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Characteristics of Korean phonology: Review, tutorial, and case studies of Korean children speaking English

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Abstract

A significant number of bilinguals in English-speaking countries speak Korean as their first language. One such country is the United States (U.S.). As the U.S. becomes increasingly diverse, providing more effective services for culturally and linguistically diverse children is a critical issue and growing challenge for speech-language pathologists. The U.S. Census Bureau reports that the number of Korean immigrants in the U.S. has steadily increased over the past decade. As a result, a greater number of children who speak Korean as a first or second language may need speech, language, and hearing services. This paper provides a review of the literature on (1) phonological characteristics of the Korean language and (2) speech sound acquisition and developmental patterns for phonological processes in Korean children. We illustrate how language knowledge of Korean might impact the learning of English based on case studies of three Korean children speaking English in the U.S. We describe considerations for more appropriate evaluation and treatment of speech sound disorders in Korean-English-speaking children.

Learning outcomes: Readers will be able to: (1) understand phonological characteristics of the Korean language and speech sound acquisition and developmental patterns for phonological process in Korean children, (2) describe characteristics of English speech sound acquisition in successive bilingual English-Korean learners and interference patterns that result from the influence of two independent phonological and phonetic systems, and (3) describe considerations and clinical implications for the more appropriate evaluation and treatment of speech sound disorders in Korean-English speaking children.

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1. Introduction

Due to the cultural and linguistic diversity of many English-speaking countries, providing more effective services for culturally and linguistically diverse children is a big challenge for speech-language pathologists. The present paper focuses on one such country, the United States (U.S.), and one language other than English spoken by a substantial number of its people: Korean. The U.S. Census Bureau results show that foreign born individuals from Korea made up the seventh-largest immigrant group in 2000 (U.S. Bureau of the Census, 2006). Within the Asian population in the United States, the number of foreign born people from Korea increased by 52% between 1990 and 2000. The Overseas Koreans Foundation (http://eng.korean.net) reported that the Korean immigrant population in the U.S. in 2007 was

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approximately 2 million. It is projected that more than half of the Korean immigrants speak Korean at home (U.S. Bureau of the Census, 2006).

Given the substantial increases in the Korean immigrant population in the U.S., we might expect the number of bilingual children speaking Korean and English to have increased. Consequently, speech-language pathologists will more likely encounter bilingual children speaking Korean and English who show phonological disorders. The issue of clinical service for bilingual children speaking Korean and English is also important in other English-speaking countries including Canada, Australia, the United Kingdom (U.K.), and New Zealand. According to the Overseas Koreans Foundation, there were approximately 2.5 million Korean immigrants living in English-speaking countries in 2007.

Yavas and Goldstein (1998) suggested that speech-language pathologists should understand ''common and uncommon phonological patterns in first and second language acquisition and bilingual phonology, interference patterns between languages, dialect patterns, and language-specific patterns that are exhibited in one language but not in the other'' (p. 58). To identify these patterns, speech-language pathologists need basic knowledge about Korean phonology as it compares to English. It is necessary to identify and discern the causes of the children's phonological problems, which might include difficulty with English phonological acquisition due to the effect of a second language, the nature of Korean or English phonology, or underlying phonological problems without regard to either of the two languages. This knowledge makes it possible to provide appropriate clinical services to Korean children with phonological disorders.

The characteristics of bilingual speech acquisition are different with respect to types of bilingualism (i.e., simultaneous bilingual speaker versus successive bilingual speaker) and levels of language dominance (Yavas, 2007). If children move to countries speaking English after they have nearly or completely acquired their native Korean language, their Korean phonological and phonetic system might have a strong influence on English speech production. In such cases, it is critical to differentiate Korean children who are phonologically disordered in one or both languages from Korean children who demonstrate typical phonological development in their native language and whose errors in English merely reflect the influence of the Korean language. Knowledge about phonological characteristics of the Korean language contrasted with English is needed to provide accurate speech evaluation and appropriate speech treatment.

The purpose of the present paper is to provide a literature review on phonological characteristics of the Korean language in comparison to English, as spoken by adults, and speech sound acquisition and developmental patterns for phonological processes in Korean children. Also, we provide case studies of three Korean children speaking English in the U.S. The three children are successive bilingual learners as they were born in Korea and have completely acquired the Korean speech sound system before moving to the U.S. We expect that these case studies will show characteristics of English speech sound acquisition typical of successive bilingual learners and interference patterns that result from the influence of two independent phonological and phonetic systems (Paradis, 2001). We illustrate how language knowledge of Korean might impact the learning of English, and we describe considerations and clinical implications for the more appropriate evaluation and treatment of speech sound disorders in Korean-English-speaking children, based on a literature review and case studies.

2. The Korean language

The Korean language is composed of seven geographically based dialects including the Central dialect, which has been considered the standard Korean dialect in South Korea, and the Phyengan dialect, designated as the standard Korean dialect in North Korea (Sohn, 1999). Although there are geographical and socio-political dialectal differences, the Korean language is relatively homogeneous, whereby speakers from different areas can communicate with each other with little effort or difficulty. In particular, due to mass media and education based on standard Korean, dialects in South Korea have become standardized (centralized) and more homogeneous. Approximately 75 million people in the world speak Korean as a first language (Kim & Pae, 2007). The Korean Culture and Information Service (http://www. Korea.net) reported that there are 48 million people in South Korea, 22 million in North Korea, and 5 million outside of Korea who speak Korean as their first language.

2.1. The sound patterns of the Korean language

The sound patterns of standard Korean consist of 19 consonants, 10 vowels, 2 semivowels, and 11 diphthongs (Lee & Ramsey, 2000; Sohn, 1999).

Table 1
Korean vowels.

Place	Front		Central	Back	
	Lips		Lips	Lips	
Tongue	Unround	Round	Unround	Unround	Round
High	i	y	ɨ		u
Mid	e	ø		ʌ	o
Low	ɛ			a	

2.1.1. Vowels and diphthongs

The 10 vowels of Korean can be categorized with respect to tongue position (high–mid–low, front–central–back) and lip rounding (rounding–unrounding) in the same manner as English (see Table 1). In standard production, all Korean vowels are voiced and nonnasal like English vowels. Both Korean and English vowels are nasalized for a certain duration when they precede or follow nasal consonants (Ha & Kuehn, 2006). Unlike English vowel production that is described as tense (long) or lax (short) (Kent, 2004), Korean vowels are not categorized in terms of tense or lax features. Several studies of English vowel production and perception in Korean speakers suggest that Korean speakers learning English or Korean-English bilinguals have difficulty perceiving and producing English vowels in the same manner as native English speakers (e.g., Bohn & Flege, 1992; Ingram & Park, 1997; Tsukada et al., 2005). The major findings of these studies were that Korean speakers show difficulty with perception and production of English /i/-/I/ and /ɛ/-/æ/ contrasts due to differences between the vowel systems of English and Korean, especially the lack of a ''tense–lax'' distinction in the Korean vowel system.

One distinctive characteristic of the Korean vowel system is its diphthongs. Two semivowels, /w/ and /j/, are described as combining with other vowels to form 11 diphthongs: /ja, je, jo, ju, jaj, jej, wa, we, waj, wej, uj/. It remains to be demonstrated acoustically or physiologically, however, whether these ''diphthongs'' truly are different from glide plus vowel or vowel plus glide combinations in the English system. Assuming that such difference exists, it may take more time for Korean children to master diphthongs than single vowels with regard to pronunciation and spelling, due to the relatively greater number of sounds classified as phonemic diphthongs in Korean than English and the possible difficulty of articulating diphthongs. Indeed, Korean literature about the developmental pattern of Korean vowels indicates that all the vowels are acquired before age 3 but some diphthongs, in particular /wa, we, waj, wej/, are not acquired even by the age of 5 (Kwon, 1981; Um, 1994).

2.1.2. Consonants

Table 2 provides a classification of the 19 Korean consonants by manner and place of articulation and includes the English consonant system for better understanding of contrastive and noncontrastive characteristics of the consonant systems of the two languages. Korean has fewer consonants than English. Korean has neither labiodental fricatives nor linguadental fricatives such as the /f/, /v/, /θ/, and /ð/ of English. Also, the /z/, /ʃ/, /ʒ/, /tʃ/, /dʒ/, and /r/ sounds do not exist in Korean.

In Korean, all consonants except nasal /ŋ/ can occur in the initial position of a word, but only seven consonants, /p/, /t/, /k/, /m/, /n/, /ŋ/, and /l/ can occur in syllable-final position. In syllable-final position, only variants of stops that traditionally have been described as lax consonants (e.g., /p, t, k/) are allowed; and in that position, the consonants are unreleased. When the lips close to articulate the final /p/ of /cip/ meaning ''*house*'', for example, they remain closed, with no breath of air escaping. This feature of production is different from the optional release of English consonants in syllable-final position.

Originally, /l/ did not normally occur in word-initial position in Korean. There are no native Korean words that begin with this consonant. Modern borrowings, however, do not follow this pattern, and there are many loan words in Korean today beginning with /l/ (e.g., *line* pronounced as /la-in/). The phonetic characteristics of /l/ sounds in syllable-initial and final positions are different from each other. In word-final position the consonant /l/ is always produced as a lateral approximant, whereas /l/ in word-initial position is frequently produced as a flap consonant, which is produced with a brief contraction of the muscles so that the tongue is thrust against the alveolar ridge (Lee, 1989). The consonant /n/ is another phoneme that does not normally occur in word-initial position when followed by the vowels /i/ or /y/, but modern loans from English are not subject to this constraint (Lee & Ramsey, 2000).

Table 2
Korean and English consonants.

	Bilabial		Labio-dental		Lingua-dental		Lingua-alveolar		Lingua-palatal		Velar		Glottal	
	K	E	K	E	K	E	K	E	K	E	K	E	K	E
Stop (Plosive)														
Tense	/p*/						/t*/				/k*/			
Lax[a]	/p/						/t/				/k/			
Aspirate	/p^h/						/t^h/				/k^h/			
Voiceless		/p/						/t/				/k/		
Voiced		/b/						/d/				/g/		
Affricate														
Tense									/c*/					
Lax									/c/					
Aspirate									/c^h/					
Voiceless										/ʧ/				
Voiced										/ʤ/				
Fricative														
Tense							/s*/							
Lax							/s/							
Aspirate													/h/	
Voiceless				/f/		/θ/		/s/		/ʃ/				/h/
Voiced				/v/		/ð/		/z/		/ʒ/				
Nasal	/m/	/m/					/n/	/n/			/ŋ/	/ŋ/		
Liquid							/l/	/l/		/r/				
Glide		/w/								/j/				

Note: K = Korean; E = English; * = traditionally described as having a ''tense'' quality in Korean; ^{h} = traditionally described as having an ''aspirated'' quality in Korean.

[a] Korean symbols /p, t, k, c, s/ without the diacritics * and ^{h} are traditionally described as have a ''lax'' quality.

It is a convention in Korean linguistics to characterize Korean stops and the fricatives /s/ and /s*/with a language-specific set of features (see Table 2). Whereas English stop consonants are conventionally categorized by features of voicing and aspiration (i.e., Lisker & Abramson, 1964), Korean linguistic convention is to classify Korean stop consonants by degree of tensity (tensing) and aspiration (e.g., Kim, 1965). Korean linguists do not consider there to be any voicing contrast in Korean. They consider all stop and fricative consonants to be voiceless, except for the lax stops which may become lightly voiced between voiced sounds. Regardless of whether or not one agrees with the characterization of all Korean stops and fricatives as voiceless, phonemically in Korean there is a three-way contrast (tense–lax–aspirate) in stop consonants and palatal affricates, a two-way contrast (tense–lax) in the alveolar fricatives, and no contrast for the glottal fricative /h/ (Sohn, 1999). The consonants /p*/, /t*/, /c*/, /k*/, and /s*/ are categorized as tense (or ''fortis'' or ''reinforced''), where the symbol [*] is used in keeping with the conventions of the published literature on Korean phonology. The consonants /p/, /t/, /c/, /k/, and /s/ are categorized as lax (or ''plain''); and the consonants /p^h/, /t^h/, /c^h/, /k^h/, and /h/, as aspirate. The remaining four consonants are liquid and nasal consonants, /l/, /m/, /n/, and /ŋ/.

The classification of consonants by the articulatory features, tense, lax, and aspirate reflects a characteristic of the Korean language which is not found in most other languages. Kim (1965) was the first to provide evidence that it is not the voicing feature but a tensity feature that is the primary feature for discriminating among Korean stop consonants, based on acoustic, airflow, palatographic, and electromyographic data. The tense feature (tensity) continues into the vowel, giving it a throaty or laryngeal quality according to perceptual classifications by native Korean phoneticians (Lee & Ramsey, 2000). In a review of the literature by Yoon (2007), it was found that several studies have provided additional evidence to support the notion of tensity as a perceptual feature: for acoustic features such as voice onset time (VOT) (Hardcastle, 1973) and fundamental frequency (Choi, 2002), perceptual features such as pitch (Kim & Duanmu, 2004), and physical production features such as duration of linguapalatal contact (Cho & Keating, 2001) and intraoral pressure (Cho, Jun, & Ladefoged, 2002). Whether or not these features result in a perceptual interpretation of

a ''voiced'' or ''voiceless'' quality similar to English can only be determined by comparing such perceptual interpretations of Korean and English stops and fricatives by both English and Korean native speakers.

Kim (1965) also suggested that VOT is a secondary feature for differentiating Korean stop consonants. The consonants classified as tense are pronounced with the shortest VOT among the stop consonants, about a 12 ms VOT, indicating little aspiration. The consonants classified as lax or ''plain'' are slightly aspirated in word-initial position and produced with a longer voicing delay of about 30–50 ms. The terms ''tense'' and ''lax,'' as used in the Korean system, may be confusing in relation to the use of these terms in the English system, given that consonants with short VOT in English are sometimes classified as lax and those with longer VOT are sometimes classified as tense, or ''fortis,'' i.e., the reverse of the descriptions in Korean. However, consonants classified as ''aspirated'' in the Korean system are produced with strong aspiration lasting approximately 100 ms (Lee & Ramsey, 2000). English voiceless consonants are generally produced with about 70–85 ms of voicing delay and aspiration, about mid-way between the VOT values of Korean lax and aspirated consonants; as a result, English speakers are often unable to hear the distinction between the Korean lax and aspirated consonants (Lee & Ramsey, 2000).

McCrea and Morris (2005) described English voiced stops as usually displaying VOT durations of 0–25 ms (see also Forrest, Weismer, & Turner, 1989; Lisker & Abramson, 1964) although the VOT values of English voiced consonants have shown variation in terms of speakers and may show a negative range as great as −170 to −210 (Caramazza, Yeni-Komshian, Zurif, & Carbone, 1973; Zlatin, 1974). English speakers tend to identify the Korean tense consonants with the voiced consonants of their own language, which might be due to the fact that English voiced stops (i.e., /b, d, g/) show a positive VOT range that overlaps that of Korean ''tense'' stops (e.g., /p*, t*, k*/). However, the tense consonants are considered voiceless as well as unaspirated because voice onset of the Korean tense consonants occurs almost simultaneously with release of the burst of the consonant (Lee & Ramsey, 2000). The distribution of VOTs for the ''tense'' stops of Korean appears to never be as negative as the voiced stops of English, perhaps contributing to the claim that all Korean stops are ''voiceless.''

There is a two-way distinction for the alveolar fricatives: /s*/ and /s/, that is, tense and lax (Sohn, 1999). Unlike all the other lax consonants, /s/ does not become voiced between vowels. It is always pronounced as a voiceless fricative. There is no phonemic /z/ in Korean, as described earlier. Korean consonant /s/ has only slight air escape, which sounds unlike the /s/ of English. The Korean tense consonant /s*/ often sounds more like the /s/ of English than does the Korean /s/ (Lee & Ramsey, 2000). When speaking English, Koreans often pronounce English /s/ with the tense quality of the /s*/ in their own language. Furthermore, the lax, or plain /s/ is palatalized before /i/ and the diphthong, /wi/, that is, Korean /si/ sounds like /ʃi/ and /swi/ like /ʃwi/ (e.g., *swiri*, meaning ''name of fish,'' pronounced as /ʃwi-ri/). Tense /s*/ is usually not palatalized. Kim (1996) reported that the /s*/ phoneme is the last consonant that typically developing Korean children acquire. It is assumed that young children have difficulty pronouncing /s*/ accurately due to the combination of the fricative manner and the tense feature.

In addition, the most distinctive contrast between Korean and English is associated with consonant clusters. The Korean phonetic syllable structure is of the form (C)(G)V(C) which consists of only one optional consonant (C) and one optional glide or semivowel (G) in the initial position, and one optional consonant in word-final position. A vowel (V) is the only obligatory element in the Korean phonetic syllable structure (Sohn, 1999). Due to the influence of this phonetic syllable structure, Korean speakers tend to insert a vowel [ɨ] when they pronounce words including consonant clusters. For instance, the single-syllable English word ''strike'' is borrowed as a four-syllable word [sɨ-t^{h}ɨ-lai-k^{h}ɨ] (Sohn, 1999). Similarly, Korean written words with consonant clusters lose one consonant when spoken, because two consonants are not acceptable in postvocalic position in spoken Korean (e.g., *kaps*, meaning ''price'' → /kap/). This characteristic of Korean phonetic syllable structure shows that there are no syllable-initial or syllable-final consonant clusters in spoken Korean, in contrast to English. Therefore, with respect to phonological development, Korean children do not have speech problems related to syllable-initial or syllable-final consonant clusters as identified in English-speaking children. Rather, Korean children speaking English are likely to show vowel addition between syllable-initial or syllable-final consonant clusters. Also, Korean children have some difficulty spelling and reading consonant clusters in Korean print, due to a difference between the written and spoken systems of Korean (i.e., changes in pronunciation governed by phonological rules) for consonant clusters. For example, young Korean children are easily confused by the spelling of the Korean word, *talk* (pronounced as /tak/ and meaning ''chicken'').

Compared to English, which is a ''stress-timed'' language, Korean is a ''syllable-timed'' language. Each syllable in the Korean language is distinctly pronounced, with equal stress. Instead of having consonant clusters in its phonetic syllable structure, Korean has syllabic consonant clusters which occur between two syllables, in word-medial position.

For example, in the Korean word, *yangmal* (pronounced as /jaŋ-mal/, meaning ''socks''), each syllable of the word is equally stressed and distinctly pronounced. Both /ŋ/ and /m/ are located in word-medial position, with /ŋ/ located in syllable-final position and /m/ in syllable-initial position. Thus, the two sounds form a syllabic consonant cluster in the word-medial position.

As another example of differences in syllabification, the two-syllable English word ''lipstick'' is borrowed as a three-syllable word [lip-si-tik]. The consonants /p/ in syllable-final position and /t/ in syllable-initial position are located in word-medial position, which is acceptable in the Korean language. However, consonant clusters like /st/ do not exist in spoken Korean and therefore the vowel /ɨ/ is added between /s/ and /t/ sounds. This ''syllable-timed' characteristic of the Korean language is related to a unique phonological process error called syllabic cluster simplification (i.e., deletion of one consonant of a syllabic cluster) in Korean children. For example, young Korean children are likely to pronounce *yangmal* /jaŋ-mal/ as /ja-mal/.

3. Speech sound acquisition

The Korean literature on speech sound acquisition shows language-specific developmental patterns of Korean-speaking children as well as universal developmental patterns similar to those reported in the literature for English. With regard to similarities, in children who speak English and those who speak Korean as a first language, early inventories contain stops, nasals, and glides, whereas fricatives and liquids are among the last acquired sounds. Anterior sounds (i.e., labial and alveolar) tend to precede posterior ones and, therefore, bilabial and alveolar sounds are earlier acquired than palatal and velar sounds (e.g., Dodd, Holm, Hua, & Sharon, 2003; Goldman & Fristoe, 2000; Kim & Pae, 2005). At age 2 years, word-final phonetic repertoires are much smaller than word-initial repertoires (Kim, 1996; Stoel-Gammon, 1985). A comparison of the basic and common patterns of acquisition in children speaking either Korean or English as a first language would support the existence of certain universal patterns and a fairly predictable order of acquisition.

The timing of the acquisition of each Korean sound is slightly different among studies due to variations in the test target words, criteria for age of acquisition, methods of analysis, and so on. Kim and Pae (2005) have reported the most recent normative data on children's development of Korean phonology (see Table 3). Using naturalistic samples of speech, they investigated production accuracy of Korean consonants, developmental order, and age of acquisition of phonemes in 220 Korean children between the ages of 2;6 and 6;5 living in Seoul, South Korea. The authors reported the Percentage of Consonants Correct (PCC) as well as the Percentage of Consonants Correct-Revised (PCC-R), in 6-month intervals. Common and uncommon clinical consonant distortions were scored as correct for PCC-R (Shriberg,

Table 3
Developmental patterns of Korean consonants (Kim & Pae, 2005).

Age	Developmental stage of phonemes		
	Customary	Acquisition	Mastery
2;6–2;11	/k*/, /k^h/, /t^h/, SI/t/, /c*/ /c^h/, SI& SF /n/ SI & SF /m/, SF /l/ SF /p/, SF /t/, SI /k/ SF /k/, SF/ŋ/	/p^h/, /h/, SI /p/	/p*/, /t*/
3;0–3;5	/c/, SI /l/	/k*/, /c*/, /c^h/, /t^h/ SI /n/, SI /t/, SF /m/, SF /p/, SI /k/	/k*/, /t^h/, /p^h/, /h/, SI /p/, SF /t/, SI /m/, SI /n/, SF /l/
3;6–3;11	/s/	/c/, SF/n/	SF /p/
4;0–4;5		/k^h/, SF /k/, SF/ŋ/	/c/, /c*/, /c^h/, SI /t/ SI /k/, SF /m/, SF/n/
4;6–4;11	/s*/		/k^h/, SF /k/, SF/ŋ/
5:0–5;5		SI /l/	
5;6–5;11			SI /l/
6;0–6;5			

Note: Customary = age of customary correct production (i.e., 50–74% of children in an age group produce the sound correctly); acquisition = age of acquisition (i.e., 75–89% of children in an age group produce the sound correctly); mastery = age of mastery (i.e., 90–100% of children in an age group produce the sound correctly). SI = syllable-initial position; SF = syllable-final position. These ages were determined using the PCC (rather than PCC-R) metric.

Austin, Lewis, McSweeny, & Wilson, 1997a). In addition, the authors demonstrated that the 19 Korean consonants may show different ages of acquisition in various syllable and word positions. Because Korean is a syllable-timed language, the authors separately considered each phoneme in syllable-initial position, both word-initially and word-medially, and in syllable-final position, both word-medially and word-finally.

The authors found that 2-year-old Korean children earn scores of approximately 60% for PCC and 70% for PCC-R, averaged across 43 Korean consonants, including the various positions. PCC increased most remarkably between 2;6 and 3;11, and children over 4 years of age earned PCC and PCC-R scores of more than 90%. Using a specified criterion for age of acquisition (i.e., 75–89% of children in an age group produced the sound correctly), Kim and Pae reported that by late 2 or 3 years, Korean children have acquired stops and nasals (except for velars in syllable-final position), the glottal fricative /h/, liquids in syllable-final position, and affricates. Korean children acquire velars in syllable-final position by age 4 and liquids in syllable-initial position by age 5. The last acquired sounds are the alveolar fricatives, /s/ and /s*/, which are not yet acquired even when children are 6;5. When common and uncommon clinical consonant distortions are scored as correct, Korean children acquire /l/ in syllable-initial position by age 4 and /s/ and /s*/ by age 5 (i.e., 1 year earlier than when such distortions are scored as errors).

All phonemes except /l/ generally emerge and are acquired earlier in syllable-initial position than in syllable-final position. In contrast, /l/ first emerges in syllable-final position and then emerges in syllable-initial. This result regarding the acquisition of /l/ is consistent with that of Um (1994) with respect to Korean consonants, as well as that of Stoel-Gammon and Dunn (1985) with respect to English consonants. Kim and Pae (2005) suggest that this different pattern of acquisition of /l/ from that of other consonants might be due to different phonetic characteristics of Korean /l/ sounds in syllable-initial position (often a flap) and final position (always a lateral approximant). Giles and Moll (1975) also found articulatory differences between pre- and postvocalic /l/ in English speakers which appear to be consistent with the findings for Korean speakers. With regard to consonant manner, typically developing Korean children appear to acquire tense, aspirate, and lax stops and affricates in that order, with the three-way stop contrast acquired by age 4 (Kim & Pae, 2005; Kim & Stoel-Gammon, 2007). Unlike the tense-before-lax acquisition order for stops and affricates, however, the Korean lax fricative /s/ appears to be acquired earlier than the tense fricative /s*/.

The Korean literature consistently reports that /s/ and /s*/ are the last acquired sounds in typical speech development. Furthermore, the acquisition periods for /s/ and /s*/ are protracted compared to other phonemes (Kim & Pae, 2005). Even children aged 6;5 in the Kim and Pae (2005) study had not yet reached the age of acquisition for correct production of /s/ and /s*/ (i.e., correct production by 75–89% of children, as seen in Table 2). In addition, /s/ and /s*/ are the most frequently replaced (i.e., error) sounds in the speech of children with articulation and phonological disorders (Chun & Lee, 1999). Um (1994) showed that typically developing Korean children aged 3–4 years often replaced /s/ with /t/, /h/, and /c/ or produced a lingua-dentalized /s/ which sounds like the English phoneme /θ/.

Chun and Lee (1999) reported developmental patterns (i.e., rate and period of acquisition and percent of production accuracy) for /s/ and /s*/ in typically developing Korean children between the ages of 2 and 7 years, with some differences due to the vowel context. The results of the study suggest that the developmental error pattern for /s/ progresses in the following order: from deletion; to substitution by /h/, /t^h/, and then palatalized /s/; to correct production of /s/. Likewise, the developmental error pattern for /s*/ progresses in the following order: from deletion, to substitution by /h/, /t*/, palatalized /s*/, and then /s/. Based on an acquisition criterion of 75% correct for /s/ in various vowel contexts, /s/ in the /si/, /sə/, and /sɨ/ contexts was acquired from 5;6 to 5;11, and /s/ in /so/ context was acquired from 6;6 to 6;11. However, /s/ in the /su/ context did not reach the 75% acquisition criterion even during the period from 7;6 to 7;11. Furthermore, when a 90% acquisition criterion was used, /s/ in the /sɨ/, /sɛ/, /so/, and /su/ contexts was not acquired during the period from 7;6 to 7;11 and continued to develop afterwards. Turning to /s*/, the consonant was acquired in the /s*a/ and /s*ɛ/ contexts (i.e., met the 75% criterion) from 6;6 to 6;11. In the /s*ə/ and /s*o/ contexts, it was acquired from 7;0 to 7;5. In the /s*ɨ/ and /s*u/ contexts, it had not yet reached the 75% acquisition criterion by 7 years. Indeed, no /s*/ in any vowel context reached the higher 90% acquisition criterion by 7 years, which means that /s*/ continues to develop after 7 years. The consonants /s/ and /s*/ in the context of /i/ showed the highest percent of production accuracy. On the other hand, /s/ and /s*/ in the context of /u/ showed the lowest percent of production accuracy. In other words, /s/ and /s*/ preceding the vowel /i/ are most easily produced by children, whereas /s/ and /s*/ preceding the vowel /u/ are the most difficult phonemes for children. The reason for the former acquisition pattern might be related to the allophonic features of /s/ and /s*/ in the /i/ context. In the phonological rules for adult Korean, /s/ and /s*/ become palatalized before the vowel /i/. Therefore, /s/ and /s*/ before the vowel /i/ have a different place of

articulation from these same consonants before other vowels. Young Korean children are able to produce palatalized /s/ and /s*/ with relative ease and at earlier ages. Chun and Lee (1999) concluded that the /i/ vowel context elicits accurate production of /s/ and /s*/ relatively easily. This has clinical implications for the diagnosis and treatment of children with articulation and phonological disorders in Korean, namely that /s/ and /s*/ preceding the vowel /i/ would be a good starting point for children who have difficulty in producing /s/ and /s*/.

With regard to developmental phonological patterns for Korean and English, the most striking contrasts are associated with consonant clusters and some phonemes that do not exist in Korean such as /θ/ and /ð/. English-speaking children show a longer period for acquiring all the speech sounds of the language than those speaking Korean, perhaps due to consonant clusters and the phonemes /θ/ and /ð/ (i.e., Shriberg, 1993; Shriberg et al., 1997a; Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997b; Smit, Hand, Freilinger, Bernthal, & Bird, 1990). Korean-speaking children are usually expected to acquire all the sounds in Korean and show adult-like articulation and phonological ability around 6 or 7 years of age. In contrast, the acquisition process for consonants and consonant clusters in English-speaking children continues until 9 years of age according to some accounts (e.g., Smit, 1993; Smit et al., 1990). The last acquired consonants in Korean are /s/ and /s*/, which are acquired by 6 or 7 years, whereas among the last acquired singleton consonants in English are /θ/ and /ð/, which are typically acquired at 7 or 8 years (Chun & Lee, 1999; Kim, 1992a, 1996; Smit et al., 1990), and /s/ and /z/, which according to some normative studies may not be mastered by 90% of children until 9 years (Smit et al., 1990). Shriberg and his colleagues report ''Late-8'' consonants from a profile of consonant mastery taken from a group of 64 children aged 3–6 years with speech delays (Shriberg, 1993; Shriberg et al., 1997a,b). The Late-8 consonants included /θ/, /ð/, /s/, /z/, /ʃ/, /ʒ/, /l/, and /r/, and these consonants averaged less than 25% correct in continuous conversational speech. Because of their late acquisition, both in children with and without speech delays (see also Goldstein, Fabiano, & Washington, 2005), the Late-8 consonants could be considered as ''marked'' in the language or greater in complexity.

The preceding English developmental sound patterns suggest that Korean children speaking English might have even more difficulty in acquiring and correctly articulating consonant clusters and some sounds that do not exist in Korean. Among the Late-8 consonants of English, all sounds except for /s/ and /l/ do not exist in Korean. Therefore, this characteristic suggests that speech-language pathologists working with Korean children speaking English should pay special attention to the six marked consonants, /θ/, /ð/, /z/, /ʃ/, /ʒ/, and /r/. Furthermore, for the development of Korean, it would be helpful to consider the Korean ''Late 7'' consonants /s/, /s*/, /l/, /k/, /k^h/, /c/, /c*/, which we have identified on the basis of the Korean literature as marked or more complex, due to their late acquisition (Kim & Pae, 2005; Kim & Stoel-Gammon, 2007; Um, 1994).

4. Phonological processes

Some Korean studies have reported phonological error patterns which occur frequently in the speech of Korean children between 2 and 6 years of age (Han & Shin, 1987; Kim, 1995, 1992a,b, 2006; Kim & Shin, 1992; Pae, 1987). Kim (2006) investigated phonological error patterns in 220 Korean preschool children aged 2;6 to 6;5 using a preliminary version of Assessment of Phonology and Articulation for Children (APAC) (Kim, Pae, & Park, 2007). She found that more than 10% of late 2-year-olds showed the following phonological processes more than three times: (1) reduplication or consonant harmony, (2) word-final consonant deletion, (3) syllabic cluster simplification, (4) tensing, (5) deaspiration, (6) velar fronting, (7) nasalization or stopping of liquids, (8) liquid simplification, (9) affrication, (10) palatalization, (11) stopping of fricatives or affricates, and (12) interdentalization of fricatives. Among these phonological processes, (1) reduplication or consonant harmony, (2) word-final consonant deletion, (3) nasalization or stopping of liquids, (4) velar fronting, (5) tensing, and (6) deaspiration resolved by age 3. By age 4, (1) syllabic cluster simplification, (2) liquid simplification, (3) affrication and (4) palatalization had resolved, and by age 5, stopping of fricatives or affricates had disappeared.

Kim (1995) also investigated phonological processes in 60 children with articulation disorders and 60 children with normal speech. Kim showed that there was no phonological pattern that occurred more than 10% of the time in typically developing 4-year-old Korean children. Also, the author reported that children with articulation disorders showed significant differences compared to children with normal speech in terms of higher frequency of developmental phonological patterns and more deviant processes (i.e., greater than 40% occurrence for such patterns or processes in possible contexts). The term ''deviant processes'' refers to phonological patterns which do not usually occur in the speech of typically developing children. Deviant processes found in the speech of children with

articulation disorders included: (1) deletion of bilabial and alveolar plosives, (2) deaspiration (changing a feature of aspirate consonants), and (3) fronting of the glottal fricative, /h/. Kim (1995) suggested that these deviant phonological processes should be considered a higher priority for treatment than those commonly used by typically developing children.

In the Korean literature, the age when some phonological processes disappear is consistent with that reported in the literature for English. Stoel-Gammon and Dunn (1985) and Smit (1993) reported that final consonant deletion usually disappears by about age 3 and some phonological processes such as cluster reduction usually persist after age 3. Likewise, word-final consonant deletion in the speech of Korean children resolves at age 3 and syllabic (word-medial) cluster simplification usually persists after age 3 (Kim, 2006).

According to the literature on developmental phonology in the two languages, both Korean-speaking and English-speaking children show common simplification patterns, such as sound (or syllable) deletion or reduction, and assimilation patterns, such as fronting near other front consonants. The literature consistently suggests that common phonological patterns in both languages are resolved around 3–4 years of age in the speech of typically developing children.

Besides common phonological patterns, some specific phonological patterns can be identified in each language that would not be applicable to the other language. For example, consonant cluster reduction, prevocalic voicing, and devoicing of word-final consonants, processes that frequently occur in English-speaking children, are not applicable to Korean-speaking children because unlike English, Korean has no consonant clusters in word-initial or word-final position, and Korean consonants are not distinguished by the feature of voicing (i.e., are not considered to have both voiced and voiceless sounds). Instead, Korean-speaking children frequently show syllabic cluster simplification in the word-medial position, and tensing or deaspiration of prevocalic or word-final consonants related to the three-way contrast of stops and affricates in Korean (i.e., tense–lax–aspirate contrasts).

5. Contrastive analysis

When successive bilingual children produce English, it is valuable for speech-language pathologists to be able to discern whether phonological patterns that fail to match adult English reflect the influence of the Korean language (i.e., interference patterns) or a phonological disorder. One approach commonly used is contrastive analysis (Owens, 2008, pp. 403–406; Leonard & Weiss, 1983; McGregor, Williams, Hearst, & Johnson, 1997). In the contrastive framework for viewing bilingual acquisition, sounds found in the second language or L2 (e.g., /r/ in English) that are absent in the first language or L1 (e.g., Korean) are considered difficult for the individual to produce, and may result in error patterns for those L2 targets. McGregor et al. (1997) state that ‘‘contrastive analysis is a method for separating expressive speech-language patterns that are consistent with a client’s first dialect or language (D1/L1) from patterns that represent true errors’’ (p. 45). True errors, which cannot be accounted for by L1 influences or typical developmental patterns for L2, would be considered signs of a phonological disorder. In the present paper, our intent is to identify L1 patterns of Korean that may influence L2 English acquisition.

Contrastive analysis is not the only framework in which bilingual development can be examined. Interlanguage phenomena that do not reflect either L1 or L2, but rather general constraints on language learning, have attracted interest in recent years. Such phenomena in bilingual children could be indicated by bidirectional cross-linguistic effects, as described by Vihman and McLaughlin (1982) and reported by Keshavarz and Ingram (2002) for a Farsi-English bilingual child. These effects may arise from differences in the phonemic repertoires of the two languages, positional constraints, or phonotactic constraints (Goldstein et al., 2005). Interlanguage phenomena are perhaps best examined by comparison of bilinguals to monolinguals in each language, which is beyond the scope of the present paper (for recent examples, see Goldstein et al., 2005). Regardless, Goldstein and colleagues report that cross-linguistic effects are infrequent in the speech of children, accounting for less than 1% of all consonants produced in their studies of Spanish-English bilinguals, and perhaps more likely to be demonstrated by children younger than 5 years of age. Similarly, in the study by Goldstein et al. (2005), it was rare for bilingual children to produce substitutions atypical in monolingual development, making it difficult to distinguish interlanguage phenomena from common substitutions used by monolingual children (Vihman & McLaughlin, 1982). Consequently, the present paper employs only contrastive analysis of the phonemic repertoires of Korean and English to make predictions about how bilingual children might produce English.

When the phonemic repertoire of Korean is contrasted with that of English (see Tables 1 and 2), there are at least 7 vowel and 12 consonant phonemes in English that do not exist in Korean. According to contrastive analysis, our

prediction is that these English sounds should be susceptible to change by successive bilingual speakers. The sounds include (a) the vowels and diphthongs, /I, æ, ʊ, ɔ, aI, ɔI, aʊ/, and (b) the consonants, /b, d, g, f, v, θ, ð, z, ʃ, ʒ, dʒ, r/. Because /θ, ð, z, ʃ, ʒ, r/ are among the Late-8 consonants acquired in English, they may be doubly challenging for Korean successive bilingual children to learn.

With respect to phonological processes, Korean children speaking English may show not only processes that frequently occur in the speech of children who are native speakers of English, but also specific processes influenced by the Korean language (for a similar argument, see McGregor et al., 1997). The number of occurrences for each phonological process in Korean children speaking English would therefore be expected to be different from that reported for children developing English as their native language. The contrastive framework suggests a number of predictions for phonological simplification of English by successive bilinguals due to the influence of the Korean language. First, because Korean lacks a number of English vowels, we predict that successive bilingual children will exhibit vowel deviations in English. Among these vowel-related deviations, we also predict the occurrence of vowelization of /ɚ/, because rhotic quality does not exist in Korean. Second, because Korean has a reduced repertoire of final consonants compared to English, we predict the occurrence of word-final consonant omission beyond the typical age range for monolingual English-speaking children, i.e., beyond the age of 2;6 (Owens, 2008, p. 406; Preisser, Hodson, & Paden, 1988). Third, because the three-way lax–tense–aspirate contrast for obstruents in Korean does not directly correspond to the two-way voiced–voiceless contrast in English, we predict voicing alterations in English. Specifically, if the lax Korean stops, /p, t, k/, are substituted for the voiceless English stops, /p, t, k/, English transcribers are likely to perceive voiced English cognates, /b, d, g/. Fourth, given that English fricatives and affricates for the most part are not shared with the Korean sound system, we predict that stopping, sibilant distortions, and deaffrication in Korean children speaking English might be more prevalent than in monolingual English-speaking children. Because the lax /s/ in Korean is acquired earlier than the tense /s*/, lax /s/ most likely would be the substitute chosen by children for the English /s/. Recall, though, that the Korean lax /s/ is made with much weaker frication than the English /s/. This might result in sibilant distortions in English. Additionally, because the Korean /s/ is palatalized when it co-occurs with /I/, we predict that palatalization of English /s/ may occur. Other patterns affecting manner or place of fricatives or affricates also might be predicted, such as affrication and depalatalization. Lastly, it is likely that Korean children speaking English may have even more difficulty in acquiring consonant clusters in word-initial and word-final positions than young monolingual speakers of English and may more frequently show cluster reduction. Bilingual children may show vowel addition between adjacent consonants in English (i.e., epenthesis) as well. With these predictions in mind, we turn to several case studies to examine actual occurrences of sound errors in successive bilingual children.

6. Case studies

The following are case studies of three Korean children speaking English. All three children were born in Korea and lived in an exclusively monolingual Korean-speaking environment before moving with their families to Knoxville, TN, in the U.S. All three speak the standard Korean (Central) dialect, and in the U.S., have received exposure primarily to the Appalachian regional dialect of American English, as spoken in Knoxville (Flipsen, 2007; Owens, 2008, p. 395). The three children have no history of speech and language problems related to the Korean language, hearing problems, or orofacial anomalies based on parental report. The three children have learned and speak English in their community and their regular education programs, but speak only Korean at home. All three children can be considered successive, rather than simultaneous, bilingual Korean (L1)–English (L2) speakers, because they were first exposed to English (L2) after the age of 3;0 (Owens, 2008) and had largely completed acquisition of Korean phonology at the time of data of collection. In addition, the contexts in which they speak and are exposed to Korean and English are clearly separate.

The children differ, however, with regard to the following factors which are critical to speech sound acquisition in bilingual speakers: chronological age, age of beginning exposure to English, and amount of time being exposed to and producing English. The three children have been included here to provide insight into the interaction between dual phonological and phonetic systems. Presumably these successive bilingual speakers have two separate phonological systems, yet interference patterns may be still be evident (Paradis, 2001). Also, this set of cases can be considered as a pilot study to examine the relation between speech acquisition patterns in bilingual speakers and general demographic factors that describe their bilingual experience (i.e., age, amount of exposure and experience with each language, etc.).

Among the three cases chosen for presentation in the present paper, two were selected to represent children with relatively little experience speaking English. In the U.S., they would be considered English Language Learners. One of these children was selected to illustrate completed acquisition of L1 Korean, whereas the other was selected to illustrate a point mid-way in Korean acquisition, just before 4 years of age. Recall that at this age in Korean development, the child should have a PCC approaching 90%, and all but six Korean phonemes (including /s/ and /s*/) mastered in syllable-initial and syllable-final position (see Table 3). In this way, differences in sound errors between these two participants could be attributed to age of first exposure to L2 English, given comparable and limited experience with English. This allowed us to examine the issue of timing of exposure to English during bilingual phonological development. Unlike the two English Language Learners, a third participant was selected to illustrate several years of experience speaking English, yet with exposure to English having begun at about the same age as the younger of the two English Language Learners. In this way, differences in sound errors between the second and third participants could be attributed to degree of L2 experience (Roseberry-McKibbin, 1994), rather than age of first exposure to English.

Korean articulation abilities of the three children were evaluated based on conversation and administration of the Korean articulation test tool, Assessment of Phonology and Articulation for Children (Kim et al., 2007). All of the children showed typical Korean speech sound development and appeared to have acquired all the consonants of Korean. To identify levels of each child's English speech sound acquisition, and phonological patterns, the Goldman Fristoe 2 Test of Articulation (GFTA-2), and Hodson Assessment of Phonological Patterns, Third Edition (HAPP-3), were administrated. Speech intelligibility for English was also evaluated, by an examiner who is a native English speaker. Each child's responses were analyzed to identify speech sound errors, phonological patterns, and intelligibility.

6.1. Participant 1

Participant 1 was 11 years old at the time of data collection. She moved to Knoxville 1 month before data collection. At the time of data collection, it was difficult to elicit English connected speech samples from her, therefore, her samples included only single words or two-word phrases on the GFTA-2 and the HAPP-3. Notably, though, she was able to produce most of these English words spontaneously on the two tests, except for two or three words (e.g., *wagon*, and *shovel*). As mentioned previously, with her limited ability to speak English, she would be considered an English Language Learner. The Korean APAC was not administered because Participant 1 had no history of speech and language problems in Korean and did not show any articulation errors during conversations in Korean.

6.1.1. English

With respect to English, no speech intelligibility issues at the single-word level were noted for Participant 1. PCC scores on the GFTA-2 and the HAPP-3 were 95% and 93%, respectively. She performed at the 5th percentile, and at age 11 years, earned an age equivalent score of 5;5 on the GFTA-2. She showed consonant articulation errors for /v, θ, ð, z, ʒ/. On the HAPP-3, she exhibited eight phonological processes: (1) final consonant deletion (e.g., /blæk/ → /blæ/), (2) reduction of a word-medial consonant sequence (e.g., /dʒuəlri/ → /dʒuəli/), (3) stopping (e.g., /faIv/ → /faIb/, /fɛðəˠ/ → /fɛdəˠ/), (4) vowelization (e.g., /skrudaIvəˠ/ → skrudaIb**ʌ**/), (5) vowel deviation (e.g., /skwɛəˠ/ → /skw**ʌ**əˠ/), (6) affrication (e.g., /zIpəˠ/ → /dʒIpəˠ/, (7) voicing alteration (e.g., /zipəˠ/ → /sipəˠ/), and (8) sibilant distortion. There was, however, no phonological pattern that occurred more than four times in the test administration. Stopping and vowel deviations were most frequently observed. In particular, she showed difficulty in distinctly producing the English vowels /I, ɛ, e, æ, ʊ, ɔ/ (e.g., /bɛd/→/bæd/).

6.2. Participant 2

Participant 2 was 3;10 at the time of data collection. He moved to Knoxville 3 months before data collection and started to attend a regular preschool there 1 month before data collection. Given his age (and therefore limited attention to longer tasks) and limited English-speaking ability, only the Korean APAC and HAPP-3 were administered to him. Also, the target words on the HAPP-3 test were elicited by having him imitate words modeled by the examiner and no connected speech sample of English was obtained. As mentioned previously, with his limited ability to speak English, he would be considered an English Language Learner. His Korean speech sound acquisition appeared to exceed that of

his typically developing, same-aged peers. On the Korean APAC test, his PCC was 97%. He showed syllabic (word-medial) cluster simplification and deaspiration of the /h/ sound (once each) and had two vowel diphthong errors.

6.2.1. English

Participant 2 exhibited a PCC of 76% on the HAPP-3 test. His English phonological errors showed percentages of occurrence greater than 15% for the strident (21%), liquid (/l/ – 18%; /r/ – 19%), and glide (20%) sound groups. In particular, sound errors for the fricatives /f, v, s, z, ʃ, ʒ, ð/ and affricates /tʃ, dʒ/ were the most striking. On the HAPP-3, he showed 12 phonological processes: (1) syllable reduction (e.g., /skrudaIvɚ/ → /skrudaI/), (2) consonant sequence reduction (e.g., /bouts/ → /bous/), (3) addition of the vowel /ʌ/ or epenthesis (e.g., /sneIk/ → /sʌneIk/), (4) stopping (e.g., /tɛləvIʒən/ → /tɛləbIʒən/), (5) gliding (e.g. /hæt/ → /jɛt/), (6) vowelization (e.g., /zIpɚ/ → /ʃIpʌ/), (7) vowel deviations (e.g, /smouk/ → /sʌmʌk/), (8) depalatalization (e.g., /watʃ/ → /wats/), (9) palatalization (e.g., /glæsIz/ → /glæʃIʃ/), (10) assimilation (e.g., /jɛlo/ → /lɛlo/), (11) voicing alterations (e.g., /fɔək/ → /bɔək/), and (12) sibilant distortions. Among these phonological error patterns, four occurred more than six times in the test administration: (1) stopping, (2) vowel deviations, (3) voicing alterations, and (4) sibilant distortions. Some sibilant sounds were dentalized and partially voiced. He replaced all fricatives /f/ and /v/ with the stops /b/ or /p/ (i.e., /fIʃ/ → /bIʃ/) and, therefore, stopping was the process exhibited most frequently.

6.3. Participant 3

Participant 3 had just turned 6 years old at the time of data collection. She had attended a regular preschool and kindergarten class in Knoxville for 2.5 years since her family moved to the U.S. from Korea. Her PCC on the Korean APAC test was 99%. She had only one vowel diphthong error.

6.3.1. English

With respect to English, no speech intelligibility issues at the single-word or sentence levels were noted for Participant 3. The results of the English speech sound error and phonological process analyses for the GFTA-2 and HAPP-3 showed that she was able to produce all English sounds correctly. Her PCCs on the GFTA-2 and HAPP-3 were 95% and 97%, respectively. She scored at the 39th percentile on the GFTA-2, with occasional substitution errors such as /f/ for /θ/, for an age equivalent score of 5;5 (close to her chronological age of 6;0). On the HAPP-3, she sometimes exhibited errors on strident sounds (error rate = 7%, i.e., 3 errors out of 43 possible occurrences). She showed only three phonological processes for English on the HAPP-3: (1) stopping (e.g., /ʃʌvəl/ → /ʃʌbəl/, /fɛðɚ/ → /fɛdɚ/, /lif/ → /lip/), (2) final consonant omission (e.g., /slaId/ → /slaI/), and (3) vowel deviations (e.g., /sæntəklɔz/ → /sæntəklʌz/). She inconsistently replaced /f/, /v/, and /ð/ with /p/, /b/, and /d/, respectively. Therefore, stopping was her most prevalent phonological process. Analysis of a 70-utterance connected speech sample showed a PCC of 98% and 18 consonant errors including (1) cluster reduction (e.g., /ʌraund/ → /ʌdraun/) and (2) deaffrication (e.g., /dʒəræf/ → /dəræf/). Cluster reduction was the most common phonological error in her connected speech.

7. Discussion

7.1. Summary of case studies and implications for clinical speech-language pathology

Case studies of the three Korean children speaking English revealed interference patterns which Korean-English bilingual children are likely to exhibit. Table 4 provides a summary of the three case studies. Although the three participants have different characteristics with regard to chronological age, age of beginning exposure to English, and amount of time being exposed to and producing English, analysis of their speech production suggests that there are common speech sound error patterns which might result from the influence of the Korean language and differences between English and Korean. Also, the case studies demonstrate how successive bilingual speakers acquire English sounds appropriately in natural and regular education settings in the U.S., and they provide a picture of how English sound production might change over time for successive bilinguals. Participants 1 and 2 were exposed to and produced English for a short period of time (i.e., 1 month) whereas Participant 3 had been exposed to and produced English for 2.5 years. Compared to the speech sound error patterns of Participants 1 and 2, Participant 3 showed a lower occurrence of speech sound errors and a smaller number of different speech error types. Although she occasionally

Table 4
Summary of the three case studies.

Measure	Participants		
	1	2	3
Chronological age	11 years	3;10	6;0
Korean			
PCC APAC	ND[a]	97%	99%
English			
Age of beginning exposure to English	11 years	3;7	3;6
Amount of time exposed to English	1 month	1 month	2 years, 6 months
PCC GFTA-2	95%	ND	95%
PCC HAPP-3	93%	76%[b]	97%
PCC connected speech	ND[c]	ND[c]	98%
Intelligibility	Good, single-word level	Good, single-word level	Good, sentence level
PR GFTA-2	5th	ND	39th
AE GTA-2	5;5	ND	5;5
Targets in error	/v, θ, ð, z, ʒ/	/f, v, s, z, C, ʒ, tʃ, dʒ/	/f, v, ð, θ/
Substitutions	/z, ð/ → /d/ /v/ → /b/ /θ/ → /t/ /ʒ/ → /ʤ/	/f, v/ → /b/ /z, s/ → /ʃ/ /tʃ/ → /s/ /ð/ → /d/	/f/ → /p/ /v/ → /b/ /ð/ → /d/ /θ/ → /f/
Common phonological processes	Stopping Vowel deviations	Stopping Vowel deviations Voicing alterations Sibilant distortions	Stopping Cluster reduction

Note: PCC = Percentage of Consonants Correct; APAC = Assessment of Phonology and Articulation for Children; GFTA-2 = Goldman Fristoe 2 Test of Articulation; HAPP-3 = Hodson Assessment of Phonological Patterns, Third Edition; PR = percentile rank; AE = age equivalency; ND = not done.

[a] Not done, due to error free speech in Korean.

[b] Imitated productions only.

[c] Not done due to limited connected speech in English.

presented stopping errors, Participant 3 produced English like typically developing children who are native speakers of English.

Comparison of the two participants with limited exposure to English shows that the 11-year-old had fewer consonant errors and phonological processes than the 3-year-old, despite the 3-year-old's complete and precocious acquisition of Korean. It may be that older successive bilinguals are better able to use general language knowledge from L1 to aid acquisition of L2 (Owens, 2008, p. 413).

7.1.1. Stopping and sibilant distortions

All three children most frequently showed stopping when speaking English, which can be interpreted as interference patterns. Stopping seldom occurs in the speech of 4-year-old monolingual Koreans (Kim, 1995) and completely disappears in the speech of 5-year-old monolingual Koreans (Kim, 2006). Fricatives and affricates /v/, /f/, /θ/, /ð/, /ʤ/, /ʧ/, /z/, and /ʃ/ do not exist in Korean phonology and five of these are among the Late-8 consonants in English phonological development (and therefore could be considered marked or complex). As predicted, the three children tended to replace the fricatives and affricates with homorganic stops. Also as predicted, two participants (Participant 2 in particular, as well as Participant 1) demonstrated sibilant distortions. Other predicted patterns affecting fricatives and affricates were demonstrated by the three children as well, including deaffrication of /dʒ/ (Participant 3), palatalization of /s, z/ near /I/ (Participant 2), affrication of /z/ (Participant 1), and depalatalization (Participants 2 and 3). Therefore, fricatives and affricates that contrast between Korean and English, and particularly those that are marked or complex, accounted for much of phonological error exhibited by these successive bilinguals.

Dodd et al. (2003) reported that stopping resolves between 3;6 and 3;11 in typical British English-speaking children. Also, Hodson and Paden (1981) reported that stopping was one of the phonological processes most

commonly identified in the speech samples of 60 ''essentially unintelligible'' children between the ages of 3 and 8 years. Therefore, speech-language pathologists who work with Korean children speaking English should make efforts to help them acquire English fricatives and affricates and resolve the stopping process to improve speech intelligibility.

7.1.2. Other phonological processes

Other predicted phonological processes were found in the three case studies. First, addition of a vowel between adjacent English consonants (epenthesis) was demonstrated by Participant 1, as predicted. Furthermore, Participant 3 in particular, and the other two participants to some extent, exhibited cluster (consonant sequence) reduction, as predicted. Given that there are no consonant clusters for syllable-initial and final positions in Korean phonology, vowel addition between consonant clusters and cluster reduction should be interpreted as resulting from the influence of the Korean language rather than from a phonological disorder.

Second, considering the different vowel systems of Korean and English, Korean children speaking English are likely to show vowel deviations more than monolingual children in either Korean or English. As predicted, Participant 1 in particular showed difficulty in producing some English vowels distinctively and often exhibited vowel deviations. Participant 2 had vowel deviations as well (as did Participant 3, to a lesser extent). Additionally, as predicted, vowelization of /ɚ/ was demonstrated by Participants 1 and 2, despite Participant 1 being 11 years old. Third, as predicted, final consonant omission was exhibited to some extent by Participants 1 and 3. Lastly, predicted voicing alterations were demonstrated by the youngest participant, Participant 2, where sounds perceived by the transcriber as voiced replaced voiceless targets. Overall, in the three case studies, there is ample demonstration of phonological patterns that might be interpreted as interference effects of Korean on children's production of English.

7.1.3. Korean influences versus phonological disorder

Speech-language pathologists who work with Korean-English bilingual children with phonological disorders should be mindful of English sounds which do not exist in Korean, as well as unique Korean sounds. Basic knowledge about unique characteristics of the Korean language and its speech sound acquisition and developmental patterns would help speech-language pathologists who work with Korean-English bilingual children to identify phonological difficulties, determine any related underlying issues, and implement appropriate intervention approaches (McGregor et al., 1997). Case reports in this study represent our first efforts to document phonological patterns in typically developing Korean-English bilingual children. As for Korean-English bilingual children with phonological disorders, it is likely that they will show greater use of both types of patterns, in Korean and English, and some patterns that may be different from those of monolingual speakers.

8. Summary and conclusions

There are several characteristics of Korean phonology that differ from those of English, which speech-language pathologists should consider when working with Korean-English speakers. The distinctive characteristics are as follows:

1. The sound patterns of standard Korean are described as consisting of 19 consonants, 10 vowels, 2 semivowels, and 11 diphthongs.
2. Korean speakers may show difficulties with perception and production of some English vowels including /ɪ/, /ɛ/, and /æ/ (and perhaps /ʊ /, /ɔ/, and /ɚ/ as well) due to differences between the vowel systems of English and Korean, especially the lack of a ''tense–lax'' distinction and the rhotic quality in Korean vowels.
3. The English fricative and affricate consonants /f/, /v/, /θ/, /ð/, /z/, /ʃ/, /ʒ/, /ʧ/, and /ʤ/ do not exist in Korean. Korean children speaking English might have more difficulty in acquiring sounds that do not exist in Korean phonology.
4. Korean children tend to show stopping more often than other phonological processes, which can be interpreted as a phonological interference pattern.
5. Because there are no consonant clusters within syllables in Korean as there are in English, Korean children speaking English might have more difficulty in acquiring consonant clusters. Alternately, Korean speakers might insert a vowel between consonants in clusters (epenthesis) to make pronunciation conform to Korean syllable structure when they speak English, another likely interference pattern.

6. Unlike English consonants, which are distinguished by voicing and degree of aspiration, Korean consonants are described by Korean phoneticians as being distinguished by degree of tensity and aspiration, without a voicing contrast. There are tense consonants (/t*/, /c*/, /k*/, and /s*/) in Korean, which do not exist in English.
7. The Korean ''Late 7'' consonants are /s/, /s*/, /l/, /k/, /k^h/, /c/, and /c*/. The Korean literature consistently reports that /s/ and /s*/ are the last acquired sounds in typical speech development for Korean children. In addition, /s/ and /s*/ are the sounds most frequently in error in the speech of monolingual Korean-speaking children with articulation and phonological disorders.

The literature review and case studies presented here suggest some directions for future research. First, it is necessary to longitudinally study English sound acquisition and phonological process patterns in Korean children speaking English. Further study is needed to demonstrate how typically developing Korean children acquire English sounds appropriately in natural and regular education settings in the U.S. and to determine how long it usually takes for them to catch up with peers who are native speakers of English. This information would be helpful to differentiate Korean children who are phonologically disordered in one or both languages from Korean children who demonstrate typical phonological development in their native language. The former group would require speech-language services, whereas the latter group exhibits errors in English that merely reflect the normal process of acquiring a second language. Furthermore, there is a need to examine the phonological patterns of phonologically disordered Korean children speaking English, so that we have better knowledge about the quantitative and qualitative differences between their phonological patterns and those of typically developing, Korean-English bilingual children or young monolingual speakers of either Korean or English.

Appendix A. Continuing education

1. Korean vowels are categorized in terms of tense or lax features like English vowels.
a. True
b. False
2. The fricative and affricate consonants /v/, /f/, /¿/, /ð/, /J¿/, /./, /z/, and /C/ do not exist in Korean.
a. True
b. False
3. English consonants are distinguished by _____ and degree of aspiration whereas Korean consonants are distinguished by degree of _____ and aspiration.
a. Voicing; VOT
b. Voicing; tensity
c. Tensity; voicing
d. VOT; tensity
4. Which of the following phonological processes can be seen most often in Korean children who are speaking English?
a. Backing
b. Stopping
c. Vowel deviation
d. b and c
e. a, b, and c
5. Simplification patters and assimilation patterns are commonly observed as developmental phonological patterns in both Korean-speaking and English-speaking children.
a. True
b. False

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