PB &lt; C</td>
<td></td>
</tr>
<tr>
<td>English word recognition</td>
<td>39.26</td>
<td>36.16</td>
<td>73.40</td>
<td>134.41***</td>
<td>.66</td>
<td>PE = PB &lt; C</td>
</tr>
<tr>
<td>Chinese character recognition</td>
<td>165.66</td>
<td>128.52</td>
<td>172.42</td>
<td>18.27***</td>
<td>.21</td>
<td>PB &lt; PE = C</td>
</tr>
</tbody>
</table>

Note. C = typically developing controls; PB = poor English readers with native Chinese-reading difficulties; PE = poor English readers without native Chinese-reading difficulties. Bonferroni correction was applied to the post hoc comparisons. **p < .01. ***p < .001.
was the final score. For the Chinese task, the length of the syllable strings ranged from two to 11 syllables. There were 30 items, with 10 sets of three trials each. The number of syllables increased through each set. The internal reliability coefficient (Cronbach’s alpha) was .76. For the English task, the length of the syllable strings ranged from two to six syllables. There were 18 items, with five sets of three trials each for the first set, which contained six trials. The internal reliability coefficient was (Cronbach’s alpha) .77.

**Procedure**

Six assessors who had majored in psychology received two training sessions and conducted all assessments. The first training session lasted about three hours, mainly on construct concepts, detailed task procedures, instructions to students, and strategies for working with children, parents, and teachers. The second session lasted two to three hours. In the second session, new assessors observed experienced assessors’ demonstration by video or direct observation and rehearsed their operations until the supervisor was satisfied. After training in the lab, new assessors observed experienced assessors’ administration in the field several times and then went to test students with experienced assessors’ supervision once or twice.

The data collection consisted of two phases. First, we administered the screening tests, including the nonverbal cognitive ability test, English word recognition, and Chinese character recognition, in a group at school for all 962 students. We also collected school exam scores from school records, student nominations from teachers, and family background information from parents. Second, we individually administered the Chinese- and English-reading, phonological awareness, phonological memory, and rapid naming tasks to the poor and typically developing controls identified from the first phase of the study in a quiet room at the school. All the tasks were grouped into three or four sessions, and each session lasted approximately 30–40 minutes. The order of Chinese and English tasks was counterbalanced across students. Small gifts were offered to students as a token of appreciation.

**Results**

Table 2 shows the means and standard deviations of all measures by group in study 1. We conducted two separate multivariate analyses of covariance (MANCOVAs) with mother’s education level as the covariate Wilks’s Lambda to examine group differences. We used Pillai’s trace to examine the violation of assumptions.

For the Chinese measures, the group effect was significant, Pillai’s trace = .31, F(10, 262) = 4.77, p < .001, partial η² = .15. We conducted separate analyses of variance to examine each task and applied Bonferroni-adjusted tests (p = .02) to control for Type I error. The three groups—the poor readers of English only (PE), the poor readers of both languages (PB), and the typically developing controls (C)—did not perform significantly different on the Chinese phonological awareness measures (ps > .05; Cohen’s ds ≤ 0.41). On rapid naming, the two groups of poor English readers performed significantly worse than the typically developing readers (ps < .01, Cohen’s ds ≥ 0.62). On Chinese phonological memory, the PB group performed significantly worse than the other two groups (ps < .05, Cohen’s ds > 0.72), and no significant difference was found between the latter two groups (p > .10, Cohen’s d = 0.28). Perhaps poor English reading may not be closely linked to the problem in Chinese phonological awareness but may be associated with poor Chinese rapid naming skill irrespective of students’ native-reading status. Intact native phonological memory may protect some poor second-language readers from reading difficulties in their native language.

For the English measures, the group effect was also significant, Pillai’s trace = .33, F(8, 264) = 6.48, p < .001, partial η² = .16. Post hoc tests with Bonferroni adjustments found that the two groups of poor readers performed significantly worse than the control group on English phonemic awareness and rapid letter naming (ps < .001, Cohen’s ds ≥ 0.90). Further, the PB group performed significantly worse on English onset-rime awareness (p < .05, Cohen’s d = 0.61) than the C group. On English phonological memory, the PB group also performed significantly worse than the PE and C groups (ps < .05, Cohen’s ds ≥ 0.54). These findings show the crucial roles of both English phonemic awareness and rapid naming in learning to read English. Intact phonological memory and onset-rime awareness may protect students with specific English-reading difficulties from reading problems in the native language.

We further compared the deficit incidence on various Chinese and English skills between the two groups of poor English readers. A deficit was defined as performance of 1 standard deviation below the typically developing controls’ mean score on a certain skill (Aaron, Joshi, & Williams, 1999). Our findings in the present study largely replicated previous findings from English native speakers. As shown in Figure 2, poor English readers with and without Chinese-reading difficulties both demonstrated higher English phonemic awareness and rapid naming deficits than the typical readers (all χ²(1) > 6.29, ps < .01), which was consistent with the double-deficit hypothesis for reading difficulties (Wolf & Bowers, 1999). Also, phonological awareness and rapid naming deficit have been found to be the two major deficits in English-reading difficulties (50–80%; Goldberg, Wolf, Cirino, Morris, & Lovett, 1998; Lovett, Steinbach, & Frijters, 2000; Wolf et al., 2002). In
### TABLE 2
Mean Scores and Standard Deviations on Various Chinese and English Measures by Groups of Study 1 ($N = 137$) and Study 2 ($N = 112$)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Reliability</th>
<th>PE ($n = 34$ (25))</th>
<th>PB ($n = 50$ (44))</th>
<th>C ($n = 53$ (43))</th>
<th>$F(2, 134)$</th>
<th>$\eta^2$</th>
<th>Post hoc comparison</th>
<th>Cohen's $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study 1’s Chinese measures (pretest of study 2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese rime awareness</td>
<td>.73</td>
<td>(.70)</td>
<td>(.82)</td>
<td>(.24)</td>
<td>(.86)</td>
<td>(.22)</td>
<td>.85 (.22)</td>
<td>PE = PB = C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.27)</td>
<td>(0.89)</td>
<td>(.19)</td>
<td>(0.84)</td>
<td>(0.22)</td>
<td>.37 (.05)</td>
<td>PE = PB = C</td>
</tr>
<tr>
<td>Chinese phonemic awareness</td>
<td>.75</td>
<td>(.75)</td>
<td>(.80)</td>
<td>(.23)</td>
<td>(.75)</td>
<td>(.25)</td>
<td>.79 (.19)</td>
<td>PE = PB = C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.19)</td>
<td>(0.78)</td>
<td>(0.25)</td>
<td>(0.84)</td>
<td>(0.22)</td>
<td>.45 (.02)</td>
<td>PE = PB = C</td>
</tr>
<tr>
<td>Chinese tone awareness</td>
<td>.73</td>
<td>(.77)</td>
<td>(.92)</td>
<td>(.16)</td>
<td>(0.85)</td>
<td>(.23)</td>
<td>.92 (.17)</td>
<td>PB = PE = C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.16)</td>
<td>(0.85)</td>
<td>(0.23)</td>
<td>(0.95)</td>
<td>(0.10)</td>
<td>3.11 (.27)</td>
<td>PB = PE = C</td>
</tr>
<tr>
<td>Chinese phonological memory</td>
<td>.76</td>
<td>(.75)</td>
<td>(10.00)</td>
<td>(2.72)</td>
<td>(8.20)</td>
<td>(2.28)</td>
<td>10.77 (2.84)</td>
<td>PB = PE = C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.84)</td>
<td>(2.26)</td>
<td>(2.39)</td>
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<th>C (n = 43)</th>
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<th>$\eta^2$</th>
<th>Post hoc comparison</th>
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<td>.20</td>
<td>PB &lt; PE = C</td>
</tr>
</tbody>
</table>

Note. C = typically developing controls; PB = poor English readers with native Chinese-reading difficulties; PE = poor English readers without native Chinese-reading difficulties. Values in parentheses are the data of the pretest in study 2. Bonferroni correction was applied to the post hoc comparisons.

- Controlling for mothers’ education levels.
- For the C group, pretest and posttest were the same data.
- Chinese character reading, English word reading, and English pseudoword reading were only measured for the participants in study 2.

*p < .05. **p < .01. ***p < .001.
addition, the poor readers in both Chinese and English also showed a higher phonological memory deficit on both Chinese and English than the typical readers did (all $\chi^2(1) > 4.78$, $p < .05$), indicating that impaired phonological memory may result in reading difficulties in both the native and second language.

**Summary of Study 1**

Phonemic awareness deficit in English may be specific to reading difficulties in English. The two groups of poor readers in English demonstrated significantly weaker English phonemic awareness, and poor readers in English only did not show other phonological awareness deficits in either language. Therefore, English phonemic awareness may be critical for English reading even for native Chinese-speaking students, similar to what has been found among native English-speaking students (Melby-Lervåg et al., 2012). As expected, the two groups of poor readers in English demonstrated rapid naming deficits in both languages, confirming that rapid naming deficits may be common for both native- and second-language reading difficulties (Chung & Ho, 2010; Ho & Fong, 2005). Perhaps, for the first time, it has been shown that whereas poor readers in two languages show phonological memory problems in both languages, poor readers in English only do not show phonological memory deficits in either language. Therefore, deficits in the fundamental phonological storage ability may result in reading problems in either language. Also, intact fundamental phonological storage ability may exempt students from reading difficulties in their native language.

## Study 2

As mentioned previously, because inadequate instruction and experience may be particularly related to second-language reading difficulties (Elbro et al., 2012), study 2 further examined how various native- (Chinese) and second-language (English) skills may contribute to second-language reading difficulties by offering intensive and explicit training on phonological skills that are critical for learning to read in English. First, we examined whether the two groups of poor English readers showed similar or distinct Chinese and English skill profiles after a short-term intensive and explicit training on English phonological skills. Then, we examined how native-language reading problems were associated with persistent second-language reading difficulties. We hypothesized that poor English readers without Chinese-reading difficulties may benefit more from the English phonological skill intervention than those with Chinese-reading difficulties.

The two groups of poor readers completed reading and language skill assessments in the two languages before the intervention (grade 4 pretest), right after the intervention (grade 4 posttest), and one year later (grade 5 follow-up test). As a comparison, the typically developing controls were assessed at grades 4 and 5.

## Method

### Participants

One hundred twelve students from study 1 participated in study 2: 44 poor English readers with Chinese-reading
problems (PB group: 34 boys, \( M_{\text{age}} = 119.52 \) months, 
\( SD = 4.07 \) months), 25 poor English readers without 
Chinese-reading problems (PE group: 14 boys, \( M_{\text{age}} = 121.16 \) 
months, \( SD = 5.37 \) months), and 43 typically developing 
controls (C group: 21 boys, \( M_{\text{age}} = 119.88 \) months, \( SD = 2.23 \) 
months). The participants in study 2 were not significantly 
different from those in study 1 in age, nonverbal cognitive 
ability, mothers’ education levels, English word recognition, 
and Chinese character recognition, respectively. As in 
study 1, we controlled for mothers’ education levels in the 
subsequent analyses because the poor readers in both 
Chinese and English had mothers with significantly lower 
education levels than the typical readers (\( ps < .01 \)).

On English word recognition, the two groups of 
poor readers (PE group: \( M = 45.12, SD = 12.18; \) PB 
group: \( M = 39.34, SD = 9.57 \)) performed significantly 
more poorly than the C group (\( M = 75.63, SD = 7.86; \) \( ps < .001 \)), 
and no significant difference was found between the 
two groups of poor readers (\( p > .10 \)). On Chinese char-
acter recognition, the PB group (\( M = 140.65, SD = 27.78 \)) 
performed significantly worse than the PE (\( M = 187.34, 
SD = 5.64 \)) and C groups (\( M = 192.31, SD = 7.02; \)
\( ps < .001 \)), whereas the PE group performed comparably 
to the C group (\( p > .05 \)).

**Intervention**

We provided poor English readers with explicit training 
on both letter knowledge and phonological awareness 
in addition to their regular school English instruction. 
The intervention followed the guidelines of the National 
Reading Panel’s report (NICHD, 2000) and lasted for 10 
hours across three weeks. Poor readers received one 
hour of training in small groups (7–12 students) three 
or four times every week. Each one-hour training 
session entailed two half-hour subsessions with a 
10-minute break between. Letter knowledge training 
comprised letter names, letter sounds, and letter combi-
nation sounds (e.g., \( a \) [ei], \( a \) [æ], are [\( \alpha: \) r]). Phonol-
egical awareness training entailed identification, 
segmentation and blending of syllables, onset-rimes, 
and phonemes. Onset-rimes and phonemes were fo-
cused on more than syllables, as most students did not 
show difficulties at the syllable level. Consonant clus-
ters as part of the onset-rime training were highlighted 
because native Chinese-speaking students have per-
formed particularly poorly on English onset-rime ma-
nipulation with consonant clusters (Tao et al., 2005).

The activities, slides, flashcards, and hands-on 
sheets were developed and edited based on guidelines 
of Blachman, Ball, Black, and Tangel (2000) and the 
Florida Center for Reading Research (2008). All real 
words used in the intervention were available in stu-
dents’ textbooks in grades 1–3. Lessons were intro-
duced and implemented as games and activities. For 
example, in the phonological awareness training, stu-
dents learned to blend different sound units by fixing a 
puppet’s broken language (Fix-It games) and to seg-
ment different sound units in moving corresponding 
blocks, circles, and so forth (Elkonin card games); in 
the letter knowledge training, students learned to find 
a certain letter in alphabet cards and say the letter 
name or sound according to the instruction (Show Me 
Your Letter games) and to say words starting with a let-
ter from the alphabet cards (I’m Thinking of a Word 
games).

Under the supervision of the second author, three 
graduate students majoring in developmental psychol-
ogy prepared for and implemented the intervention. For 
each session, one primary trainer delivered the train-
ing, and one assistant trainer took care of the students 
who did not follow the instruction, kept record of the 
activities on a checklist, and reminded the trainer of the 
activities when necessary. The graduate students re-
viewed and reported to the second author after training 
on every training day. The second author did the field 
visit twice every week. According to the graduate stu-
dents’ report and the senior researcher’s field visits, all 
activities were implemented as planned.

**Measures**

The Chinese and English phonological awareness, pho-
notogical memory, and rapid naming measures were 
identical to those in study 1. The additional measures 
were administered individually and are described in the 
following subsections.

**CHINESE CHARACTER READING.** This measure con-
isted of 154 Chinese characters from the textbooks 
used by the participants. Students were required to read 
 aloud Chinese characters printed in a booklet one by 
one from top to bottom and from left to right. One point 
was given for each correct response, and the maximum 
score was 154. The overall internal consistency reliability 
coefficients for this task were all above .92.

**ENGLISH WORD READING.** This measure consisted 
of 100 English words randomly selected from the 
textbooks used by the participants. The word lengths 
ranged from three to 11 letters. Students were required 
to read aloud English words printed in a booklet one by 
one from top to bottom and from left to right. The total 
number of words read correctly was the final 
score, and the internal consistency reliability coeffi-
cients were all above .95 across times.

**ENGLISH PSEUDOWORD READING.** This measure 
consisted of 31 items in VC (verb–consonant), CVC, 
and CVCC structures (e.g., \( af, pem, vist; \) Snowling, 
Stackhouse, & Rack, 1986). Students were required to
read aloud these pseudowords printed on a sheet one by one from top to bottom and from left to right. One point was given for each correct response, and the maximum possible score was 31. The internal consistency reliability coefficients of this task were all above .81 across times.

Procedure
All students individually completed the tasks of English word/pseudoword reading, Chinese character reading, English and Chinese phonological awareness, rapid naming, and phonological memory in a quiet room at the school. Testers were trained graduate and senior undergraduate students majoring in psychology. The poor readers were assessed three times: grade 4 pretest, grade 4 posttest, and grade 5 follow-up test. Because the testing time was limited and there was no change found on rapid naming and phonological memory within one month based on our pilot study, we did not administer the two tasks at the posttest. We also did not administer the Chinese measures at the posttest. The typical readers were assessed twice, at grades 4 and 5. Permission was obtained from parents, school principals, teachers, and children, and small gifts were offered to students after the assessments as a token of appreciation.

Results
Table 2 shows the means and standard deviations of all measures for the poor English readers with (the PB group) or without (the PE group) native Chinese-reading problems and for the typically developing controls (the C group) on the pre-, post-, and follow-up tests.

Native- and Second-Language Skill Deficit Profiles for Poor English Readers With and Without Native-Language Reading Difficulties After the Intervention
We conducted a series of MANCOVAs, with mother’s education level as the covariate, to examine group differences on various Chinese and English word-reading and language skill measures at three times of assessments. If there was any violation of the assumptions, Pillai’s trace was replaced by Wilks’s Lambda for the MANCOVA.

At the pretest, we found similar results as in study 1 for both the Chinese and English measures. At the posttest, we found a significant overall group effect, Wilks’s $\Lambda = .73$, $F(8, 210) = 4.38$, $p < .001$, partial $\eta^2 = .14$. The post hoc comparisons with Bonferroni adjustment indicated that right after the intervention, both the PB and PE groups caught up with the C group on all English phonological awareness measures ($p > .05$, Cohen’s $d$s $\leq 0.39$). In addition, the PE group caught up on English pseudoword reading ($p > .10$, Cohen’s $d = 0.01$). More interesting, the PE group performed significantly better than the PB group on English word and pseudoword reading ($p < .05$, Cohen’s $d$s $\geq 0.58$) right after the intervention. However, neither group of poor English readers caught up with the typical readers on English word reading despite significant improvements ($p < .05$, Cohen’s $d$s $\geq 0.74$).

At the follow-up test, all of the Chinese measures except phonemic awareness showed similar profiles as in the pretest. Despite the comparable performance at the pretest, the PB group performed significantly worse than the typical readers on Chinese phonemic awareness at the follow-up test. For the English measures, MANCOVA showed a significant group effect, Pillai’s trace = .70, $F(12, 208) = 9.36$, $p < .001$, partial $\eta^2 = .35$. Bonferroni-adjusted post hoc comparisons showed that both groups of poor English readers performed significantly worse on rapid letter naming and English word reading than the typical readers did ($p < .001$, Cohen’s $d$s $\geq 1.00$). Again, the PB group showed significantly weaker English phonemic awareness one year later than the typical readers did ($p < .001$, Cohen’s $d = 0.75$). Importantly, we observed significantly more improvement on English phonemic awareness and word and pseudoword reading for the PE group than the PB group at the follow-up test ($p < .01$, Cohen’s $d$s $\geq 0.56$), whereas the two groups of poor English readers were not significantly different on these measures at the pretest ($p > .05$).

To examine whether native-language reading abilities may affect poor second-language readers’ gain from the phonological skill intervention, we conducted a repeated measure of ANOVA. Four measures (English word reading, pseudoword reading, onset-rime awareness, and phonemic awareness) and three test times (the pretest, posttest, and follow-up) were included as the within-group variables, and group (the poor English readers with or without Chinese-reading difficulties) was included as the between-group variable. The result showed a significant interaction effect of time and group, $F(6, 396) = 2.95$, $p = .014$, partial $\eta^2 = .22$. Whereas the PB and PE groups performed comparably on all four measures at the pretest ($p > .05$), the PE group performed significantly better than the PB group on English word and pseudoword reading ($p < .001$, partial $\eta^2 = .35$). Again, the PB group showed significantly worse on rapid letter naming and English word reading than the typical readers did ($p < .001$, Cohen’s $d$s $\geq 1.00$). Again, the PB group showed significantly weaker English phonemic awareness one year later than the typical readers did ($p < .001$, Cohen’s $d = 0.75$). Importantly, we observed significantly more improvement on English phonemic awareness and word and pseudoword reading for the PE group than the PB group at the follow-up test ($p < .01$, Cohen’s $d$s $\geq 0.56$), whereas the two groups of poor English readers were not significantly different on these measures at the pretest ($p > .05$).

The Persistence of Second-Language Reading Difficulties and Relevant Skill Profiles
Poor readers who scored above the 30th percentile on the English word recognition test at grade 5 were classified as no longer poor English readers (PE-N), and
those who still scored below the 25th percentile were classified as persistently poor English readers (PE-P). Thirty percent of students were identified as PE-N when there were no Chinese-reading difficulties, whereas only 4% were identified as PE-N when there were Chinese-reading difficulties. Group comparisons confirmed that in relation to the PE-N students, significantly worse performance was found on English word and pseudoword reading at grade 5 for the PE-P students, $F(1, 23) > 25.95, ps < .001$.

Table 3 shows the means and standard deviations of all skill measures by the four groups at grade 5. MANOVA revealed significant group differences, Pillai’s trace $= .36, F(27, 306) = 2.74, p < .001$, partial $\eta^2 = .19$. As before, we adopted Bonferroni adjustment for the post hoc tests. Games–Howell post hoc test was used when the equal variance assumption was violated. As shown in Table 3, the PE-N group performed comparably to the typical readers on all Chinese and English skills ($ps > .05$). In contrast, the PE-P group performed significantly worse than the typical readers on Chinese and English rapid naming ($ps < .001$). As to the skill deficits, we found at grade 5 that the PE-N group showed many fewer skill deficits (0–13%) in both languages, which was consistent with their adequate bilingual reading performance. In contrast, many more students in the PE-P group showed English phonological awareness deficits (24–43%) and English and Chinese rapid naming deficits (67% and 53%, respectively) than the PE-N group did (all $\chi^2(1) > 3.94, ps < .05$) at grade 5. The PE-N group also showed much less deficit in English pseudoword reading (25% vs. 71%) and phonemic awareness (25% vs. 76%) than the PE-P group did on the grade 4 pre-test, $\chi^2(1) > 7.76, ps < .01$. Moreover, the PE-N group had intact phonological memory, supporting the significance of intact basic phonological storage ability for helping poor second-language readers overcome their difficulties.

**Summary of Study 2**

When free of Chinese-reading difficulties, poor English readers caught up with the typically developing controls on English phonemic awareness and word

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<th>PB (n = 44)</th>
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<th>PE-N (n = 8)</th>
<th>C (n = 43)</th>
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<td>0.91</td>
<td>0.87</td>
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<td>Chinese tone awareness</td>
<td>0.93</td>
<td>0.98</td>
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<td>0.98</td>
<td>$F(3, 108) = 2.49$</td>
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<td>7.96</td>
<td>8.76</td>
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<td>$F(3, 108) = 6.51^*$</td>
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<tr>
<td>Rapid digit naming</td>
<td>19.82</td>
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<td>16.96</td>
<td>$F(3, 108) = 6.47^*$</td>
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<td>0.61</td>
<td>0.66</td>
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<td>0.69</td>
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<tr>
<td>English phonemic awareness</td>
<td>0.64</td>
<td>0.71</td>
<td>0.90</td>
<td>0.78</td>
<td>$F(3, 108) = 6.99^*$</td>
</tr>
<tr>
<td>English phonological memory</td>
<td>10.79</td>
<td>13.17</td>
<td>13.75</td>
<td>13.30</td>
<td>$F(3, 108) = 8.75^*$</td>
</tr>
<tr>
<td>Rapid letter naming</td>
<td>25.24</td>
<td>25.47</td>
<td>24.02</td>
<td>20.40</td>
<td>$F(3, 108) = 9.52^*$</td>
</tr>
</tbody>
</table>

**Note.** C = typically developing controls; PB = poor English readers with native Chinese-reading difficulties; PE-N = poor English readers without native-reading difficulties who were no longer poor in English reading at grade 5; PE-P = poor English readers without native-reading difficulties who were persistently poor in English reading at grade 5. Bonferroni correction was applied to the post hoc comparisons.

**p < .01.***p < .001.
decoding and even retained their gains over one year with an intensive and explicit intervention on English phonological skills. However, in the presence of Chinese-reading difficulties, poor English readers did not retain their progress on phonemic awareness from the intervention and even lagged behind on Chinese phonemic awareness one year later. Therefore, whereas poor second-language readers may improve their second-language skills with an intensive intervention, those students also suffering from native-language reading difficulties may need more and continuing support to catch up with their typically developing peers in the long run.

In addition, poor English readers had persistent rapid naming deficits irrelevant to their Chinese-reading status, and poor readers in both languages also had persistent phonological memory deficits. Further, the persistent poor English readers demonstrated broader and more severe language skill deficits. The distinct skill profiles for persistently and remediable poor English readers were consistent with previous findings from native-English readers that persistently poor readers performed significantly worse on phoneme segmentation, rapid naming, and verbal memory than the readily remediated readers did (Vellutino et al., 1996).

**General Discussion**

We examined the relations between various native- and second-language skills and second-language reading difficulties for Chinese ESL students by combining group comparisons and intervention/follow-up studies. Results indicated both dissociations and associations between native- and second-language reading difficulties (Ho & Fong, 2005; McBride-Chang et al., 2012, 2013). Difficulties in one’s native-language reading may hinder second-language reading acquisition, even when the two languages are in sharp contrast. Findings from this study support the linguistic interdependence hypothesis (Cummins, 1979) and partially support the linguistic coding differences hypothesis (Sparks et al., 1989). Because some poor second-language readers who are free of native-language reading difficulties showed distinct skill profiles in this study and previous studies (Ho & Fong, 2005; McBride-Chang et al., 2012, 2013), second-language reading difficulties may not be just a byproduct of native-language reading difficulties. The linguistic coding differences hypothesis fails in accounting for the dissociations between native- and second-language reading difficulties. Thus, in addition to the association between native- and second-language reading difficulties in line with the linguistic interdependence hypothesis, the dissociation may suggest that the type of orthography has to be taken into consideration while examining that hypothesis.

First, English phonemic awareness plays important roles in learning to read English even for second-language learners whose native language is nonalphabetic. We found that worse English phonemic awareness was particularly associated with poor English reading concurrently and across time and that English phonological skill training significantly improved English-reading performance for poor English readers. These findings underscore the importance of phonological awareness, particularly phonemic awareness, for learning to read English even for children who learn English as a second language (McBride-Chang, Tong, et al., 2008). We did not observe significantly worse Chinese phonological awareness in poor readers only in English, which is consistent with the findings of previous studies of native Chinese students from mainland China (McBride-Chang et al., 2013) but inconsistent with some findings of previous studies of Hong Kong students (McBride-Chang et al., 2012; Tong et al., 2015). Different reading instruction may account for the inconsistency between findings from Hong Kong and mainland China students. For example, students in mainland China learn pinyin as a tool for learning to read Chinese characters, but Hong Kong students do not. Pinyin learning prompts native Chinese speakers to develop their phonological awareness (Read, Zhang, Nie, & Ding, 1986; Shu, Peng, & McBride-Chang, 2008). Students from mainland China performed significantly better in Chinese and English syllable and phoneme-onset deletion than students from Hong Kong did (McBride-Chang, Bialystok, Chong, & Li, 2004). Although Chinese phonological awareness plays important roles for learning to read Chinese (Song, Georgiou, Su, & Shu, 2016), future studies might examine the roles of native-language phonological awareness in learning to read a second language across different types of instruction.

Second, rapid naming may be universal for reading development in both native and second languages, and rapid naming deficit in one’s native language may be a marker for reading difficulties in both languages (Chung & Ho, 2010; McBride-Chang et al., 2013; Pan et al., 2011). We further found persistent rapid naming deficits for poor second-language readers irrespective of their native-language reading status. Both this study and a previous study (McBride-Chang et al., 2013) found worse Chinese rapid naming performance for poor readers only in English despite their adequate Chinese-reading performance. Rich native-language exposure and more reading experiences may compensate for rapid naming deficit in reading in a native language, as shown by a meta-analysis of 137 studies finding rapid naming more strongly related to word reading in beginning readers (Araújo, Reis, Peterssson, & Faisca, 2015). Therefore, rapid naming deficit may
not necessarily lead to reading difficulties in one’s native language, particularly for students at grades 4 and above. More research is needed to explore the roles of native-language rapid naming at different developmental stages of second-language reading.

Third, phonological memory may be one universal language skill in learning to read. We found persistent phonological memory deficits in two languages for both bilingual and persistent second-language reading difficulties even after phonological skills training. Therefore, deficits in basic phonological storage ability may result in reading difficulties in any language and may persist even after remediation. These findings are consistent with those of previous studies in that phonological memory significantly predicted new word learning (Masoura & Gathercole, 1999), especially for beginning second-language learners with poor vocabulary (Cheung, 1996). Because most students in this study may have had limited English vocabulary because of their limited English-language exposure, phonological memory may be particularly important for learning to read in English and, thus, their gains from the intervention.

In study 2, we found that even one year after the intervention, the performance of about one third of students who were poor in English only were comparable to the performance of their typically developing peers. Thus, English phonological awareness and letter knowledge play critical roles in learning to read in English even for learners with a nonalphabetic native-language background. Furthermore, insufficient instruction on such critical skills may result in poor reading performance, at least for some second-language learners. However, the majority of the poor English readers showed persistently poor English-reading performance, English phonemic awareness, and rapid naming in both languages. Therefore, on the one hand, such a short-term intervention on phonological skills cannot resolve second-language reading difficulties for most poor readers. More prolonged and more comprehensive learning supports may be required for helping students overcome their second-language reading difficulties, especially for bilingual poor readers. On the other hand, second-language reading difficulties may not be simply attributed to insufficient instruction. More studies are needed to explore the underlying mechanisms for individual differences in learning to read a second language.

There are limitations in the present study. First, because we focused on second-language reading difficulties, we did not include a group of students only exhibiting native-language reading problems (Chung & Ho, 2010; Ho & Fong, 2005; McBride-Chang et al., 2012). Future studies might include groups varying in second-language reading status to produce more comprehensive evidence for understanding the associations and disassociations between native- and second-language reading problems. Second, we did not measure the spoken-language skills of the participants. Spoken language is important in reading development (Liu & Tao, 2007; Manis & Lindsey, 2010), particularly for second-language learners with poor vocabulary (Cheung, 1996). Further studies should examine how vocabulary may moderate the relation between various language skills and second-language reading. Third, the intervention in this study was short and focused on phonological skills and letter knowledge. Future studies may use a more comprehensive and prolonged intervention (e.g., on both phonological skills and vocabulary) to examine how second-language reading difficulties are related to broader skill profiles in native and second languages.

In summary, although closely related, second-language reading difficulties are not just residuals of native-language reading difficulties. The roles of native- and second-language skills in second-language reading difficulties may depend on the requirements of the second language and students’ instructional and learning experiences. For native Chinese-speaking English learners, phonemic awareness deficit is more specific to English-reading difficulties, whereas rapid naming deficits are linked to both English- and Chinese-reading difficulties, and phonological memory may be an indicator for reading difficulties in both the native and second language. Persistent rapid naming and phonological memory deficits may be linked with persistent English-reading difficulties across time. Furthermore, English phonological awareness problems appear to be remediable by explicit instruction. However, improving phonological awareness alone cannot fully resolve word-reading problems for struggling English readers, as other skills, such as vocabulary, may have to be improved.

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