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Phonological awareness and morphological awareness: differential associations to regular and irregular word recognition in early Korean Hangul readers

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Abstract A large battery of reading related skills were orally administered to 111 4-year old and 118 5-year old Korean kindergartners, who were also tested on reading of regular and irregular Korean Hangul words. In regression equations, speeded naming was uniquely associated with reading of both regular and irregular words. In contrast, only the three measures of phonological awareness at the levels of phoneme onset, coda, and syllable uniquely explained Hangul regular word recognition, whereas only morphological awareness consistently explained irregular word recognition. Results suggest somewhat different cognitive demands for reading of regular and irregular words, based on the dual-route model, in Korean Hangul.

Keywords Korean Hangul · Morphological awareness · Coda · Phoneme onset · Syllable

Introduction

Although there are probably hundreds of studies on early predictors of literacy in alphabetic orthographies and a growing number of studies on Chinese, a non-alphabetic script, little is known about the acquisition of Korean Hangul, an

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alphabetic syllabary (Taylor & Taylor, 1995). Use of an alphabet in Korean Hangul is one feature that shares similarities with orthographies such as English or French. On the other hand, the morphological and syllable structure of Korean has stronger commonalities with Chinese than with these alphabetic orthographies. In the present study, we explore the extent to which cognitive abilities in the areas of phonological awareness, morphological awareness, speeded naming, and visual skills might explain early Korean Hangul acquisition for both regular and irregular words. This exploration may highlight some of the cognitive skills that are "universals" or "specifics" of early literacy development across orthographies (e.g., Ziegler & Goswami, 2005, for a review). Thus, below, we introduce the Korean Hangul script and then consider how each of these cognitive skills might be associated with early reading of it.

As a phonemic alphabet, Korean Hangul consists of 14 basic consonants and 10 basic vowels. Each letter is visually distinctive and is composed of 1–4 strokes (i.e., mostly straight lines, vertical or horizontal, and one circle character) with vowels and consonants having distinctive shapes (Kim-Renaud, 1997). In addition, although it is fundamentally alphabetic, Hangul letters are printed in syllable blocks of up to four graphemic elements per syllable, with each block separated and a larger space between words. The sound structure of Korean is fairly simple, with either an open or CVC structure. Every syllable of Korean is equally stressed across multi-syllabic words (Yoon, Bolger, Kwon, & Perfetti, 2002). Most Korean words range in length from one to three syllables.

The way in which children are taught to read Korean Hangul reflects the structure of the Korean language and orthography. Most children are taught to read by making use of a CV chart of possible syllables. In a typical CV chart, 14 basic consonant letters are arranged in columns and 10 basic vowel letters in rows to generate CV syllable blocks. Children learn to recognize such syllable blocks first at the age of 4, even before learning to recognize individually the names or sounds of the Korean alphabet. Later at about 5, children are taught to read by combining these initially learned CV syllables with final consonants. Most children master grapheme–phoneme correspondence rules and they can read CVC words quite well by age 6, when they enter primary school. A recent survey reported that close to 85% of children have been given literacy training at home by parents or by private tutors before they begin primary school (Korean Association of Child Studies & Hansol Education Research Center, 2002).

In addition, Korean children learn some phonological alterations of the Korean language triggered by resyllabification, simplification in coda, consonantal assimilation, and palatalization from primary school. Pronunciation of some Korean graphemes is irregular and depends on context. The constraints on the relation between graphemes and phonemes are based on morphophonemic writing and assimilation phenomena (Kim-Renaud, 1997). Korean orthography has adopted a morphophonemic principle, requiring letter strings to be written with maximum morphophonemic transparency. Morphemes are transparent in Korean orthography. For example, a verb stem 깊 (meaning "deep") /gip/ + a noun suffix 이 /i/ is written using the two morphemes' underlying representations, 깊이, although its pronunciation is changed to /gi pi/ (기피 meaning "avoidance"). As shown in this example,

resyllabification is common in multi-syllabic words and in using particles and adjective and verb inflectional endings in Korean: when a coda is followed by a vowel, the consonant is carried over to the following syllables as its onset. Some Korean irregular words are difficult to read because they are subjected to two or more phonological changes due to resyllabification, coda simplification, and palatalization.

Do strategies for reading of phonologically regular and irregular Korean Hangul words differ in very young children? In the literature focused primarily on adult word recognition, dual-route models assume two possible pathways, lexical and sublexical, to the processing of a printed word in many languages, including English, Chinese, and Korean (Cho & Chen, 1999; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Seidenberg, 1985; Simpson & Kang, 1994). The lexical route activates phonological information by matching an orthographic input stimulus to a known word stored in an internal lexicon. In contrast, in the sublexical path, the phonological code is assembled on the basis of grapheme–phoneme correspondence rules. Reading phonologically regular words tends to depend upon sublexical processing, whereas reading exception words depends primarily on lexical processing. Although the dual-route model has not been applied directly to the process of learning to read, these basic features have been discussed with reference to children with reading impairments (e.g., Coltheart et al., 2001), as well as to an unselected sample of 7- and 8-year olds (Nunes, Bryant, & Olsson, 2003). The same features of the model may apply to children's reading development in some aspects.

Thus, based on the dual-route model, we hypothesized that different cognitive skills might be associated differently with early Korean Hangul recognition of regular and irregular words. Specifically, Korean Hangul recognition of regular words might be more related to phonological awareness tasks because they primarily require awareness of speech sounds to assemble. In contrast, recognition of irregular words might rely particularly on morphological awareness because a direct mapping of morphemes, or units of meaning, to orthography may be an effective strategy for recognizing irregular Korean Hangul exception words comprised of two or more morphemes. The importance of our measures of phonological awareness and morphological awareness for reading development in Korean Hangul are reviewed below. Following this review, we also overview rapid automatized naming and visual skills, two other abilities measured in the present study, in relation to early reading.

Phonological awareness and Korean Hangul acquisition

Phonological awareness, the ability to identify and manipulate speech sounds, was measured by asking children to delete a sound from a given word in the present study. These speech sounds included phoneme onset, coda, and syllable levels. From a cross-cultural and developmental perspective, the interesting phonological features relevant for early literacy acquisition in Korean center on the centrality of the syllable and the primacy of final consonants in word recognition. The syllable unit is emphasized in initial reading and in building a sight word vocabulary. At the same time, children must learn to focus on phonemes for building syllables, but

these phonemes are particularly salient in the coda position of the syllable (e.g., Yoon et al., 2002). Initial phonemes are clearly relevant for reading in Korean Hangul as well (Kim & Cho, 2001). Thus, it is not surprising that Korean children demonstrate strong sensitivity to phonological cues in word recognition (Kang & Simpson, 1996). In particular, as expected given the salience of both syllables and phonemes for early Hangul reading, previous studies on Korean Hangul acquisition have demonstrated that both syllables and phonemes are important phonological units in Korean Hangul reading (Cho & McBride-Chang, 2005; Kim, Gong, & Jo, 2004). Cho and McBride-Chang (2005), for example, found that both syllable and phoneme awareness uniquely explained Hangul word recognition among Korean kindergartners and second graders. However, in that study, the authors neither distinguished awareness of phoneme onset from awareness of phoneme codas nor recognition of regular words from irregular word reading. Given the nature of Korean Hangul, particularly in the focus on blending CV syllables with final consonants for efficient reading, an exploration of coda awareness may be important for understanding early Korean word recognition. Few if any studies have tested the unique contributions of all three aspects of phonological awareness, at the levels of syllable, phoneme onset, and coda, simultaneously, to Korean Hangul reading. Thus, in the present study we explored the separate contributions of each to Hangul recognition of regular and irregular words in very young readers. We expected to find that measures of phonological awareness would be uniquely associated with regular word recognition, in particular given the primacy of phonological coding for reading of regular words. We also hypothesized that all three levels of phonological awareness would be uniquely associated with regular word recognition because of the unique functions of each in reading development.

Morphological awareness and Korean Hangul acquisition

In contrast, we hypothesized that our measure of morphological awareness might be particularly strongly associated with Korean Hangul exception word reading. The ability to manipulate and recognize morphemes may be helpful in generalizing these morphemes to new words, facilitating early reading. In Korean, both inflectional and derivational morphology are fundamental to the morphological structure of the language (Zho et al., 2003). Inflected morphology is generated through combining final ending suffixes with the base form of predicates. Korean complex words include compound and derived words but not inflected words. In particular, Korean relies heavily on lexical compounding for vocabulary terms. Lexical compounding is quite common in Korean, in part because many Korean words have been borrowed from Chinese (estimated at 50% borrowed words—Lim, 2002; Taylor & Taylor, 1995; Zho et al., 2003). However, lexical compounding is not limited to these borrowed words. Native Korean words also make use of compounding. For example, the word for *tear* (resulting from crying) in Korean can be literally translated as *eye water* (눈물 /nun mul/). Another interesting example of native Korean word lexical compounding is the word *fish*, which is literally translated as *water meat* (물고기 /mul kko ki/). We focused on this aspect of morphological

awareness in the present study because lexical compounding may be a salient feature of the Korean language and, by extension, word recognition among very young children, as it is in other languages (e.g., Clark, 1995; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003).

Given this characteristic of Korean, we created a task that required children to generate new concepts from previously learned morphemes by combining them appropriately. This task, called morphological construction, has previously been demonstrated to predict unique variance in Chinese character recognition among both kindergartners and second graders (McBride-Chang et al., 2003) and to explain unique variance in word recognition in Korean among second graders (McBride-Chang, Cho, Liu, Wagner, Shu, Zhou, Cheuk, & Muse, 2005a). An English equivalent of the kind of lexical compounding required in the morphological construction task is the following: *The metal shoes put on horses are called horseshoes. If we put metal shoes on pigs, what should these be called?* (The answer is *pigshoes*.)

In previous research (McBride-Chang et al., 2005a), morphological construction was argued to be a potentially unique aspect of reading in both Chinese and Korean because most Chinese and Korean words consist of two or more morphemes. Understanding how these morphemes are logically structured in the language may be helpful for reading in two ways. First, recognizing a given morpheme may be helpful in identifying it by sound and sight. That is, familiarity with the morpheme, as demonstrated by this task, might help children to learn to read new words containing the target morpheme by generalizing it. Second, knowing the logic of one's language such that the ways in which morphemes can and cannot be combined could help children to make educated guesses about a multi-morpheme word given that one of the morphemes in the word is familiar. A (crude) example of such analogy-drawing in English might be a young child who is able to read the word *sunlight* because she recognizes the morpheme *sun* and can use some knowledge (e.g., begins with *l*) of the other morpheme and context to identify the whole word. Given the large amount of lexical compounding of Korean and the fact that analogy may be one useful tool in reading (e.g., Goswami, 1986), we included this construct in the present study. We expected that this measure would be more strongly linked to exception as compared to regular word recognition because awareness of meaning units is more important when phonological cues are less reliable.

Speeded naming and Korean Hangul acquisition

We also included tasks of speeded naming in the present study because of their links to reading ability across cultures. Studies of diverse orthographies, including German, English, and Chinese, have demonstrated that speeded naming is associated with word recognition. Those who are faster in tasks of speeded naming tend to be more accurate in early reading. Researchers continue to debate the constructs represented by tasks of speeded naming (e.g., Bowers & Newby-Clark, 2002; Manis, Seidenberg, & Doi, 1999). For example, speeded naming has been called a phonological processing skill because it involves accessing the names for a

set of stimuli and articulating them (Wagner & Torgesen, 1987). Tasks of speeded naming also involve visual sequencing skills, because such tasks typically involve identifying several stimuli presented over rows, similar to reading itself. Others (Manis et al., 1999) have related the importance of speeded naming to a so-called "arbitrariness factor." That is, tasks of speeded naming involve sequencing names of stimuli, where the names themselves are arbitrary. In word recognition, the visual form of the word is also somewhat arbitrary relative to its representation.

For all of these reasons, speeded naming tasks might be important correlates of word recognition in Korean. However, in previous research, speeded naming tasks have not explained unique variance in Korean Hangul reading (e.g., Cho & McBride-Chang, 2005; Kim et al., 2004). We included two measures of speeded naming, of numbers and objects, in the present study in order to consider the extent to which previous findings on Korean might be replicated or whether, in the present sample, speeded naming might account for unique variance in Hangul recognition, for either regular or exception word reading.

Visual skills and Korean Hangul acquisition

Finally, we included two tasks of visual perceptual skills in the present study because of growing evidence that visual skills may be important in very beginning reading development, particularly among Chinese children (e.g., Ho & Bryant, 1997; Huang & Hanley, 1994). The Korean Hangul alphabet also has some distinctive visual features that might also require distinct visual representations. Each Hangul letter is composed primarily of straight lines (vertical or horizontal lines) and one circle character. We, therefore, explored the importance of two visual perceptual abilities for Korean word recognition. One visual perceptual skill we included was a task of Visual Spatial Relationships (Gardner, 1996). This task, which requires children to distinguish the position (e.g., image vs. mirror image) of two-dimensional stimuli, was the strongest correlate of Chinese character recognition from among three visual tasks in a study of Chinese kindergartners (McBride-Chang, Chow, Zhong, Burgess, & Hayward, 2005b). The task of Visual Spatial Relationships also clearly distinguished dyslexic from non-dyslexic readers in a cognitive profiling study of older Chinese children (Ho, Chan, Tsang, & Lee, 2002). The other task of Visual Discrimination (Gardner, 1996) was also strongly associated with Chinese character recognition among kindergarten Chinese readers (McBride-Chang et al., 2005b). This task is sensitive in requiring careful attention to visual details of two-dimensional line figures. We anticipated that the visual skills included in the present study might be more strongly associated with reading of exception, as compared to regular words, because exception word reading may require more memorization of visual configurations. Just as the exception words in English such as *know* or *Wednesday* may require some visual representation to master their spellings, Korean Hangul exception words may demand some visual skills not required for reading of regular words, for which regular phonological cues are sufficient.

To summarize, the present study was an exploration of the associations of multiple cognitive constructs to Korean Hangul regular and irregular words. We

focused on those constructs that are most often included in studies of early literacy. However, we tailored these constructs to tap skills that Korean Hangul reading might most reasonably be expected to require. Of great interest was the extent to which three aspects of phonological awareness, syllable awareness, phoneme onset awareness, and coda awareness might independently explain variance in Korean word recognition, particularly for regular words. We were also interested in the associations of one aspect of morphological awareness, lexical compounding, particularly for reading of irregular words. The importance of visual and speeded naming skills for very early Korean Hangul reading was also examined because both have been linked to very early reading development across diverse orthographies in previous research.

Method

Participants

Participants were 111 4-year old children (49 girls and 62 boys) with a mean age of 4.87 years and 118 5-year olds (59 girls and 59 boys) with a mean age of 5.93 years. All participants were native speakers of Korean from two private kindergartens for 4-year olds and one public kindergarten for 5-year olds in Masan, South Korea. The children were mainly from middle-class backgrounds. Testing sessions took place in June through July of 2004. The kindergartens had begun teaching Hangul reading and writing to the kindergartners from March 2004. The two kindergartens for the 4-year olds emphasized teaching of syllables and whole words. Similarly, the public kindergarten for 5-year olds took the "whole language" approach, i.e. they did not explicitly teach letter names and analytic letter-sound correspondence rules. At the same time, in line with a recent survey that reported that up to 85% of children have been given literacy training at home (Korean Association of Child Studies & Hansol Education Research Center, 2002), most of the 5-year-old children in this study were likely learning letter names and analytic phonics at home. However, we did not measure the level of literacy training of the children at home in this study. Note that public kindergartens follow the curriculum suggested by Ministry of Education and Human Resource Development (1998), in which kindergartners are expected to develop interests and motivation to read and write, but not to learn decoding skills. Nevertheless, private kindergartens and preschools tend to use relatively eclectic approaches, combining whole language and phonics in teaching of literacy skills.

Procedure

Children were tested individually at school by psychology majors in a local university. Each child participated in two separate testing sessions that took place on separate days. Each session lasted approximately 30 min. All children were administered the following tasks.

Measures

Korean word recognition

This test contains 35 regular words and 30 irregular words, all of which are two-syllable. Words increased in difficulty level from the beginning to the end of the list with the introduction of diphthongs (ㅑ/ya/, ㅙ/we/) and compound consonants (e.g., ㄲ, ㅆ, ㅃ). The first 35 words were regular words that could be read correctly by applying Korean letter-phoneme correspondences, but additional Korean phonological changes were not required to read them. The final 30 words were irregular words that were subjected to phonological alterations due to the application of Korean phonological rules such as resyllabification, consonantal assimilation, palatalization, and simplification of complex codas [e.g., ㄺ/lk/ in 닭 /dak/ (meaning *chicken*)] to be read. The words were selected from elementary school text books and the Korean Orthography notified by Ministry of Education and Human Resource Development (1988). A word was defined as regular if it only contained grapheme–phoneme conversion rules, and a word was defined as irregular if it contained some additional phonological changes which could not be converted into a phoneme using the normal conversion rules (cf., Sprenger-Charolles, Siegel, & Bonnet, 1998). The regular and irregular words were matched according to length (2 syllables) but not in frequency. The mean and median frequencies were 291 and 38 (range: 0–5,898) for regular Hangul words, and 493 and 23 (range: 0–10,248) for irregular words, respectively (Lee et al., 1991). Thus irregular words were not infrequent ones. Children were instructed to begin reading from the beginning of the test. Experimenters stopped testing when five consecutive items were failed. Feedback was not given to the children. For each word correctly read aloud according to the Korean phonological rules, 1 point was allotted. The maximum score for regular word reading was 35, and for irregular word reading, it was 30. All test items are available from the first author upon request.

Syllable awareness

In this task, children were asked to listen to orally presented three-syllable words and non-words. From each three-syllable stimulus item, children were asked to delete one syllable [e.g., *ja dong cha* (자동차) without *cha* (차) would be *ja dong* (자동)]. Eight items were real words and eight were non-words, for a total of 16 items on this task. Because pilot testing indicated that deleting the middle syllable of such words is most difficult for young children, eight of the 16 items on this task required the deletion of the middle syllable to increase variability on this task. Of the remaining eight items, four involved deletion of the first syllable, and four required that the last syllable of the three-syllable word be deleted. Items increased in difficulty level by including real words first and non-words toward the end. Experimenters stopped testing when five consecutive items were failed. Feedback was not given to the children. For each item correctly responded, 1 point was allotted. The maximum score was 16.

Phoneme onset deletion

For this task, children were asked to delete the first phoneme from a one-syllable real word that was orally presented to them by the experimenter. For example, saying *mil* (밀) without the initial sound would be *il* (밀). Eight of the items administered were CV words, and eight were CVC words, for a total of 16 items on this task. Items increased in difficulty level by including CV words first and CVC words toward the end of testing. Experimenters stopped testing when five consecutive items were failed. Feedback was not given to the children. For each item correctly responded, 1 point was allotted. The maximum score was 16.

Phoneme coda deletion

For the phoneme coda deletion measure, children were orally presented with one-syllable CVC real words from which they were asked to delete the final phoneme. For example, saying *sol* (솔) without the final sound would be *so* (소). Sixteen items were included in this measure, and all of them were CVC words. Items increased in difficulty level by including diphthongs (ㅑ/ya/, ㅙ /we/) and compound consonants (e.g., ㄲ, ㅆ, ㅃ). Experimenters stopped testing when five consecutive items were failed. Feedback was not given to the children. For each item correct, 1 point was allotted. The maximum score was 16.

Visual perceptual skills

Gardner's (1996) Test of Visual-Perceptual Skills (Non-motor) Revised was used to test the children's visual perceptual skills. Two of the subtests were administered to the children following standardized testing and scoring procedures. The Visual Discrimination subtest required children to look at a target two-dimensional line-drawn figure and locate the identical figure (target) on the same page. There were five alternatives, including the target, and four visually confusable distracters. The Visual Spatial Relationships subtest presented children with five visual forms simultaneously. Children were asked to identify which one of the five forms was in a different direction from the other forms. The items presented gradually shifted from a focus on the orientation of the entire figure to the orientation of a part of the figure. The two tasks each consisted of one practice item and 16 test items. Each test was terminated when the child failed four out of five consecutive items.

Rapid automatized naming

Two tasks of rapid automatized naming, rapid picture-naming and rapid number-naming, were administered in the present study. Both measures required that children name all the stimuli presented as quickly as possible. Children were given two trials in which to accomplish this naming for each task, and the average speed

across these two trials was used in our analyses. Three rows of the same five pictures, presented in varying orders across rows, comprised the rapid picture-naming task. Each of the five common objects presented in this task across rows had a two-syllable Korean name. The rapid number-naming test consisted of five rows of five digits. Each of the five digits was presented in different orders across each row. Because there were few naming errors in either of these tasks, only speed of naming was included in our analyses; naming errors were not.

Vocabulary

To measure general vocabulary skills, we used the Korean-Wechsler Preschool and Primary Scale of the Intelligence vocabulary subtest (Park, Kwak, & Park, 1995). This vocabulary subtest was included as a proxy for general intelligence. In the test, children were asked to define or explain pictures of objects and, at a more difficult level in the test, concepts. The ceiling for this task was 0 marks for five consecutive items. The test consisted of 25 items, and the maximum possible score on this measure was 47.

Morphological awareness

The Morphological construction test was administered to test children's morphological structure awareness ability. In this task, 20 scenarios were orally presented in 2- or 3-sentence stories. The first 3 scenarios were aided with pictures so as to make them easy for children to understand; the remaining items were not accompanied by pictures. One example of an item from this task is this: *When a refrigerator keeps Kimchi* (*김치*) *in it, then we call it Kimchi refrigerator* (*김치 냉장고*). *If a refrigerator keeps a flower* (*꽃*) *in it, what would we call it? The correct answer should be flower refrigerator* (*꽃 냉장고*). Children were required to construct words for the objects or concepts presented in the scenarios. The maximum score for this task was 20. Items increased in difficulty level by moving from relative concrete to more abstract concepts as the test progressed. Experimenters stopped testing when five consecutive items were failed. Feedback was not given to the children. All test items are available from the first author upon request.

Results

Means and standard deviations on all tasks are displayed separately for 4- and 5-year olds in Table 1. Reliabilities for these tasks (test–retest for the speeded naming tasks; internal consistency reliabilities for the other measures) were all at or above .70. Skills on all measures presented as raw scores improved across age levels. Older children were quicker on the rapid naming tasks and better on total scores for all other measures. All tasks had adequate variability as indicated by their standard deviations and none except onset deletion task for 4-year olds, for whom

Table 1 Reliabilities, means, standard deviations and *F* tests for differences between 4-year and 5-year children for the variables

Variable	Reliability	4-year olds		5-year olds		*F*(1,227)***
		M	*SD*	*M*	*SD*	
Age (in months)	–	58.88	4.00	71.20	3.65	
Regular word reading (35)	.98	16.64	13.08	28.21	8.16	65.31
Irregular word reading (30)	.94	8.17	7.06	11.47	7.76	24.80
Visual discrimination (16)	.80	4.98	3.08	8.01	3.30	51.33
Visual spatial-relationships (16)	.87	3.86	3.51	7.64	3.94	58.50
Vocabulary (47)	.73	16.00	4.04	20.86	4.71	69.67
Syllable deletion (16)	.91	5.10	4.26	10.08	4.27	77.95
Coda deletion (16)	.95	5.10	5.25	10.03	5.38	49.25
Onset deletion (16)	.92	2.45	3.21	4.97	4.35	24.73
Rapid number naming (s)	.93	27.12	11.05	19.04	5.97	48.19
Rapid picture naming (s)	.70	20.71	5.18	17.34	3.32	34.71
Morphological construction (20)	.89	3.96	4.14	7.96	4.83	51.14

Note. The number possible is indicated in parentheses

$N = 111$ for 4-year olds; $N = 118$ for 5-year olds; *** $p < .001$

45 out of 111 children scored 0, were at ceiling or floor levels, as indicated by the means of each. The means of regular word reading were higher than those of irregular word reading at both ages. Note that the means for phoneme onset and coda deletion differed from one another at both ages. A comparison across these two tasks suggests that phoneme onset deletion appears to be a challenge relative to coda deletion in young Korean children.

Table 2 shows intercorrelations among all measures included in this study, partialing for children's ages, separately for the 4- and 5-year olds. Both Hangul regular and irregular word recognition were significantly associated with most of the tasks administered across both samples of children. However, the strengths of associations across tasks differed. Perhaps most striking is the fact that the correlation coefficients of all of the phonological awareness tasks with Korean Hangul regular word recognition were at or above .48. In addition, the speeded naming for numbers task was associated with Korean Hangul regular word recognition at a magnitude of above .50 across samples. Such associations are impressively strong. However, the correlation coefficients of the tasks of phonological awareness and rapid number-naming with irregular word recognition were somewhat less strong ($r = .50$ and below). Tasks of phonological awareness tended to be relatively strongly associated with one another as well. For example, children's scores on phoneme onset and coda deletion tended to be above .50 for both samples. Patterns of associations across samples appeared fairly similar in the 4-year-old and 5-year-old samples separately. Therefore, we combined the samples in our subsequent regression analyses.

Table 3 shows the final standardized beta weights with all variables as well as grade simultaneously used to predict Hangul regular and irregular word reading in a

Table 2 Correlations of all variables controlling for age

Measure	1	2	3	4	5	6	7	8	9	10	11
1. Regular word reading	–	.60***	.29***	.30***	.21*	.48***	.70***	.50***	–.51***	–.27**	.30***
2. Irregular word reading	.59***	–	.31***	.19*	.29**	.36***	.50***	.46***	–.42***	–.24**	.41***
3. Visual discrimination	.30***	.25**	–	.30**	.15	.27**	.24**	.34***	–.25**	–.09	.12
4. Visual spatial - relationships	.24*	.14	.46***	–	.19*	.24*	.35***	.22*	–.15	–.23*	.13
5. Vocabulary	.18	.10	.34***	.25**	–	.25**	.25**	.38***	–.18*	–.16	.40***
6. Syllable deletion	.57***	.43***	.17*	.28**	.11	–	.34***	.38***	–.30**	–.15	.24**
7. Coda deletion	.48***	.40***	.11	.26**	.22*	.49***	–	.58***	–.44***	–.34***	.29**
8. Onset deletion	.64***	.49***	.26**	.28**	.24*	.51***	.52***	–	–.31**	–.29**	.45***
9. Rapid number naming	–.66***	–.35***	–.20**	–.12	–.11	–.42***	–.34***	–.43***	–	.35***	–.07
10. Rapid picture naming	–.26**	–.21*	–.15	–.10	–.02	–.33***	–.31***	–.25**	.47***	–	–.24*
11. Morphological construction	.18	.20*	.24**	.33***	.34***	.23**	.22*	.37***	–.07	–.08	–

Note. *$p < .05$; **$p < .01$; ***$p < .001$. (Correlations above the diagonal represent associations among the 5-year olds; correlations below the diagonal represent associations among the 4-year olds)

Table 3 Standardized beta weights for regression equations for the combined sample of 4-year and 5-year children with Korean Hangul regular and irregular word recognition as the dependent measure

Variable	Regular words		Irregular words	
	B	*t*-value	*B*	*t*-value
Age	–11	–1.38	–.07	–.69
Grade	.14	1.84	–.01	–.07
Visual discrimination	.06	1.34	.16	2.32*
Visual spatial-relationships	.03	.54	–.08	–1.19
Vocabulary	–.05	–.93	–.01	–.08
Syllable deletion	.21	3.98***	.15	1.94
Coda deletion	.24	4.31***	.26	3.40***
Onset deletion	.15	2.83**	.14	1.92
Rapid number naming	–.43	–8.34***	–.16	–2.19*
Rapid picture naming	.08	1.65	.03	.49
Morphological construction	.03	.59	.18	2.76**

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

$N = 229$; Regular words: $R^2 = .70$; irregular words: $R^2 = .43$

regression equation for the combined sample of children. We included both measures of age and grade in this analysis because some cognitive skills (e.g., syllable awareness) associated with reading tend to change primarily as a function of development, whereas others (e.g., phoneme awareness) are more likely to change as a function of educational experiences (Morrison, Smith, & Dow-Ehrensberger, 1995). Although the children were still in preschool, they might have experienced more preliteracy instruction in the second level of preschool (age 5) as compared to the first level.

In this regression equation, with all measures included, all three levels of phonological awareness, i.e., syllable deletion, onset deletion, and coda deletion, were uniquely associated with beginning Korean Hangul regular word recognition. Interestingly, in contrast to previous findings, rapid number-naming (but not picture-naming) was also significantly associated with Korean word recognition in this sample. In contrast, age, grade, and the vocabulary measure were not significant in this equation. With all of these variables included, the total variance explained in beginning Hangul reading of regular words was 70%. On the other hand, Hangul irregular word recognition was uniquely explained by the Visual Discrimination task, coda deletion, rapid number naming, and morphological construction tasks. With all of these variables included, the total variance explained in beginning Hangul reading of irregular words was 43%.

Since irregular words were included in the final part of a reading list, we did another regression analysis to predict irregular word reading among those 121 participants who could read at least one of irregular words (41 4-year olds and 80 5-year olds). Table 4 shows correlation coefficients and the final standardized beta weights of irregular word reading with all variables included in the present study. In the regression analysis, rapid number naming and morphological construction tasks

Table 4 Correlations of Korean Hangul irregular word reading controlling for age and grade and standardized beta weights for regression equations predicting irregular word reading for the children who could read at least one of the irregular words

Variable	*r* with irregular word reading	*B*	*t*-value
Age	–	.06	.39
Grade	–	–.17	–1.04
Visual discrimination	.17	.16	1.64
Visual spatial-relationships	.07	–.12	–1.25
Vocabulary	.27**	.09	.88
Syllable deletion	.27**	.15	1.62
Coda deletion	.33***	.23	1.96
Onset deletion	.29**	–.05	–.48
Rapid number naming	–.28**	–.26	–2.47*
Rapid picture naming	–.22*	.12	1.08
Morphological construction	.33***	.32	3.12**

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

$N = 121$; $R^2 = .32$

were uniquely associated with irregular word recognition. With all of these variables included, the total variance explained in beginning Hangul reading of irregular words was 32%.

Discussion

The focus of this study was an exploration of cognitive factors that might explain early word recognition processes in Korean. We used a large battery of tasks in our study, including three phonological awareness task, two tasks of visual skills, two speeded naming measures, and a morphological construction task, in addition to general vocabulary knowledge. Among the strongest predictors of Hangul regular word reading in the present study were syllable awareness, phoneme onset awareness, and coda awareness as well as rapid number-naming. Despite the relatively strong associations of these tasks with one another, each level of phonological awareness uniquely explained variance in Korean Hangul recognition of regular words. On the other hand, the most prominent correlates of irregular word recognition were morphological awareness and rapid number naming. These findings are discussed below.

With such a large battery of cognitive tasks administered in the present study, it is indeed striking that all three of our phonological awareness tasks independently contributed to Korean Hangul recognition of regular words. Given the strong overlap among these tasks themselves or with other measures, one might not necessarily expect that all levels of phonological awareness would be independent predictors of word recognition in this sample. However, these results are consistent with previous findings on Hangul reading (Cho & McBride-Chang, 2005; Kim et al., 2004). For example, Cho and McBride-Chang (2005) found that syllable and

phoneme onset awareness uniquely explained Hangul word recognition both among Korean kindergartners and second graders. However, ours is among the first studies to demonstrate the unique contributions of these phonological awareness skills along with coda awareness in Korean. The independence of these phonological awareness tasks in explaining early reading suggests that Korean children must integrate several phonological processes in their early word recognition. The training in literacy that they receive, with an early emphasis on syllable recognition, followed by training in CV syllable and coda blending, perhaps represents a relatively novel feature of early teaching of reading skills. Furthermore, Korean children are asked to focus on letter names and onsets of syllables only later in their training. The relatively simple syllable structure of Korean, in addition to this training method for literacy, make our findings clearly interpretable: children in the very beginning stages of reading Korean need to understand the onset, coda, and syllabic properties of their script to read optimally.

Our findings, that children in the present study performed better on coda deletion than onset deletion, are also consistent with the results of Yoon et al. (2002). In their study, Korean participants performed more accurately in substituting coda as compared to onset phonemes. These researchers concluded that early sensitivity to phoneme codas is integral to Korean children's phonological awareness. Our results extend these findings to demonstrate the importance of such phonological awareness for reading itself.

Another relatively new finding of the present study was that morphological awareness uniquely explained variance in Korean Hangul exception word recognition. In considering the English orthography, Mann (2000) questioned whether morphological awareness could make a unique contribution to word recognition, separable from the well-known contribution of phonological awareness. This is because, in English, phonological and morphological information often overlap strongly. For example, in the word *blankets*, the *s* represents both a morpheme (indicating a plural form) and a phoneme (i.e., /s/). Similarly, the form *hydro*, in the word *hydrofoil*, represents both a morphological and a phonological unit. We explored morphological awareness in relation to lexical compounding, which is sometimes characterized as one aspect of derivational morphology. Our findings suggest that, at least for Korean, morphological awareness in the form of lexical compounding may be important for early irregular word reading, separable from the effects of phonological awareness. It may be that knowledge of the structure of the morphemes in one's language is particularly helpful for early irregular word recognition in Korean because such knowledge facilitates children's use of analogies to map a morpheme from a known word to a new word. Such knowledge also may affect phonological transformations across words. For example, some morphemes may change in pronunciation when combined with other derivational forms (e.g., in English, *know/knowledge*; *photo/photography*). Such transformational processes involving morphology are unnecessary for regular Korean Hangul words, because phonological processes are all that is needed to pronounce the word. However, additional semantic knowledge may be essential for learning exception words.

This finding is particularly interesting because of the other variables statistically controlled in the study. For example, vocabulary knowledge, sometimes linked to

morphological awareness of various types, was included in all regression equations. Nevertheless, the association of morphological awareness to irregular word recognition was among the strongest (though still moderate) correlates of word recognition, particularly among children who could read one or more irregular words. Admittedly, these results are preliminary and warrant replication. The children in the present study were quite young and many of them were limited in their abilities to read irregular words. However, at the same time, this unique association of an orally administered measure of morphological awareness to beginning reading of irregular words is an intriguing one to replicate in future research and is in line with previous results on Korean Hangul recognition in adults.

Overall, our findings indicated that Hangul regular word recognition was uniquely explained by the three measures of phonological awareness, whereas irregular word recognition was better explained by morphological awareness support a dual-route model, which dictates that there are two separate routes to word identification—a phonological and a lexical route. The lexical route involves analysis of the morphemic structure of written words as well as direct access to one-morpheme written words (Chialanti & Caramazza, 1995). In particular, the dual-route model has been supported in the word recognition of Korean Hangul among adults (Cho, 2001; Simpson & Kang, 1994). For example, Cho (2001) found that the phonological route was favored in the processing of low frequency Hangul words, but the lexical route was more often used in recognizing high frequency words using semantic categorization tasks. In addition, Lee (1997) tested college students and found a frequency effect in the naming of irregular Hangul words which included irregular codas or consonantal assimilation to be read, indicating the use of direct lexical access. At the same time, however, the frequency effect was not found in the naming of regular Hangul words, suggesting the use of the phonological route in reading these words (Lee, 1997). Lee's findings are similar to our results in that reading phonologically regular words tends to depend upon phonological processing, whereas reading exception words depends primarily on lexical processing.

Another cognitive ability that was strongly associated with Hangul word recognition in both age groups and across both types of word reading was number-naming. These results are interesting since previous studies on Hangul reading did not find a significant contribution of tasks of speeded naming to reading in kindergartners or second graders once other reading-related measures were included in analyses (Cho & McBride-Chang, 2005; Kim et al., 2004). It is possible that some of the discrepancy in findings across studies results from sample differences. For example, in the study by Cho and McBride-Chang (2005), children on the whole could read most of the Hangul words presented to them. Thus, the depressed variability in Hangul recognition likely diminished the magnitudes of association of it with the speeded naming tasks. Our findings in Korean, from a large sample with adequate variability across tasks, are similar to previous results across orthographies indicating that graphological naming tasks are better predictors of reading than are non-graphological ones. Graphological naming tasks involve naming of printed symbols, such as numbers or letters, whereas non-graphological stimuli include pictures or blocks of color. Our results suggest that tasks of speeded naming should be included in future studies of early reading development in Korean Hangul. It may

be that speeded naming tasks are particularly good indicators of those who are at-risk for reading disability, just as they are in other diverse orthographies such as English (e.g., Bowers & Newby-Clark, 2002) or Chinese (e.g., Ho et al., 2002).

Finally, the task of Visual Discrimination was a unique predictor of irregular word reading skill in the present study, at least in our analysis of the full sample of children. These results are similar to the findings for Chinese children, that visual processing measures can explain some of the variance in Chinese character recognition, though primarily among younger children (Ho & Bryant, 1997; McBride-Chang et al., 2005a; Siok & Fletcher, 2001). Kim and Davis (2004) argue that Hangul reading may not demand visual skills because the spacing and regularity of Hangul may make it particularly easy to read relative to other script. However, in that study, participants were fifth graders, for whom visual skills are likely well developed. Our findings suggest that visual processing may be a relevant aspect of Hangul reading for very young children. Future studies should perhaps explore the specific visual skills that are most strongly linked to reading in early Korean Hangul acquisition. Apart from visual discrimination abilities, skill in visual integration, sequencing, or closure might be additionally useful in the beginning stages of Korean word recognition acquisition.

Several aspects of the present study could be improved in future work. First, this study was correlational. Although such studies are likely necessary for isolating the most relevant cognitive aspects of reading in an orthography about which relatively little is known, such as Korean, future work should examine the extent to which the constructs we have identified might longitudinally predict variability in reading. Correlational studies cannot determine causality, and an interesting question related to this study is whether (and which) relations of cognitive tasks and reading might be unidirectional vs. bidirectional. For example, it is likely that those who are better readers develop superior phonological awareness, as demonstrated in many previous studies on alphabetic languages (see Castles & Coltheart, 2004, for a review). In future studies, then, we would like to determine the extent to which levels of phonological awareness predict subsequent word recognition. The same issues could be addressed in relation to the other constructs included in the present study. For example, it is possible that those with good reading skills apply their well-honed print discrimination skills to discriminating other visual figures, such as the ones on the task we administered to them. Longitudinal studies, particularly those following children who cannot yet read or who are in the very initiation into reading, will be useful for sorting out directions of association across time.

Second, we would also like to know more about the home backgrounds of these children. For example, although some of the children tested likely had some formal introduction into the Korean syllables chart from their parents, we do not know how much time or energy, if any, their parents devoted to literacy skills. This would be a useful dimension to document.

Finally, in retrospect, we should have included measures of children's knowledge of letter and syllable names and sounds in the present study. With previous studies of alphabets as a model, we are aware that alphabet knowledge is a key predictor of early literacy in young alphabetic readers (e.g., Adams, 1990). In Korean, letter names and sounds are similar in consonants and the same in vowels. Since letter knowledge and phoneme knowledge are closely related in Korean and both are

taught to children later in their literacy training, the phoneme awareness measures used in this study might be considered good proxies for letter knowledge. At this point, determining the extent to which phonological awareness skills and letter knowledge are distinguishable in emergent Korean literacy is an important goal of ours for future studies.

Despite these limitations, our study offers some interesting distinctions between very early regular and irregular reading in Korean Hangul. Regular word recognition depends primarily on phonological processes, and in Korean, there are three salient aspects of phonological awareness that may be important for beginning reading. As in alphabetic orthographies, phoneme awareness is important for Korean. However, unlike English, coda awareness appears to be relatively well-developed in young Korean children. Moreover, in addition to phoneme awareness, syllable awareness appears to be particularly important in young Korean readers, similar to early Chinese readers (e.g., McBride-Chang & Ho, 2000). In contrast, exception word reading, though involving phonological processes, also appears to make use of morphological awareness in Korean, which requires reading of multi-morpheme words from the beginning. The importance of our measure of morphological awareness for reading likely depends on the necessity of reading multi-morpheme words, which is common in Korean and Chinese but less common for beginning readers of English (McBride-Chang et al., 2005a). In addition, visual skills may also facilitate early irregular word recognition in Korean Hangul.

These findings demonstrate that both universal and specific aspects of cognitive skills apply to reading of Korean. A universal of early reading appears to be that some form of phonological awareness is important for word recognition. Some potential "specifics" include particular dimensions of visual skills or morphological structure awareness. These abilities may be more useful for early reading of Korean or Chinese than for reading English, for example. Practically, these results offer practitioners some ideas about what to look for in Korean children who might be at-risk for reading or language problems. Phonological awareness at three levels can reliably be assessed and evaluated for Korean children beginning at age four, for example. In addition, very slow speeded naming or difficulties on the morphological construction task may also signal potential problems for early language and literacy learning. Thus, in addition to their theoretical implications, these preliminary findings may be useful for future clinical and educational work.

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