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Adaptation of English stops into Mandarin Chinese*

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Hui, Yang and Mira Oh. 2015. Adaptation of English stops into Mandarin Chinese. *Linguistic Research* 32(2), 403-417. This study investigates the adaptation of English stops into Mandarin Chinese. English stops have a binary [±voice] contrast, whereas Mandarin Chinese stops are distinguished by aspiration. A corpus study based on 720 English loanwords shows that English voiced stops are mapped to the unaspirated stops in Mandarin Chinese while English voiceless stops are mapped to the aspirated stops in Mandarin Chinese, regardless of whether the English stops are aspirated or unaspirated. This finding is in favor of the phonological view on loanword adaptation in that phonemic contrast in the source language is maintained through one-to-one mapping between the source sounds and the loan sounds. However, the English bilabial aspirated stop [p^h] is mapped to either the aspirated or unaspirated bilabial stop in Mandarin Chinese. Further, the English velar stop before a high front vowel is mapped to the Mandarin Chinese affricate. Such mappings differ from the general pattern and can be explained by perceptual similarity based on VOT between the source sounds and the loan sounds. We draw a conclusion that both faithful phonological contrast and perceptual similarity work together for the adaptation of English stops into Mandarin Chinese. **(Qingdao University of Science and Technology · Chonnam National University)**

Keywords loanword adaptation, phonological view, perceptual view, English stops, stops in Mandarin Chinese

1. Introduction

Loanword adaptation reflects the interaction between phonetics and phonology from the source and the borrowing languages. Borrowers attempt to preserve as much phonetic and phonological information from the source language as possible while satisfying the phonotactic constraints in the borrowing language. There are two

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views on the extent to which phonological and phonetic information plays a role in loanword adaptation. LaCharité and Paradis (2005) argue that transfer of L1 patterns of phonological feature distinctions plays a fundamental role. For example, English /b/ is adapted as Spanish /b/ despite being acoustically closer to Spanish /p/. Although the VOT values of English voiced stops /b, d, g/ are around 0~30 ms, which is similar to those of Spanish voiceless stops /p, t, k/, the /b/ in the English word *bar [baɹ] is adapted* as /b/ in Spanish, i.e., [baɾ] rather than *[paɾ] (Lacharité & Paradis 2005). In contrast, the perceptual view contends that the sounds of the source word are mapped to the perceptually similar loan sounds in the borrowing language (Peperkamp and Dupoux 2003; Kim 1999; Silverman 1992; Boersma and Hamann 2009). According to the perceptual view, the listeners' perception of relative phonetic similarity between sounds in the source and borrowing languages is usually determined by their acoustic and articulatory similarity (Kim 1999; Kang 2003).

Hseih et al. (2009) analyzed the adaptation of English coda nasals into Mandarin Chinese (MC). In MC, the fronted vowel /a/ comes before the dental nasal /n/, whereas the velar nasal /ŋ/ combines with the preceding back vowel /ɑ/. Thus, when the sequence of a back vowel and a dental nasal in English is adapted to MC, the dental nasal is loaned as the velar nasal in order to preserve the quality of the back vowel in the source language, e.g., E. *ounce* [aun] → MC. *ang.si* [ɑŋ]. On the other hand, an English velar nasal appearing after a front vowel is mapped to the alveolar nasal, e.g., E. *Angora* [æŋ] → MC. *an.ge.la* [an]. Yang and Oh (2014) also found that the phonotactic constraint in MC plays a decisive role in loanword adaptation in that while the voiceless alveolar fricative /s/ in English is generally mapped to /s/ in MC, it is mapped to /ɕ/ when followed by /i/, since the sequence */si/ is not allowed in MC. Likewise, the same sound in the source language can be mapped to multiple sounds in the borrowing language depending on the vowel context, which is in favor of the perceptual view on loanword adaptation.

Conversely, the adaptation of English stops in MC loanwords supports the phonological view. English stops are mapped to the aspirated stops in MC, regardless of whether they are realized as aspirated or unaspirated, e.g., E. *pie* → MC. *pai* [pʰai], E. *Scott* → MC. *si. ke. te* [sɿ. kʰɤ. tʰɤ] (Miao 2005; Paradis and Tremblay 2009). The adaptation of English stops in Korean loanwords also exhibits a similar pattern in that both aspirated and unaspirated stops in English are uniformly mapped to the aspirated stops in Korean, e.g., E. *pie* → K. *파이* [pʰai], E. spy →

K. 스파이 [sɨpʰai] (Oh 1996; Ahn and Lee 2008; Shinohara 2008).

However, Lin (2009) reported variable adaptation of English unaspirated stops into MC, e.g., E. *Scotland* → MC. *su. ge. lan* [su kɤ lan] vs. E. *Scott* → *si. ke. te* [sɿ kʰau tʰɤ]).[1] Likewise, the adaptation of English stops into MC still requires more investigation regarding whether it totally supports the phonological view. Furthermore, Paradis and Tremblay's (2009) study on the adaptation of English stops into MC was based on 500 data points taken from only 77 loanwords. The size of the data studied in Lin's and Miao's research was also small. In this paper, we will present some of the results of a corpus study of loanwords in MC. We analyze a corpus of 720 English loanwords in MC. By doing so, we investigate how English stops with voicing contrast are mapped to stops with aspiration contrast in MC, and how the sound sequences in English which are not allowed in MC are loaned into MC.

The current study is structured as follows. Section 2 presents the phonotactic constraints in English and MC relevant to the current study on the adaptation of English stops into MC. Section 3 consists of three subsections. The first subsection presents the general pattern of the adaptation of English stops in MC by conducting a corpus study on the way in which MC accommodates the English binary voiceless-voiced opposition of stops. The second demonstrates that disproportionate adaptation of the English bilabial voiceless aspirated stop as the unaspirated /p/ in MC is in favor of the perceptual view. In the third subsection, adaptation of the English velar stops before a high front vowel as an unaspirated alveopalatal affricate in MC is examined. The final section presents the multiple factors at play in loanword adaptation and concludes the discussion.

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1 Mandarin Chinese has five vowel phonemes: high [i y u]; mid [ə]; and low [a] (Duanmu 2007). [ɤ] is a variant of mid vowel [ə] which occurs in open syllables, but not after a labial or a palatal. High vowel /i/ has three allophones depending on the preceding consonant (Duanmu 2007, Zhu 2010): [i] (palatal), [ɿ] (alveolar), and [ʅ] (retroflex). [ɿ] occurs after the alveolar fricative /s/ and [ʅ] occurs after the retroflex /ʂ/, whereas [i] occurs after palatal /ɕ/ and other consonants.

2. Phonotactic constraints of English and Mandarin Chinese

English allows consonant clusters in the onset and coda, e.g., /str/ in 'street', /kt/ in 'fact'. In contrast, MC has the maximum syllable structure of (CG)V(X) (C: consonant, G: glide, V: vowel or syllabic consonant, X: V, [n], [ŋ] or [ɹ]), e.g., 林lin /lin/ 'forest', 冷leng /ləŋ/ 'cold', 儿er /əɹ/ 'son'.

English stops are contrastive in voicing. Voiced stops /b, d, g/ are unaspirated, but voiceless stops /p, t, k/ can be realized as either the aspirated [pʰ, tʰ, kʰ] or unaspirated [p, t, k], e.g., 'top' [tʰap] vs. 'stop' [stap]. While stops in MC are voiceless, they are distinguished by aspiration: aspirated /pʰ, tʰ, kʰ/ and unaspirated /p, t, k/, e.g., *ba* [pà] 'father' vs. *pa* [pʰà] 'fear'. Table 1 illustrates the obstruents in MC.

Table 1. Obstruents in Mandarin Chinese

Obstruents	Aspiration	Voicing	Labials	Dentals	Palatals	Retroflexes	Velars
Stops	unaspirated	voiceless	p	t			k
	aspirated	voiceless	pʰ	tʰ			kʰ
Affricates	unaspirated	voiceless		ts	tɕ	tʂ	
	aspirated	voiceless		tsʰ	tɕʰ	tʂʰ	
Fricatives		voiceless	f	s	ɕ	ʂ	

In addition, English allows the sequence of /ki, gi/ as in 'key' and 'gear'. In contrast, neither sequence is allowed in MC.

3. Corpus experiment

A total of 942 data points out of 720 loanwords whose source words in English contain voiced stops /b, d, g/ or voiceless stops /p, t, k/ were analyzed. For example, the initial sound [tʰ] in English 'ton' was taken as one data point or a token. Loanwords were collected from 3 different corpora: Loanwords in the dictionary (Oxford Learner's English – Chinese Dictionary, 2009), Xiandai Hanyu Cidian (Modern Chinese Dictionary, 2009) and loanwords found through Google search (March 2014-May 2014). They consisted of common first names, last names, place names, medicine names, common words and brand names, excluding abbreviations, acronyms and chemical terminology. The current study focuses on the loanwords based on sound-to-sound mapping. The online Oxford and Collins dictionaries were referenced to ensure correct pronunciation.

3.1 General pattern of the adaptation of English stops into MC

English voiced unaspirated stops are consistently mapped to the voiceless unaspirated stops in MC, as illustrated in Table 2.

Table 2. The number of tokens where English voiced unaspirated stops /b/, /d/, /g/ are loaned into aspirated and unaspirated stops in MC

English stops	MC asp. stops	MC unasp. stops	Sum
b	0	152	152
d	1	216	217
g	0	59	59
Sum	1	427	428

The adaptation of English voiced stops into MC unaspirated stops can be accounted for by either the phonological view or the perceptual view. According to the phonological view, English voiced stops are expected to be mapped to unaspirated stops in MC to maintain phonological voicing contrast in English, given that voiceless stops in English are loaned as aspirated stops in MC.

The perceptual view can also explain the mapping between English voiced stops and MC unaspirated stops based on acoustic similarity. The VOT values of MC voiceless unaspirated stops are around 9~30 ms (Shimizu 2011; Shinohara 2011; Zhao and Meng 1997), which is similar to those of English voiced stops, 0~30 ms (Lisker and Abramson 1964; Klatt 1975; Oh and Daland 2011). Therefore, the adaptation of English voiced stops into MC voiceless unaspirated stops can be attributed to their VOT similarity.

Unlike English voiced stops, however, English voiceless stops surface as two allophones which differ in aspiration. English voiceless stops are aspirated in the stressed syllable-initial position (Katamba 1989) but unaspirated in the unstressed syllable-initial position after the sound /s/ (Rogers 2000; Kahn 1976) or at the syllable-final position (Hansen 2001). Table 3 shows the VOTs of English and MC stops.

Table 3. Mean VOT values of English and MC stops (AE: American English, BE: British English)

VOT of English stops (ms)

Studies \ English stops	[b]	[d]	[g]	[pʰ]	[tʰ]	[kʰ]	[p]	[t]	[k]
Lisker and Abramson (1964, AE)	1	5	21	58	70	80			
Klatt (1975, AE)	11	17	27	47	65	70	12	23	30
Docherty (1992, BE)	15	21	27	42	64	62			
Shinohara et al. (2011, AE)	12.9	1.9	3.0	49.7	59	71			
Yang (2011, AE)	17	20	32	77	95	88	16	25	29

VOT of Chinese stops (ms)

Studies \ MC stops	[pʰ]	[tʰ]	[kʰ]	[p]	[t]	[k]
Shinohara et al. (2011)	97.5	93.5	95.9	11.9	12	26.2
Zhao and Meng (1997)	67	74	75	13	9	21

As shown in Table 3a, the VOT values of English voiceless unaspirated stops are much shorter than those of English voiceless aspirated stops, and are rather similar to those of the English voiced stops. The VOT values of MC voiceless unaspirated stops are much shorter than those of MC aspirated stops, and are similar to the voiceless unaspirated stops in English. Then, under the perceptual view on loanword adaptation, English voiceless aspirated stops and unaspirated stops are expected to be mapped to MC voiceless aspirated and unaspirated stops, respectively. However, the examples in (1) in fact show that this is not necessarily the case in practice.

(1) Adaptation of English voiceless aspirated and unaspirated stops into MC (Stops of interest are underlined.)[2]

a. Stressed syllable-initial position

pound [pɑŋ] puff [pʰɑu fu]

[2] English voiceless stops in the syllable-final position are all adapted as the aspirated stop in MC, e.g. trust [tʰuo sɿ tʰɤ], Philip [fei li pʰu].

Paul [pɑu luo] poker [p^hu k^hɤ]

b. Unstressed syllable-initial position

Peru [pi lu] Patricia [p^hĄ tɤ li ɕia]

c. Post-/s/ position

Austin [ɑu sɿ tiŋ] asprin [Ą sɿ p^hi lin]

Kirsty [k^hɤ sɿ ti] springs [sɿ p^hu lin sɿ]

The analysis of the data summarized in Table 4 shows that English voiceless aspirated stops were mostly adapted as MC aspirated stops (χ^2=44.88, *df*=1, *p*=.000) as expected. Interestingly, however, despite the VOT similarity between English voiceless unaspirated stops and MC voiceless unaspirated stops, most English voiceless unaspirated stops were also loaned as MC aspirated stops (χ^2=49.60, *df*=1, *p*=.000).

Table 4. The number of tokens where English voiceless stops were loaned into MC aspirated and unaspirated stops

English stops	MC asp. stops	MC unasp. stops	Sum	*p-value*
Voiceless aspirated	156	58	214	*p*=.000*
Voiceless unaspirated	193	76	269	*p*=.000*

The results show that English voiceless stops are generally mapped to aspirated stops in MC regardless of whether they are aspirated or not, which is in line with Miao (2005) and Paradis and Tremblay (2009). This suggests that the adaptation of English voiceless stops in MC loanwords is in favor of the phonological account.

4. The adaptation of English /p/ into MC

We demonstrated above that English voiceless and voiced stops are generally mapped to aspirated stops and unaspirated stops in MC, respectively. However, close examination of the data according to the place of articulation of the stops revealed that adaptation of the English bilabial voiceless stop shows substantial variation, with almost half of the tokens adapted as unaspirated: 56% of English voiceless aspirated [p^h] was mapped to the aspirated stop [p^h] in MC but 44% mapped to unaspirated stop [p]. No statistical significance between the mapping of English [p^h] to MC [p^h] and to [p] was found (χ^2=.69, *df*=1, *p*=.405). On the other hand, 75% of English voiceless aspirated [t^h] was mapped to MC aspirated stops [t^h], with only 25% mapped to unaspirated stops [t] (χ^2=16.00, *df*=1, *p*=.000). In addition, 81% of English voiceless aspirated [k^h] was to MC aspirated stops [k^h], with 19% loaned to unaspirated stops [k] (χ^2=36.74, *df*=1, *p*=.000). In other words, English [p^h] tended to be adapted either as aspirated [p^h] or unaspirated [p] in MC to about the same degree, while English aspirated [t^h] and [k^h] were mostly mapped to MC aspirated stops. The results are summarized in Table 5.

Table 5. The number of tokens where English voiceless stops are loaned into aspirated and unaspirated stops in MC according to the place of articulation

English stops		MC asp. stops	MC unasp. stops	Sum	*p-value*
Voiceless aspirated	p^h	29(56%)	23(44%)	52	p=.405
	t^h	48(75%)	16(25%)	64	*p*=.000*
	k^h	79(81%)	19(19%)	98	*p*=.000*
Voiceless unaspirated	p	27(67%)	13(33%)	40	*p*=.027*
	t	84(61%)	54(39%)	138	*p*=.011*
	k	82(90%)	9(10%)	91	*p*=.000*

VOT values increase in the order of /p/ < /t/ < /k/ in English (Davidsen-Nielsen 1974; Klatt 1975). Analysis of the data points demonstrated that the rate of adaptation of English voiceless stops as aspirated stops in MC is positively correlated with the increase of VOT, according to the place of articulation, as shown in Figure 1.

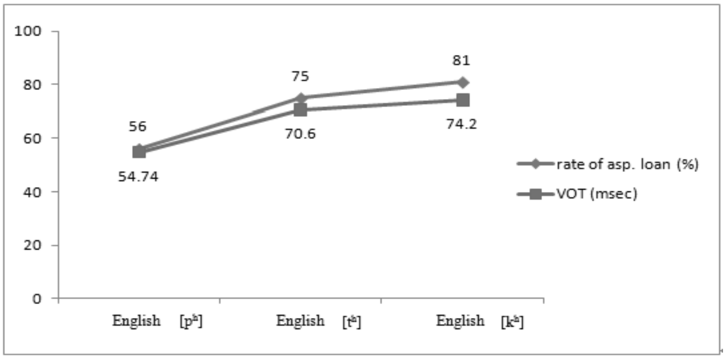

Figure 1. Rate of adapting English voiceless stops as MC aspirated stops and the VOT of English stops according to the place of articulation (VOT values of English stops were taken by averaging the values from Lisker and Abramson 1964; Klatt 1975; Docherty 1992; Shinohara et al. 2011; Yang 2011.)

A question arises as to why only the English [p^h] allows variable adaptation in MC. The comparison between the VOT values of English stops and MC stops given in Table 3 provides one possible answer to the asymmetrical pattern between the adaptation of English [p^h] and that of English [t^h] and [k^h] in MC. The VOT values of [p^h] are much shorter than those of [t^h] and [k^h] in English, but the VOT values of [p^h] do not differ much from those of [t^h] and [k^h] in MC. The study of Shinohara et al. (2011), however, presented rather longer VOT values of [p^h] than those of [t^h] and [k^h] in MC as given in Table 3. Such VOT values of the MC stops are supported by Zhu's (2010) finding that MC stops are made at a more fronted position than English stops. Given this fact, if English [p^h] were mapped to MC [p^h], there would be a larger acoustic difference in the VOT values between English [p^h] and MC [p^h] compared to those between English [t^h, k^h] and MC [t^h, k^h]. When hearing the English sound [p^h], Chinese listeners may not be certain about the identity of the sound since the English [p^h] is produced with such a shorter VOT compared to the [p^h] in MC. This uncertainty may cause them to be unsure of the exact quality of the sound. Therefore, English [p^h] could be perceived either as [p^h] or [p] by MC listeners. Consequently, the disproportionate adaptation of the English bilabial voiceless aspirated stop as the unaspirated /p/ in MC compared to the English non-labial voiceless aspirated stops seems to support the view that borrowers are sensitive to the acoustic features, which differ across places of articulation between the source and borrowing languages.

5. The adaptation of English velar stops before a high front vowel as an affricate in MC

In section 3.1, we showed that English velar stops are mapped to velar stops in MC. However, the examples in (2) show that they are instead mapped to the alveopalatal affricate in MC when followed by a high front vowel.

(2) Adaptation of English velar stops before a high front vowel as alveopalatal affricate in MC

English		MC
kit	→	ji te /tɕi t^hɤ/
guitar	→	ji ta /tɕi t^hA/

Table 6 illustrates the number of tokens where the English velar stops were loaned into velar or alveopalatal plosives in MC.

Table 6. Number of data points where English velar stops before a high front vowel were loaned as MC plosives

MC loan sound / English sound	k^h	k	$tɕ^h$	tɕ	$tɕ^h$/ tɕ	Sum
[k^hi] or [k^hɪ]	0	1	0	9	0	10
[ki] or [kɪ]	3	0	1	16	1	21
[gi] or [gɪ]	0	3	0	4	0	7
Sum	3	4	1	29	1	38

English voiceless aspirated [k^h], unaspirated [k], and voiced unaspirated [g] before a high front vowel are mapped to the MC affricate [tɕ], as shown in Table 6 (29 out of 38 cases, χ^2=17.89, *df*=1, *p*=.000). The sequences of /ti/, /pi/, /di/ and /bi/ are possible, but neither /ki/ nor /gi/ is allowed in MC. Furthermore, the velar stops in /ki/ and /gi/ are fronted before a high front vowel in English (Katamba

1989). Then, both the phonotactic constraint disallowing the sequence of a velar stop and a high front vowel in MC and the realization of the English velar stop before a high front vowel as a fronted velar stop conspire to trigger the adaptation of the English velar stops as affricates in MC.

In addition to the adaptation of English velar stops as affricates in MC, another interesting point needs to be mentioned. English voiceless velar stops are mostly mapped to MC voiceless *unaspirated* affricate [tɕ] as opposed to the *aspirated* one [$tɕ^h$], contrary to the general pattern of English stop adaptation wherein English voiceless stops are loaned as MC *aspirated* stops. According to Iwata (1976), the VOT of the MC voiceless aspirated affricate [$tɕ^h$] is 140 ms, while that of MC unaspirated affricate [tɕ] is 50 ms. It is obvious that the VOT of the MC aspirated affricate is too long to be mapped to the English voiceless aspirated velar stop. In other words, the English voiceless aspirated velar stop is perceived as the MC unaspirated affricate due to higher acoustic similarity of the VOT values between the English voiceless aspirated velar stop and the MC unaspirated affricate than between the English voiceless aspirated velar stop and the MC aspirated affricate. In such a way, the account based on the VOT similarity between source sounds and the corresponding loan sounds again supports the perceptual view on loanword adaptation.

6. Conclusion

The present study investigated the adaptation of English stops into MC by conducting a corpus experiment. Three main results were found. First, English voiceless and voiced stops are mapped to the aspirated and unaspirated stops in MC, respectively. Such one-to-one mapping between English stops and MC stops can be accounted for by the phonological view. Under the phonological view, this can be interpreted as a way to maintain the phonological contrast between the sounds in the source and borrowing languages. Second, the English voiceless bilabial stop [p^h] exhibits a different pattern in loanword adaptation from the stops with other places of articulation. It can be mapped to either the MC aspirated bilabial stop [p^h] or the unaspirated bilabial stop [p], at about the same degree. Perceptual uncertainty due to the large difference in VOT between the English [p^h] and MC [p^h] gives rise to the variable adaptation of English [p^h] into either the MC aspirated or unaspirated stop. Third, English velar stops followed by a high front vowel are adapted as the MC affricate [tɕ]. Faithful mapping to the phonetic output in English and the phonotactic constraint in MC disallowing the sequence of a velar stop and a high front vowel work together to get such mapping. Furthermore, the adaptation of English velar stops followed by a high front vowel as the MC unaspirated affricate [tɕ] indicates that difference in VOT between the source sounds and the loan sounds again functions in loanword adaptation.

The general pattern in the adaptation of English stops into MC is in favor of the phonological view. However, close examination of the data revealed that one-to-one mapping cannot be totally held due to phonetic differences such as VOT values between the source sound and the loan sound. To be specific, the English bilabial aspirated stop [p^h] can be mapped to either MC [p^h] or [p], and the English voiceless velar stop before a high front vowel is not loaned as the MC aspirated affricate but as the MC unaspirated affricate. Furthermore, phonemic mapping maintaining the phonological contrast cannot be made due to phonotactic constraints in the borrowing language. For example, the English velar stop before a high front vowel is not loaned as the MC velar stop, but as the MC affricate, due to the phonotactic constraint disallowing the sequence of a velar stop and a high front vowel in MC. These examples attest that multiple factors such as perceptual similarity and the phonological patterns of the borrowing language are at play in assigning loan sounds to source sounds.

We have shown that both phonetic and phonological information from the source and the borrowing languages constitute important factors in determining loan sounds in loanword adaptation. However, how and when faithful phonological contrast and faithful perceptual similarity interact in loanword adaptation still needs to be investigated in more detail. We assumed that MC stops are made in a more fronted position than English stops, following Zhu (2010). However, we leave an articulatory study to verify this assumption for further study.

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