Changing models across cultures: Associations of phonological awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea, and the United States

Catherine McBride-Chang a,*, Jeung-Ryeul Cho b, Hongyun Liu d, Richard K. Wagner c, Hua Shu d, Aibao Zhou d, Cecilia S-M. Cheuk a, Andrea Muse c

a Department of Psychology, Chinese University of Hong Kong, Shatin, N.T., Hong Kong
b Department of Psychology, Kyungnam University, Masan, South Korea
c Department of Psychology, Florida State University, Tallahassee, FL 33206, USA
d Department of Psychology, Beijing Normal University, Beijing, People’s Republic of China

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Abstract

Using data provided by approximately 100 second graders each from Beijing, Hong Kong, Korea, and the United States, we investigated relations among phonological awareness, morphological structure awareness, vocabulary, and word recognition. Our results indicate that across languages, phonological awareness and morphological structure awareness are similarly associated with one another and with vocabulary knowledge; however, phonological awareness and morphological structure awareness have different associations with word recognition in different scripts among second graders. Specifically, phonological awareness may be more important for reading in English and Korean than for reading in Chinese. In contrast,

* Corresponding author. Fax: +852 2603 5019.
E-mail address: cmcbride@psy.cuhk.edu.hk (C. McBride-Chang).

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Introduction

Most current developmental textbooks that address the topic of reading in children emphasize the importance of phonological awareness for early reading (e.g., Bee, 2000; Feldman, 2004). However, the extent to which phonological awareness is associated with reading development likely depends on the language in which it occurs and the script to which it is linked as well as the developmental level of the child. In the current study, we examined the strength of association of phonological awareness with word recognition in four cultures: two in which phonological awareness may be of relatively limited utility for word recognition in primary school (Hong Kong and China) and two in which it appears to be relatively important (United States and Korea). Based on striking features of the languages and scripts of these cultures, we also explored the importance of early morphological structure awareness for reading development. We began with the premise that although sensitivity to phonological and morphological information is essential for language development across cultures, the usefulness of such information as predictors of word recognition in second grade depends on the characteristics of the scripts to be read.

Conceptualizing morphological structure awareness across cultures

Our focus on meaning targets a single aspect of it: morphological structure awareness. Morphemes are the smallest units of meaning in words. English-speaking children begin to demonstrate knowledge of morphological structure very early, for example, when they apply the morpheme *s* at the end of certain nouns to make them plural. Adolescents and adults continue to use morphological structure knowledge, for example, when they use their understanding that *hydro* means water to comprehend the meaning of *hydrofoil* in context. Morphological structure awareness is the awareness of and access to morphemes, reflected in the ability to apply morphemic knowledge to recognize and create new word forms that are morphologically complex and conform to the structure of a given language.

Morphological structure knowledge is important in the transition from language learning to literacy skills. For example, Byrne (1996) noted that English-speaking children tend to notice the morphological features, rather than the phonological features, of new words during the earliest stages of learning to read. Thus, young children tend to distinguish word pairs such as *cup/cups* but not *bug/bus*, presumably because they attend to the plural form indicated in the first pair and care less about word distinctions in the second pair. Studies have demonstrated the importance of morphological awareness for reading in Chinese and Korean than for reading in English at this grade level.

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morphological awareness for reading in both alphabetic (e.g., Carlisle, 1995; Carlisle & Nomanbhoy, 1993; Mahony, Singson, & Mann, 2000) and Chinese orthographies (e.g., Ku & Anderson, 2003; Li, Anderson, Nagy, & Zhang, 2002; Shu & Anderson, 1997; Shu, Anderson, & Zhang, 1995). However, empirical evidence on the association of morphological awareness with reading is sparse, particularly relative to the many studies on the association of phonological awareness with reading.

The idea for morphological structure awareness as measured in the current study emerged from the linguistic structure of Chinese (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003). Chinese is described as an analytic language, meaning that morphemes can be combined in regular and predictable ways to form new, sometimes more complicated concepts. Thus, although the English terms woman and adult are linguistically opaque in the sense that they are morphologically unrelated to one another, this is not the case in Chinese. In Mandarin, for example, these terms share the base morpheme ren2, meaning person. As another example, whereas in English the names of countries are sometimes linguistically opaque, such as in Albania, Germany, and Korea, in Mandarin all countries’ names end with the morpheme guo2, meaning country. Parallels in English might be the fact that stoplight, lighthouse, and highlight all contain the root word light and that bumblebee, honeybee, and beehive all contain the root word bee. Although such English examples of compounding exist, they are infrequent relative to those in Chinese languages. This regularity of Chinese languages may focus Chinese children on patterns of association and category earlier and more systematically than does English. For example, children may come to understand that words ending with guo2 generally indicate countries or that words ending in ren2 generally indicate a person of some type. Furthermore, those who recognize such patterns more easily might also learn to read more easily by mapping such linguistic patterns onto Chinese characters.

This idea was tested in a group of kindergarten and second-grade children from Hong Kong (McBride-Chang et al., 2003). In that study, the task of morphological structure awareness was the only one that uniquely predicted variance in reading across both samples of Chinese children in regressions, with phonological awareness, speed of processing, speeded naming, and vocabulary as additional predictors. Morphological structure awareness was an orally administered measure, so the associations with print were encouraging for understanding how awareness of morphological structure in spoken language and in print might be associated.

Following connectionist models (Gonnerman, Seidenberg, & Andersen, 2005; Plunkett & Marchman, 1991, 1993), we view morphological structural ability as similar across derivational and inflectional morphology. For example, in English, describing the moon going down at night as a moonset or claiming that a term for more than one mig is migs both reflect morphological structure awareness because they reflect understanding of the morphological structure of the language. In the current study, we constructed indigenous tasks of morphological structure awareness in Cantonese, Mandarin, Korean, and English. These tasks contained different items depending on the language. In both Chinese languages and Korean, morphological structure awareness involved lexical compounding only, whereas in English, this task included both compounding and inflectional morphology items.
Most studies of morphological awareness and English word recognition underscore the strong association of morphological awareness and phonological awareness (Carlisle, 1995; Fowler & Liberman, 1995). For example, in their discussion of factors predicting reading and reading disability, Fowler and Liberman (1995) argued, “If morphology does play a separate role from phonology, . . . it is a small role indeed” (p. 179). This issue is important to consider in relation to language, orthography, and developmental level across cultures. We examined the extent to which morphological structure awareness and phonological awareness could be distinguished in associations with word recognition across cultures in the current study.

**Conceptualizing phonological awareness across cultures**

Tasks of phonological awareness have been created and refined in scores of studies on English-speaking children learning to read English (e.g., Adams, 1990; Brady & Shankweiler, 1991; Pressley, 1998; Wagner et al., 1997). Most of these tasks have focused on phoneme manipulation. A phoneme is a single speech sound. Because learning to read alphabets involves combining individual speech sounds (e.g., *bat* can be read by combining the sounds /b/--/æ/--/t/), the ability to isolate and manipulate phonemes is advantageous.

However, phonological awareness need not be measured at the phoneme level only. Even in nonalphabetic scripts such as Chinese, phonological awareness is a good predictor of very early reading (e.g., Ho & Bryant, 1997; McBride-Chang & Kail, 2002). Each Chinese character represents a single syllable. Speech sound sensitivity to syllable rimes or onsets (parallels in English might be “What rhymes with *cat*? *Fat* or *ball*?” and “What begins the same as *cat*? *Fan* or *calf*?”) or syllable awareness (e.g., say **baseball** without saying **base**) are typical reliable measures of phonological awareness in Chinese (Leong, 1997; Siok & Fletcher, 2001). Phonemic awareness is less typically used to predict Chinese character recognition because the Chinese script is not represented at the phoneme level, so phonemic awareness is unnecessary for learning to read Chinese. Nevertheless, at least in English, phonological awareness of different levels of speech is best represented by a single-factor model (Anthony & Lonigan, 2004; Anthony et al., 2002). That is, explicit awareness of syllables, rhymes, phoneme onset, and phonemic skills often overlaps strongly and has been treated as a single indicator of phonological sensitivity in past studies.

Because languages and scripts differ, phonological awareness might not universally be a good developmental predictor of reading beyond its initiation. For example, researchers examining reading in Turkish (Öney & Durgunoğlu, 1997), German (Wimmer, 1993), and Chinese (McBride-Chang & Kail, 2002) have suggested that the importance of phonological awareness for reading is time-limited in a way that might not be the case for English due to the properties of these scripts. Because Turkish and German are relatively transparent orthographies, children tend to learn to combine phonemes fairly easily in early elementary school. In contrast, children master syllabic awareness, the primary unit of phonological awareness of importance in Chinese reading, by early elementary school (e.g., Treiman & Zukowski, 1991). Thus, although phonological awareness does appear to predict very early reading
across cultures (McBride-Chang & Kail, 2002; Wimmer, 1996), its importance for word recognition past first grade, the first year of literacy instruction in some cultures, appears to depend on the script under study.

Language and literacy characteristics in the four cultures included

The cultures we drew on in the current study represented those whose languages and orthographic structures might maximally capitalize on either phonological awareness, morphological structure awareness, or both for children to master word recognition. We tested children from the United States, China, Hong Kong, and South Korea to explore the relative importance of phonological awareness and morphological structure awareness for reading. Relevant language- and orthography-related aspects of children learning to read in these cultures are described below.

In the United States, children learn to read using an alphabet. Learning to read an alphabet is greatly facilitated when children grasp the alphabetic principle, that is, the idea that each letter can represent at least one (and often more than one) phoneme. Children are taught letter sounds and blending of these sounds in school, and early primary school is a time when children often focus concentrated efforts on sounding out words. The morphology of the English language is focused on inflections that primarily involve grammatical adjustments (e.g., making nouns plural, making verbs past tense) and derivations. Derivations include prefixes and suffixes (e.g., unbelievable combines the morphemes un, believe, and able) and compounds (e.g., sunrise is made up of the morphemes sun and rise, both of which are words on their own). Although knowledge of prefixes and suffixes is clearly linked to reading in English (e.g., Adams & Henry, 1997), such knowledge is greater and easier to tap in older children than in second graders. Thus, we tested only inflectional and compounding morphological awareness in the current U.S. sample.

One striking aspect of measurement of word recognition in second-grade English-reading children from the United States is that standardized tasks of word recognition contain few morphologically complex words. That is, most words that are tested at this level have few inflections or derivations. Unlike Korean or Chinese, where there is typically a one-to-one correspondence between syllable and morpheme, in English syllables and morphemes are relatively dissociated. For example, a relatively difficult word such as moustache is composed of only a single morpheme.

In Hong Kong, children learn to read Chinese using the “look and say” method. Teachers demonstrate how each character looks and then teach pupils to memorize it. No phonics instruction is given to aid in character recognition. The morphology of Chinese involves relatively few grammatical rules such as inflections, and these languages have few prefixes and suffixes. However, Chinese languages use extensive lexical compounding, as described previously. Moreover, because the vast majority of Chinese words are composed of two or more morphemes, word recognition at the second-grade level primarily involves such words. In Hong Kong, Cantonese is spoken.

In Beijing, China, Mandarin is spoken. This Chinese language differs from Cantonese to the extent that speakers of these two languages cannot communicate with...
one another orally without learning the other language. In China, Pinyin, a phonemic coding system, is taught to children from the beginning of literacy instruction. A Pinyin representation of each new Chinese character is paired with it when teaching word recognition. This presumably facilitates acquisition of Chinese characters and also promotes phonological awareness in children from China relative to those in Hong Kong (e.g., Huang & Hanley, 1995). In relation to morphology, the analytic nature of Mandarin closely mirrors that of Cantonese described earlier. Tasks of word recognition, composed primarily of items of two or more morphemes, are also similar.

In South Korea, Korean Hangul is taught from kindergarten. Hangul has been referred to as an alphabetic syllabary (Taylor & Taylor, 1995) because this script uses both phoneme- and syllable-level units. Children learn to read Hangul by combining the phonological units of onsets, middle vowels, and finals into syllables. Thus, Korean Hangul differs from Chinese in that sounding out new words in the former requires that children learn to blend phonemes. Although Korean does not have consonant clusters as English does, it nevertheless relies on phonological skills in combining speech sounds, in contrast to Chinese. However, the morphological structure of Korean is closer to Chinese than to English (Lim, 2002). Word recognition tasks at the second-grade level in Korean are primarily composed of words of two or more morphemes, similar to those in Mandarin and Cantonese but different from those in English.

Because this was a cross-cultural study focused on differences in languages and scripts, we sought to create tasks intended to represent identical constructs but modified to measure them sensibly within each language. For example, we focused on phonological awareness at the onset and syllable levels only in Chinese and Korean but at the phonemic level in English. Similarly, although we sought to measure morphological structure awareness across languages, the items used to measure this ability differed in ways that mirror our categorization of these languages. Our focus was on the associations among these tasks (and a comparison of these associations) rather than on a comparison across groups on such tasks. We were particularly interested in the associations of morphological structure and phonological awareness tasks with vocabulary and word recognition in each language.

**Hypotheses**

Researchers have consistently found evidence that morphological awareness is associated with vocabulary growth (e.g., Carlisle, 1995). For example, in a large-scale study of Chinese- and English-speaking children in the second, fourth, and sixth grades (Ku & Anderson, 2003), associations of a variety of morphological awareness tasks with vocabulary knowledge were similar across cultures. Theoretically, morphological awareness skills both promote new vocabulary growth and emerge as a result of vocabulary learning. Phonological processing skills have also been demonstrated to have strong links to vocabulary knowledge in previous studies, at least in English (Avons, Wragg, Cupples, & Lovegrove, 1998; Bowey, 2001; Gathercole, Service, Hitch, Adams, & Martin, 1999; Gathercole, Willis, Emslie, &
Baddeley, 1992; Metsala, 1999). For these reasons, we hypothesized that morphological structure awareness, phonological awareness, and vocabulary knowledge would be similarly associated across cultural groups.

In contrast, we hypothesized that associations of phonological awareness and morphological structure awareness with word recognition would differ across cultures. Because the processes of learning to read English and learning to read Korean Hangul both involve learning to combine phonemes, whereas learning to read Chinese requires syllable awareness only, phonological awareness was expected to be more strongly associated with reading in English and Korean than in Chinese. At the same time, overlap among phonological, semantic, and orthographic associations may be stronger and more transparent in Chinese and Korean than in English. Particularly given the mismatch of syllables and morphemes in English, the likelihood of morphological structure awareness having a strong unique association with word recognition independent of phonological awareness at the second-grade level was hypothesized to be low. In contrast, morphological structure awareness was hypothesized to be significantly associated with word recognition in the Korean and Chinese orthographies among second graders. We tested the associations among morphological structure awareness, phonological awareness, vocabulary, and word recognition in a model presented in Fig. 1.

**Method**

**Participants**

In Hong Kong, 100 second-grade students (47 girls and 53 boys, mean age = 94.51 months) in three primary schools participated. They all were native speakers of Cantonese. Testing took place during the months of February through
April 2002. In Beijing, 100 second graders (mean age = 98.24 months) from two primary schools participated. They all were native Mandarin speakers. Of these, there were 48 girls, 38 boys, and 14 participants for whom gender was not recorded. Testing took place during the months of April through June 2002. In Korea, 100 second graders (53 girls and 47 boys, mean age = 95.37 months) from Masan participated. They all were native speakers of Korean from one public primary school. Testing took place during the months of June through July 2003. In the United States, 105 second graders (55 girls and 50 boys, mean age = 96.42 months) participated. They all were native speakers of English in the eastern part of the country. Testing sessions took place during the months of November 2002 through March 2003.

Measures

Word recognition

In Hong Kong, one- and two-character words used previously (e.g., McBride-Chang & Ho, 2000) were combined with a character recognition task from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (Ho, Chan, Tsang, & Lee, 2002), which includes 150 two-character words. All children were asked to read from the beginning of the test, with the words increasing in difficulty level. Testing stopped when children failed to read 15 consecutive items. The maximum possible score on this task was 211, and it had an internal consistency reliability of .97.

In Beijing, a test of character recognition similar to that used in Hong Kong was used. However, it was shortened and modified; there were 120 items, and its reliability was .97. Testing stopped when children failed to identify 15 consecutive items.

For Korean second graders, the reading test consisted of 20 two-syllable and 20 three-syllable words. Korean phonological rules, such as liaisons, consonantal assimilations, palatalizations, and simplifications of complex codas (e.g., `lk`/`/talk/ “hen”), were added to increase difficulty. A word was marked as correct when children were able to pronounce the word according to Korean phonological rules. The maximum possible score on this task was 40, and the test had an internal consistency reliability of .92.

In the United States, the letter–word identification subtest of the Woodcock–Johnson III Test of Achievement (Woodcock, McGrew, & Mather, 2001) was used to assess children’s letter recognition and sight word efficiency. Children were asked to identify letters expressively and receptively as well as to read printed words. The test stopped when children failed six items in a row, provided that those six items were at the end of a page.

Vocabulary

In Hong Kong, the Stanford–Binet Intelligence Scale vocabulary subtest (Thorn-dike, Hagen, & Sattler, 1986), which was translated and adapted for Hong Kong children, was used to measure children’s vocabulary knowledge. There were 32 items, and the maximum possible score was 64. The reliability of this measure was .77.
The Stanford–Binet Intelligence Scale vocabulary subtest (Thorndike et al., 1986) was also used in Beijing except that some items were modified to make it suitable for local culture. In Beijing, the reliability was also .77.

In Korea, the Korean–Wechsler Intelligence Scale for Children–III vocabulary subtest (K-WISC-III) (Kwak, Park, & Kim, 2001) was used. There were 25 items, and the maximum possible score was 50. The internal consistency reliability was .77.

In all three of these vocabulary tasks, children were asked to orally explain concepts and objects of increasing conceptual difficulty. There is a marking scheme to score each explanation from 0 (incorrect) to 1 (partially correct or correct but not specific enough) to 2 (model answer). Experimenters stopped testing children on the Chinese vocabulary tasks when children obtained zero across five consecutive items. Testing of the K-WISC-III stopped when children obtained zero marks for four consecutive items.

In the United States, the Expressive One-Word Picture Vocabulary Test–Revised (Gardiner, 2000) was used to assess children’s expressive vocabulary. This task requires students to identify pictured items. Testing stopped when children identified six consecutive pictures incorrectly.

**Phonological awareness**

A single task, which included both syllable and phoneme deletion items, was used to assess children’s phonological awareness ability in Chinese and Korean.

In Hong Kong and Beijing, children were asked to take away one syllable from three-syllable phrases (e.g., dai6 mun4 hau2 without mun4 would be dai6 hau2) in the syllable deletion task, which was orally presented in Cantonese and Mandarin in Hong Kong and Beijing, respectively. A similar task has been used successfully in past research to demonstrate syllable awareness among Hong Kong Chinese kindergartners (McBride-Chang & Ho, 2000; McBride-Chang & Kail, 2002). This part of the task consisted of 16 items, with half of the items being nonsense words conforming to the phonological constraints of Cantonese/Mandarin to maximize the difficulty level. Across both real and nonsense words, two items required taking away the first syllable, two required taking away the last syllable, and four required taking away the middle syllable. Onset phoneme deletion was also tested. In this section of the task, children were orally presented with one-syllable Cantonese/Mandarin words and asked to take away the initial phoneme (e.g., tsal without the initial sound would be a1). Across Chinese languages, a total of 20 items of phoneme onset deletion were included, with 10 real words and 10 nonsense words. Thus, in both Hong Kong and Beijing, the total number of items on the phonological awareness task was 36. This task had an internal consistency reliability of .91 in Beijing and .94 in Hong Kong.

Like the children in Hong Kong and Beijing, the Korean second graders were orally presented with three- and four-syllable real words or nonwords in the syllable deletion portion of the phonological awareness task. All three-syllable items required taking away the middle syllable. Of the four-syllable items, 4 items required taking away the second syllable and 4 required taking away the third syllable. Again, there were a total of 16 items: 8 with three syllables and 8 with four syllables. Children were also
asked to delete phonemes from 20 one-syllable Korean words, of which half were one-syllable consonant–vowel–consonant (CVC) words and half were nonwords. Altogether, this task consisted of 36 items, and its internal consistency reliability was .89.

In the United States, the Comprehensive Test of Phonological Processing (CTOPP) (Wagner, Torgesen, & Rashotte, 1999) Elision subtest was administered. This task consists of 20 items. For the first 3 items, children were asked to say a compound word after deleting a syllable from it (e.g., popcorn without corn is pop). For the remaining items, children were asked to delete a single phoneme from each word (e.g., tan without /t/ is an).

**Morphological structure awareness**

In all locations, the morphological construction test was administered to assess children’s morphological structure awareness ability. In each task, 20 scenarios were presented orally in story form. Children were asked to construct new compounds/words for the presented objects or concepts based on previously acquired morphemes. The maximum possible score on the task was 20.

In Hong Kong and Beijing, all items were the same, although the ideas were presented in Cantonese and Mandarin, respectively. All scenarios were presented in three-sentence stories. The first nine scenarios were presented with pictures to make them as easy to understand as possible, whereas the remaining scenarios were not. (Items are available from the authors on request and were similar in style to the compounding examples given below in Korean and English.) The internal consistency reliability of this task was .77 in Beijing and .70 in Hong Kong.

In Korea, all scenarios were presented in two- or three-sentence stories. The first three scenarios were presented with pictures, whereas the remaining items were not. One example of the items is as follows: “When we keep kimchi (김치) in a refrigerator, then we call it kimchi refrigerator (김치 냉장고). If we keep a flower (꽃) in a refrigerator, what would we call it?” The correct answer is flower refrigerator (꽃 냉장고). The internal consistency reliability of this task was .73.

In the United States, all scenarios were presented in two- to four-sentence stories. Of the 20 stories, 14 required responses involving morpheme compounding, whereas the remaining 6 items involved inflections. One example of the compounding items is as follows: “Basketball is a game where you throw a ball through a basket. Tim made up a new game where he throws a ball into a bucket. What should he call the game?” (The correct response is bucketball.) An example of a syntactic manipulation is as follows: “This is a musical instrument called a hux. Now we have three of them. These are three_____. ” (The correct response is huxes.) The internal consistency reliability of this task was .80.

**Procedure**

All measures were administered to the children individually by trained psychology majors. Each child participated in two separate testing sessions, each lasting about 45 min, on two separate days to avoid fatigue.
Results

For all of the tasks, zero-order correlation coefficients, means, and standard deviations are reported in Table 1 for each culture separately. Students did not reach ceiling on any of the tasks in any culture. Because the tasks were derived indigenously in each culture, and sometimes different numbers of items were used to represent each task or construct, comparisons of raw scores across cultures are meaningless. The table shows the correlations of the tasks of vocabulary, morphological structure awareness, and phonological awareness within cultures. Across all cultures, measures of phonological awareness were significantly correlated with reading, vocabulary knowledge, and morphological structure awareness. In addition, measures of morphological structure awareness were consistently significantly associated with vocabulary knowledge. In both Chinese and Korean societies, morphological structure awareness was significantly associated with reading as well. However, this task was not significantly correlated with reading in English. For the purpose of excluding the influence of measurement unit and different indigenously derived tasks, we used standardized scores in the following analyses.

Associations of morphological structure awareness and phonological awareness with vocabulary

Multigroup analyses were used to test the path model shown in Fig. 1. We analyzed an unconstrained model for four cultures (baseline model) simultaneously and then defined a model by constraining some parameters as equal across groups (constrained model). Because the constrained model was nested within the unconstrained model, we could test the extent to which the constraint was tenable by testing the difference in $\chi^2$ between the two models. Here, the standardized scores were used for the purpose of examining the correlations rather than the covariances.

For the correlation of vocabulary and morphological structure awareness, the invariance test was conducted by constraining this correlation to be equal across the four cultures. A $\chi^2$ test of invariance was $2.229$, $df = 3$, $p = .513$. When we did the same test constraining the correlation of phonological awareness with vocabulary, results were similar, $\chi^2 = 2.036$, $df = 3$, $p = .565$. These results indicate that both equality constraints held across the four cultures included in the current study. Thus, despite substantial differences in the items used to measure each construct, associations among these measures did not differ from one another across cultures. This finding supports our first hypothesis that morphological structure awareness, phonological awareness, and vocabulary knowledge would be similarly associated across cultures.

Associations of morphological structure awareness and phonological awareness with word recognition

Our second hypothesis was that, despite similarities of the associations of morphological structure awareness and phonological awareness with vocabulary
Table 1
Correlations, means, and standard deviations of all variables for second graders

<table>
<thead>
<tr>
<th></th>
<th>Beijing (98.16 months)</th>
<th>Hong Kong (94.51 months)</th>
<th>Korea (95.37 months)</th>
<th>United States (96.42 months)</th>
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<td>3. Morphological</td>
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<tr>
<td>4. Phonological</td>
<td>.30**</td>
<td>.29**</td>
<td>1.00</td>
<td>.32**</td>
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<tr>
<td>Standard deviation</td>
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<td>6.06</td>
<td>2.93</td>
<td>7.33</td>
</tr>
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</table>

* * * p < .001.
** p < .01.
* p < .05.
knowledge, their associations with word recognition would differ by culture. To test this hypothesis, unconstrained path models of how all four constructs included (phonological awareness, morphological structure awareness, vocabulary knowledge, and word recognition) predicted word reading in each of the four cultures were analyzed.

These models are shown separately for each culture in Figs. 2–5. In the model for Beijing (Fig. 2), the morphological structure awareness task significantly predicted word recognition, $\beta = 0.266$, $SE = 0.103$, $t = 2.588$, whereas the phonological awareness task did not, $\beta = 0.155$, $SE = 0.099$, $t = 1.566$, after controlling for the effects of vocabulary. In Hong Kong (Fig. 3) similar to Beijing, the morphological structure awareness task was a significant predictor of word recognition, $\beta = 0.230$, $SE = 0.105$, $t = 2.192$, whereas our test of phonological awareness was not, $\beta = 0.175$, $SE = 0.099$, $t = 1.774$. In Korea (Fig. 4), both phonological
awareness, $\beta = 0.393$, $SE = 0.101$, $t = 3.906$, and morphological structure awareness, $\beta = 0.210$, $SE = 0.103$, $t = 2.040$, contributed significantly to word recognition after controlling for vocabulary. In the United States (Fig. 5), only the phonological awareness task significantly predicted word recognition, $\beta = 0.424$, $SE = 0.098$, $t = 4.321$, whereas the morphological structure awareness task was nonsignificantly associated with it, $\beta = -0.058$, $SE = 0.103$, $t = -0.568$. Because all of the models were saturated, their fits to the data were perfect. In addition, vocabulary significantly predicted word recognition only for Hong Kong, not for the other cultures.

We then compared a model in which all four predictors of reading were allowed to vary freely in predicting word recognition with ones in which either the morphological structure awareness construct or the phonological awareness construct was constrained to equal 0 in each culture separately. This was done to test the extent to
which either phonological awareness or morphological structure awareness, as measured in this study, was necessary for the prediction of word recognition. Table 2 summarizes the $\chi^2$ changes across all four cultures when either the phonological awareness measure or the morphological structure awareness measure was removed from the model. As hypothesized, removing the morphological structure awareness construct from the model reduced the model’s fitness in both Chinese groups and in Korean children ($\chi^2$ values were 6.68, 4.83, and 4.20 for Beijing, Hong Kong, and Korea, respectively, $p < .05$) but not in American children ($\chi^2 = 0.33$, $p > .05$). In contrast, removing the phonological awareness construct from the model reduced the model’s fitness in English and Korean children ($\chi^2$ values were 14.60 and 17.64 for Korea and the United States, respectively, $p < .001$) but not in Chinese children ($\chi^2$ values were 2.50 and 3.20 for Beijing and Hong Kong, respectively, $p > .05$).

From these results, we can see that the relative contributions of tasks of both phonological awareness and morphological structure awareness to word recognition differed across cultures. However, the extent to which these differences were statistically significant across cultures has not yet been demonstrated. To do this, we tested alternate models across cultures simultaneously. First, we examined the hypothesis that morphological structure awareness would predict word recognition more strongly in Chinese and Korean than in English by comparing two nested models. In one model, we constrained the path of morphological structure awareness to word recognition to be equal across Beijing, Hong Kong, and Korea. In this model, the results showed adequate fit of data with the equality constraints, $\chi^2 = 0.158$, $df = 2$, $p = .924$. In another model with an equal restriction of this path across all four cultures, the $\chi^2$ was higher, $\chi^2 = 6.330$, $df = 3$. The comparison yielded a $\chi^2$ difference value of 6.172, $df = 1$, $p < .05$. Thus, the morphological structure awareness construct predicted word recognition differently across cultures.

Finally, using the same method, we tested the hypothesis that phonological awareness would uniquely predict word recognition of Korean and English children but not of Chinese children. In one model, we constrained the path of phonological awareness to word recognition to be equal across Korea and the United States and also to be equal across Beijing and Hong Kong. The model fit indexes for this model, $\chi^2 = 0.072$, $df = 2$, $p = .965$, indicated that the model fit the data very well. Another model with the restriction of the path of phonological awareness to word recognition constrained to be equal across four cultures yielded a $\chi^2$ value of 6.250, $df = 3$. A
comparison of this model with the above model yielded a difference $\chi^2$ value of 6.178, $df = 1$, $p < .05$. Again, these results demonstrate that phonological awareness predicted word recognition differently across cultures.

**Discussion**

Across all four cultures, tasks of phonological awareness and morphological structure awareness were similarly correlated with vocabulary knowledge. At the same time, phonological awareness was more strongly associated with word recognition in English and Korean; it did not explain unique variance in word recognition in the Chinese languages. In contrast, the morphological structure awareness task was uniquely associated with word recognition in Korean and Chinese, but it was not significantly associated with reading in English. These findings are discussed in more detail below.

Across cultures, vocabulary knowledge appears to build on both the phonology and morphology of a language. These results are interesting because our tasks designed to measure phonological awareness and morphological structure awareness were indigenously derived in four unique cultures. Indeed, based on the characteristics of the given languages, they measured different morphological and phonological structures. For example, in English, knowledge of inflectional morphology was part of the morphological structure awareness construct, and phonemic awareness was part of the phonological awareness task. These aspects were not included in tasks of morphological structure awareness or phonological awareness in Korean or Chinese because they are not prominent in these languages or scripts. Given this diversity, the consistent associations of phonological awareness and morphological structure awareness with vocabulary knowledge are noteworthy. Correlations of morphological structure awareness with vocabulary measures ranged from .39 to .47 across all four cultures, a fairly narrow range. Associations of the phonological awareness measure with vocabulary also did not differ from one another.

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In contrast, the importance of phonological awareness and morphological structure awareness for word recognition differed, depending on script, in the current study. Removing the phonological awareness measure from the path analysis predicting word recognition in either English or Korean significantly reduced model fit in these two models. This is not surprising given the plethora of studies on the importance of phonological awareness for reading English. This result is also interesting for Korean Hangul. Although there are relatively few studies on the importance of phonological awareness as a predictor of reading in Korean children, the structure of Korean Hangul, in combining phonemes most often in a CVC pattern, requires that children have some sense of phoneme onsets, as well as syllables, to become fluent readers.
In contrast, across Chinese societies, our measure of phonological awareness was not significantly associated with reading of Chinese characters. This result held not only in Hong Kong, where children are not taught a phonological coding system as an aid to reading, but also in Beijing, where children are taught Pinyin. These results suggest that even though Pinyin is used as a phonological coding strategy to help children learn to read Mandarin, phonological awareness might not be central to reading development in Chinese second graders. Rather, because children need only to recognize speech segments at the syllable level to read, the importance of phonological awareness for word recognition is less in Chinese languages than in either English or Korean.

Initially, this argument might appear to contradict findings from several previous studies (e.g., Ho & Bryant, 1997; Hu & Catts, 1998; McBride-Chang & Ho, 2000; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001) demonstrating the importance of phonological awareness for reading Chinese. However, the current study included multiple predictors of word recognition. Thus, the idea that phonological awareness is relatively unimportant for reading development in Chinese is just that—a relative one. Because the morphological structure task was developed based on the linguistic structure of Chinese, it appears to fit the nature of the Chinese language and script well. None of the past studies on the importance of phonological awareness for reading Chinese included this task along with phonological measures as statistical predictors simultaneously. Indeed, even in the current study, Chinese character recognition was significantly correlated with phonological awareness in both Beijing and Hong Kong. Our results suggest, however, that the morphological structure task may be more strongly associated with word recognition in Chinese than are measures of phonological awareness, at least in second graders. These results fit well with a connectionist model (Gonnerman et al., 2005) in which phonology, semantics, and orthography are consistently linked but associated differently depending on the overall structure of the language and orthography of a given system. In Chinese, although phonology is clearly important for reading acquisition (e.g., Hu & Catts, 1998), the transparent semantic system in the language and orthography across words makes its morphological structure particularly important for learning to read. Morphological structure awareness is also important in Korean, a language that has a morphological structure similar to that of Chinese.

In contrast, excluding the morphological structure awareness task from the path analysis predicting English word recognition did not reduce model fit. In addition, of the English words tested in a typical reading task appropriate for American second graders (Woodcock et al., 2001), few were composed of more than one morpheme. Thus, the lack of regularity or quantity of multimorphemic words in English might not facilitate early pattern recognition of morpheme structure in reading words as it does in Korean or in Chinese languages.

Limitations and future directions

There are several limitations of this study. First, our account of the ways in which phonological awareness and morphological structure awareness interact
with vocabulary knowledge and word recognition skill is overly simplistic. Our measures of phonological awareness and morphological structure awareness contained different items across cultures. For example, neither phonemic awareness nor grammatical inflections were measured in either of the Chinese languages or in Korean, whereas they were in English. Some who regard phonological awareness at the levels of the syllable, rhyme, phoneme onset, and phoneme to be distinct constructs may argue that our measure of phonological awareness was inconsistent across societies. Our choice of phonological awareness tasks was based on findings from each culture and characteristics of different languages. Nevertheless, future studies might strive to create phonological awareness tasks that are better equated across cultures. For example, they might want to test the same model for American children who were given only syllable and phoneme onset deletion tasks.

A similar criticism could be offered for our morphological structure awareness task. Did our mixing of inflectional morphology and lexical compounding items in English gloss over linguistic distinctions that are crucial for understanding vocabulary development in young English-speaking children? Although the connectionist model proposed by Gonnerman and colleagues (2005) suggests that the system of meaning in different languages, captured in our study by our morphological structure awareness measure, is highly flexible across languages, our task of morphological awareness was preliminary. Until we do detailed analyses of the role of inflectional morphology relative to lexical compounding in both reading development and vocabulary development in English, for example, we cannot be certain that our morphological awareness task captured the important features of morphological awareness in English for this age group.

Another limitation of this study is that the model of reading tested implies causality of phonological awareness and morphological structure awareness to reading. In fact, both phonological awareness (e.g., Wagner et al., 1997) and morphological structure awareness (e.g., Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003) are likely bidirectionally associated with reading development and vocabulary development. Both may help children to learn to read (in some cultures) and to acquire new vocabulary (in all cultures). In turn, learning to read and learning new vocabulary words likely facilitate phonological awareness and morphological structure awareness. Longitudinal data in future studies will help to clarify these bidirectional associations with development and across cultures.

A final limitation that offers a direction for future research is that our results may be specific to second graders and word recognition in the cultures included. Morphologically complex words become more common in tasks of English word recognition among older children (e.g., Adams & Henry, 1997), whereas beginning readers of Korean and Chinese are most often presented with words that contain two or more morphemes. In our task of English word recognition, there were relatively few morphologically complex words. It is likely that among older children, sensitivity to morphological cues becomes increasingly important for reading English (e.g., Carlisle, 2000). Work on French (Casalis & Louis-Alexandre, 2000), Dutch (Rispens,
2004), and Danish (Elbro & Arnbak, 1996) also underscores the importance of certain aspects of morphological awareness for reading development and impairment. Such studies have been careful to distinguish inflectional, derivational, and lexical compounding morphological tasks in a way that the current study did not and to consider how associations of morphological awareness and reading might change with development. Furthermore, the associations of phonological awareness and morphological structure awareness with reading depend strongly not only on children’s developmental level across cultures but also on the reading task included. We tapped only word recognition in the current study, and associations of these constructs with other measures of reading, such as reading comprehension, might yield very different results.

Despite these limitations, one strength of the current research is that we used tasks indigenously derived in different cultures. The idea of phonological awareness arose from the alphabetic principle on which English reading and phonics instruction is based (for a review, see Shankweiler, 1999). Many studies of reading across cultures have adjusted this construct to fit the language and orthography being tested, thereby incorporating an idea arising in one culture to fit another culture. In the current study, we used a construct developed based on Chinese languages and examined its utility for learning to read in Korean and English as well. Thus, the study benefits from a relatively cross-culturally balanced view of reading development. Cross-cultural studies of reading development remain relatively difficult to carry out precisely because of the many adjustments for language and script necessary in doing so.

Nevertheless, the current study has offered two potentially useful findings related to literacy development across cultures. First, both phonological awareness and morphological structure awareness may be similarly associated with vocabulary development across cultures. Second, the relative importance of phonological awareness and morphological structure awareness for reading development differs across cultures in second graders. Such differences are likely attributable to differences in language and script.

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**References**


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