Perceptual Similarity in Korean Vowel Epenthesis

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0. Introduction

In studies of loanword adaptation, vowel epenthesis has been phonologically motivated by appealing to constraints on syllable structure of the borrowing language (e.g. Jacobs and Gussenhoven 2000, LaCharité and Paradis 2005; but see Peperkamp and Dupoux 2002, 2003 for a phonetics-based account). For example, when a consonant cluster is adapted into a language that bars consonant clusters, an epenthetic vowel is inserted between consonants, breaking the cluster. This explanation is simple, in fact, as I will argue, too simple.

I present variable patterns of vowel epenthesis in English-to-Korean loanwords and show that the standard phonological approach is insufficient to account for Korean vowel epenthesis. Vowel epenthesis is specific to loanwords, not a general property of the language. But then, it is not clear why vowel epenthesis is assumed instead of other possible ways to satisfy the same set of syllable constraints. Following the lead of Steriade (2001), Kenstowicz (2003), and in particular Kang (2003), I argue that perception plays a significant role in loanword adaptation and show that the immediate motivation for Korean vowel epenthesis is to increase perceptual similarity between the English source forms and the Korean adapted forms.

Specifically, the results from a perceptual discrimination test show that Korean speakers perceive certain English CVC words as similar to epenthetic Korean CVCV forms, while, crucially, other English CVC words are perceived as similar to non-epenthetic CVC forms. This asymmetry is dependent on the perceptual cues of the final English consonant such as frication, voicing, and release. The results imply that vowel epenthesis in Korean is closely related to borrowers' judgments on perceptual similarity between the source and adapted forms. Contrary to previous assumptions, Korean vowel epenthesis occurs, not merely as a repair for illegal syllable structures, but because epenthesis ensures a higher degree of perceptual similarity between the perceived English input and the adapted Korean output.

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1. Korean Vowel Epenthesis

1.1 Loanword Specific Vowel Epenthesis

Korean vowel epenthesis occurs in two environments of loanword adaptation: in consonant clusters and after certain simple coda consonants. Although the main focus of the paper is vowel epenthesis after simple codas, let us briefly consider both cases to understand the broader picture of Korean vowel epenthesis.

Korean syllable structure does not allow complex margins.[1] When Korean adapts an English consonant cluster, the cluster must be simplified to meet this constraint. Vowel epenthesis can repair the syllable structure, as in (1):

(1) Vowel Epenthesis Breaking Consonant Clusters in Loanwords

a.	feminism /fɛmɪnɪzm/	→	[p^hɛ.mi.ni.c**ɨ**m]
b.	camp /kæmp/	→	[k^hæm.p^h**ɨ**]

In native words, the same constraint on syllable structure—No Complex Margins—is satisfied differently. Consonant clusters are simplified by deleting one of the two consonants, shown in (2):

(2) Consonant Deletion Simplifying Consonant Clusters in Native Words

a.	/kɑps/	→	[kɑp˺]	'price'
b.	/tɑlk/	→	[tɑk˺]	'chicken'

Korean syllable structure also imposes a restriction on consonants which may occur in coda position. Of the nineteen consonants in Korean, only the sonorants and the plain stops may occupy coda position and they must be unreleased:

(3) Korean Consonant Inventory[2]
/p, p^h, p', t, t^h, t', k, k^h, k', c, c^h, c', s, s', h, m, n, ŋ, l/

(4) Korean Coda Condition
Only [p, t, k, m, n, ŋ, l] are allowed in coda position.
All codas must be unreleased.

For all other consonants, coda neutralization occurs to satisfy the Coda Condition in native words: aspirated, tense, affricate, and fricative obstruents become unreleased stops. (5a) shows neutralization of stops; (5b) shows neutralization of fricative and affricate codas.

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[1] It is usually assumed that Korean syllable structure can maximally be CGVC (G is a glide) and consonant clusters are obligatorily simplified. There is some evidence, though, that cluster simplification is incomplete and optional (e.g. Cho 1999).

[2] This is the standard inventory widely assumed in the literature. However, instead of having three-way voiceless contrasts, there is an alternative view claiming that the Korean plain stop is in fact phonologically voiced (e.g. Kim and Duanmu 2004).

(5) Coda Neutralization in Native Words

a.	/pɑp/	→	[pɑp˺]	'rice'
	/pɑt^{h}/	→	[pɑt˺]	'field'
	/pɑk'/	→	[pɑk˺]	'outside'
b.	/pis/	→	[pit˺]	'comb'
	/pic/	→	[pit˺]	'debt'
	/pic^{h}/	→	[pit˺]	'light'

In loanwords, however, vowel epenthesis replaces neutralization:

(6) Vowel Epenthesis in Loanwords

a.	bus /bʌs/	→	[pʌ.s'**ɨ**]
b.	peak /pik/	→	[p^{h}i.k^{h}**ɨ**]

As demonstrated, one of the most important aspects of Korean vowel epenthesis is that vowel epenthesis is specific to loanword adaptation. To repair complex margins and disallowed codas, vowel epenthesis occurs in loanwords, while other processes including consonant deletion and neutralization occur in native words. This discrepancy is not explained by the standard phonological approach, because with other resolutions available, but unused, vowel epenthesis cannot be solely motivated by constraints on syllable structure.

1.2. Vowel Epenthesis after English Simple Codas

Korean has several patterns of vowel epenthesis after English simple coda consonants. I present these patterns using data drawn from the body of loanwords collected by the National Academy of the Korean Language (NAKL) in 1991.[3]

After a sonorant coda, vowel epenthesis hardly ever applies. Out of 952 words ending with a postvocalic sonorant /m, n, ŋ, l, r/, 949 were adapted without vowel epenthesis.[4] Representative examples are given in (7):

(7) Sonorant: No Epenthesis

a.	team /tim/	→	[t^{h}im]
b.	can /kæn/	→	[k^{h}æn]
c.	king /kɪŋ/	→	[k^{h}iŋ]
d.	bell /bɛl/	→	[pɛl]
e.	bar /bɑr/	→	[pɑ]

[3] This is the same collection of loanwords from which Kang (2003) draws her data. Note that the 1991 NAKL list is by no means an exhaustive list of loanwords. It contains loanwords that appeared in certain newspapers and magazines published in 1990.

[4] The three words adapted with epenthesis were all *–r* ending words: *tar, ether,* and *polyester.*

The original codas are preserved except in words ending in postvocalic /r/, which mostly gets deleted.[5]

After a fricative coda consonant, on the other hand, vowel epenthesis always applies. All of 191 words ending with a postvocalic fricative /s, z, f, v/ are adapted with vowel epenthesis, exemplified in (8):

(8) Fricative: Epenthesis

a.	bus /bʌs/	→	[pʌ.sʼɨ]
b.	jazz /ʤæz/	→	[cʼæ.cɨ]
c.	puff /pʌf/	→	[p^hʌ.p^hɨ]
d.	love /lʌv/	→	[rʌ.bɨ][6]

If epenthesis does not occur, the original fricative coda /s/ and /z/, adapted as /s/ and /c/ in Korean, must be neutralized to [t˺] due to Coda Condition. Similarly, the original fricative /f/ and /v/, adapted as /p^h/ and /p/ in Korean, must be neutralized to [p˺] if no epenthesis applies.

Unlike the all-or-none application of vowel epenthesis after fricative or sonorant codas, patterns of vowel epenthesis after stop codas vary. Kang (2003) reports that, out of 447 words with a postvocalic word-final stop in the NAKL list, 225 words (50%) were adapted with vowel epenthesis, 195 words (44%) without vowel epenthesis, and 27 words (6%) with optional epenthesis. This variation within stops is mostly due to split patterns of vowel epenthesis following a voiceless stop rather than more or less uniform vowel epenthesis following a voiced stop. Out of 102 words with postvocalic word-final voiced stops /b, d, g/, 90 words were adapted with vowel epenthesis and 10 words without epenthesis. On the other hand, out of 335 words ending with postvocalic word-final voiceless stops /p, t, k/, 185 words were adapted without epenthesis and 125 words with epenthesis.

(9) Voiced Stop: Epenthesis (Mostly)

a. Epenthesis 88%

bed /bɛd/	→	[pe.dɨ]
gag /gæg/	→	[kæ.gɨ]

b. No Epenthesis 10%

jab /ʤæb/	→	[cæp˺]
bag /bæg/	→	[pæk˺]

c. Optional Epenthesis 2%

pyramid /pɪrəmɪd/ → [p^hi.rɑ.mit˺] [p^hi.rɑ.mi.dɨ]

[5] English /Vr/ has been observed to be realized as a single [r]-colored or rhoticized vowel (e.g. Ladefoged 2001), which can explain the deletion of postvocalic /r/.

[6] Although Korean lacks voiced stops in its phoneme inventory, the plain voiceless stop becomes voiced in inter-sonorant environments. This is why [b], not [p], is realized in this example. Additionally, Korean liquid /l/ is realized as [r] in the onset position.

(10) Voiceless Stop: Variation

a. Epenthesis 39%

mat /mæt/	→	[mæ.t^{h}ɨ]
peak /pik/	→	[p^{h}i.k^{h}ɨ]

b. No Epenthesis 54%

cap /kæp/	→	[k^{h}æp$^{\neg}$]
book /bʊk/	→	[puk$^{\neg}$]

c. Optional Epenthesis 7%

cut /kʌt/	→	[k^{h}ʌt$^{\neg}$] [k^{h}ʌ.t^{h}ɨ]

Kang (2003) proposes that stop release is a crucial conditioner of the variation. English released stops are acoustically similar to the sequence of Korean stop + [ɨ] (e.g. Jun and Beckman 1994). Moreover, a positive correlation between stop release and vowel epenthesis has been observed (e.g. Jun 2002).

In the experiment described in Section 2, the effects of stop voicing and stop release on the perception of stop codas are examined. The results show that a given stop coda is perceived similar to an epenthetic form than a non-epenthetic form, when the coda is released and voiced.

1.3. Limitations of the Standard Phonological Approach

The standard phonological approach to loanword adaptation assumes that adaptation is a phoneme-based process, where source forms are adapted via phoneme to phoneme mapping. Thus, subphonemic information is considered irrelevant to the adaptation process. This approach also assumes that the grammar of the borrowing language determines the adaptation process. For example, *bus* /bʌs/ is first mapped to /pʌs/ because the phonologically closest phoneme to /b/ available in the Korean consonant inventory is /p/, differing in voicing. The form /pʌs/, however, is still unacceptable because it contains an illegal fricative coda /s/. A phonologically unmarked vowel /ɨ/ is inserted, resulting in the legal /pʌsɨ/.

While the standard phonological approach correctly assumes that constraints on syllable structures guide the adaptation process, it nevertheless falls short in accounting for the variable patterns that actually occur in Korean. As discussed earlier, a discrepancy exists between native and loanword strategies. To satisfy No Complex Margin, loanwords employ vowel epenthesis while native words undergo consonant deletion. To satisfy Coda Condition, loanwords again employ vowel epenthesis while native words undergo coda neutralization. If the grammar of the borrowing language that operates on native words is also responsible for the adaptation process, as assumed in the standard phonological approach, we would not expect different repair strategies for native words and loanwords. When ill-formed input forms enter the adaptation process, constraints on syllable structures require repair, but it seems that the native Korean grammar does not dictate how to repair them. Therefore, an independent reason, outside the native grammar, must motivate vowel epenthesis instead of native processes.

The standard phonological approach also does not provide a prediction concerning the decision between equally possible adapted forms to one input. Let us assume, for instance, that the grammar requires a repair of a $C_1C_2V_1$ form to satisfy No Complex Margin. There are multiple possible repaired forms, including $C_1V_1C_2V_1$, $V_2C_1C_2V_1$, $C_1V_2C_2V_1$, $C_1V_3C_2V_1$, and so forth. The phonological approach cannot choose one over the others, because, structurally speaking, all of them are equally approximate to the input form, involving one structural change—one deletion or one insertion of a segment. This "too many solutions" problem is a major drawback of the phonological account, often criticized by proponents of the perceptual similarity account (Steriade 2001).

Additionally, the within-phoneme variation associated with epenthesis is incompatible with a simple phoneme-to-phoneme mapping system. The standard phonological approach predicts that all instances of the same phoneme in English map to the same corresponding Korean phoneme and thus behave the same with respect to vowel epenthesis. This, however, is not the case, as exemplified by English voiceless stops, which show variation within a single phoneme.

Finally, Korean vowel epenthesis exhibits phonologically unnecessary epenthesis, where an epenthetic vowel is inserted even when no structural reason requires it. English /bɛd/ phonemically maps to Korean /pɛt/, and since /t/ is a legal coda consonant in Korean, no phonological reason exists to apply vowel epenthesis to repair bad syllable structure. Nevertheless, vowel epenthesis still applies, resulting in /pɛtɨ/, which is realized as [pɛ.dɨ]. In a similar vein, if vowel epenthesis after a stop coda is in fact sensitive to stop release (which will be shown to be the case in the following experiment), the standard phonological approach cannot accommodate this conditioning, because subphonemic phonetic details such as stop release are considered irrelevant to the adaptation process.

2. Experiment

I have argued that vowel epenthesis in Korean cannot be entirely motivated by constraints on syllable structure. With vowel epenthesis after a simple coda, in particular, there must be an independent explanation for why loanwords exhibit vowel epenthesis instead of coda neutralization, and why the application of vowel epenthesis widely varies after stop codas. I hypothesize that the motivation of vowel epenthesis in English-to-Korean loanwords is to produce forms that are perceptually maximally similar to the source forms while respecting the structural constraints of Korean. The claim that perceptual similarity plays a significant role in Korean vowel epenthesis has been argued for by several researchers (notably Kang 2003), but no studies have directly shown that English words adapted with epenthesis are actually perceptually more similar to epenthesis forms than to non-epenthesis forms, and vice versa. The goal of the present experiment is to directly test the perceptual similarity hypothesis. The perception test results show that perceptual similarity successfully predicts the actual patterns of vowel epenthesis after a simple coda, supporting the crucial role of perception in motivating vowel epenthesis in Korean.

When an English [CVC] is adapted into Korean, there are three possible adapted forms: non-epenthesis form [CVC], epenthesis form [CVCV] and deletion form [CV]. Note that non-epenthesis forms may require neutralization if the coda is illegal. Examples are given in (11):

(11) Examples of three possible adaptations of English CVCs to Korean

a.	[CVm]	may be adapted to	[CVm]	or	[CVmɨ]	or	[CV]
b.	[CVs]		[CVt˺]		[CVsɨ]		[CV]
c.	[CVt]		[CVt˺]		[CVt^{h}ɨ]		[CV]

Of the three possible forms, a perceptual similarity hypothesis predicts that English codas adapted with vowel epenthesis are perceptually more similar to epenthesis [CVCV] forms than the other forms. Also, English codas adapted without epenthesis should be perceptually more similar to non-epenthesis [CVC] forms than the other forms.

2.1. Methods

2.1.1. Participants

Eighteen native Korean speakers (m=3, f=15) participated. All were university students in Seoul, Korea whose ages ranged from 19-25. They had English as a foreign language since secondary school, but none had lived in an English-speaking country for more than a year. They self-reported their English proficiency as intermediate, averaging 5.0 on a nine point scale. No hearing loss was reported.

2.1.2. Stimuli and Procedure

Twenty English CVC forms differing only in coda sound were recorded by a female native American English speaker: [p^{h}ɛC] with C being one of (i) four sonorants [m, n, l, r], (ii) four fricatives [s, z, f, v], (iii) six released stops [p, t, k, b, d, g], or (iv) six unreleased stops [p˺, t˺, k˺, b˺, d˺, g˺].[7] Additionally, corresponding Korean CVC, CVCV forms and a CV form—[p^{h}ɛC], [p^{h}ɛCɨ], and [p^{h}ɛ]—were recorded by a female native Korean speaker.[8] Speakers were recorded in Praat, using a condenser microphone Shure 849. The input was low-pass filtered at 4 kHz and digitized at a sampling rate of 10 kHz.

The test forms were then sequenced in an ABX format: X was an English CVC form; A and B were two out of the three corresponding Korean forms. A .7 second pause was inserted between forms. For a given English CVC form, the following three ABX conditions were formulated:

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[7] The words recorded were *pem, pen, pell, pear, pess, pez, peff, pev, pep, pet, peck, peb, ped,* and *peg.* Some of these are not real words in English.

[8] CVC form were [p^{h}ɛm], [p^{h}ɛn], [p^{h}ɛl], [p^{h}ɛp˺], [p^{h}ɛt˺], and [p^{h}ɛk˺]; CVCV forms were [p^{h}ɛ.mɨ], [p^{h}ɛ.nɨ], [p^{h}ɛl.lɨ], [p^{h}ɛ.sɨ], [p^{h}ɛ.cɨ], [p^{h}ɛ.p^{h}ɨ], [p^{h}ɛ.t^{h}ɨ], [p^{h}ɛ.k^{h}ɨ], [p^{h}ɛ.bɨ], [p^{h}ɛ.dɨ], and [p^{h}ɛ.gɨ].

(12) Three ABX conditions

a.	[CVC]	[CVCV]	Eng.[CVC]
b.	[CVC]	[CV]	Eng.[CVC]
c.	[CVCV]	[CV]	Eng.[CVC]

A total of 60 ABX sequences were formulated (20 English CVC forms * 3 conditions) and randomly presented to listeners four times (240 ABX sequences in total). The relative order of A and B was counterbalanced. A 2.5 second silence was inserted between sequences.

The subjects listened to the 240 ABX sequences in one session. They were told that they were going to listen to three meaningless words in a row, two Korean words followed by an English word. They were asked to decide whether the last English form (X) sounded more similar to the first Korean form (A) or to the second Korean form (B). Before the actual test, each subject listened to five practice sequences to familiarize themselves to the pace and the stimuli of the test. The test took about twenty-five minutes.

2.2. Results

Table (13) shows the mean percentage of epenthetic CVCV responses as opposed to non-epenthetic CVC:

(13) Mean percentage of CVCV responses (as opposed to CVC) by Manner (left) and by Stop Release and Voicing (right)

CVCV vs. CVC	Manner			Stop Release and Stop Voicing			
	Fricative	Stop	Sonornt	Releasd	Unrel.	Voiced	Vceless
Mean % CVCV	83.7	65.6	17.0	81.0	50.2	73.6	57.6
St. deviation	27.2	34.2	24.8	26.2	34.4	31.7	35.0

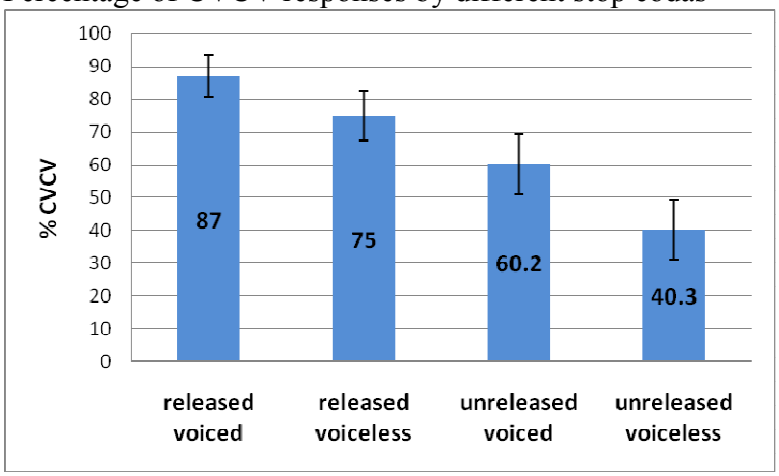
There was a significant effect of manner on the percentage of CVCV responses [$F(2, 357) = 92.45$, $p < .0005$]. A post-hoc test revealed that fricative codas received more CVCV responses than stops, which received more CVCV responses than sonorants. T-tests also showed that fricative and stop codas received more CVCV responses than CVC responses [$p < .0005$], whereas sonorant codas received more CVC responses than CVCV responses [$p < .0005$]. A large variation within stop codas (from 33% of [t˺] to 90% of [d]), however, forced us to examine stop codas in more detail.

There were also significant effects of stop release and stop voicing on CVCV responses [stop release, $F(1, 204) = 61.38$, $p < .0005$; stop voicing, $F(1, 204) = 16.52$, $p < .0005$]. Released stop codas received more CVCV responses than unreleased stop codas; voiced stop codas received more CVCV responses than voiceless stops. T-tests showed that released stops and voiced stops received more CVCV responses than CVC responses [$p < .0005$]; voiceless stops received CVC

responses significantly more than CVCV responses [p = .03]; and notably, unreleased stops received neither responses significantly more than the other [p = .9].

Stop release and stop voicing did not interact [F(1, 204) = 1.00, p = .32]. As the graph (14) shows, the percentage of CVCV responses is 87% for released voiced stops, and it gradually decreases to 75%, 60% and to 40%. T-tests confirmed that only unreleased voiceless stops were perceived as more similar to CVC [p < .03], and all other stops were perceived as more similar to CVCV [released voiced, released voiceless, p <.0005; unreleased voiced, p < .03].

(14) Percentage of CVCV responses by different stop codas



Although there was no main effect of stop place [F(2, 204) = 1.91, p = .15], an interaction was found between stop place and stop voicing [F(2, 204) = 3.13, p < .05]. Labial stops, unlike coronal or velar stops, did not show the voice effect: voiced labial stop /b/ does not differ from /p/ in terms of its CVCV responses. A post-hoc analysis on stop codas also shows a similar result. Unreleased voiced labial stop [b˺] was grouped together with the unreleased voiceless stops, whereas other unreleased voiced stops and all released stops all show high CVCV responses. That [b˺] received lower CVCV responses may be due to the fact that the [b˺] token in the test showed the shortest voicing into closure (.022 vs. .027 for [d˺]; .059 for [g˺]) and the shortest vowel duration (.116 vs. .145 for [d˺]; .147 for [g˺]), which suggests the voicing of [b˺] may not be as strong as the other voiced stops.[9]

Finally, results of the conditions involving CV forms are summarized below:

[9] Since there was only one token, this observation cannot be readily generalized to all voiced labial stops. But it is intriguing to find that /b/ in fact is adapted with vowel epenthesis not as much as the other voiced stop codas. In the NAKL list, only 44.5% of the postvocalic word-final /b/ is adapted with vowel epenthesis, while 75% and 98.5% of word-final /d/ and /g/ are adapted with vowel epenthesis, respectively.

(15) Mean percentage of CV responses by Manner and by Stop Release and Voicing, as opposed to CVCV (top) and CVC (bottom)

CV vs. CVCV	Manner		Stop Release and Stop Voicing			
	Fricative	Sonorant	+R +V	+R -V	-R +V	-R –V
Mean % CV	**11.1**	42.4	**6.0**	**15.2**	**27.3**	**38.0**
St. deviation	**20.1**	34.5	**13.7**	**25.4**	**33.0**	**35.3**

CV vs. CVC	Manner		Stop Release and Stop Voicing			
	Fricative	Sonorant	+R +V	+R -V	-R +V	-R –V
Mean % CV	53.1	**10.4**	48.2	**22.7**	**35.7**	**20.4**
St. deviation	33.9	**19.1**	18.6	**26.3**	**33.2**	**21.8**

Cells that received significantly [$p < .02$] less CV responses than its competitor CVCV or CVC are bolded. No cell received significantly more CV responses than its competitor. Crucially, whenever a coda received more CVCV responses than CVC responses (i.e. fricative, released voiced/voiceless, and unreleased voiced codas), it also received more CVCV responses than CV responses; whenever a coda received more CVC responses than CVCV responses (i.e. sonorant and unreleased voiceless codas), it also received more CVC responses than CV responses. This means that a given English CVC is perceived most similar either to a non-epenthesis CVC or to an epenthesis CVCV, but never to a deletion CV form.

2.3. Discussion

The results show that a given English CVC form is perceptually more similar to having a following vowel [ɨ] in Korean, when: (i) the coda is a fricative rather than a stop, (ii) the coda is a stop rather than a sonorant, (iii) the coda is a released stop rather than an unreleased stop, and (iv) the coda is a voiced stop rather than a voiceless stop. The results also show that given English CVC forms are perceptually most similar to a Korean epenthesis form [CVCV], when the codas are fricatives, released stops, or voiced stops. But given English CVC forms are perceptually most similar to a non-epenthesis form [CVC], when the codas are sonorants or unreleased voiceless stops.

The perceptual similarity of fricative codas to epenthetic CVCV forms shows that vowel epenthesis creates higher perceptual similarity to the English forms than coda neutralization does. Recall that if there was no following epenthetic vowel, the fricative coda has to be neutralized to unreleased stop. Thus, the fricative coda in English [p^hɛs] will be either neutralized, losing its frication, as in Korean [p^hɛt˺] or be followed by an epenthetic vowel, surviving in the onset position, as in Korean [p^hɛ.sɨ]. In terms of meeting Coda Condition, either neutralization or vowel epenthesis would do, but what we see here is that neutralization costs more than vowel epenthesis in terms of perceptual similarity. For sonorant codas, on the other hand, inserting an epenthetic vowel perceptually costs more than not inserting it. Since sonorants are allowed in coda position, a sonorant coda in English

[p^hɛm] will survive in the Korean non-epenthesis form [p^hɛm]. The non-epenthesis form is already maximally similar to the English form; therefore, inserting an epenthetic vowel as in [p^hɛ.mɨ] would instead decrease the perceptual similarity by unnecessarily making the coda an onset.

In the case of voiced stop codas, having a following [ɨ] creates an intervocalic environment in which the stop can preserve its voicing. Recall, in Korean, stops can be voiced only in inter-sonorant positions. Thus, the voiced stop in English [p^hɛd] will remain voiced in the epenthesis form [p^hɛ.dɨ], but, without epenthesis, it will have to be neutralized to [p^hɛt˺], losing its voicing. Stop release effect shows the similar effect. Without epenthesis, a released stop coda in English [p^hɛt] will have to be neutralized to [p^hɛt˺], losing its release, but epenthesis preserves the release in [p^hɛ.t^hɨ].

The foregoing results demonstrate that perceptual similarity is a good indicator that correctly predicts the actual vowel epenthesis patterns found in English-to-Korean loanwords. The perception test results clearly reflect the observed patterns of vowel epenthesis as summarized below:

(16) Comparison between vowel epenthesis patterns and perception test results

		Observed Patterns	Perception Test Results
Sonorants		No Epenthesis	CVC
Fricatives		Epenthesis	CVCV
Stops	Voiced	Epenthesis (Mostly)	Released CVCV Unreleased CVCV
	Voiceless	Variation	Released CVCV Unreleased CVC

When the coda is perceived to be more similar to non-epenthesis CVC forms, epenthesis does not apply. When the coda is perceived to be more similar to epenthesis CVCV forms, epenthesis applies. When the coda is perceived to be more equally similar to both forms, the pattern varies depending on the presence or absence of stop release. Thus, the perceptual similarity hypothesis holds: Korean vowel epenthesis applies to increase perceptual similarity between English source forms and Korean adapted forms.

3. Conclusion

This study has argued that the standard phonological approach to loanword adaptation is insufficient to motivate Korean vowel epenthesis and, instead, has supported the perceptual similarity account by showing that vowel epenthesis occurs only when epenthetic forms are perceptually most similar to the source forms. The results suggest that some loanword adaptation processes are not only phonological repairs but also active strategies utilized by borrowers to achieve a higher degree of similarity to the source. To fully account for loanword adaptation, therefore, any phonological approach should incorporate perceptual factors.

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