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# Loanword adaptation of English coronal fricatives into Mandarin Chinese*

**Hui Yang** · Mira Oh*****
**(Qingdao University of Science and Technology · Chonnam National University)**

**Yang, Hui and Mira Oh. 2020. Loanword adaptation of English coronal fricatives into Mandarin Chinese.** *Linguistic Research* 37(1), 71-93. This paper investigates how the coronal voiceless fricatives /s/ and /ʃ/ in English are adapted in Mandarin Chinese. The few-to-many mappings between /s/ and /ʃ/ in English and /s, ʂ, ɕ/ in Mandarin Chinese will be studied based on the corpus of 493 English loanwords taken from Oxford Advanced Learner's English – Chinese Dictionary (7th edition, 2009), Xiandai Hanyu Cidian (Modern Chinese Dictionary 6th edition, 2009) and Google searches (2013). The results of a corpus study demonstrate three key findings. First, the alveolar fricative in English is mapped to the corresponding loan sound in Mandarin Chinese, depending on the following vowel to conform to native phonotactics. Second, the adaptation of the palato-alveolar fricative is mainly determined by its internal acoustic cues. Third, it is noted that the stress of the s-initial syllable exerts influence on how /s/ in a cluster (/s/ followed by another consonant) is mapped to a loan sound in Mandarin Chinese. These findings suggest that loan adaptation makes a crucial reference to featural co-occurrence constraints, in that a consonant of interest can be mapped to different loan sounds due to native phonotactics. Notably, they also indicate that suprasegmental information comes into play when vocalic information is not available next to a consonant of interest. The roles of external and suprasegmental cues in the adaptation of coronal fricatives of English into Mandarin Chinese argue for the perceptual view (Silverman 1992) as opposed to the phonological view (Lacharité and Paradis 2005) on loanword adaptation. **(Qingdao University of Science and Technology · Chonnam National University)**

**Keywords** loanword adaptation, coronal fricatives of English and Mandarin Chinese, perceptual approximation, external and suprasegmental cues

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** First author
*** Corresponding author

## 1. Introduction

### 1.1 Loanword adaptation

Generally speaking, loanword adaptation reflects how the borrowers perceive the non-native sounds, by modifying them in such a way that native phonotactic or segmental constraints are satisfied (Silverman 1992; Yip 1993; Paradis and LaCharité 2002; Peperkamp and Nakamura 2008). Frequently, loanword adaptation naturally has provided many insights onto the relationship between speech perception and the phonological grammar. In particular, loanword adaptation provides a unique window onto the interaction between the relational aspect of phonetics and phonology of the source and borrowing languages (Daland et al. 2019). There are two main views on the extent to which phonetic and phonological information influences loanword adaptation. The phonological view claims that the phonological representation of a source language plays a central role in adaptation, while phonetic approximation exerts little influence on loanword adaptation (Lacharité and Paradis 2005). On this view, a non-native segment is adapted to the corresponding segment subject to the need to preserve contrast. To be specific, although VOT of English voiced stops /b/ is around 0~30 ms which is similar to that of Spanish voiceless stops /p/ (0~30 ms), /b/ in English word ‘bar’ [bɑɹ] is adapted into Spanish /b/ in [baɾ] rather than *[paɾ] (Lacharité and Paradis 2005: 251). Paradis and Tremblay’s (2009) study also presents a case for the phonological view on loanword adaptation. They investigate how English stops, which are contrastive in voicing, are adapted into Mandarin Chinese (MC) stops, which are contrastive in aspiration. They show that both English voiceless aspirated stop as in ‘pie’ and voiceless unaspirated stop as in ‘Scott’ are adapted into aspirated stops as illustrated in [pʰai] and [sɻ.kʰɤ.tʰɤ]~[ʂɻ.kʰɑu.tʰɤ] in MC although English voiceless aspirated stops are more similar to MC aspirated stops and English voiceless unaspirated stops to MC unaspirated stops in terms of their VOT values. On the other hand, English voiced stops are loaned as MC unaspirated stops, e.g., [pa.tʰɤ] ‘barter’. Yang and Oh’s (2015) study also reports that English voiceless stops are adapted into MC aspirated stops regardless of aspiration and English voiced stops are loaned as unaspirated stops.

On the other hand, the perceptual view takes the position that borrowers adapt a non-native segment to one which they feel most perceptually similar to the former (Silverman 1992; Kim 1999; Peperkamp and Dupoux 2003; Boersma and Hamann 2009). According to this view, among all surface forms that are grammatical in the borrowing language, it is shown that the borrowers choose the one that is the most perceptually similar to the surface form in the source language. In this case, there are many types of segmental and phonotactic phenomena that are able to testify the perceptual effect on loanword adaptation. For example, as for the adaptation of English /s/ to Korean, 'sign' is loaned as [s'ain] with the tense [s'], but 'star' as [sit$^{h}$a] with the lax [s] in Korean (Kim and Curtis 2002; Oh 2003). Particularly, the loanword, [sit$^{h}$a], reveals three relevant facts. To begin with, the initial /s/ is loaned as the lax [s] as opposed to the tense [s'] in Korean, since Korean listeners are biased to hear [s] to be faithful to short duration of the cluster-initial /s/ in English (Kim and Curtis 2002). Next, it is noted that the Korean listeners are likely to hear [s] with a following epenthetic vowel, since noisy sounds are more likely to induce the perception of an epenthetic vowel (de Jong and Park 2012; Daland et al. 2019). Finally, the low perceptibility of /r/ after back vowels will induce its deletion in Korean (Kenstowicz 2003). In like manner, the word-final nasals of French with audibly stronger releases tend to be more mapped onto Japanese forms with a following epenthetic vowel, as compared to the word-final nasals of English (Peperkamp et al. 2008). Such acoustically-driven mappings support the perceptual view on loanword adaptation.

Another key point is that the perceptual view and the phonological view differ in that the former allows a powerful influence of subphonemic details on loanword adaptation, but the latter does not. However, the use of loanword adaptation in a language can provide the evidence for both views, as exemplified in the adaptation of English consonants into Korean. For example, the adaptation of English voiceless stops in Korean can support the phonological view. At this juncture, there seems to be some pressure in loanword adaptation for the same phoneme to be adapted in the same way.

In particular, English voiceless stops are (almost) always adapted as aspirated stops in Korean regardless of whether they are aspirated or unaspirated, e.g., [p$^{h}$ai] 'pie', [sɨp$^{h}$ai] 'spy'.[1] On the other hand, the adaptation of English /s/ in Korean can be accounted for by the perceptual view. Here, it is shown that English /s/ is loaned either as the tense [s'] or the lax [s] in Korean depending on the duration of the coronal fricative, e.g., 'sign' [s'ain] vs. 'star' [sɨt$^{h}$a] (Kim and Curtis 2002).

### 1.2 Adaptation of English coronal fricatives into Mandarin Chinese

Suffice it to state that most of the previous studies on loanword adaptation in Mandarin Chinese (MC) focused on historical, etymological and sociolinguistic aspects of loanwords (Liu 1986; Masini 1993). Some research investigated tonal adaptation (Chang and Bradley 2011; Mar and Park 2012; Glewwe 2015; Zheng and Durvasula 2015; Chang 2020). It is noted that only a few studies dealt with phonetic and phonological aspects of loanword adaptation in Chinese. Upon review of Silverman's (1992) study, it showed that Cantonese speakers adapted English /s/ and /ʃ/ as /s/ since Cantonese possesses only a single coronal fricative. Later, Miao (2005) investigated loanword adaptation of consonants from three source languages, English, German and Italian, in MC. He contends in his research that perceptual similarity plays a crucial role in loanword adaptation, supporting the cross-linguistic finding that faithfulness of manner features takes preference over faithfulness of other features such as voicing and place (Broselow 1999; Steriade 2002), and segment preservation over deletion in loan adaptation (Paradis and Lacharité 1997; Uffmann 2001, 2006). Additionally, Miao (2005) notices that vowels play a role in adapting coronal fricatives in that vowel height in the source language positively correlates with the rate of Mandarin fricative /ɕ/ as a loan sound. Furthermore, Lin (2009) also suggests that allophonic distributions affect loan adaptation by showing that English

1 The adaptation of /p/ in 'spy' as [p$^{h}$] in Korean can also be understood to be in favor of the perceptual view. The unaspirated post-/s/ stop in English is perceived as an aspirated stop as opposed to a tense stop. The vowel is shorter after an aspirated stop than after a tense stop in Korean (Cho 1996). Then, the adaptation of the unaspirated stop as the aspirated stop as opposed to a tense stop is to maximize perceptual similarity between an epenthetic vowel and no vocalic acoustic cue in the input (Oh 2006).

palato-alveolar /ʃ/ before a high front vowel is mapped to the alveo-palatal /ɕ/ in MC. Chang (2020) investigates the adaptation of English fricatives into MC through a listen-and-write down/say experiment where the subjects were asked to say or write down the corresponding MC characters after they heard English words. Chang's (2020) study shows that English /s/ is adapted 86 out of 101 cases into MC /s/, 15 cases into /ʂ/ but no case into /ɕ/. On the other hand, it shows that English /ʃ/ is adapted 2 out of 101 cases into MC /s/, 91 cases into /ʂ/ and 8 cases into /ɕ/. It does not discuss the vocalic effect on the adaptation of English fricatives into MC because English /si/ is not included in the study. However, it is clear that English coronal fricatives are mapped to multiple sounds in MC and furthermore, the English /s/ is mostly adapted as /s/ but the English /ʃ/ mostly as /ʂ/ in MC as will be demonstrated later in this study.

Two voiceless fricatives, /s, ʃ/, are in contrast in English but three voiceless fricatives, /s, ʂ, ɕ/, are in contrast in MC. /s/ and /ʃ/ in English can be loaned as /s/, /ʂ/ and /ɕ/ within a word in MC as shown in Table 1.

Table 1. Adaptation of English /s, ʃ/ into MC (Mandarin words are transcribed based on Pinyin transliteration. The examples are taken from the corpus studied in Section 3.)

a. Adaptation of English /s/ into Mandarin Chinese

| Positions of /s/ \ Adaptation | English | MC | Loan sounds in MC |
|---|---|---|---|
| i. Word-final /s/ | Alice | ɑi.li.si | /s/ |
| ii. Word-initial /s/ | Sandy | sɑng.di | /s/ |
| | Cindy | xin.di | /ɕ/ |
| iii. Intervocalic /s/ | Lucy | lu.xi | /ɕ/ |
| | Faso | fa.suo | /s/ |
| iv. Before a schwa | Wilson | wei.er.sen | /s/ |
| | | wei.er.sheng | /ʂ/ |
| | | wei.er.xun | /ɕ/ |
| v. /s/ in a cluster | Scott | si.ke.te | /s/ |
| | | shi.kɑo.te | /ʂ/ |

b. Adaptation of English /ʃ/ into Mandarin Chinese

| Positions of /ʃ/ \ Adaptation | English | MC | Loan sounds in MC |
|---|---|---|---|
| i. Word-final /ʃ/ | Bush | bu.shi | /ʂ/ |
| ii. Word-initial /ʃ/ | Shaping | she.bin | /ʂ/ |
| | Sheila | xi.lɑ | /ɕ/ |
| iii. Intervocalic /ʃ/ | Gresham | ge.lei.sha.mu | /ʂ/ |
| | Lucia | lu.xi.ya | /ɕ/ |
| iv. Before a schwa | Patience | pei.xing.si | /ɕ/ |
| v. /ʃ/ in a cluster | Shrewsburry | shi.lu.si.bo.li | /ʂ/ |

Contrary to Miao's (2005) contention that English /s/ and /ʃ/ are perceived similarly to /s/ and /ʂ/, respectively, by MC listeners, it will be shown that English /s/ can be mapped to one of the three fricatives, [s, ʂ, ɕ], but English /ʃ/ can be adapted as [ʂ] or [ɕ] in MC in this study. Then, we must ask how we can account for such multiple mappings between English /s, ʃ/ and their corresponding loan sounds in MC. This study will investigate the question as it is posed above.

### 1.3 The current study

Most previous studies on loanword adaptation centered on one-to-one mapping between consonants (Peter 1984; Silverman 1992; Miao 2005; Lin 2009), vowels (Lin 2008, 2009), and stress and tone (Silverman 1992; Lin 2009; Glewwe 2015; Zheng and Durvasula 2015; Chang 2020) between the source and borrowing languages. However, it must be remembered that the coronal fricative /s/ in English is mapped into /s/, /ʂ/, or /ɕ/ in MC and English /ʃ/ to /ʂ/ or /ɕ/ in MC as given in Table 1. Then, a question arises as to why such multiple mappings take place. Incidentally, the question can be answered in terms of articulatory or acoustic similarity between source and loan sounds. Previous studies demonstrated that English /s/ and /ʃ/ are not produced in the same way as MC /s/ and /ʂ/, respectively. For example, Peter et al.'s (1984) study found that English /s/ is similar to Pekingese /s/ but English /ʃ/ has nothing in common with either of the Pekingese fricatives /ʂ, ɕ/ through the articulatory analyses, such as palatograms and x-ray photograph and acoustic

analyses. On the other hand, Duanmu (2007) demonstrated that English /s/ is articulated more backward than its counterpart in MC. Given that English coronal fricatives do not match coronal fricatives in MC articulatorily and acoustically, multiple mappings of English coronal fricatives into corresponding loan sounds can be expected.

This study investigates the adaptation of English voiceless coronal fricatives, /s, ʃ/, into MC by conducting a corpus experiment to confirm multiple mapping patterns between English voiceless coronal fricatives and corresponding loan sounds in MC. Further, it seeks to review and aims to show that English coronal fricatives are mapped to different loan sounds in MC depending on adjacent vowels following Lin (2009). In MC, the front vs. back specification of non-high vowels determines the coda nasal. To be specific, back variants appear before the velar nasal and front variants before the coronal nasal. Hsieh et al. (2005, 2009) find that in the adaptation of English loans which contain a combination of vowel and nasal coda which is illegal in MC (back vowel + [n] or front vowel + [ŋ]), it is the backness of the vowel that determines the place specification of the coda nasal consonant. For instance, the English velar nasal is mapped to the alveolar nasal when preceded by a front vowel in English, e.g., E. *Angora* [æŋ] → MC. *an.ge.la* [an].[2] When the consonantal feature at stake is perceptually vulnerable consonantal place features, the vocalic feature is maintained (Shinohara 1997; Hsieh et al. 2005; Kenstowicz 2007). Indeed, the place contrast of the coda nasal is notable for its low salience that makes it more prone to assimilation and neutralization cross-linguistically (Jun 1995). Then, it is important to note that a question arises concerning whether the adaptation of English coronal fricatives also attests such vocalic feature faithful mapping over consonantal feature mapping, although fricatives contain perceptually salient acoustic cues like frication. Furthermore, it will be studied whether stress information of the source words in English plays a role in loanword adaptation. In this case, if the external and suprasegmental cues play a role in adapting English coronal fricatives into MC, the perceptual view (Silverman 1992) will be supported as opposed to the phonological view (Lacharité and Paradis 2005) on

2 Note that the front vowel [æ] in *Angora* is loaned as [a] in MC. It suggests that English [æ] is perceived as [a] rather than as [e] by MC listeners due to similarity in openness and vowel height between [æ] in English and [a] in MC.

loanword adaptation.

The rest of this paper is structured as follows. Whereby, Section 2 provides a brief review about phonotactic constraints in MC and English. Next, Section 3 analyses a corpus whose data were collected from dictionaries and Google search, and generates the results on the adaptation of English fricatives into MC. Finally, Section 4 will discuss the results of this study in light of two views on loanword adaptation and conclude the study.

## 2. Phonotactics in MC and English

English syllable structure is (C)(C)(C)V(C)(C)(C)(C) which allows a consonant cluster in onset and coda; MC has the syllable structure of (CG)V(X) (C: consonant, G: glide, V: vowel or syllabic consonant, X: V, n, ŋ or ɹ).[3] Table 2 illustrates English and MC obstruents of interest and Table 3 shows the vowel inventory of MC.

Table 2. Voiceless coronal fricatives in English and MC
(POA: place of articulation)

| Fricatives \ POA | Alveolar | Palato-alveolar | Palatals | Retroflexes |
|---|---|---|---|---|
| English | s | ʃ | | |
| MC | s | | ɕ | ʂ |

Table 3. Vowels of Mandarin Chinese

| Height \ Frontness | Front | Central | Back |
|---|---|---|---|
| High | i, y | | u |
| Mid | | | ɣ, o |
| Low | | a | |

English voiceless alveolar fricative /s/ and palato-alveolar fricative /ʃ/ can be mapped to /s/ (alveolar), /ɕ/ (palatal), and /ʂ/ (retroflex) in MC (Miao 2005). At this point, we need to note that the vowel /i/ has three allophones

3 Nasals and [ɹ] can only be allowed in coda; e.g., 林lin /lin/ (forest), 冷leng /ləŋ/ (cold), 儿er /əɹ/ (son). Fricatives contrast in place in MC, whereas English fricatives contrast in both place and voicing.

depending on the preceding consonant in MC; alveolar [ɿ] occurs after the alveolar fricative /s/ ([sɿ]), retroflex [ʅ] occurs after the retroflex /ʂ/ ([ʂʅ]), whereas palatal [i] occurs after palatal /ɕ/ ([ɕi]) and rest of consonants (Duanmu 2007; Zhu 2010). Both [ʅ] and [ɿ] occur only in open syllables and are often called apical vowels by the linguists in China (Lee and Zee 2003).[4]

## 3. Corpus experiment

A total of 493 loanwords containing English /s, ʃ/, which were reported in Yang (2015), were analyzed in this study. They were collected from 3 different corpora: Loanwords from two dictionaries, i.e., Oxford Advanced Learner's English − Chinese Dictionary (2009) and Xiandai Hanyu Cidian (Modern Chinese Dictionary, 2009), and loanwords in Google searches (March to May 2013). They consist of common first names, last names, place names, medicine names, common words and brand names, excluding abbreviations and acronyms. Additionally, the online dictionaries such as Oxford and Collins were used to ensure the correct pronunciation. Finally, SPSS 20.0 was employed for the statistical analysis in this study.

### 3.1 Vowel effect on the adaptation of English voiceless alveolar fricative in MC

The vowel [i] is realized differently according to its context where it occurs in MC; [ɿ] after the alveolar fricative /s/, [ʅ] after the retroflex /ʂ/, but [i] after palatal /ɕ/ and rest of consonants. It means that the phonotactic constraint in MC does not allow a sequence of /si/. Then, how can the phonotactically illegal sequence of /si/ in English be perceptually repaired in MC? To fully understand how English /s/ is differently adapted depending on the following vowels, the vowels following /s/ in English were divided into three groups: /i/, /ə/, */-i,

4 Some studies treat the syllable-initial [s] as apico-laminal or laminal dental-alveolar, the syllable-initial [ʂ] as apical post-alveolar, and the syllable-initial [ɕ] as lamino-anterodorsal post-alveolar or pre-palatal (Lee and Zee 2003; Xu and Yang 2011). In this study, we characterize [s] as alveolar, [ʂ] as retroflex, and [ɕ] as palatal in MC.

-ə/.[5] In this case, Figure 1 summarizes the overall rate of multiple mappings of prevocalic /s/ and the word-final /s/ of English into MC.

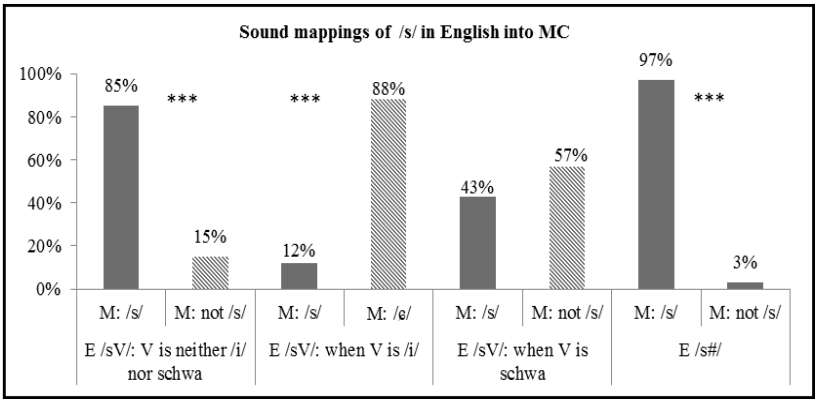


Figure 1. Sound mappings of English prevocalic /s/ and word-final /s/ into Mandarin Chinese (E: English, M: Mandarin Chinese, *: p 〈0.05, **: p〈0.01, ***: p〈0.001)

As shown in Figure 1, in its most positive context the prevocalic /s/ in English is adapted 85% as /s/ in MC and mapped 15% to either /ʂ/ or /ɕ/ when the following vowel is neither /i/ nor a schwa. In other words, the prevocalic /s/ in English is significantly highly adapted as /s/ ($\chi^2$=29.07, *df*=1, *p*=.000). The examples are given in (1).

(1) Adaptation of English /s/ before a vowel other than /i/ or a schwa in MC

| | | | |
|---|---|---|---|
| Sandy | → | sɑng. di | [sɑŋti][6] |
| Sally | → | sɑ.li ~ shɑ.li | [sʌli] ~ [ʂʌli] |
| Somalia | → | suo.mɑ.li | [suomʌli] |

However, the mapping pattern is different when /i/ follows the fricative /s/ in English. English /s/ before a high front vowel is mapped 88% to MC /ɕ/

5 */-i, -ə/ indicates that the vowel is neither /i/ nor a schwa.

6 MC /a/ has five allophones: [a] is used in MC pinyin 'ai', 'an' and 'ia'; [A] after consonants or when used alone; [ɑ] in 'ang', 'iang', 'uang', 'ao', 'iao', and 'ua'; [æ] in 'ian' and 'yan'; [ɐ] is used in r-ending retroflex.

but mapped 12% to /s/ in MC ($\chi^2$=29.84, *df*=1, *p*=.000). The examples are given in (2).

(2) Adaptation of English /s/ before a high front vowel in MC

| | | | |
|---|---|---|---|
| Lucy | → | lu.xi | [luɕi] |
| Nancy | → | nan.xi | [nanɕi] |

On the other hand, English /s/ before a reduced vowel is mapped 43% to /s/ and 57% to /ʂ/ or /ɕ/ in MC. In this case, the statistic analysis yields that there is no significant difference between the two groups ($\chi^2$=1.57, *df*=1, *p*=.210). The examples are given in (3).

(3) Adaptation of English /s/ before a reduced vowel in MC

| | | | |
|---|---|---|---|
| Anderson | → | ɑn.de.sen | [antɤsən][7] |
| | → | ɑn.de.sheng | [antɤʂəŋ] |
| | → | ɑn.de.xun | [antɤɕyn] |
| Sassoon | → | sa.xun | [sɑɕyn] |
| | → | sha.xun | [ʂɑɕyn] |

The word-final /s/ in English is loaned 97% as /s/ in MC ($\chi^2$=105.3, *df*=1, *p*=.000). The examples are given in (4).

(4) Adaptation of the word-final /s/ in English in MC

| | | | |
|---|---|---|---|
| Alice | → | ai. li. si | [ailisɿ] |
| ounce | → | ang. si | [ɑŋsɿ] |

Likewise, the vowels following /s/ in English determine the loan sounds in MC. Decidedly, when the English fricative /s/ is followed by the high front vowel, it is likely loaned as the palatal /ɕ/ in MC. Overall, that suggests that when native phonotactic requirements make it impossible to maintain both vocalic and consonantal features of the English source words, vocalic feature is

7 MC /e/ has four allophones: [ɤ] is used after consonants or when used alone; [e] is used in 'ei' and 'ui (/uei/)'; [ɛ] in 'ie' and 'üe'; [ə] in 'en', 'eng', 'un (uen)' and 'ueng'.

maintained at the expense of change in consonantal quality. In other words, the sequence of /si/ is not allowed in MC and such a sequence in English is loaned as /ɕi/. Furthermore, it is shown that English /s/ is mapped to various sounds in MC when it is followed by a schwa. In particular, /s/ before the /ən/ or /əl/ sequence in English is mapped to /s/, /ɕ/ or /ʂ/, which suggests that vowels with unclear quality like a schwa induce ambiguous perception on the part of Chinese listeners. Likewise, it is noted that multiple mappings of English /s/ in MC occur when the cues of the following vowels alone are not perceptually enough to decide the loan sounds for English /s/.

### 3.2 Adaptation of English voiceless palato-alveolar fricative in MC

Table 4 and Figure 2 illustrate the number and percentage of the data for each loan sound which English /ʃ/ is mapped to in MC according to the following vowel, respectively.

Table 4. Adaptation variation (number of data) of English /ʃV/ in MC fricatives according to the following vowel

| Loan sound in MC / English /ʃV/ | /ʂ/ | /ɕ/ | /s/ | sum |
|---|---|---|---|---|
| V=[i] | 1 | 5 | 0 | 6 |
| V=schwa | 6 | 9 | 0 | 15 |
| V=neither [i] nor schwa | 7 | 17 | 0 | 24 |
| Sum | 14 | 31 | 0 | 45 |

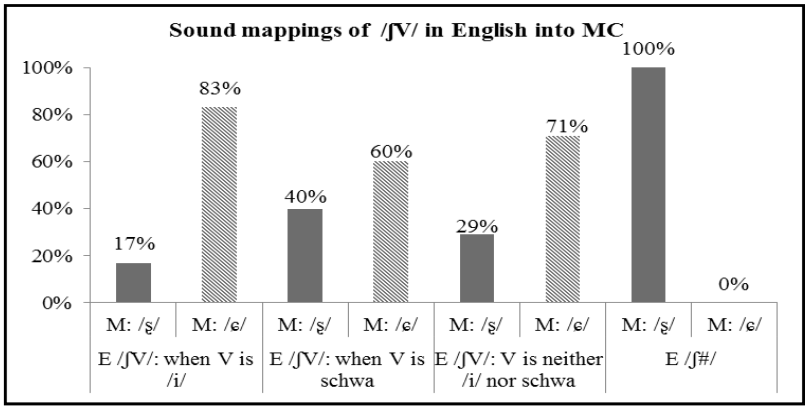


Figure 2: Adaptation variation (%) of English /ʃV/ in MC fricatives according to the following vowel

English /ʃ/ in the prevocalic position is mostly mapped to /ɕ/ in MC regardless of the quality of the following vowel as given in (5).

(5) Adaptation of the prevocalic /ʃ/ in English in MC

a. Before /i/

| | | | |
|---|---|---|---|
| Sinead | → | xi.nei.de | [ɕineitɤ] |
| Sheila | → | xi.la | [ɕilA] |

b. Before vowels other than /i/

| | | | |
|---|---|---|---|
| Shirley | → | xue.Li | [ɕyɛli] |
| Shannon | → | xiang.nong | [ɕiɑŋnuŋ] |
| patience | → | pei.xing.si | [p$^{h}$eiɕiŋsɿ] |

However, the word-final /ʃ/ in English is mapped to /ʂ/ as given in (6).

(6) Adaptation of the word-final /ʃ/ in English as /ʂ/ in MC

| | | | |
|---|---|---|---|
| Bush | → | bu.shi | [puʂɿ] |
| Mackintosh | → | mai.jin.tuo.shi | [maitɕint$^{h}$uoʂɿ] |

The results show that unlike English /s/, English prevocalic /ʃ/ is almost always loaned as /ɕ/ in MC (31 out of 45 data) ($\chi^2$=6.42, *df*=1, *p*=.011). The results are in line with Miao (2005) in that in Miao's study 8 out of 11 English prevocalic /ʃ/ are adapted to MC /ɕ/. In contrast, it is noted that the word-final /ʃ/ in English is always mapped to /ʂ/ in MC. No vowel follows the word-final /ʃ/ in English and the mapping of the fricative cannot be determined by vocalic cues. Instead, due to the similarity in spelling between English <sh> in 'Bush' and <sh> (/ʂ/) in MC Pinyin system, the word-final /ʃ/ in English could have been mapped to /ʂ/ in MC. That account suggests that orthography also plays a role in loanword adaptation.

### 3.3 Suprasegmental effect on the adaptation of English fricatives

Given that the loan sound for English /s/ is mostly determined by the segmental property of the following vowel, we now raise two questions

regarding the adaptation of English coronal fricatives into MC. First, does the suprasegmental property also affect the adaptation? Second, how is English /s/ in a cluster which is not followed by a vowel adapted into MC?

In order to answer these questions, we need to examine the adaptation of English /s/ in both the stressed and unstressed syllables. To be specific, we closely examine how English singleton /s/ in #sV (e.g. Sandy), Vs# (e.g. Alice), and VsV (e.g. Faso) and /s/ in a cluster in #sC (e.g. Spencer), VsC# (e.g. trust), and VsCV (e.g. Chester) are adapted in MC.

To begin with, we investigate whether English singleton /s/ is adapted differently between in the stressed and unstressed syllables in MC. Table 5 shows the number of the data for each loan sound which English singleton /s/ is mapped to in MC according to following vowel's stress.

Table 5. Adaptation variation (number of data) of English singleton /s/ in MC according to stress

| Stressed/Unstressed | Stressed (95) | | Unstressed (133) | |
|---|---|---|---|---|
| Loan sound in MC | /s/ | /ʂ, ɕ/ | /s/ | /ʂ, ɕ/ |
| Number of data | 64 | 31 | 94 | 39 |

Table 5 shows that the pattern of the loan sounds for English singleton /s/ is similar between the stressed and unstressed syllables. That suggests that stress does not affect the adaptation pattern of English singleton /s/ in MC. Figure 3 demonstrates the rate at which the singleton /s/ in stressed and unstressed syllables in English is adapted as each loan sound in MC.

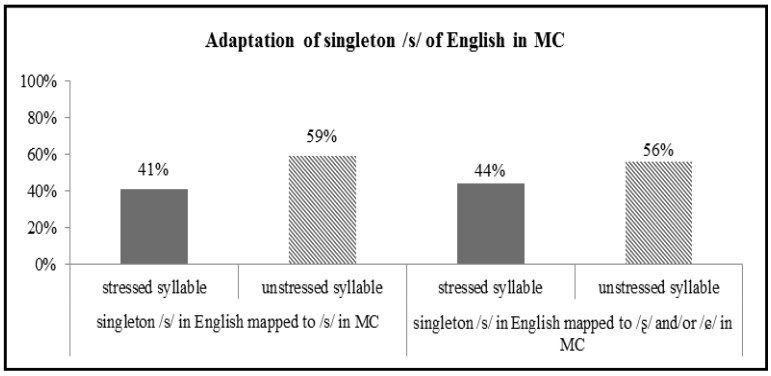


Figure 3. Adaptation variation (%) of English singleton /s/ in stressed and unstressed syllables in MC

Altogether, English singleton /s/ in the stressed syllable is 41% mapped to /s/ in MC and that in the unstressed syllable 59% mapped to /s/ in MC. Following this logic, the rate at which English singleton /s/ is adapted as /ʂ, ɕ/ is also similar to the rate at which it is adapted as /s/: English singleton /s/ in the stressed syllable 44% to /ʂ, ɕ/ and that in the unstressed syllable 56% to /ʂ, ɕ/ in MC. Likewise, it can be shown that the mapping rates between the English singleton /s/ to /s/ and the English singleton /s/ to other fricatives, /ʂ, ɕ/, in MC are almost the same regardless of whether the singleton /s/ in English belongs to a stressed or an unstressed syllable ($\chi^2$=.29, *df*=1, *p*=.593).

Next, we will examine whether English /s/ in a cluster is affected by stress of the following vowel in MC. The examples in (7) illustrate the adaptation of English /s/ in a cluster in MC.

(7) English MC

a. Scott /s/ → si.ke.te [sɿkʰɣtʰɣ]

→ shi.kɑo.te [ʂɻkʰɑutʰɣ]

b. Oscar /s/ → ao.si.ka [ɑusɿkʰA]

Broadly speaking, English /s/ in a cluster can be loaned either as /s/ or /ʂ/ when the sC-cluster belongs to a stressed syllable as in (7a) but as /s/ when it belongs to an unstressed syllable as in (7b). To test the possibility that stress in English affects the split mappings of English /s/ in a cluster in MC, we present Table 6 where the number of the data for each loan sound which English /s/ in a cluster is mapped to in MC according to following vowel's stress.

Table 6. Adaptation variation (number of data) of English /s/ in a cluster in MC according to following vowel's stress

| Stressed/Unstressed | Stressed (64) | | Unstressed (49) | |
|---|---|---|---|---|
| Loan sound in MC | /s/ | /ʂ, ɕ/ | /s/ | /ʂ, ɕ/ |
| Number of data | 38 | 26 | 47 | 2 |

Table 6 demonstrates that English /s/ in a cluster is loaned as either /s/ or /ʂ, ɕ/ about the same degree when it constitutes an onset of the stressed syllable, but it is not likely mapped to /ʂ, ɕ/ when it belongs to the unstressed

syllable.

Figure 4 shows the rate at which English /s/ in a cluster is adapted as each loan sound depending on whether it constitutes the onset of the stressed or the unstressed syllable.

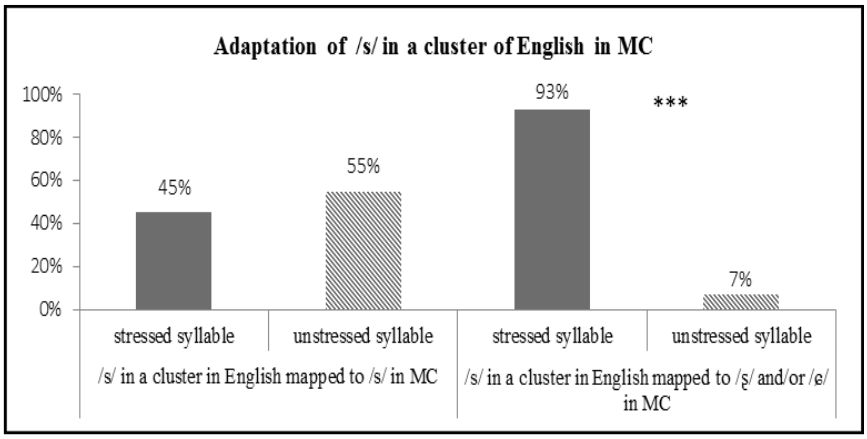


Figure 4. Adaptation variation (%) of English /s/ in a cluster in stressed and unstressed syllables in MC

To be sure, English /s/ in a cluster is 45% mapped to /s/ in MC when it lies in the stressed syllable and 55% when it is in the unstressed syllable. It shows that when English /s/ in a cluster is adapted as /s/ in MC, it does not matter whether it belongs to a stressed or an unstressed syllable ($\chi^2$=.333, $df$=1, $p$=.564). However, it is interesting to note that stress matters when English /s/ in a cluster is adapted as /ʂ/ or /ɕ/. When English /s/ in a cluster is loaned as /ʂ, ɕ/ in MC, 93% of the data occurs when it belongs to the stressed syllable ($\chi^2$=19.89, $df$=1, $p$=.000***).

To summarize, the two findings are apparent in Figures 3 and 4. First, stress does not influence the adaptation of the English singleton /s/ in MC, but the following vowel quality instead crucially affects the adaptation. Second, stress in English partially influences the adaptation of /s/ in a cluster since there is no vowel following /s/. It also in this case suggests that stress takes over the responsibility to account for the split mappings of English fricatives in MC, when the following segmental effect cannot be expected.

## 4. Discussion and conclusion

This paper investigated the adaptation of English voiceless fricatives /s/and /ʃ/ into MC, based on the data collected from dictionaries and Google searches. Four main results were found. First, the vowel effect on the adaptation of consonants was found. In this case, when English /s, ʃ/ are followed by the high front vowel /i/, both /s/ and /ʃ/ are found to be adapted as /ɕ/. It suggests that when the phonotactic constraints of the adapting language disallow a particular CV sequence, faithful mapping of the vowel takes precedence over faithful mapping of the consonants. As shown in section 2, /i/ cannot occur after /s/ but [ɿ] instead comes after it in MC. Given that a sequence of /si/ is not allowed in MC, the vowel /i/ after /s/ in English is preserved at the expense of place of articulation of /s/. In other words, the English fricative /s/ is mapped to MC /ɕ/. The result is in line with Yang and Oh's (2015) study about the adaptation of English stops into MC. They claim that the sound sequences of /ki/, /k$^{h}$i/ and /gi/ in English are adapted as /tɕi/ in MC. It suggests that faithfulness of vocalic information is more important than that of consonantal information when the corresponding sound sequence is not allowed in the borrowing language. Incidentally, we raised a question in Section 1 regarding whether the vocalic faithfulness still takes precedence over the consonantal faithfulness in loanword adaptation, when the consonantal feature like frication is perceptually salient. Markedly, the vowel effect in this study suggests that vocalic features are more salient than consonantal features in loanword adaptation.[8]

The second finding of this study is that when English /s/ is followed by a reduced vowel, it can be variably mapped to /s/, /ɕ/ or /ʂ/ in MC. This result suggests that when the following vowel quality is not salient enough, the adaptation of English /s/ cannot be determined by the following vowel and English /s/ is likely mapped to various loan sounds in MC. Further, a schwa

8 Bond (1999) investigated vowel perception errors in English casual speech involving vowel height, tenseness and frontness, showing that errors distribute unevenly between front vowels and other vowels (i.e. central and back vowels). He found that front vowels are more likely to be misperceived. However, this study shows that the front vowels are salient enough to be perceived in loanword adaptation.

/ə/ can be mapped to various vowels, such as /i/, /a/ and /u/, etc. For instance, Lin (2009) claims that faithful vowel mapping depends on perceptual saliency. In addition, that being said, given that the reduced vowels are perceptually weaker than the stressed vowels, such variable mappings of the unstressed vowel can be explained. In fact, this finding can also be supported by Keyser and Stevens (2006) who investigate the properties of /ən/ sequence. They found that when producing words like 'lesson', the release of consonant /s/ is overlapped with the /ə/, which causes the lowering of the soft palate back to the fricative /s/ during the /ə/. As a result, the intraoral pressure for /s/ goes down to zero abruptly, and the tongue is closed. This process makes a nasal consonant to be produced right after the frication for /s/. And to be sure, the tongue is never fully released for /s/. The result and conclusion made in this study support Daland et al.'s (2015) claim that orthography contributes more to the adaptation of unstressed vowels, while perception contributes more to the adaptation of stressed vowels. Thus, the adaptation of schwa provides another piece of evidence that the quality of the following vowel determines the mapping of the consonants. The second result of this study indicates that variable mappings of the source sound occurs, when acoustic cues of the input are weak and there are competing parses of the input.

The third finding of this study is that the adaptation of English voiceless palato-alveolar fricative into MC is determined by the property of the fricative itself. English /ʃ/ is [-back] and the adaptation of /ʃ/ to /ɕ/ is to be faithful to the frontness property of /ʃ/.

The final finding of this study is that stress in English exerts an influence on the mapping of English fricative /s/ in a cluster as opposed to English prevocalic singleton /s/. The sC-cluster has been analyzed as a complex segment (Broselow 1992) and has been discussed a lot with reference to L1 and L2 acquisition and loanword phonology (Barlow 2001; Gouskova 2004; Goad 2012; Enochson 2014; Jang 2016). Barlow (2001) claims that the sC sequence is connected to some higher prosodic word level. Beckman (1997) claims that stress exerts influence on the phonological processes in that segments display stronger resistance to certain phonological processes in stressed syllables than those in unstressed syllables. Miao (2005) also argues that stress should be taken into account in loanword adaptation, since consonants in stressed syllables which

stand in a perceptually salient position are less likely to be deleted than those in unstressed syllables. In this study, we have shown that stress plays a crucial role in mapping English /s/ in a cluster to /ɕ/ or /ʂ/ in MC. That is to say, in this case /s/ in a cluster is more likely perceived as /ɕ/ or /ʂ/ in MC when it belongs to the stressed syllable in English. Likewise, stress influences the listener's perception of English /s/ when vocalic information is no longer available. This finding also lends evidence in understanding of the complexity of sC-cluster.

The most compelling information is that the results of this study shed light on the issue regarding how much information of the input is referred to in loanword adaptation. Few-to-many mappings between /s, ʃ/ in English to /s, ʂ, ɕ/ in MC are in favor of the perceptual view (Silverman 1992) as opposed to the phonological view (LaCharité and Paradis 2005) on loanword adaptation. Decidedly, it is shown that English /s/ is not uniformly borrowed as a single loan sound in MC, but it is rather mapped to multiple loan sounds depending on the following vowel quality and stress of the syllable containing /s/. Further, the rate of the variable mappings of English /s/ in MC is higher when the following vowel is a schwa than it is a full vowel. Likewise, it is noted that loan adaptation is not local in that the adaptation of consonants refers to not simply the consonants of interest, but also adjacent vocalic information and suprasegmental information.

In summary, this paper showed that the perceptual view is supported by the roles of both external and suprasegmental cues, that are seen in mappings of the coronal fricatives from English to MC. However, there are still other factors that need to be explored. English /s/ spelled in <ss> is loaned as /ʂ/ instead of the general candidate /s/ in MC when followed by a reduced vowel. To be specific, /s/ spelled in <ss> in English, e.g., Alyssa, Venessa, Melissa, Tessa, is mapped to /ʂ-/ in MC although it is expected to be loaned as /s/ in MC. To be sure, orthographic information may influence the way how the adaptation occurs (Daland et al. 2015). Chang (2020) also argues for the role of orthography in loanword adaptation in MC. We leave more detailed investigation of the orthographic factor in loan adaptation to further study.

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**Hui Yang**
Lecturer
English Department
Qingdao University of Science and Technology
99, Songling Road, Laoshan District,
Qingdao, 266061, China
E-mail: yanghui@qust.edu.cn

**Mira Oh**
Professor
Dept. of English Language and Literature
Chonnam National University
300 Yongbong-ro, Buk-gu,
Gwangju, 500-757, South Korea
E-mail: mroh@chonnam.ac.kr

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