

A comparison between loanword adaptation and cross-language perception by prosodic position: Cases of English /θ/ in Korean*

Mi-Hui Cho
(Kyonggi University)

Cho, Mi-Hui. 2012. A comparison between loanword adaptation and cross-language perception by prosodic position: Cases of English /θ/ in Korean. *Studies in phonetics, phonology and morphology* 18.1, 163-183. The current paper attempts to account for all of the borrowing mapping patterns of English /θ/ in Korean. To this end, a systematic loanword database is extensively established in order to obtain comprehensive borrowing mapping patterns of /θ/. Then, the patterns of the borrowing mapping are compared with the perceptual mapping patterns of /θ/ from a cross-language study to examine the extent to which the borrowing mapping patterns conform to the perceptual mapping patterns. Results show the multi-faceted nature of loanword adaptation in that there is more than the perceptual factor that affects loanword adaptation. Specifically, the borrowing mappings of /θ/ onto Korean fortis [sʰ]/[ʃʰ] and [tʰ] are accounted for by perceptual effect while the borrowing mappings onto Korean stop series [tʰ, t(d), t̚] are accounted for by orthographic effect. In addition, the borrowing mappings onto Korean lenis [s]/[ʃ] are due to prescribed standardization. Also, L1 phonology effect is attested in the borrowing mappings onto [ʃʰ]/[ʃ], [d] and [tʰ], which are subject to palatalization, intervocalic voicing and coda neutralization in Korean. (Kyonggi University)

Keywords: loanword adaptation, cross-language perception, English /θ/, perceptual effect, orthographic effect, standardization, L1 phonology effect

1. Introduction

In world's languages interdental fricatives do not occur frequently, thus being less common than other consonants (Maddieson 1984: 45). The infrequent occurrence of interdental fricatives may be related to relative intensity of fricatives (Stevens 1960) and/or perceptual salience of fricatives (Wang and Bilger 1973, Goldstein 1977), as interdentals are ranked low in the rankings of intensity and perceptual saliency. Given the low frequency of interdentals, it is expected that in contact between the languages interdental fricatives in one language are frequently replaced by other sounds in another language that does not have interdental fricatives in the inventory.

There has been much research on different replacement of English

* This work is supported by the Korea Research Foundation Grant funded by the Korean Government (KRF-2008-327-A00591). I thank anonymous reviewers for helpful comments on the paper.

interdental fricatives either in loanword adaptation (Oh 2002, Iverson and Lee 2004, Lee 2006) or in second language acquisition (Weinberger 1990, Cho and Lee 2001, Brannen 2003, Lombardi 2003). There are even studies like Ahn (2003) which investigate the substitution patterns of English interdentals regardless of the corpora (i.e., data both from loanword adaption and second language acquisition). It has been observed that English /θ/ is frequently produced as either fricative /s/ series or stop /t/ series depending on language backgrounds in the second language acquisition literature. In the literature on Korean loanword phonology, English /θ/ is mapped onto either Korean fortis /s'/ or /t'/ ([s'ɪŋk^hɪ] / [t'ɪŋk^hɪ] 'think') as analyzed by Oh (2002) and Ahn (2003). However, the loanword mapping pattern of English /θ/ in Korean has not been extensively accounted for given aspirated /t^h/-mapping ([marat^hon] 'marathon'), as observed in Lee (2006). Specifically, Lee states "Although Ahn (2003) successfully accounts for the adaptation of tense [s'] (and lax [t]), he does not consider the data for the realization of aspirated [t^h]" (p. 144, footnote 12). Further, the borrowing patterns of English /θ/ in varied prosodic locations are not fully investigated though the comment, "this pattern is varied, which has nothing to do with syllable or word position" (Lee 2006: 143). In addition to the loanword mapping of fortis /s', t'/ and aspirated /t^h/, there is plain /s/-mapping for English /θ/ ([sændə]/[s'ændə] 'thunder') in spite of Ahn's (2003: 991) claim, "/θ/ is substituted by [s'] or [t'], rather than [s]."

Surprisingly, previous studies on English /θ/ loanword adaption cite examples even from second language acquisition data, although loanword adaptation may be influenced by second language acquisition or vice versa. This would be because there is no systematic loanword database established. Moreover, most studies just cite specific loanword forms to illustrate one particular aspect of characteristics of loanword phonology (e.g., ([s'ɪŋk^hɪ]/[t'ɪŋk^hɪ] 'think', [marat^hon] 'marathon'), even though some studies like Kang (2003, 2010) are based on a systematic database by conducting a survey from various sources (e.g., National Institute of the Korean Language). Therefore, one of the purpose of this study is to provide an extensive loanword mapping pattern of English /θ/ by position based on a systematic Korean loanword database.

From a theoretical perspective, at least two different approaches to loanword adaptation have been emerged: phonetic adaptation and phonological adaptation. In the phonetic approach to loanword adaptation, borrowing is seen as perceptually matching the words of the source language into the borrowing language, thus relying on phonetic similarity (Silverman 1992, Peperkamp and Dupoux 2003, Peperkamp, Vendelin and Nakamura 2008, Steriade 2001a, b, Kenstowicz 2001, 2005, Shinohara 2004, 2005). Hence, the role of perception has been emphasized in loanword adaptation. By contrast, the phonological approach contends that the words of the source language are incorporated into the borrowing

language based on phonological similarity between the phonemic categories of the two languages. Accordingly, low-level subphonemic phonetic details do not play a role in the phonological approach (LaCharite and Paradis 2002, 2005). Importantly, one cannot evaluate the two different approaches without comparing a loanword mapping pattern with a perceptual mapping pattern in parallel.

There have been cross-language perception studies which show how Korean speakers perceive English consonants and label them into Korean (Kim 1972, Schmidt 1996, Cho and Lee 2007, Park and de Jong 2008). Results from cross-language perception studies can be an important touchstone in loanword adaptation studies because they can provide auditory perception patterns of English consonants by Koreans. Specifically, the borrowing mapping patterns found are compared with the perceptual mapping patterns obtained from a corpus of perceptual mapping data. The attempt, here, is to determine the degree to which the borrowing mapping patterns conform to the perceptual mapping patterns.

In order to evaluate different competing theories, the following null hypothesis is posited; if the patterns of loanword mapping exactly correspond to those of perceptual mapping, then loanword adaptation would be purely based on auditory perception.¹ If this null hypothesis is rejected, then there should be additional factors other than the perceptual factor in loanword adaptation.

The purpose of this paper is as follows: 1) to elucidate the comprehensive loanword mapping patterns of English /θ/ by position in Korean by extensively establishing a systematic loanword database, 2) to compare the borrowing mapping with perceptual mapping in order to examine the extent to which auditory perception affects borrowing patterns, 3) to find out what factors other than auditory perception determine loanword adaptation.

The remainder of the paper is organized in the following way. Section 2 examines theoretical backgrounds on loanword phonology and previous studies on the adaptation of English /θ/ in Korean. Section 3 provides quantitative data from cross-language speech perception study and loanword database. Section 4 reports the comprehensive borrowing pattern of English /θ/ by position and compares it with the perceptual mapping pattern to test the null hypothesis that the borrowing pattern corresponds to the perceptual pattern. Section 5 concludes the paper discussing the results of the analysis and further implications of the results.

¹ The null hypothesis is similar to claims made by Peperkamp and her colleagues (Peperkamp and Dupoux 2003, Vendelin and Peperkamp 2006, Peperkamp, Vendelin and Nakamura 2008) in that loanword adaptation originates in speech perception.

2. Background

2.1 Theories of loanword adaptation

One extreme view in the phonetic approach to loanword adaptation developed by Peperkamp and her colleagues is to conceive loanword adaptation as being accomplished during speech perception, which is in an extra-grammatical module (Peperkamp and Dupoux 2003, Vendelin and Peperkamp 2006, Peperkamp, Vendelin and Nakamura 2008). Less strong version of the phonetic approach developed by many scholars assumes that the knowledge of phonetic perception is rather indirectly encoded as part of grammar so that the borrowed sounds are evaluated by the grammar including universal perceptibility degrees based on acoustic properties of the sounds (Steriade 2001a, b, Kenstowicz 2001, 2005, Shinohara 2004, 2005). Importantly, in both views phonetic similarity is responsible for the mapping of source language forms into the borrowing language. In other words, foreign sounds are assimilated to perceptually most similar sounds in the borrowing language. For instance, according to Kim and Curtis (2002), English pre-consonantal /s/ is mapped onto Korean lenis /s/ ([sɪlʌmp] ‘slump’, [tesɪti] ‘test’) given that English pre-consonantal /s/ is perceptually most similar to Korean lenis /s/ due to the commonality of short frication duration between the two. By contrast, English /s/ in other contexts with longer duration than pre-consonantal /s/ is adapted to Korean as fortis /s’/ whose friction duration is also longer than Korean lenis /s/ ([s’ollo] ‘solo’, [pəs’i] ‘bus’). This indicates that durational differences of English source (and Korean) which are not phonemic but subphonemic phonetic details play an important role in the borrowing process.²

On the contrary, some scholars claim that loanword adaptation is operated by highly proficient bilinguals at the phonemic level of the source language and borrowing language. Hence, allophonic differences at the subphonemic level are abstracted away. One example of phonological adaptation comes from the adaptation of American English flap in LaCharite and Paradis (2005).³ The coronal stops /t, d/ in words like *heater* and *grader* are adapted to Quebec French with /t/ and /d/, respectively, preserving phonemic categories of the source language. This is unexpected from the perspective of the phonetic approach because /t, d/ in the source language are phonetically realized as flap [ɾ]. This shows that

² Davis and Cho (2005), however, argue against the durational analysis of Kim and Curtis (2002) by providing counterexamples such as [t’æns’i] ‘dance’ and [k’es’i] ‘gas’. Namely, word-final /s/ regardless of whether it is in a cluster or alone is adapted to Korean as fortis [s’] because it is in a position which requires to take on phonologically laryngeal features evidenced by the native Korean phonological system (e.g., coh+ko ‘like (and)’ [cok^ho], coh+so ‘good idea (I like it)’ [cos’o]).

³ Cho and Lee (2010) also adopt the phonological approach in the analysis of English /f/ adaptation in Korean showing that category preservation of the source language is one of the factors in loanword adaptation.

Quebec French speakers do seem to ignore non-distinctive phonetic properties of the source word in the borrowing process and to be aware that American English flap is an allophone of the phonemes /t, d/. Consequently, this case shows that adaptation of the English sounds is on the basis of English phonemes, not on the basis of English allophones.⁴

Although the role of orthography in loanword adaptation has been underestimated especially in the phonological approach (LaCharite and Paradis 2005), some studies acknowledge the effect of orthography given that many cases of loanword adaptation are based on written input (Iverson 2005, Dohlus 2005, Smith 2006, Vendelin and Peperkamp 2006). Specifically, Iverson (2005) argues that Korean adapters are well aware of the fact that English spelling *p*, *t*, and *k* correspond to Korean aspirated stops irrespective of their degree of aspiration in English. Consequently, English /p, t, k/ are uniformly adapted as Korean aspirated /p^h, t^h, k^h/, respectively. For example, the English velar stop /k/ in words like *key* [k^hi] and *s*ki** [sɪk^hi] is rendered as aspirated /k^h/ in Korean loanwords, although the fortis [k'] should be the best fit for the unaspirated velar stop in the case *s*ki** due to the lack of aspiration in English source.⁵ Based on this case, Iverson contends that the adapter's awareness of the source language spelling conventions may play a key role in shaping borrowed sounds into the borrowing language.

2.2 Previous work on English /θ/ adaptation in Korean

The borrowing pattern of English /θ/ has been analyzed by several scholars, but they mostly focus on the mapping of /θ/ onto Korean fortis /s'/ or /t'/. The following presents data in previous work on English /θ/ adaptation in Korean, which amounts to only 12 loanwords across previous studies examined here.

(1) English /θ/ adaptation in Korean

- a. Oh (2003, recited from Iverson and Lee, 2004: 18)
 - i. Initial position: *think* [s'ɪŋk^hi] or [t'ɪŋk^hi]
 - ii. Final and medial position: *health* [hels'i], *something* [s'əms'ɪŋ]
- b. Ahn (2003: 991, 992)
 - i. In a singleton: *think* [s'ɪŋk^hi], *thousand* [s'auʃəndi], *month* [mans'i]

⁴ Vendelin and Peperkamp (2006) provide an alternative explanation which argues for orthographic adaptation in this case. Instead of knowing that American English flap is allophones of English stops /t, d/, Quebec French adapters may be aware of the fact that graphemes <t> and <d> simply correspond to /t/ and /d/, respectively, by means of grapheme-to-phoneme correspondence rule.

⁵ It is well-known that English voiceless stops after /s/ have very short lag VOT (voice onset time) values relative to those in initial position (Ladefoged 2006). Korean fortis stops are also known to have shorter lag VOT values than lenis stops, which in turn have shorter lag VOT values than aspirated stops (Lisker and Abramson 1964, Abramson and Lisker 1972, Kim 1965, Han and Weitzman 1970, Kagaya 1974, Han 1996).

- ii. In a cluster: three [s'iri], through [s'iru], throw [s'irou]
- c. Lee (2006: 142)
 - i. [s]: thrill [siril]
 - ii. [s'] with variant [t']: thank you [s'ɛŋk^hyu]/[t'ɛŋk^hyu]
 - iii. [t]: Thatcher [tec^hə]
 - iv. [t^h]: marathon [marat^hon]

According to Oh (2003), /θ/ is adapted to Korean as [s'] or [t'] in word-initial position but as [s'] in word-final and word-medial position. Iverson and Lee (2004) ascribe the variable forms [s'] or [t'] in word-initial position to variation in source language productions. That is, native speakers of English may articulate /θ/ with a variable degree of turbulence, and this may attend to the perceptual source of variation for Korean listeners. When /θ/ is articulated with more turbulence, it is adapted as Korean /s'/, which is inherently released. On the other hand, when articulated with less turbulence, it is adapted as Korean /t'/, which is unaspirated.

Ahn (2003) observes that English /θ/ is always adapted to Korean as fortis /s'/ regardless of whether it occurs in a singleton or in a cluster, as illustrated in (1b). This is because English /θ/ is manifested as tenseness and continuancy to which Korean fortis /s'/ closely approximates. In his analysis the absence of voicing (i.e., voicelessness) for /θ/ is matched to [+stiff vocal folds] (Avery and Idsardi 2001), which is realized as fortis or aspirated in Korean. On the contrary, the presence of voicing (i.e., voicedness) is matched to [-stiff vocal folds], which is realized as lenis in Korean. In order to maintain the dichotomy between /θ/ with fortis substitution and /ð/ with lenis substitution, Ahn rather strongly claims, "there is no [s] realization substituting the English /θ/ for Korean speakers" (p. 992, footnote 12).

Lee (2006) follows Ahn's analysis in adopting the constraint Ident[stiff vocal folds] which is responsible for mapping voiceless /θ/ onto Korean fortis /s'/ (or /t'/). She further notices various loanword mappings onto Korean lenis /s, t/ and aspirated /t^h/, as in (1ci, iii, iv), although she treats the mappings onto Korean lenis /s, t/ as not being stable (p. 143). Thus, she only analyzes the mapping onto Korean aspirated /t^h/ by proposing the constraint Ident[tense] which singles out /t^h/ over /s'/ and /t'/. In summary, the borrowing pattern of English /θ/ in Korean is not comprehensively established given the paucity of the data (only 12 loanwords across previous studies) and the controversial nature of English-to-Korean borrowing mapping patterns.

3. Data

3.1 Cross-language perception

Cross-language perception studies are a good source for establishing perceptual mapping patterns of foreign sounds given that adult listeners have to map L2 speech input onto L1 phonological structures by decoding the continuous and variable speech signals into sound categories. There have been several cross-language perception studies of English consonants by Korean listeners (Kim 1972, Schmidt 1996, Cho and Lee 2007, Park and de Jong 2008). Schmidt (1996) examined perceptual category mapping of 22 English word-initial consonants by 20 native Korean listeners, which replicates and verifies Kim (1972) in that speech perception does not work in the same way for all listeners, although it is not entirely random. Similarly, Cho and Lee (2007) investigated segmental similarity between Korean and English by asking 40 native Korean to label 10 English obstruents located in 4 different prosodic contexts with most similar Korean categories. It was shown that perceptual mapping patterns varied according to prosodic position and stress. Park and de Jong (2008) showed how Korean (L1) categories were used in identifying English (L2) categories by incorporating the confidence rates evaluated by Korean listeners to predict L2 perception pattern quantitatively.

The perceptual mapping patterns of English /θ/ are extracted from a corpus of English-to-Korean perceptual category mapping data gathered as part of a larger project which investigated the acquisition of English consonants including /θ/.⁶ The perceptual mapping data used in this paper contain stimuli sampling English /θ/ in various prosodic locations by testing the perception of 40 monolingual Korean listeners who were presented with nonword speech tokens. The speech tokens in varied prosodic locations (θa, aθá, áθa, aθ) were produced by 4 native speakers of American English (2 males and 2 females), and thus the total number of tokens amounted to 160 per prosodic position (4 speakers * 40 Korean listeners). The listeners performed a forced-choice categorization task in which they were asked to choose one of the 13 Korean consonants (p^h, p', p, t^h, t', t, s', s, c^h, c', c, l, h) presented in Korean orthography and the listeners also had an option to write down what they heard when they could not find the closest match.

The following provides extensive perceptual mapping patterns of English /θ/ by prosodic position.

⁶ de Jong and Cho (2012) also examined Korean perception of English obstruents in parallel to the loanword mapping patterns of the same English target consonants in order to test various theories of loanword adaptation. I appreciate Ken de Jong for providing the corpus.

(2) Proportion of English-to-Korean perceptual category mappings for English /θ/⁷

a. Initial onset (160)	b. Final coda (160)	c. Intervocalic before stress (160)	d. Intervocalic after stress (160)
/s'/ 40% (64)	/p ^h / 31.9% (51)	/s'/ 48.8% (78)	/p ^h / 28.1% (45)
/t'/ 24.4% (39)	/s'/ 25% (40)	/t'/ 24.4% (39)	/s'/ 28.1% (45)
/p ^h / 16.3% (26)	/h/ 13.1% (21)	/p'/ 6.9% (11)	/t'/ 19.4% (31)
/p'/ 6.9% (11)	/s/ 11.3% (18)	/p ^h / 6.3% (10)	/p'/ 9.4% (15)
/t/ 6.9% (11)	/p/ 4.4% (7)	/s/ 6.3% (10)	/p/ 6.3% (10)
/s/ 4.4% (7)	/p'/ 3.1% (5)	/h/ 3.8% (6)	/t/ 3.1% (5)
	/t'/ 3.1% (5)	/t ^h / 1.3% (2)	/t ^h / 1.9% (3)
	/t ^h / 2.5% (4)		/s/ 1.9% (3)
			/h/ 1.3% (2)

The most salient perceptual mapping category for English /θ/ was Korean fortis /s'/, 40% of the time (64 of the 160 responses) in initial onset position and 48.8% of the time (78 of the 160 responses) in intervocalic position before stress. The next salient Korean perceptual mapping category was fortis /t'/ in both locations, 24.4% of the time. One may ask why the constricted consonants perceptually match to the target fricative /θ/ in majority cases. An aspirated consonant would be a worse perceptual match with /θ/ than a fortis consonant. This is because the release of air for /θ/ is not strong enough to be realized with Korean aspirated consonants, although the fricative target is inherently released. Also, a lenis consonant which is voiced intervocalically would be a worse perceptual match with the target than a fortis consonant because the target /θ/ is voiceless. In Korean both aspirated and fortis obstruents do not undergo intervocalic voicing unlike lenis obstruents.

In final coda position and intervocalic position after stress the most prominent Korean perceptual mapping category was aspirated /p^h/ (31.9% and 28.1% of the time, respectively), which was followed by fortis /s'/ (25% and 28.1% of the time, respectively). The perceptual match of /θ/ as Korean aspirated /p^h/ is understandable given the fact that the targets /θ/ and /f/ are acoustically quite similar, and English /f/ was predominantly perceived as Korean /p^h/ (Cho and Lee 2007). Non-sibilant /f/ and /θ/ are known to be low in intensity and the place distinction between /f/ and /θ/ is not conspicuous enough due to the similarity between the locations of spectral peaks for /f/ and /θ/ (Stevens 1960, Edwards 2003, Ladefoged 2006). In consequence, it seems to be possible for some listeners to confuse /θ/ with /f/ especially in weak locations like coda and intervocalic position after stress, which results in the perceptual mapping of /θ/ onto

⁷ Perceptual mapping proportions below 0.6% (1 of the 160 responses) and "others" responses are excluded.

Korean /p^h/.

The English-to-Korean mapping categories were more various in final coda position and intervocalic position after stress, relative to initial onset and intervocalic position before stress. Further, the proportions of the most dominant mapping category (i.e., /p^h/) were only 31.9% and 28.1%, which implies that Korean listeners were more confused in labeling English /θ/ with their close L1 category in these locations. It is well known that phonetic (acoustic) cues are weak in final coda position and intervocalic position after stress due to the lack of prominence or stress, thus showing positional effect and stress effect given the various perceptual mapping patterns (Lee and Cho 2006).

Further, the diverse perceptual mappings across position indicated listener variation in that some Korean listeners heard Korean /s'/ was the closest matching category for /θ/ while others heard Korean /t'/ as most similar to English /θ/. Schmidt (1996: 3209) also noticed listener variation by stating “for some Korean listeners, English /θ/ has a strong fricative element (i.e., /s'/), to other Korean listeners English /θ/ has a strong dental elements (i.e., /t'/), and for still other Korean listeners English /θ/ has a strong labial element (i.e., /p^h/)”.

3.2 Loanword database

As mentioned above, the borrowing pattern of English /θ/ in Korean has not been fully established. Thus, in this section a loanword database is introduced, wherein the borrowing pattern of /θ/ in Korean is extracted in order to compare the borrowing pattern with the perceptual mapping pattern found in (2). The loanword database is made by using Microsoft Excel and consists of 14576 lines of consonantal entries, having 4.89MB. English loanword data were collected from various sources. First of all, most of the loanword data were selected from two loanword dictionaries published in Korea: 21C the latest loanword dictionary from Clover publishing company (2004), and Loanwords dictionary from Minjungseoguan (2006). Besides, the data were collected from the published sources as well as a survey conducted to native Koreans in Seoul and Kyungsang province, mostly university students enrolled in phonetics and phonology classes. When the data did not agree among the sources, they were also checked from various internet sites such as Naver portal web site (<http://www.naver.com>) and the web site of The National Institute of the Korean Language (<http://www.korean.go.kr>).

The database excludes unfamiliar terms such as very technical chemistry and medical terminologies in the loanword dictionaries. The database in the form of a matrix consists of 4031 loan words which would be familiar to native Korean speakers. For each loanword, several rows were generated depending on the number of consonants the word contains. Hence, total 14576 rows were generated from the total 4031 words. For example, the

word *zipper* contains three rows because it has three consonants, which are /z/, /p/, /r/.

The database in Microsoft Excel consists of several columns including English target consonants, position of the target (Initial, Medial, Final), syllable position of the target (Onset, Coda), prosodic position of the target (CV, VC, VCVV, VVCV, VCV, VVCVV), cluster/singleton, English orthography, the pronunciation of the English word, English-to-Korean mapping, and Korean orthography. Also, an automatic filter is used in the Microsoft Excel database in order to easily search for data according to the columns such as English target consonants, prosodic locations, and cluster or singleton.

The proportions of English-to-Korean mappings for each English consonant in the loanword database can be counted by using the pivot table. For example, for the proportions of English /p/ mappings onto Korean in CV position, the number of the relevant words, *paint*, *pilot*, etc. is displayed in the pivot table so that the proportions of each English-to-Korean loanword mapping (e.g., English /p/ → Korean [p^h], English /p/ → Korean [p']) are calculated.

The loanword mapping proportions of English /θ/ onto Korean segment are obtained from the loanword database using the pivot table, as given in (3)⁸.

(3) Proportion of English-to-Korean borrowing mappings for English /θ/

a. Initial onset (23)	b. Final coda (17)	c. Intervocalic before stress (16)	d. Intervocalic after stress (22)
[s'] ([ʃ]) 37.8% (8.7)	[s'i] 40.2% (6.8)	[t ^h] 38.5% (6.2)	[t ^h] 34.4% (7.5)
[s] ([ʃ]) 33.5% (7.7)	[si] 40.2% (6.8)	[d] 21.7% (3.5)	[s'] ([ʃ]) 21.1% (4.6)
[t ^h] 18.3% (4.2)	[t'] 13.6% (2.3)	[s'] ([ʃ]) 19.9% (3.2)	[s] ([ʃ]) 21.1% (4.6)
[t'] 7.0% (1.6)	[di] 5.9% (1)	[s] ([ʃ]) 19.9% (3.2)	[d] 19.7% (4.3)
[t] 3.5% (0.8)			[t'] 3.7% (0.8)

In the loanword database there are 23 loanwords which contain the source /θ/ in initial onset position, 17 words in final coda position, 16 words in intervocalic position before stress, and 22 words in intervocalic position after stress.

Importantly, the majority of the loanwords with English /θ/ in the database have more than one form. Specifically, in initial onset position 20 loanwords have lexical variants (e.g., [t^herapi]/[s'erapi]/[serapi] 'therapy') among 23 loanwords. Likewise, in final coda position 15 words out of 17 words, in intervocalic position before stress 14 out of 16, and in

⁸ Here, only the mappings of singleton English /θ/ located in CV (initial onset), VC (final coda), VCVV (intervocalic position before stress), and VVCV (intervocalic position after stress) are examined so as to be compared with the mapping results from the perception study in (2). Thus, only singleton /θ/, not in clusters, is considered in this paper.

intervocalic position after stress 19 out of 22 have variants with fortis /s'/, lenis /s/, aspirated /t^h/, lenis /t/ etc., 87.2% of the time on average across position.⁹

(4) Proportion of lexical variants with multiple mappings per prosodic position

Initial onset	Final coda	Intervocalic before stress	Intervocalic after stress
87.0% (20/23)	87.0% (15/17)	87.5% (14/16)	86.4% (19/22)

Smith (2006) also observed two different types of forms for the same lexical item: forms with orthographic adaptation in more indirect and distant contact and forms with auditory adaptation in more direct and immediate contact. Similarly, Korean loanwords with /θ/ show a large proportion of variable forms including doublets and even triplets.

Variable forms are analyzed by splitting their occurrences to each mapping equally. For example, when 2 loanwords with English /θ/ are realized as triplets ([t^herapi]/[s'erapi]/[sɛrapi] 'therapy'; [t^helmosi]/[s'əmos'i]/[səmosi] 'thermos'), 2 occurrences are split to 3 different mappings ([t^h]-mapping, [s']-mapping, [s]-mapping) resulting in 0.7 for each mapping, which is rounded off. Likewise, when 6 loanwords with /θ/ are realized as doublets with [s']-mapping and [s]-mapping, each mapping is calculated as 3 occurrences, respectively. The fact that English /θ/ is borrowed with different Korean consonants depending upon the word has not been fully investigated and incorporated in the analyses of previous work, although Smith (2006) reports the existence of doublets in Japanese loanword adaptation which involve two different concurrent mappings (forms with consonant deletion and with vowel insertion) for the same loanword. In the next section, the proportions of English-to-Korean borrowing mappings in (3) are compared with those of English-to-Korean perceptual category mappings in (2) in order to determine the degree to which perceptual mapping accounts for borrowing mapping.

4. Analysis

4.1 Initial onset position

While the majority of the perceptual mapping for /θ/ would predict a strong preponderance of fortis [s']-borrowing mapping, followed by fortis [t']-

⁹ As pointed out by an anonymous reviewer, the regulation of how to transcribe loanwords in Korean orthography had been changed by the Ministry of Education since 1933. For instance, the normative conventions before 1941 prescribed that English /s/ be spelled as Korean fortis <ss> while the normative conventions in 1941 and 1986 dictated that the same target be written as Korean lenis <s> (and <si> in coda) (Park and Kim 2004). This kind of diachronic changes in orthography norms may contribute to the occurrence of variable loanword forms.

mapping, there are other conspicuous borrowing mappings such as lenis [s]-mapping and aspirated [t^h]-mapping, as shown below.

(5) English /θ/ adaptation in initial position

- a. fricative series: [s'], [s], [ʃ'], [ʃ]
 - [sændə]/[s'ændə] thunder [səməmit^hə]/[s'əməmit^hə] thermometer
 - [ʃinnə]/[ʃ'innə] thinner [ʃiət^hə]/[ʃ'iət^hə] thearer
- b. both fricative and stop series: [s'], [s], [ʃ'], [ʃ], [t^h], [t']
 - [sæŋk^hi]/[s'æŋk^hi]/[t'æŋk^hi] thank [ʃiŋk^hi]/[ʃ'iŋk^hi]/[t'iŋk^hi] think
 - [serap^hi]/[s'erap^hi]/[t^herap^hi] therapy
 - [səmosi]/[s'əmos'i]/[t^helmos'i] thermos
- c. [t^h] only
 - [t^hema] theme [t^horium] thorium

The borrowing mapping of /θ/ onto palatal fricative [ʃ] or [ʃ'] occurs only before the high front vowel /i/, which seems to be transfer of Korean (L1) palatalization. The influence of phonology native to the borrowing language has been observed by many scholars (Silverman 1992, Davis and Cho 2006 among others).

In order to examine the degree to which borrowing mapping corresponds to perceptual mapping, the proportions of borrowing mappings in column (3a) are plotted against the proportions of perceptual mappings in column (2a). As illustrated in Figure 1, a significant correlation between borrowing mapping and perceptual mapping was not found ($r^2 = .1094$)

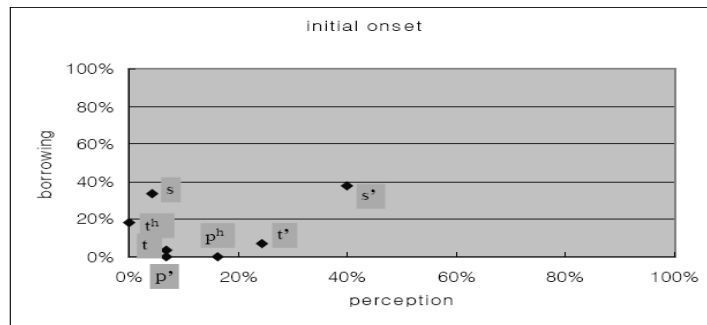


Figure 1. The relationship between the borrowing mapping proportions and perceptual mapping proportions for English /θ/ in initial onset position

The data points in Figure 1 tend to be shifted toward the lower left corner. The distribution of data points along the y-axis shows that English /θ/ is mainly borrowed with different Korean consonants [s'], [s], and [t^h]. Among the 3 different consonants, only [s']-borrowing mapping is

predicted by on-line auditory perception.¹⁰ By contrast, lenis [s]-borrowing mapping and aspirated [t^h]-borrowing mapping are not perceptually motivated. In particular, lenis [s]-borrowing mapping is prescribed by the National Institute of the Korean Language (www.korean.go.kr) in such a way that English loanwords are recommended to be represented as lenis /s/ that is <s> in Korean orthography, not fortis /s'/ that is <ss> in orthography.¹¹ On the other hand, aspirated [t^h]-borrowing mapping seems to be influenced by orthography because some loanwords with /θ/ are likely to enter the Korean language through written materials rather than spoken input through scholarly influence. Then, the adapters, who seem to be mostly scholars, may interpret the English orthography *th* as Korean aspirated [t^h]¹². Also, note that perceptual mappings are not always reflected in borrowing mappings, as witnessed by data points [p^h] and [t'], which have a very low (or zero for [p^h]) proportion along the y-axis.

4.2 Final coda position

In final coda position English /θ/ is mostly adapted as Korean released fricatives with the inserted vowel [i]. In addition, the sequence of [d]-plus-[i] as well as unreleased [t'] occurs as optional variants, as in (6b) and (6d).

(6) English /θ/ adaptation in final position

- a. fricative series: [si], [s'i]
 - [pusi]/[pus'i] 'booth' [k^henesi]/[k^henes'i] 'Kenneth'
- b. both fricative and stop series: [si], [s'i], [di]
 - [simisi]/[simis'i]/[simidi] 'Smith'
 - [mammosi]/[mammos'i]/[mæmædi] 'mammoth'
- c. unreleased stop: [t']
 - [nasaret']/[nəjaret'] 'Nazareth' [kolliat']/[koriaat'] 'Goliath'
- d. both fricative series and unreleased stop: [t'], [si], [s'i]
 - [lut']/[lusi]/[lus'i] 'Ruth'

The adaptation of /θ/ as [d]-plus-[i] is considered to be a similar case to the triplet, [serap^hi]/[s'erap^hi]/[t^herap^hi] 'therapy'. Namely, English orthography "*th*" in words such as *Smith* and *mammoth* is interpreted as

¹⁰ The role of perception in Korean loanword adaptation is also investigated in Park (2008) in a different way.

¹¹ The prescribed normative form, lenis <s> seems to cause the avoidance of the fortis [s'] pronunciation, although in casual fast speech standard Korean speakers tend to produce fortis [s'] for English targets before a vowel except Kyungsang speakers. It is hard for Kyungsang speakers to produce fortis [s'] so that they even pronounce [sal] for [s'al] 'rice'.

¹² For English loanword like "dam" some Koreans Romanize it as "tam", while others as "dam". Those who use "tam" would match Korean aspirated [t^h] onto grapheme <th>. On the other hand, those who adopt "dam" would match Korean aspirated [t^h] onto grapheme <ㅌ>.

Korean lenis /t/ in this case¹³, and consequently it undergoes Korean intervocalic voicing due to the following inserted vowel, resulting in [di]. If vowel insertion does not occur, then lenis [t] is realized as unreleased [t̚] in coda, as in (6c) because of Korean coda neutralization, whereby aspirated, fortis, and lenis obstruents in coda become unreleased stops [p̚, t̚, k̚] with the same place features.

The proportions of borrowing mappings in column (3b) are plotted against the proportions of perceptual mappings in column (2b).

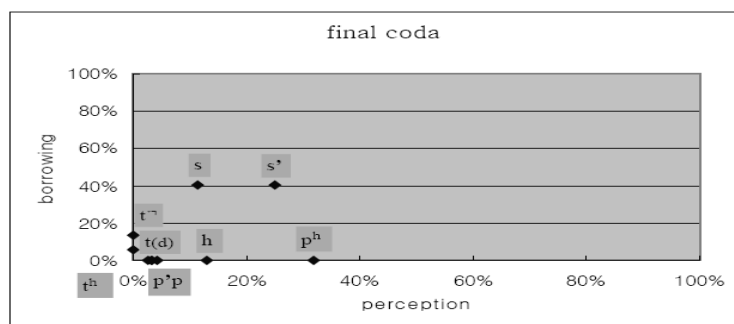


Figure 2. The relationship between the borrowing mapping proportions and perceptual mapping proportions for English /θ/ in final coda position

Figure 2 does not show a significant correlation between the proportions of borrowing and perceptual mappings ($r^2 = .0985$), as indicated by the extreme clustering of the lower leftward data points. Specifically, there is only a rough correlation between the proportions of perceptual mapping and borrowing mapping for the data point [s'] in that a dominant proportion of perceptual mapping corresponds to a dominant proportion of borrowing mapping. However, in the case of [pʰ] the most dominant proportion of perceptual mapping corresponds to zero probability of perceptual mapping, which reflects the fact that loanword adaptation is not purely perceptual. Note that the data point [s] is also considered to be slightly motivated by auditory perception in final coda compared to other prosodic position because inherent air releaseness of fricative /θ/ is realized in coda despite weak position, and Korean listeners would perceptually map this less degree of air releaseness onto Korean lenis [s],

¹³ There seems to be confusion as to whether English orthography “*th*” corresponds to Korean aspirated /tʰ/ or lenis /t/. This confusion may be partly attributed to the diachronic changes of the Korean orthography norms regulated by the Ministry of Education, as observed by scholars such as Park and Kim (2004) and Lee (2010). For example, the norms regulated in 1941 prescribe that English voiceless stops /p, t, k/ be spelled as Korean aspirated stops <pʰ, tʰ, kʰ>, respectively. By contrast, the norms in 1948 prescribe that English voiceless stops be written as Korean lenis <p, t, k>, respectively, in initial onset and final coda but as Korean fortis <pʰ, tʰ, kʰ>, respectively, in intervocalic position.

along with prescriptive standardization which prohibit fortis [s']. However, the data points [di] with vowel insertion and [t'] without vowel insertion are accounted for not by perceptual influence but by orthographic influence.

4.3 Intervocalic position before stress

Intervocalic English /θ/ before stress is adapted as either stop series or fricative series in Korean. While English /θ/ is borrowed with Korean stops [t^h] or [d] about 60% of the time, it is borrowed with Korean fricative series [s] or [s'] about 40% of the time. Further, English /θ/ are borrowed with variants of Korean fricative series and aspirated stop [t^h].

(7) English /θ/ adaptation in intervocalic position before stress

- a. stop series: [t^h], [d]
[k^hat^hari] 'is'i/[k^hadari] 'isi 'cath^harsis'
[p^hit^hagoras] 'i/[p^hidagorasi] 'Pyth^hagoras'
- b. fricative series: [s'], [s]
[k^hæs'e]i/[k^hæsei] 'Cath^hay' [osorət^hi]/[os'orət^hi] 'auth^hority'
- c. both fricative and stop series: [s'], [s], [t^h]
[misolloji]/[mis'olloji]/[mit^holloji] 'myth^hology'
- d. [t^h] only
[k^hat^holli]jim 'Cath^holicism'

Figure 3 plots borrowing mapping proportions in (3c) against perceptual mapping proportions in (2c), which does not show a significant correlation between borrowing and perceptual mappings ($r^2 = .0021$).

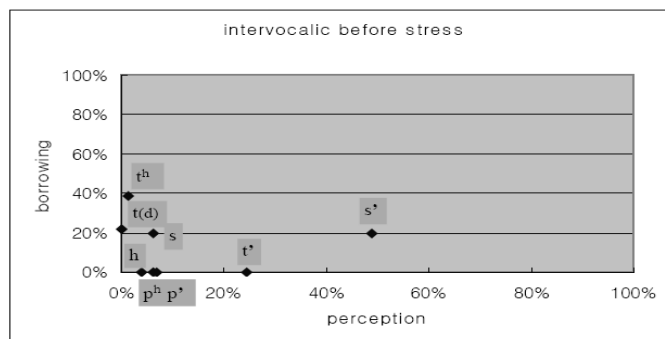


Figure 3. The relationship between the borrowing mapping proportions and perceptual mapping proportions for English /θ/ in intervocalic position before stress

The proportions of borrowing mapping of the data points do not conform to those of the proportions of perceptual mapping. Even the data point [s'] with a relatively high proportion of perceptual mapping has a low

proportion of borrowing mapping. The data points of [t^h] and [d] along the y-axis clearly shows that Korean listeners do not perceptually connect English /θ/ with the stop series. The lack of correlations as indicated by the data points toward the lower left corner indicates that there are more than perceptual factor that affect loanword adaptation.

4.4 Intervocalic position after stress

In intervocalic position after stress similar variability between Korean fricative series and stop series is observed for English /θ/ like other prosodic locations.¹⁴

(8) Adaptation of English /θ/ in intervocalic position after stress

- a. stop series: [d], [t^h], [t']
 [osit^hirallop^hidek^hus'i]/[osit^hirallop^hit^hek^husi] 'Australopit^hhecus'
 [idiop^hia]/[et^hiop^hia] 'Ethiopia' [pedel]/[pet^hel] 'Bethel'
- b. fricative series: [s], [s']
 [mesodisit^hi]/[mes'odisit^hi] 'Methodist'
 [læselwep^hon]/[lis'əlwep^hon] 'lethal weapon'
- c. both fricative and stop series [s], [s'], [ʃ'], [ʃ], [t'], [t^h], [d]
 [saiseria]/[s'ais'eria]/[ʃit^heria] 'Cytherea'
 [p^heisosi]/[p^heis'os'i]/[p^hat^hosi] 'pathos'
 [k^hæsərin]/[k^hæs'ərin]/[k^hædərin] 'Katherine'
 [nat^hʃiŋ]/[nat^hʃ'iŋ]/[nat^hiŋ] 'nothing'
- d. [t^h] only
 [et^heri] 'ether' [sik^hit^hai] 'Scythia'

As discussed above, the forms with aspirated stop /t^h/ and lenis stop /t/ are likely to be determined by English orthography whereas forms with [s'] and [t'] are accounted for by auditory perception. Lenis /t/ in the onset of the second syllable undergoes Korean intervocalic voicing (e.g., [pe.del] 'Bethel') while /t/ in the coda of the first syllable is subject to Korean coda neutralization (e.g., [pet^h.el] 'Bethel'). When /θ/ is before [i], it is realized as Korean palatal fricative series [ʃ'] and [ʃ], undergoing Korean palatalization. This indicates that L1 phonological processes are transferred to loanword adaptation.

Borrowing mapping proportions in (3d) are plotted against perceptual mapping proportions in (2d).

¹⁴ English /θ/ is also adapted as Korean aspirated [t^h] and fortis [t'] (e.g., [let^he]/[let'e] 'Lethe').

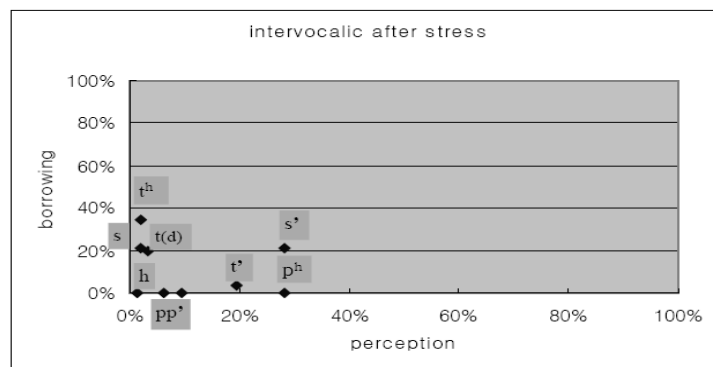


Figure 4. The relationship between the borrowing mapping proportions and perceptual mapping proportions for English /θ/ in intervocalic position after stress

Similar to the results found in other prosodic locations, no significant correlations is found ($r^2 = .0546$). Only the data point [s'] can be accounted for by perceptual influence. Data points which have high proportions of borrowing mapping do not necessarily have high proportions of perceptual mapping, as shown by the data points, [s], [t^h] and [t(d)]. This implies that other factors such as orthography of the source, prescriptive standardization and the phonology of borrowing language are involved in loanword adaptation along with the perceptual factor.

5. Conclusion

In this paper comprehensive loanword mapping patterns of English /θ/ are obtained by position from a systematic loanword database. While English /θ/ is known to be borrowed with Korean fortis [s'] or [t'] in previous work, there are more borrowing mapping patterns. English /θ/ is adapted as Korean fricative series (s', ʃ', s, ʃ) as well as Korean stop series (t^h , t', t(d), t'). Also, Korean phonological processes (i.e., palatalization, intervocalic voicing, coda neutralization) are transferred to the borrowing process. In order to investigate the degree to which auditory perception affects borrowing patterns, the borrowing mapping patterns found are quantitatively compared with perceptual mapping patterns extracted from a larger cross-language perception study which examines Korean perception of English consonants. The result shows no significant correlation between the proportions of borrowing and perceptual mappings across prosodic position. However, borrowing mapping patterns slightly vary depending on prosodic position. Also, the result indicates that only borrowing mappings of /θ/ onto Korean fortis [s']/[ʃ'] and [t'] are perceptually motivated. Lenis [s]-mapping is prescribed by norms of the community by means of standardization. The borrowing mappings onto Korean stop series,

aspirated [t^h], lenis [t(d)] and unreleased [t̚] are accounted for by orthographic influence given that loanwords with /θ/ may be transmitted to the Korean language based on written input or by Korean speakers who know the spelling of the loanwords in the source language. Then, the adapters, who may be mostly scholars, seem to interpret the English orthography *th* as either Korean aspirated [t^h] or lenis [t]. The result implies that speech perception is not the only factor that affects loanword adaptation. Other factors such as orthography, prescribed standardization, and L1 phonological processes are found to be in play in the adaptation of English /θ/ in Korean.

REFERENCES

- 21C: The Latest Loanword Dictionary. 2004. Seoul: Clover Publishing Co.
- ABRAMSON, ARTHUR S. and LEIGH LISKER. 1972. Voice timing in Korean stops. *Proceedings of the VIIIth international congress of phonetic sciences*. The Hague: Mouton, 439-446.
- AHN, SANG-CHEOL. 2003. English interdental substitution. *The Journal of English Language & Literature* 49, 981-1004.
- AVERY, PETER and WILLIAM IDSARDI. 2001. Laryngeal dimensions, completion and enhancement. In Hall T. Allan (ed.). *Distinctive Feature Theory*, 41-71. Berlin: De Gruyter.
- BRANNEN, KATHLEEN. 2002. The role of perception in differential substitution. *Canadian Journal of Linguistics* 47, 1-46.
- CHO, MI-HUI and SHINSOOK LEE. 2001. Phonological transparency and opacity in the sound substitution of interlanguages. *Studies in Phonetics, Phonology, and Morphology* 7, 449-468.
- _____. 2007. Category matching between English and Korean consonants in different prosodic environment. *English Language and Literature* 53, 731-753.
- _____. 2010. Different adaptation patterns of English /f/ in Korea loanword phonology: Cases of direct borrowing and indirect borrowing. *Studies in Phonetics, Phonology, and Morphology* 16, 259-277.
- DAVIS, STUART and MI-HUI CHO. 2006. Phonetics versus phonology: English word final /s/ in Korean loanword phonology. *Lingua* 116, 1008-1023.
- DE JONG KENNETH J. and MI-HUI CHO. 2012/To appear. Loanword phonology and perceptual mapping: Comparing two corpora of Korean contact with English. *Language*.
- DOHLUS, KATRIN. 2005. Phonetics or phonology: Asymmetries in loanword adaptation - French and German mid front rounded Vowels in Japanese. *ZAS Papers in Linguistics* 42, 117-135.
- EDWARDS, HAROLD. 2003. Applied Phonetics: The Sounds of American

- English. Thomson.
- GOLDSTEIN, LOUIS. 1977. Three studies in speech perception: Features, relative salience and bias. *UCLA Working Papers in Phonetics*. University of California, Los Angeles.
- HAN, JEONGIM. 1996. The phonetics and phonology of tense and plain consonants in Korean. PhD Dissertation. Cornell University.
- HAN, MEIKO-S. and RAYMOND S. WEITZMAN. 1970. Acoustic features of Korean /P, T, K/, /p, t, k/ and /p^h, t^h, k^h/. *Phonetica* 22, 112-128.
- IVERSON, GREGORY K. 2005. The principling role of Korean in phonological adaptation. Paper presented at the 30th Anniversary Meeting of the International Circle of Korean Linguistics, Seoul National University.
- IVERSON, GREGORY and AHRONG LEE. 2004. Perceived syllable structure in the adaptation of loanwords in Korean. Workshop on Loanword Adaptation. Linguistic Society of Korea International Conference. Seoul, Korea.
- KAGAYA, RYOHEI. 1974. A fiberoptic and acoustic study of the Korean stops, affricates, and fricatives. *Journal of Phonetics* 2, 161-180.
- KANG, YOONJUNG. 2003. Perceptual similarity in loanword adaptation: English postvocalic word-final stops in Korean. *Phonology* 20, 219-273.
- _____. 2010. The emergence of phonological adaptation from phonetic adaptation: English loanwords in Korean. *Phonology* 27, 225-253.
- KENSTOWICZ, MICHAEL J. 2001. The role of perception in loanword phonology. *Studies in African Linguistics* 32, 95-112.
- _____. 2005. Salience and similarity in loanword adaptation. *Language Sciences* 29, 316-340.
- KIM, CIN-WU. 1965. On the autonomy of the tensivity feature in stop classification (with Special Reference to Korean Stops). *Word* 21, 339-359.
- Kim, DUCKJOONG. 1972. A contrastive study of English and Korean phonology. *Language Teaching* 5, 1-36.
- KIM SOOHEE and EMILY CURTIS. 2002. Phonetic duration of English /s/ and its borrowing into Korean. *Japanese/Korean Linguistics* 10, 406-419.
- LACHARITÉ, DARLENE and CAROLE PARADIS. 2002. Addressing and disconfirming some predictions of phonetic approximation for loanword adaptation. *Langues et Linguistique* 28, 71-91.
- _____. 2005. Category preservation and proximity versus phonetic approximation in loanword adaptation. *Linguistic Inquiry* 36, 223-258.
- LEE, JUHEE. 2006. Typology of interdental fricatives with reference to loanword adaptation. *Studies in Phonetics, Phonology, and Morphology* 12, 127-148.

- _____. 2010. Influence from Japanese /h/ in English loans into Korean. *The Journal of Studies in Language* 26.3, 657-678.
- LADEFOGED, PETER. 2006. *Course in Phonetics*, 5th ed. Boston: Thomson.
- LEE, SHINSOOK and MI-HUI CHO 2006. A Positional Effect in the Perception of English Anterior Obstruents. *Korean Journal of English Language and Linguistics* 6, 849-867.
- LISKER, LEIGH and ARTHUR S. ABRAMSON. 1964. A cross-language study of voicing initial stops: Acoustical measurements. *Word* 20, 384-422.
- LOMBARDI, LINDA. 2003. Second language data and constraints on manner: Explaining substitutions for the English interdental. *Second Language Research* 19, 225-250.
- Loanword Dictionary. 2006. Seoul: Minjungsekwan.
- MADDIESON, IAN. 1984. *Patterns of Sound*. Cambridge University Press: Cambridge.
- OH, MIRA. 2002. English fricatives in loanword adaptation. In Ahn S. C. and G. K. Iverson (eds.). *Explorations in Korean Language and Linguistics*, 471-487. Seoul: Hankookmunhwasa.
- PARK, HANYONG. 2008. Limits to the role of perception in Korean loanwords: English anterior obstruents in various prosodic locations. Paper presented at Harvard Studies in Korean Linguistics, XII.
- PARK, HANYONG and KENNETH J. DE JONG. 2008. Perceptual category mapping between English and Korean prevocalic obstruents: Evidence from mapping effects in second language identification skills. *Journal of Phonetics* 36, 704-723.
- PARK, CHANGWON and SUHYEON KIM. 2004. Changes in the conventions for loanword transcription. [In Korean] *Saekukesanghwal* 14.2 (mirror.puzzlet.org/korean.go.kr/nkview/.../2004_2.html).
- PEPERKAMP, SHARON and EMMANUEL DUPOUX. 2003. Reinterpreting loanword adaptations: The role of perception. *Proceedings of the 15th International Congress of Phonetic Sciences*, 376-370.
- PEPERKAMP, SHARON, INGA VENDELIN, and KIMIHIRO NAKMURA. 2008. On the perceptual origin of loanword adaptations: Experiential evidence from Japanese. *Phonology* 25, 129-164.
- SCHMIDT, A. MARIE. 1996. Cross-language identification of consonants. Part 1. Korean perception of English. *Journal of the Acoustical Society of America* 99, 3201-3211.
- SHINOHARA, SHIGEKU. 2004. Emergence of universal grammar in foreign word adaptations. In Kager, R., J. Pater and W. Zonnevold (eds.). *Constraints in Phonological Acquisition*, 292-320. Cambridge: Cambridge University Press.
- _____. 2005. Perceptual effects in final cluster reduction Patterns. Ms. CNRS.
- SLIVERMAN, DANIEL. 1992. Multiple scansion in loanword phonology: Evidence from Cantonese. *Phonology* 9, 289-328.

- SMITH, JENNIFER L. 2006. Loan phonology is not all perception: Evidence from Japanese loan doublets. *Japanese/Korean Linguistics* 14, 63-74. Palo Alto, Cal.: CSLI.
- STERIADE, DONCA. 2001a. Directional asymmetries in place assimilation: A perceptual account. In Hume E. and K. Johnson (eds.). *The Role of Speech Perception in Phonology*, 219-250. San Diego: Academic Press.
- _____. 2001b. The phonology of perceptibility effects: The P-map and its consequences for constraint organization. Ms. UCLA.
- STREVENS, PETER. 1960. Spectra of fricative noise in human speech. *Language and Speech* 3, 32-49.
- VENDELIN, INGA and SHARON PEPERKAMP. 2006 The influence of orthography on loanword adaptations. *Lingua* 116, 996-1007.
- WANG, MARILYN. D. and ROBERT. C. BILGER. 1973. Consonant confusion in noise: A study of perceptual features. *Journal of the Acoustical Society of America* 54, 1248-1266.
- WEINBERGER, STEVEN. 1990. Minimal segment in L2 phonology. In J. Leather and A. James (eds.). *New Sounds 90: Proceedings of the Amsterdam Symposium under Acquisition of Second Language Speech*, 137-179. Amsterdam: University of Amsterdam.

Mi-Hui Cho
Department of English Language & Literature
Kyonggi University
San 94-6, Iui-Dong, Yongtong-Gu Suwon-Si
Gyeonggi-Do, 443-760, Korea
E-mail: mcho@kyonggi.ac.kr
Tel: +82-31-249-9135

received: March 22, 2012
revised: April 10, 2012
accepted: April 25, 2012