

Phonetic and phonological adaptation of loanwords: Mandarin falling diphthongs in Chinese Korean*

Abstract This study examines how Mandarin falling sonority diphthongs are adapted to a dialect of Chinese Korean. It investigates how the subtle phonetic conditions of the source language affects adaptation, and if and how those phonetic effects differ in established loanwords compared to on-line adaptation of novel loan forms. We found that in this bilingual population, while the Mandarin diphthongs are usually adapted as monophthongs, obeying the native phonological restriction against falling diphthongs, also quite common is the retention of the input diphthongs in violation of the native constraint. In addition, we found that the choice of monophthong vs. diphthong realization is strongly affected by the input phonetic duration, and that in particular, the durational difference among the different tones is robustly reflected in adaptation patterns.

Keywords: phonetic and phonological adaptation; loanwords; Mandarin falling diphthongs; Chinese Korean; tones

1 Introduction

When foreign words are borrowed into a language, they often undergo transformations in order to comply with the phonological constraints of the borrowing language. A relevant example comes from Standard Seoul Korean, which does not have diphthongs with a falling sonority. When Mandarin (MA) words with falling diphthongs /ai, au, ei, ou/ are borrowed into Standard Korean (SK), the diphthongs are generally adapted as a heterosyllabic vowel sequence as in MA *mao2 ze2 dong1* [máu tsá tōŋ], ‘Mao Zedong’¹ > SK [ma.o.ts*ʌ.tuŋ]. The current study examines how these Mandarin diphthongs are adapted in Chinese Korean (CK), the variety of Korean spoken by the ethnic Koreans living in China, where the level of community and individual bilingualism is high.

To anticipate the results of our study, we find that Chinese Korean also adapts the Mandarin diphthong to avoid illicit falling diphthongs, but the repair of choice is monophthongization through vowel coalescence, in which two segments of a Mandarin diphthong coalesce into a monophthong, as in MA *zao3*

* Acknowledgements suppressed for anonymous review

¹ In this paper, we use the pinyin tone diacritics to indicate tones in the phonetic representation and use the tone numbers in Pinyin instead of the diacritics for readability.

can1 [tsǎu ts^hān] ‘breakfast’ > CK /ts*o.ts^han/. That is, the Mandarin diphthong /au/ is replaced with Chinese Korean monophthong /o/. More interestingly, we also observe that the Mandarin diphthongs are frequently retained as diphthongs in Chinese Korean, as in MA tao3 mei2 [t^hǎu méi] ‘bad luck’ > CK [t*o.mei]. In this study, we examine how bilingual Chinese Korean speakers produce Mandarin loans with original falling diphthongs and how they adapt novel loans.

This study has two goals. The first is to examine the role of input language phonetics in adaptation (e.g., Silverman 1992; Yip 1993; Kenstowicz 2003; Y. Kang 2003). In particular, we explore how the phonetic duration of Mandarin input vowels affects adaptation. We hypothesize that the longer the duration of the input vowel is, the higher the rate of diphthongal adaptation would be. In other words, if the adaptation is sensitive to the input duration, we expect a higher rate of diphthongal adaptation in phonological contexts where the vowels are longer. To test our hypothesis, we consider a number of phonetic factors such as the Mandarin tone of the input diphthongs (Tone 1 ~ Tone 4), the target syllable position within the word (initial vs. final), and the interaction between the two. Previous studies found that Mandarin tones systematically differ in duration, in which Tone 3 is the longest and Tone 4 is the shortest (Xu 1997; Serno et al. 2015; Wu & Kenstowicz 2015). We predict that the longer the tones are, the higher the rate of diphthongal adaptation would be. In terms of the word position, since syllables are lengthened in word-final position in Mandarin (Barnes 2006; Chen 2006), we expect that diphthongal adaptations are more likely to appear in final syllable than in word-initial syllable. Finally, we look at the interaction between tone and word position. We predict that tone effects depend on the word-position, because Tone 3 is known to shorten substantially in non-final position in Mandarin (Xu 1997; Yip 2002; Wu & Kenstowicz 2015).

Second, we compare the adaptation patterns between established loanwords and on-line adaptation of Mandarin words. Investigating online adaptations has an advantage in that we can examine the speaker’s productive knowledge of cross-language mapping. Established loanwords are reflections of speakers’ lexical knowledge, which is in turn the result of the accumulation of collective history of adaptation and subsequent revisions at the community level. Thus, they may contain idiosyncrasies and historical remnants of archaic patterns that are no longer productive. Online adaptation, on the other hand, reveals speakers’ productive knowledge regarding the cross-language correspondence in action. This knowledge may draw from the generalizations of the existing lexicon (Simonovic 2017) but may not necessarily be isomorphic to them. In particular, we are interested in whether and how bilingual speakers accurately internalize the effects of subtle phonetic details in established loans and productively extend them to online loanword adaptation.

The paper is organized as follows. Section 2 reviews previous studies on loanword phonology. In Section 3, we present the background of the minority Koreans living in northeast China. This section also gives a brief overview of Mandarin and Chinese Korean phonology. Section 4 and 5 show methods and

results of Experiment 1 and Experiment 2, respectively. Experiment 1 explores whether there are durational differences among the four tones across diphthongs produced by monolingual native speakers of Mandarin. Experiment 2 examines how bilingual Chinese Korean speakers produce established Mandarin loanwords which are frequently used in Chinese Korean, and also how they adapt novel loanwords in an on-line adaptation task. Section 6 discusses several issues that arise from the present analysis. Section 7 concludes the paper.

2 Previous studies of loanword phonology

There are two different views on the role of input language phonetics in loanword phonology: the phonological stance model (Paradis & LaCharité 1997; LaCharité & Paradis 2005; Paradis & Tremblay 2009) and the perceptual stance models (Silverman 1992; Yip 1993; Kenstowicz 2003; Y. Kang 2003; Peperkamp et al. 2008; Boersma & Hamann 2009).

Paradis & LaCharité (1997) proposed that loanword adaptation is inherently phonological and borrowers are bilinguals who have access to the phonology of both the source and borrowing language. Based on 12 large corpora of English and French loanwords in several different languages, they argue that a phonological transformation, rather than phonetic approximation, is the principal mechanism of loanword adaptation. For instance, when English loanwords are adapted into French, English /b/ is preserved as /b/, despite the phonetic differences that make it acoustically closer to French /p/, because in both languages, /b/ is phonologically represented with the same feature combination, that of a voiced labial stop. In other words, if a given L2 phonological category (i.e., feature combination) does not exist in L1, this L2 category will be replaced by the closest phonological category in L1, even if the L1 inventory contains an acoustically closer alternative (Paradis & LaCharité 1997; LaCharité & Paradis 2000).

According to the perceptual models of adaptation, on the other hand, loanword adaptation is sensitive to the subphonemic phonetic information of the input structure (Silverman 1992; Kenstowicz 2003; Boersma & Hamann 2009; Peperkamp et al. 2008). While differing in the specific mechanisms by which the phonetic information affects the adaptation, they agree that non-contrastive phonetic details of the input and the borrowing language may affect the adaptation. For instance, Y. Kang (2003) examined variable vowel adaptations of English postvocalic word-final stops in Korean. Korean stops are obligatorily unreleased when they are in word-final position. She observed that word-final stops in English are more frequently released after a tense vowel than after a lax vowel, and that vowel epenthesis is more likely to appear in Korean loanwords when the pre-final vowel in the English source words is tense. For example, the English word *stick* with lax vowel is adapted as [sɪ.tʰɪk] while the English word *mic(rophone)* with a tense vowel is realized as [ma.i.kʰɪ] in Korean.

She argued that the motivation for vowel insertion in this position is to increase the perceptual similarity between the English input and the Korean output.

Hsieh et al (2005)'s investigation of the adaptation of English coda nasal in Mandarin Chinese presents an example where the perceptual similarity, rather than the phonological contrastiveness determine the adaptation pattern. In Mandarin, the coda nasal place distinction between /n/ and /ŋ/ is contrastive and conditions the allophonic variation between front and back low vowels ([a] vs. [ɑ]). Hsieh et al (2005) examined the adaptation of coda nasals preceded by a low vowel in English and found that the choice between [n] and [ŋ] is determined by the front vs. back nature of the preceding vowel in the English source words, rather than the place of articulation of nasal (e.g., *clan* [klæn] > MA [ke.lan] vs. *crown* [kɹaʊn] > MA [ke.laŋ]). In the vowel + nasal sequences, the vowel, which is phonetically more salient, has an impact on the realization of adaptation. This is the case despite the fact that coda nasal place distinction is contrastive in Mandarin while the backness of low vowels is a non-contrastive allophonic distinction in Mandarin. They therefore concluded that phonetic salience is a significant factor in loanword adaptation that can outweigh a phonologically contrastive feature of the borrowing language. In this study, we will present the results of Chinese Korean loanword adaptation and examine how the phonetic duration of the Mandarin vowel, which is not contrastive in Mandarin or Korean affect the adaptation patterns.

3 Backgrounds

3.1 Ethnic Korean population in China

Koreans are the thirteenth largest ethnic minority in China, with a total of roughly 1.9 million people. Most live in northeast China, particularly, the Yanbian Korean Autonomous Prefecture, with the rest residing in Inner Mongolia and large cities such as Beijing, Shanghai and Qingdao (Jin 2008). The majority of ethnic Koreans living in China today are descendants of immigrants who migrated from Korea between the mid 19th century and the mid 20th century. The current work focuses on Mandarin loanwords spoken by Chinese Korean bilinguals living in Dandong, a city in the Liaoning Province of China, on the border between China and North Korea. Dandong has a Korean population of around 20,000 (Cui 2011). The majority of ethnic Koreans in China are bilingual, but the dominant language is shifting from Korean to Mandarin in many communities in China (Choi 2001; Jin 2008; Han 2011, 2014). In particular, Schertz et al. (2017) found that younger speakers in Dandong use Korean less, and consider themselves to be less proficient in Korean than in Mandarin, while older speakers are dominant in Korean and have relatively low Mandarin proficiency.

3.2 Chinese Korean vowels

Chinese Korean is a branch of Korean, spoken by ethnic Koreans residing in China. According to Jin (2008), Chinese Korean has a vowel system similar to Standard Korean spoken in Seoul, except that it retains some of the contrasts that are being lost in Standard Korean. The vowel system of Korean has ten monophthongs, as provided in Table 1. In most South Korean dialects of Korean, the contrasts between the low and mid front vowels ([e] vs. [ɛ]) are lost and the front rounded vowels are realized as a diphthong ([wi] or [we]) (H. Kang 1997; Yoon et al. 2015). In contrast, Chinese Korean, in particular, the variety spoken in Dandong, retains the [e] vs. [ɛ] contrast and the front rounded vowel [y] (Jin 2008; Kang et al. 2015, 2016).

	Front unrounded	Front rounded	Back unrounded	Back rounded
High	i	(y)	ɨ	u
Mid	e	(ø)	ʌ	o
Low	(ɛ)		ɑ	

Table 1: Inventory of Korean monophthongs (Adapted from Lee & Ramsey 2011).

As for diphthongs, there are ten diphthongs in Standard Korean, nine on-glide diphthongs and one off-glide diphthong, as presented in Table 2. Standard Korean has no falling diphthongs, except for /ij/ with a questionable status (H. Kang 1997; Ahn & Iverson 2007). This diphthong is a remnant of a system of j-final diphthongs from Late Middle Korean, which subsequently monophthongized to create the front vowel series in Modern Korean, as in ʌj > e, aj > ɛ, uj > y, and oj > ø (Lee & Ramsey 2011). The status of off-glide diphthongs in Chinese Korean is less clear and the archaic diphthongal pronunciation long lost in Standard Korean is reported in some words as in [kaj]~[kɛ] ‘dog’ and [kʌj]~[ke] ‘crab’ (Jin 2008).

On-glide diphthongs				Off-glide diphthongs		
-	-	ju	wi	-	-	(ij)
je	jʌ	jo	we	wʌ	-	
(jɛ)	ja		(wɛ)	wa		

Table 2: Diphthongs in Standard Korean (Adapted from Shin et al. 2013: 109).

3.3 Mandarin vowels and tones

According to most analyses (Cheng 1973; Duanmu 2000; Lin 2007), Mandarin has five phonemic vowels /i, y, ə, u, a/, as seen in Table 3. There are four falling sonority diphthongs /ai, ei, au, ou/ in Mandarin. Examples are provided in (1). The off-glides of the diphthongs usually fall short of the high vowel position of [i] and [u] in actual articulation. Specifically, [i] in a diphthong can become [ɪ] or [e] in fast speech while [u] in a diphthong can become [ʊ] or [o], depending on the speaker and the speech rate.

	Front	Front	Central	Back
High	i	y		u
Mid			ə	
Low	a			

Table 3: Vowel inventory of Mandarin (Lin 2007: 82).

(1) Examples of Mandarin diphthongs (Lin 2007: 68)

	IPA	Pinyin	Gloss		IPA	Pinyin	Gloss
/ai/	[khāi]	kai1	'to open'	/au/	[kāu]	gao1	'high'
/ei/	[pēi]	bei1	'cup'	/ou/	[tōu]	dou1	'all'

The smallest structure of the Mandarin syllable is composed of a single nucleus (V), and the largest consists of four segments (CGVX). Only the vowels /i, u/ (as part of the falling diphthongs) and the nasal consonants /n, ŋ/ can appear in the coda position of a Mandarin syllable.

Tone is a distinctive feature in Mandarin phonology. There are four lexical tones: T1 is realized as a high tone, T2 as a mid-rising tone, T3 as a falling-rising tone and T4 as a high-falling tone (Chao 1968; Duanmu 2000; Yip 2002; Lin 2007). Examples of the contrasting tones and their pitch contours are presented in Table 4.

Tone	Pitch contour	Chao numbers	Example	Pinyin	Gloss
Tone 1	High-Level	55	妈	mā	'mother'
Tone 2	Mid-rising	35	嘛	má	'hemp'
Tone 3	Falling-rising	214	马	mǎ	'horse'
Tone 4	High-falling	51	骂	mà	'scold'

Table 4: Examples of tonal contrast in Mandarin.

Mandarin tones systematically differ in terms of duration as well. Specifically, Tone 3 is consistently of longer duration than the other three tones in monosyllabic words (Xu 1997). Tonal contours undergo certain variations

conditioned by adjacent tones (Chao 1968; Howie 1972; Yang 2015). Tone 3 is the most complicated tone in the Mandarin tonal system and a Tone 3 syllable simplifies to a Tone 2 syllable when it is followed by another Tone 3 syllable, a process known as Tone 3 Sandhi. In other words, the initial syllable of Mandarin bisyllabic words is Tone 3 underlyingly but becomes Tone 2 on the surface, as in 你好 /nǐ hǎo/ (T3-T3)→ [ní hǎo] (T2-T3), ‘hello’. The main empirical question of the current study is to examine if and how the durational difference across the tones affect the adaptation of Mandarin diphthongs in Chinese Korean.

4 Experiment 1: Mandarin diphthong production

Several studies have demonstrated that there is a durational difference in tone based on Mandarin monophthongs (Xu 1997; Sereno et al. 2015; Wu & Kenstowicz 2015). However, relatively little is known about the tonal duration of the Mandarin diphthongs /ai, au, ei, ou/. In Experiment 1, we tested whether there are significant durational differences among the four tones across Mandarin diphthongs.

4.1 Methods

4.1.1 Participants

Eight monolingual native speakers of Mandarin (4 females, 4 males), living in Dandong, China participated in the production experiment. They range in age from 23 to 62 years old, with an average age of 43 years.

4.1.2 Stimuli

The stimuli consisted of 16 real monosyllabic Mandarin words, which are minimal quadruplets contrasting by tone (See Appendix A). The stimuli were produced in isolation with each of the four tones.

4.1.3 Procedure

The Mandarin stimuli were presented on a computer screen in Chinese characters in a random order. Subjects were asked to read the 16 Mandarin words twice at a normal rate of speech. They were recorded in a quiet location in Dandong, using an AT831B microphone and a Zoom H4n digital recorder. The speech was recorded at a sampling rate of 44kHz. Two participants produced only one repetition of /ei/ words, resulting in a total of 248 tokens (16 words *

2 repetitions * 8 speakers – 8 missing tokens) of the four diphthongs /ai, au, ei, ou/.

4.1.4 Statistical analysis

For the statistical analysis, we used a linear mixed-effects model with the *lme4* package (Bates et al. 2015) in R. For significance tests and post-hoc comparisons, the packages *lmerTest* (Kuznetsova et al. 2013) and *phia* (Helios et al. 2015) were used, respectively.

4.2 Results

There are significant durational differences between tones in Mandarin diphthongs, as presented in Table 5. The post-hoc comparisons show that all tones are significantly different from one another ($p < 0.001$), with the exception of Tone 1 versus Tone 2 ($p = 0.8593$).

	Estimate	Std. Error	t-value	p-value
(Intercept)	0.3559	0.0145	24.478	< 0.0001 ***
Tone 2	0.0038	0.0210	0.179	0.8626
Tone 3	0.0718	0.0198	3.618	0.0082 **
Tone 4	-0.0796	0.0198	-4.014	0.0041 **

Significance codes: < 0.001 '***', <0.01 '**', <0.05 '*', <0.1 '.'

Table 5: Results of a linear mixed-effects regression of Mandarin tone duration.

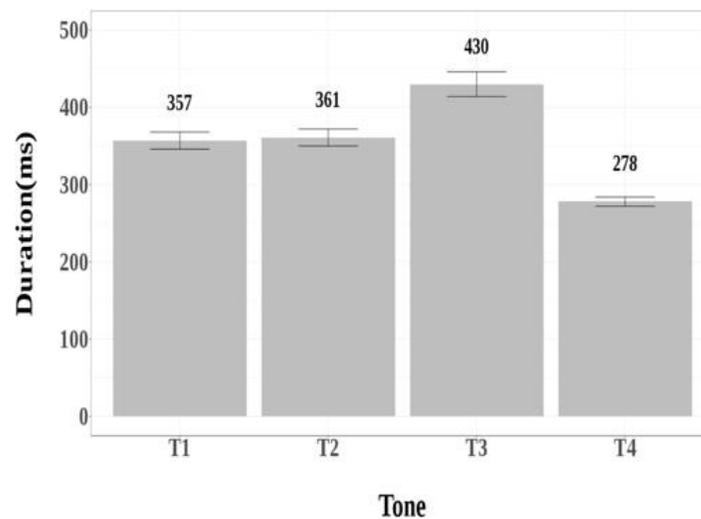


Figure 1: Average duration of Mandarin diphthongs by tone. Error bars are 95% confidence intervals.

As Figure 1 illustrates, Tone 4 diphthongs are the shortest, while Tone 3 diphthongs are the longest. We found no significant difference in duration between Tone 1 and Tone 2. These findings are consistent with previous results on the duration of monophthongs (Xu 1997; Sereno et al. 2015; Wu & Kenstowicz 2015). With this background, we now turn to our main study on the realization of Mandarin diphthongs in loanwords.

5 Experiment 2: Mandarin established loanwords and online loanwords adaptation

There are two ways Mandarin falling diphthongs are realized in loanwords in Chinese Korean: monophthongs and diphthongs. Examples of these two patterns are given in (2) and (3), respectively. The examples in (2) illustrate how Mandarin diphthongs are realized as monophthongs in Chinese Korean, through coalescence or vowel deletion (cf. Casali 1996). The back glide diphthongs /au, ou/ are realized as /o/ and the front glide diphthongs /ai, ei/ are adapted as /ɛ/ and /e/, respectively. The examples in (3) show that Mandarin falling diphthongs are also frequently retained in the loans.

(2) Monophthongal realizations

Adaptation	Mandarin	Pinyin	Korean	Gloss
/ai/ → /ɛ/	代购	dai4gou4	/t*ɛ.ko/	'generation gap'
/au/ → /o/	号码	hao4ma3	/ho.ma/	'phone number'
/ei/ → /e/	煤气	mei2qi4	/mɛ.tsi/	'gas'
/ou/ → /o/	手机	shou3ji1	/s*o.tsi/	'cell phone'

(3) Diphthongal realizations

Adaptation	Mandarin	Pinyin	Korean	Gloss
/ai/ → /ai/	下载	xia4zai3	/sia.tsai/	'download'
/au/ → /ao/ ²	雪糕	xue3gao1	/swe.k*ao/	'ice cream'

² According to Lin (2007), the Mandarin /au/ can become [aʊ] or [ao] in which the second segment becomes lower in height, depending on the speakers and their speech rate in actual articulation. Moreover, for /au/, the pinyin system uses 'ao' instead of 'au'. As several researchers suggested (Smith, 2006; Vendelin & Peperkamp, 2006; Paradis & Lacharité, 2008),

/ei/ → /ei/	倒霉	dao3mei2	/t*o.mei/	‘bad luck’
/ou/ → /ou/	采购	cai3gou4	/ts ^h ai.k*ou/	‘purchase’

Experiment 2 investigated how bilingual Chinese Korean speakers produce Mandarin loanwords in two different tasks: the production of 1) established loanwords and 2) online adaptation of novel loanwords. By examining adaptation patterns in the two tasks, we can see to what extent the input phonetic duration affects the adaptation of diphthongs in existing loanwords and if and how the duration effects are productively extended to novel adaptations. In particular, we explored how the phonetic duration of Mandarin input vowels affects the adaptation patterns. We hypothesized that the longer the duration of the input is, the higher the rate of diphthongal adaptation would be. In other words, if the adaptation is sensitive to the duration of the phonetic input, we expect a higher rate of diphthongal adaptation in phonological contexts where the vowels are longer. Specifically, we examined the effect of Mandarin tone with their varied duration, the position of the target syllable within the word (initial vs. final) and the interaction between the two. We already saw from Experiment 1 that, in Mandarin, tones affect the duration of diphthongs substantially. We predicted that the longer the tones are, the higher the rate of diphthongal adaptation would be. In terms of the word position, we expected that diphthongal adaptations are more likely to appear in final than initial position, since syllables are lengthened in final position in Mandarin (Barnes 2006; Chen 2006). We also examined the interaction between tone and word position. Since Tone 3 shortens in non-final position in Mandarin (Xu 1994; Yip 2002; Wu & Kenstowicz 2015), we predicted that the effect of tone on adaptation will differ by the position.

5.1 Method

5.1.1 Participants

Seven native speakers of Chinese Korean who reside in Dandong, China (three males, four females, age range: 26-69 years old) participated in the experiment. They were all born, raised and educated in China, speak both Korean and Mandarin, and consider Korean as their native language. No subjects reported any difficulties in speech or hearing. Participant information is summarized in Table 6. The participants provided self-assessments of proficiency in Korean and Mandarin and they all rated themselves highly proficient (4-5) in both

orthography might play a role in the adaptation process. Given the acoustic variability of the diphthong and the fact that the adapters are exposed to the pinyin system, adaptation of /au/ as /ao/ is not unexpected.

languages. Also, as part of a larger study, the participants also produced a list of Mandarin words, which were rated for accentedness by a native speaker of Mandarin³. The two oldest speakers were rated slightly more accented in their Mandarin compared to the younger speakers.

ID	Gender	Age	Self-assessed Korean proficiency	Self-assessed Mandarin proficiency	Mandarin accentedness (segmental)	Mandarin accentedness (tone)
P1	F	69	5	5	3.5	3.5
P2	M	69	5	4	3.5	3.5
P3	M	43	5	4	4	4
P4	F	41	4	4	4	4.5
P5	M	31	4	4	4	4.5
P6	F	30	4	4	4	4
P7	F	26	4	4	4.5	4.5

Table 6: Participant information for the loanword production experiment. Proficiency and accentedness ratings are on a scale from 1 (no knowledge/heavily accented) to 5 (perfectly fluent/native-like).

5.1.2 Stimuli

The stimuli for established loanword production consisted of 128 Mandarin words which are commonly used as loan forms in Chinese Korean. The words were chosen based on the loanword list of Ito & Kenstowicz's (2009a) and in consultation with a native speaker of Chinese Korean. The 128 words included 47 instances of target diphthongs /ai, au, ei, ou/ occurring with one of the four tones (drawn from 41 words, since some words have more than one diphthong)⁴. The distribution of diphthongs by tone and position is summarized in Table 7. a. Note that it was not possible to balance the distribution of diphthongs across conditions as the selection is limited by available loanwords. For the online adaptation task, the stimuli consisted of 91 disyllabic Mandarin words which are not commonly used as loan forms in Chinese Korean.⁵ They are balanced in terms of the number of different diphthong types (/ai, ei, ai, ou/), the tone (Tone 1 ~ Tone 4), and the syllable position (initial vs. final syllable) of the target diphthong, as summarized in Table 7.b. The full lists of stimuli are provided in the Appendices B (established loans) and C (online adaptation). The Mandarin

³ The authors would like to thank Luo, Yun Yun for providing the accentedness ratings.

⁴ One additional diphthong occurs with a neutral tone, which is not included in the analysis.

⁵ Thank XXX for help with selecting stimuli for the on-line task.

words and instructions were recorded by a male native speaker of Chinese Korean in his early 20s who also has a native fluency in Mandarin as spoken in Northern China.

Diphthong	(a) Established loans								(b) Online adaptation							
	Initial				Final				Initial				Final			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
/ai/	1	2	2	5	0	0	1	2	9	3	3	6	3	4	4	5
/au/	3	3	4	5	3	0	2	3	5	4	4	4	4	2	3	4
/ei/	0	1	0	0	1	1	0	1	4	2	3	6	2	1	2	4
/ou/	0	1	1	0	0	1	0	4	4	3	3	4	3	4	4	5

Table 7: Distribution of target diphthongs by tone and position: (a) established loans; (b) online adaptation.

Sometimes speakers produced two different variants for the same word; in these cases, the variants were counted as two separate tokens. A total of 337 tokens (47 diphthongs x 7 speakers + 7 variants) were analyzed for the established loans and a total of 861 tokens (121 diphthongs x 7 speakers + 14 variants) were analyzed for the online adaptation task.

5.1.3 Procedure

The loanword recording sessions took place in a quiet hotel room in Dandong and each session lasted approximately 30 minutes. Both written and oral instructions were provided to ensure that participants fully understood the task. The Mandarin stimuli were presented to the participants aurally along with the Chinese characters on a screen via Microsoft PowerPoint, and the speakers produced appropriate Korean forms embedded in contextually appropriate Korean carrier sentences twice. For example, a participant would hear the Mandarin target word [çiàtsài] ('download'), they would see the target word in Mandarin orthography '下载' and a carrier sentence in Korean orthography 'tten-no-e-seo ___ hae-la' ('Do ___ on the computer.'), as shown in Figure 2. They would then be asked to repeat the target word in its Korean form, embedded in the carrier sentence, twice. During the experiment, the subjects could listen to the Mandarin stimuli as many times as they wanted before producing their response. They were asked to produce the sentences aloud at a normal speaking rate, and their speech was recorded with a Zoom H4n recorder and an AT831B microphone. The speech was recorded at a sampling rate of 44kHz.

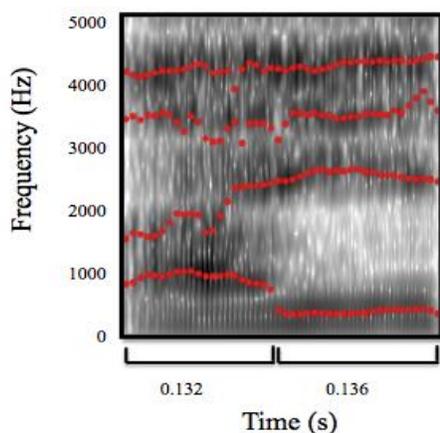


Figure 2: A sample screen display of Mandarin target word and the Korean carrier sentence.

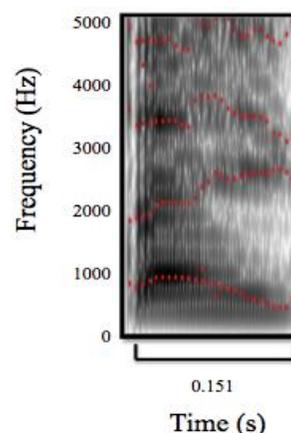
5.1.4 Transcription

The recordings were manually transcribed by the first author, a native speaker of Korean with knowledge of Mandarin. The transcriptions were later verified by a male native Korean speaker who has knowledge of Mandarin for a reliability check. There was approximately 90 percent inter-transcriber agreement as to whether the target diphthong was realized as a monophthong or a diphthong in the Korean form, the main question of interest in our study. For the cases of disagreement, the first author rechecked the data and made a decision based on the visual inspection of the formant movement.

Another question that arises in transcription is whether a non-monophthongal realization is in fact a true diphthong or a heterosyllabic vowel sequence. The intuition of native speakers of Chinese Korean is fairly clear and these sequences are true diphthongs in Chinese Korean (Personal communication: Professor Oh, Sung-Ae) and contrast with bisyllabic vowel sequences.



(a) [a.i] in /a.i/ 'baby'



(b) [ai] in /tsʰäi.kou/ 'purchase'

Figure 3: (a) A spectrogram of heterosyllabic [a.i] in a native Korean word /a.i/ ‘baby’ and (b) a spectrogram of diphthongal [ai] in a loanword from Mandarin /tsʰǎi.kòu/ 采购 ‘purchase’ by P7.

While anecdotal, the speech samples produced by the participant P7 illustrate the acoustic difference between diphthongal and heterosyllabic vowel sequences in Chinese Korean. The diphthong [ai] in a loanform of Mandarin /tsʰǎi.kòu/ ‘purchase’ is much shorter than the total duration of the native Korean vowel sequence /a.i/: 151ms for the Mandarin loanword and 268ms for the native Korean word.

5.1.5 Statistical Analysis

For the statistical analysis, we used a logistic mixed-effects model with the *lme4* package (Bates et al. 2015) in R. For post-hoc comparisons, *phia* (Helios et al. 2015) was used. The dependent variable was the binary choice of diphthongal (=1) vs. monophthongal (=0) realization of target Mandarin diphthongs. The fixed effects predictors included Tone (Tone 1or2, Tone 3, and Tone 4), Position (Initial vs. final syllable), Task (Established loans vs. Online adaptation), and their interactions. Tone is coded as a three-level predictor with Tone 1 and Tone 2 combined into one level based on the findings of Experiment 1 that these two tones do not differ significantly in duration. An exploratory analysis found that the adaptation patterns also differ by the diphthong type and as such, we included Diphthong Type (front /ai, ei/ vs. back /au, ou/) as a control predictor. Sum contrast coding was used for all predictors. As for interaction terms, the interaction of Tone * Position was included to test if the variation in tone duration by position is mirrored in adaptation. Recall that tone 3 syllables are longer than other syllables in final position but the tone 3 shortens in non-final position (Xu 1994; Yip 2002; Wu & Kenstowicz 2015), neutralizing the tonal effect on duration. Therefore, we expect that the tone effect will be different depending on whether the syllable is in final or non-final position. The two-way interactions of Task * Tone and Task * Position were included to test if the effects of tone and position attested in established loans are productively extended to online adaptation. The random effects included a random intercept for item and a random intercept and full random slopes for speaker.

5.2 Results

5.2.1 Overview

The distribution of the adaptation patterns across the two datasets (established loans and online adaptations) is presented in Figure 4, which shows that the

monophthongal adaptation is the majority pattern in both datasets. Specifically, the Mandarin diphthongs are monophthongized 79% and 75% of the time in the established loanwords and online adaptations, respectively; the remaining 21% and 25% retain the source language diphthongs.

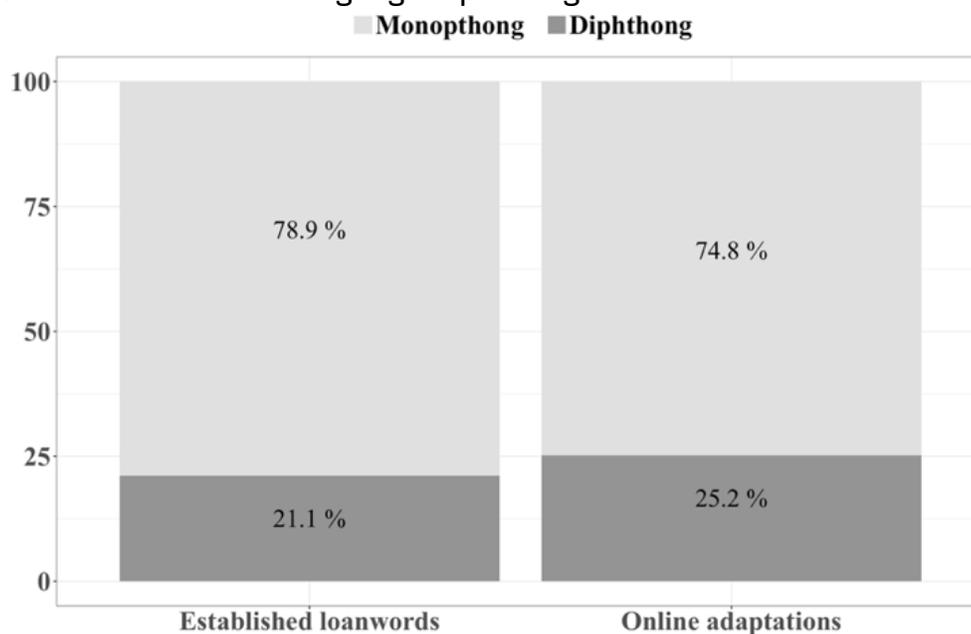


Figure 4: Distribution of two adaptation patterns of Mandarin Diphthongs in Chinese Korean.

Recall from section 3.2 that the status of falling diphthongs in Korean phonology is marginal at best. Three of the diphthongs under consideration, /au, ei, ou/, are not attested in native Korean words at all, and /ai/ is marginally available as an archaic variant pronunciation of a front vowel in Chinese Korean (e.g., /kai/ ~ /kɛ/ ‘dog’). The fact that these diphthongs are monophthongized frequently in adaptation is also suggestive of the illicit status of these diphthongs in native phonology. Diphthongal realizations may be considered a case of importation, not unexpected in this bilingual community with a high degree of individual- and community-level bilingualism (Haugen 1950; Poplack et al. 1988; Paradis & LaCharité 2008).

With this overview as a background, we now turn to the effects of phonetic duration on adaptation and examine the effects of Mandarin tone, word position, and their interaction in adaptation. Table 8 summarizes the output of the logistic regression model.

	Estimate	Std. Error	z-value	p-value
(Intercept)	2.6465	0.8390	3.154	0.0016 **
TASK (online vs. <u>established</u>)	1.2652	0.9035	1.400	0.1614

POSITION (final vs. <u>initial</u>)	-1.3477	0.6060	-2.224	0.0262 *
TONE (tone 4 vs. <u>tone 3</u>)	2.2377	0.8278	2.703	0.0069 **
TONE (tone 1&2 vs. <u>tone 3</u>)	0.6807	0.6730	1.011	0.3118
DIPHTHONGTYPE (back vs. <u>front</u>)	-4.7248	0.6727	-7.023	< 0.0001 ***
TASK (online) * POSITION (final)	1.8747	1.1226	1.670	0.0949
POSITION (final) * TONE (tone 4)	0.3200	1.3699	0.234	0.8153
POSITION (final) * TONE (tone 1&2)	-0.1090	1.2778	-0.085	0.9320
TASK (online) * TONE (tone 4)	-0.6337	1.3804	-0.459	0.6462
TASK (online) * TONE (tone 1&2)	0.6763	1.2969	0.521	0.6020

Significance codes: < 0.001 '***', <0.01 '**', <0.05 '*', <0.1 '.'

Table 8: Summary of the output of the logistic mixed effects models. The reference level of each predictor variable is underlined. The predictors are sum-contrast coded.

5.2.2 Tone

The proportion of diphthongal adaptation by Mandarin tone in the two tasks is shown in Figure 5. There is a significant main effect of Tone in loanword adaptation. Pairwise comparisons show that Mandarin diphthongs with Tone 3, the longest tone, are more likely to be realized as diphthongs in Chinese Korean than those with Tone 4, the shortest tone ($p = 0.0069$), and Tone 1&2 also induce significantly more diphthongs than Tone 4 ($p = 0.0417$). The difference between Tone 3 and Tone 1&2 is in the expected direction (i.e., more diphthongal realizations for Tone 3 than Tone 1&2), but this did not reach statistical significance ($p = 0.3118$). This finding supports the hypothesis that adapters are sensitive to the input phonetic duration in adaptation. In other words, Chinese Korean bilingual speakers can perceive the different phonetic durations of tones and this acoustic information affects the adaptation of diphthongs. We found no significant interaction of Tone and Task ($p > 0.1$), indicating that the tonal effects hold in both established loanwords and the online adaptation of novel loans.

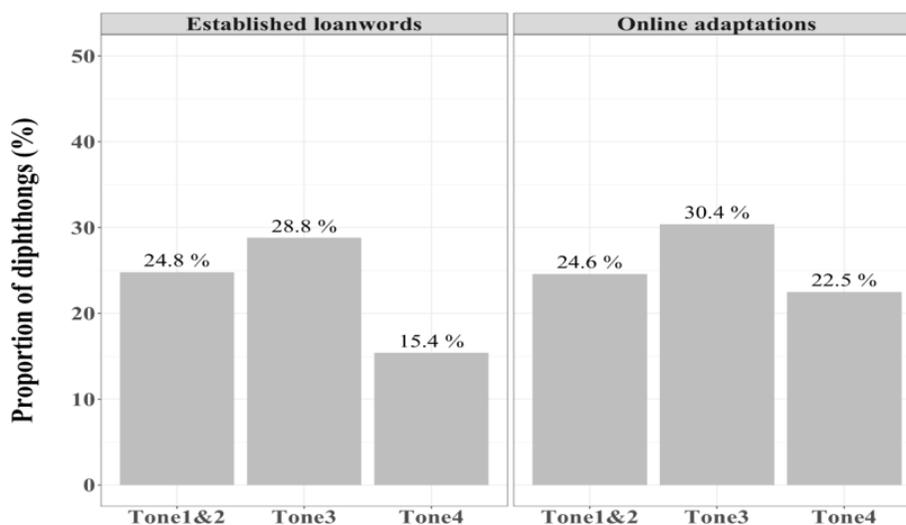


Figure 5: Proportion of diphthongal adaptation by tone and experimental task.

5.2.3 Word position

We now turn to the effects of word position. Word-final lengthening is a cross-linguistically common phenomenon (Barnes 2006) and the process also applies in Mandarin. Chen (2006) found that final lengthening exists in Mandarin disyllabic words. If adaptation of diphthongs is sensitive to the phonetic duration of the input vowel, we expect to find a positional asymmetry in adaptation. In established loans, diphthongal adaptation is more likely when the vowel occurs in a word-final syllable compared to a non-final syllable, as shown in Figure 6. This difference can be attributed to the longer duration of vowels in final than non-final syllables in Mandarin. The position effect, however, does not hold in the online adaptation. Statistical tests confirm this observation. There is a main effect of Position in adaptation ($p = 0.0267$) and the interaction of Position and Task is marginally significant ($p = 0.0949$). Post-hoc tests show that the Position effects hold for established loans ($p = 0.0200$) but not for online adaptation ($p = 0.5166$).

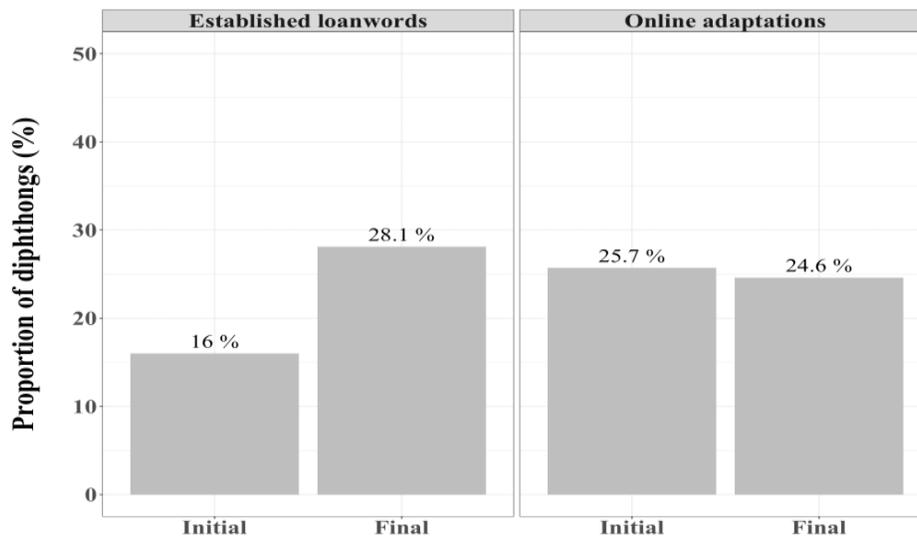


Figure 6: Proportion of diphthongal adaptation by word position and experimental task.

This discrepancy between the two tasks may stem from the difference in the stimuli characteristics used in the experiments. There was a trend of durational differences in the expected direction for the established loans, with vowels in the final syllable showing an overall longer duration than in the initial syllable, while on-line stimuli did not show that difference. However, when the stimuli duration was added as a control predictor to the adaptation model, the interaction of Position * Task still remained significant, suggesting that there may be a difference between the online adaptation and the established loans that is not explained by the stimuli duration alone⁶.

While we remain cautious in interpreting these findings, such a discrepancy between the established loans and online adaptation, if more robustly evidenced, would suggest that established loanwords and online adaptation reflect different aspects of speakers' knowledge regarding loanwords. Established loanwords are reflections of speakers' lexical knowledge, which is in turn the result of accumulation of collective history of adaptation and subsequent revisions at the community level, and therefore may contain idiosyncrasies and historical remnants of archaic patterns that no longer hold productive. Online adaptation, on the other hand, reveals speakers' productive knowledge regarding the cross-language correspondence in action. This productive knowledge may itself draw from the generalizations of the existing lexicon, without necessarily being isomorphic to them. Bilingual adapters may internalize the cross-language correspondence pattern, abstracting away from the context-dependent phonetic variation of the input.

⁶ The full model with duration added as additional predictor did not converge. The model converged when non-significant interactions (TONE * POSITION and TONE * TASK) and all random slopes were removed from the model.

Recall from section 5.2.2, however, that the effect of tone duration in established loanwords is mirrored in the on-line adaptation pattern as well. In other words, online adaptation selectively projects the effect of phonetic duration conditioned by lexical tones but not by word position. This suggests that the productive generalization in speakers draw from the lexicon may be based on tones, a phonological category of Mandarin, rather than directly on the duration. In other words, the origin of the tone effect may have been the phonetic durational difference but the generalization speakers acquire is one about tones, not about phonetic duration. However, again, this finding needs further verification through further experimentation with stimuli that are controlled for duration across tasks.

5.2.4 Interaction of tone and word position

We found that there are significant effects of tone and word position in diphthongal adaptation, especially in the established loans. We now examine how the effect of tone on adaptation interacts with the word position. As Tone 3 is substantially shortened to a level comparable to other tones in non-final position in Mandarin, if adaptation is sensitive to this tone-by-position interaction in phonetic duration, we predict the same interaction to hold in diphthongal adaptation rate. Figure 7 shows the breakdown of diphthongal importation rates, separate for tones, positions, and tasks.

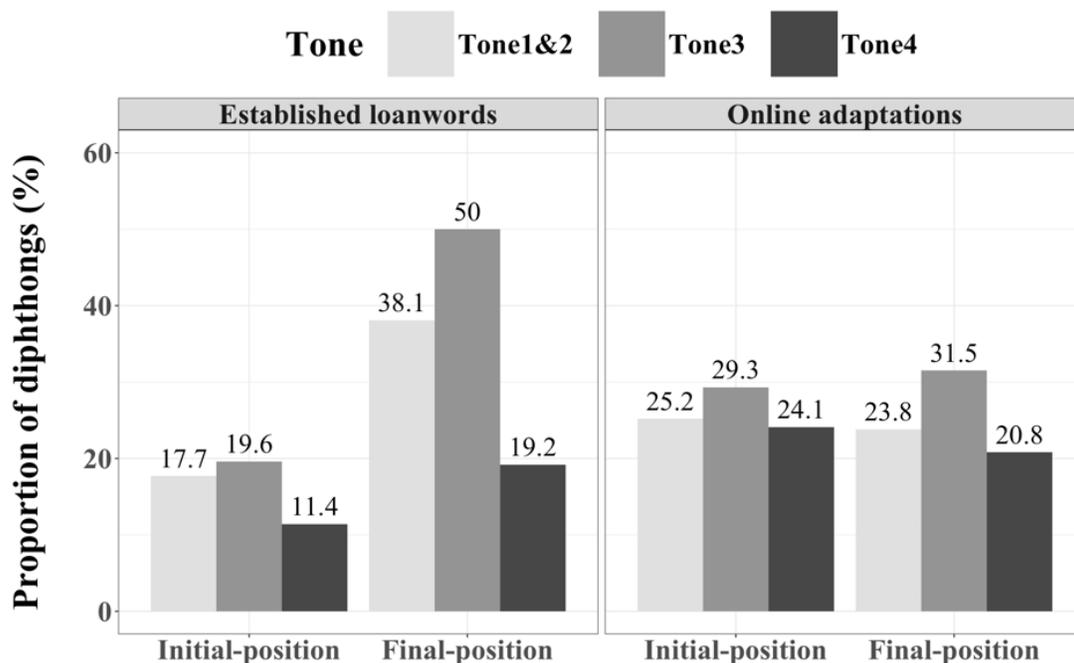


Figure 7: Proportion of diphthongal adaptation by tone, word position, and experimental task.

Figure 7 shows that the contrast between Tone 3 and other tones, in particular Tone 4, is larger in the final position than in the initial position. However, statistically, there is no significant interaction of Tone and Position, indicating that tone effects in loanword adaptation do not differ significantly by the word position ($p > 0.1$). The three-way interaction of Tone * Position * Task was also not significant indicating that there is no evidence that tonal effects on adaptation are any different depending on the position or the task⁷. This finding shows that the tone effects are robust across all conditions. In contrast to the position effect, which may be under-projected to on-line adaptation, the tonal effect seems to persist in on-line adaptation as well as in contexts where the phonetic ground for the tonal effect is reduced, i.e., non-final position.

One of the unexpected findings of our study is an asymmetrical adaptation of Mandarin diphthongs by vowel quality. The examples in (4) illustrate the variation in the adaptation of front unrounded diphthongs /ai/ and /ei/. In many cases, /ei/ and /ai/ tend to be matched with the equivalent diphthongs /ei/ and /ai/ in Chinese Korean. In monophthongal adaptation, /e/ and /ɛ/ are the most frequently realized vowels, which retain the [+front] and [-round] features of the /i/ glide and the vowel height of the original nucleus.

(4) Adaptation of front diphthongs /ai, ei/

MA	Pinyin	CK	Adaptation	Gloss
酸菜	suan1cai4	/s*wan.tshai/	/ai/ → /ai/	'pickles'
		/s*wan.tshɛ/	/ai/ → /ɛ/	
耐克	nai4ke4	/nai.k ^h i/	/ai/ → /ai/	'Nike'
		/nɛ.k ^h ʌ/	/ai/ → /ɛ/	
		/nei.k ^h ʌ/	/ai/ → /ei/	
倒霉	dao3mei2	/t*o.mei/	/ei/ → /ei/	'bad luck'
		/t*o.me/	/ei/ → /e/	

Examples in (5) show examples of back diphthongs /au/ and /ou/. In our data, Mandarin /au, ou/ are most often adapted as /o/, preserving the features [+back] and [+round] of the /u/ glide and [-high] feature of the nucleus vowel. In addition, when Mandarin /au/ is preserved as a diphthongal vowel in Chinese Korean, it is often realized as /ao/ rather than /au/ (see footnote 5).

(5) Adaptation of back diphthongs /au, ou/

MA	Pinyin	CK	Adaptation	Gloss
----	--------	----	------------	-------

⁷ The lack of significant interaction in the established loans may be an issue of statistical power, rather than a lack of genuine effect, as the stimuli are sparse and unbalanced across conditions in the established data

高清	gao1qing1	/k*ao.ts ^h iq/	/au/ → /ao/	‘HD’
		/k*o.ts ^h iq/	/au/ → /o/	
包子	bao1zi0	/p*o.c* ^h i/	/au/ → /o/	‘dumpling’
		/p*o:.c* ^h i/	/au/ → /o:/	
手机	shou3ji1	/s*o.tsi/	/ou/ → /o/	‘cellphone’
教授	jiao4shou4	/ts*o.su/	/ou/ → /u/	‘professor’
		/ts*o.so/	/ou/ → /o/	

Figure 8 shows that there is an asymmetry in adaptation patterns across different diphthongs, especially between front and back diphthongs. Mandarin /ei/ is adapted as a diphthong in about 90% of the cases in the established loanword, followed by /ai/, /au/ and /ou/. On the basis of the results, the hierarchy of diphthongal adaptation in both tasks is as follows: /ei/ > /ai/ > /au/ > /ou/. The rate of diphthong/monophthong choice evidently differs by diphthong type. In particular, there is a large difference between /ou/ and /ei/. This interesting phenomenon will be discussed in more detail in Section 6.

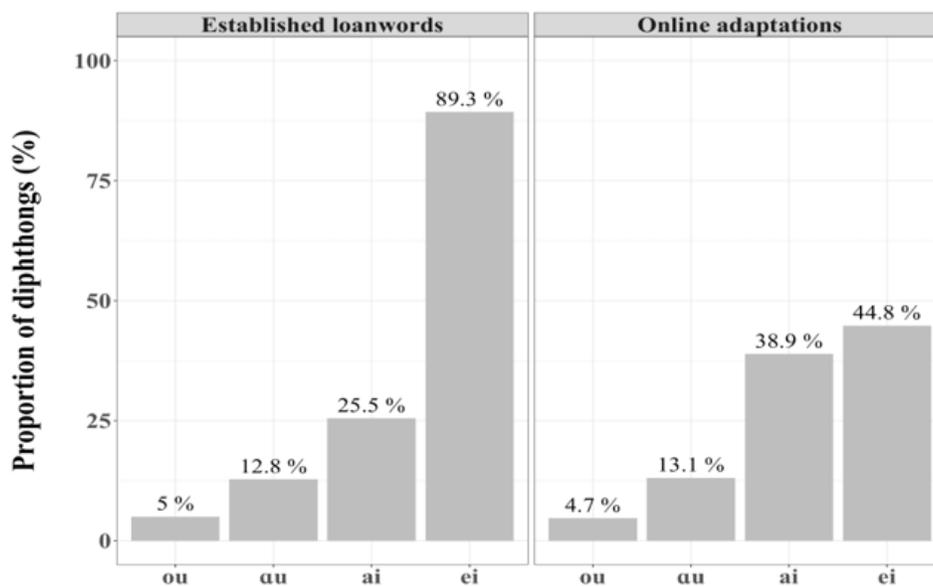


Figure 8: Proportion of diphthongal adaptation by diphthong type.

To summarize our findings from Experiment 2, the overall patterns indicate that loanword adaptation is sensitive to the phonetic duration of the input vowel, in particular the durational difference conditioned by the tone (Tone 3 > Tone 4) and, in the case of established loans, the word position (final > initial) as well. We found a consistent effect of tones across word positions and tasks. We also found that the adaptation is conditioned by the segmental composition of the

diphthongs (front unrounded diphthong /ei, ai/ > back rounded diphthongs /au, ao/).

6 Discussion

In this section, we discuss residual issues and implications that arise from the present analysis.

6.1 Emergence of asymmetrical adaptation among diphthong types

Recall from section 5 that we found a large difference in the rate of monophthongization between front and back diphthongs. This is an unexpected finding but a very robust pattern in our data. We consider a few explanations for this diphthong type effect. First of all, we examined the phonetic duration of Mandarin vowels by diphthong types in Experiment 1 and in our adaptation experiment stimuli, and found that the duration difference in Mandarin cannot account for the diphthong type effect in adaptation. The duration is similar across the diphthong types and the small difference that does exist does not support the duration-based explanation; /ai/ is the longest diphthong but /ei/ is the shortest diphthong of the four in both Experiment 1 and in our experimental stimuli.

Another possibility is that the asymmetry between front and back diphthong adaptation is due to the asymmetry in native Korean phonology. Korean has a front-falling diphthong /ij/, which is a remnant of front-falling diphthongs from Late Middle Korean (H. Kang 1997; Ahn & Iverson 2007). As mentioned above, an archaic pronunciation of some falling diphthongs (/ai/ and /ɿ/ specifically) is attested in Chinese Korean (Jin 2008). In contrast, neither diachronically nor synchronically has Korean had back falling diphthongs.

The differential treatment of front- and back-final diphthongs is also found in English loanwords in Korean. In Standard Korean, English falling sonority diphthongs are adapted as di-syllabic vowel sequences, similar to Mandarin diphthongs. The only exception is /ou/ which is always adapted as a monophthong /o/. The examples in (6) illustrate this contrast.

(6) Examples of English vowel adaptation into Standard Korean

/aɪ/	Gloss	/eɪ/	Gloss	/aʊ/	Gloss	/oʊ/	Gloss
/p ^h a.i.p ^h i/	'pipe'	/te.i.t ^h i/	'date'	/sɪ.k ^h a.u.t ^h i/	'scout'	/hom/	'home'
/ka.i.ti/	'guide'	/ke.i.t ^h i/	'gate'	/a.us/	'out'	/k ^h o.ti/	'code'
/sɪ.la.i.ti/	'slide'	/p ^h e.i.tsi/	'page'	/a.ul.les/	'outlet'	/p ^h o.k ^h i/	'folk'

This pattern is similar to that of Mandarin diphthongs in Chinese Korean, in which the Mandarin diphthong /ou/ has the highest rate of monophthongization. In contrast, the front unrounded vowels /aɪ/ and /eɪ/ as well as the back unrounded vowel /aʊ/ are consistently realized as two vowel sequences in Standard Korean.

The high rate of diphthongal adaptation of Mandarin front unrounded diphthong [ei] also has a parallel in English loans. Interestingly, there is evidence that the English diphthong /eɪ/ is adapted as a true diphthong in North Kyungsang Korean, which is a pitch accent system, as shown in the examples in (7). These diphthongs, unlike disyllabic V.V sequences, act like a long vowel and attract a double high accent. This adaptation pattern is not reported for other English diphthongs.

(7) English diphthong /eɪ/ adaptation in North Kyungsang Korean (Adapted from Kenstowicz & Sohn 2001)

/eɪ/	Gloss	/eɪ/	Gloss	/eɪ/	Gloss	/eɪ/	Gloss
/péɪ.pí/	'baby'	/tʰéɪ.púl/	'table'	/kʰéɪ.púl/	'cable'	/pʰéɪ.pʰá/	'paper'

In fact, such asymmetry between front and back diphthongs may have a cross-linguistic phonetic ground. A similar asymmetry is reported for Japanese where Katayama (1988) noted that loanwords from English tend to retain the diphthong [ai] while turning [au] into [a] in Japanese. There is a long-standing observation in the literature (going at least back to Martinet 1952) that back vowels in the vowel space are more contracted and crowded compared to front vowels acoustically. We conjecture that the two components of back diphthongs are perceived as less distinctive which makes their diphthongal quality less perceptible than their front counterparts, which in turn affects the adaptation in loans.

6.2 Influence of Sino-Korean words

Another issue is the influence of cognate Sino-Korean words in Mandarin diphthong adaptation. Korean vocabulary consists of a large number of words of Chinese origin, making up about 60% of the Korean lexicon (Sohn 2001). Sino-Korean words can be expressed in Chinese characters, but the pronunciation of the Chinese characters is different between Mandarin and Korean. For example, the word for 'tofu' is 豆腐 in Mandarin Chinese, which is pronounced /tòu.fu/. The Korean word for 'tofu' is Sino-Korean and Korean uses the same Chinese characters, but it reads as 두부 /tupu/.

Given the availability of Sino-Korean cognates, a question arises as to whether some of the pronunciations of Mandarin loans in Chinese Korean may

be based on Sino-Korean pronunciations of the cognate words, rather than a result of sound-based borrowing from contemporary Mandarin. It would be reasonable to suggest that Sino-Korean in the borrowing language may play a role in monophthongal adaptation since the monophthongal output in our data is similar to the Sino-Korean pronunciation of corresponding Chinese characters as shown in (8).

(8) Comparison of Chinese-Korean loans and Sino-Korean (SK) cognates

Vowel	MA	Pinyin	CK	Adaptation	Sino Korean cognate
/ai/	酸菜	suan1cai4	/s*uan.tse/	/ai/ → /ε/	/san.ts ^h ε/
			/s*uan.tsai/		
/au/	号码	hao4ma3	/homa/	/au/ → /o/	/ho.ma/
/ou/	教授	jiao4shou4	/tso.so/	/ou/ → /o, u/	/kjo.su/
			/tso.su/		

While one cannot rule out the possible influence of Sino-Korean cognates, there are reasons to believe that the monophthongal realization cannot be attributed solely to the Sino-Korean cognates. The evidence comes from “hybrid” forms where in words that contain two diphthongs, one diphthong is realized as a diphthong and the other as a monophthong, as in *dao3mei2* 倒霉 ‘bad luck’ > CK /t*o.mei/. The Sino-Korean transliteration of the same Chinese characters would be /to.mε/. This example also illustrates that while the diphthong may monophthongize to a vowel corresponding to the Sino-Korean cognate, the consonants do not follow the Sino-Korean pronunciation, supporting the claim that the monophthongization is a productive adaptation in and of itself rather than a repurposing of Sino-Korean pronunciation of the Chinese characters. Thus, one cannot simply assume that monophthongal adaptation is solely due to Sino-Korean cognates. It would, however, be of interest to investigate the influence of Sino-Korean cognates and their relationship with the direct Mandarin borrowings in the future.

6.3 Sociolinguistic contexts of adaptation

Recall from section 1 that in Standard Korean, Mandarin falling diphthongs are adapted as hetero-syllabic vowel sequences, as in MA *mao2 ze2 dong1* [máu tsé tōŋ], ‘Mao Zedong’ > SK /ma.o.ts*ʌ.tuŋ/. This is in contrast to the patterns found in Chinese Korean, where quite often the illicit diphthongs are not repaired at all or they are repaired by monophthongization. We propose that these differences between the two varieties of Korean are attributed to the different level of contact and bilingualism.

Table 9. Constraint ranking and differential adaptation strategies in dialects of Korean.

In the Chinese Korean community, where the degree of bilingualism is high, the diphthong importation retains the foreign structure and preserves the syllable count at the expense of violating a native phonological constraint. Thus, the ranking is DEP-SYL, *COALESCENCE >> *FALLDIPH as shown in (10).

(10) Importation of Mandarin /suan.ts^hai/ 酸菜 ‘pickles’ into Chinese Korean /s^{*}uan.ts^hai/

/suan.ts ^h ai/	DEP-SYL	*COALESCENCE	*FALLDIPH
→/s [*] uan.chai/			*
/s [*] uan.chɛ/		*	
/s [*] uan.cha.i/	*		

The optimal candidate in Tableau (10) is /s^{*}uan.ts^hai/, which faithfully maintains the prosodic structure of Mandarin phonology and avoids coalescence. On the other hand, the monophthongal adaptation, where the two segments of a diphthongs coalesce into a monophthong, obeys the constraint against falling diphthongs in native phonology as seen in (11).

(11) Adaptation of Mandarin /ɕue.kau/ 雪糕 ‘ice cream’ into Chinese Korean /swe.k^{*}o/

/ɕue.kau/	DEP-SYL	*FALLDIPH	*COALESCENCE
→/swe.k [*] o/			*
/swe.k [*] au/		*	
/swe.k [*] a.u/	*		

Note that in both patterns of Chinese Korean, DEP-SYL remains highly ranked and the prosodic structure of the input (=syllable count) is preserved. Unlike Chinese Korean, in Standard Korean, the Mandarin diphthongs are realized as separate syllabic nuclei, and this repair is possible with DEP-SYL ranked lower than other constraints, as shown in (12). In other words, this adaptation satisfies the native phonological restriction against falling diphthongs (*FALLDIPH) at the expense of altering the prosodic structure of the input (DEP-SYL).

(12) Adaptation of Mandarin /mau.tsə.tɔŋ/ 毛泽东 ‘Mao Zedong’ into Standard Korean /ma.o.ts^{*}ə.tuŋ/

/mau.tsə.tuŋ/	*FALLDIPH	*COALESCENCE	DEP-SYL
---------------	-----------	--------------	---------

/mao.ts*ə.tuŋ/	*		
/mo.ts*ə.tuŋ/		*	
→/ma.o.ts*ə.tuŋ/			*

Our finding of divergent repairs and associated roles of input language phonological structure in the two varieties of Korean is also consistent with recent findings that cross-language perception is modulated by listeners' knowledge and experience with the input language (Best & Tyler 2007; Bundgaard-Neilson et al. 2011; Nomura & Ishikawa 2016; Kwon 2017). These studies find that experienced listeners of the input language (in our case, Mandarin) tend to show more sensitivity to the input language phonological structure and tend to preserve it better in their perception than listeners with limited experience with the input language.

7 Conclusion

This paper examined the adaptation of Mandarin diphthongs into Chinese Korean. When Mandarin diphthongs are borrowed into Chinese Korean, two major adaptation patterns are found: monophthongal adaptation and diphthongal importation. About 80 % of the Mandarin diphthongs are realized as monophthongs in Chinese Korean and the remaining 20 % or so of the Mandarin diphthongs are retained from the source language. This holds in both established loans and online adaptation.

The results of Experiment 2 provide evidence for the role of phonetic information in loanword adaptation against a strictly phonological approach in loanword phonology. It was observed that Chinese Korean bilinguals use the duration of tone in the input language as a phonetic cue when adapting Mandarin words with diphthongs into Chinese Korean. Thus, diphthongs with Tone 4 are more likely than Tone 3 to be realized as monophthongs, since Tone 4 is shorter than Tone 3 in duration. This evidence supports the idea that phonetic detail in the input language plays an important role in loanword adaptation. Furthermore, it was found that word position also has an influence on loanword adaptation. Diphthongal adaptation more likely occurs when the vowel is in a final syllable than in a non-final syllable. We attribute this difference to the longer duration of vowels in final than non-final syllables in Mandarin with longer duration inducing more diphthongal adaptation. The evidence shows that Chinese Korean bilingual speakers use phonetic information such as the duration in the source language in the adaptation process. We found that the tone duration effect is robustly projected into on-line adaptation as well. However, the evidence is less clear on the projection of position effect in on-line adaptation. Such discrepancy may potentially indicate an imperfect projection of phonetic effects to productive knowledge but a

further study where stimuli duration is properly controlled is necessary to provide more clear evidence.

Unexpectedly, we also found asymmetrical adaptations between the front and back diphthongs. The Mandarin back rounded diphthongs /au, ou/ are more likely to be monophthongized than the front unrounded diphthongs /ai, ei/. We considered the potential role of native phonology—availability of front diphthongs but no back diphthongs—and similar asymmetry in English loanwords as an explanation. We also considered the quasi-universal perceptual basis of this asymmetry.

Finally, we examined the cross-dialectal variation in diphthong adaption and situated the findings in the context of how sociolinguistic contexts and the level of bilingualism affects the pattern of loanword adaptation. This study of the vowel adaptation of Mandarin loanwords in Chinese Korean contributes to our understanding of the role of perception/phonetics as well as sociolinguistics in the adaptation process. For future study, we will compare and contrast the adaptation patterns of both established loanwords and on-line adaptations produced by Chinese Korean adapters utilizing both quantitative and qualitative approaches based on a large-scale loanword corpus.

Appendices

Appendix A. Stimuli for vowel production across tones

No	Hanzi	Pinyin	Tone	Vowel	Meaning
1	摘	zhai	tone1	ai	to take, to borrow
2	宅	zhai	tone2	ai	residence, to stay in at home
3	窄	zhai	tone3	ai	narrow
4	寨	zhai	tone4	ai	stronghold, stockade
5	包	bao	tone1	ao	to cover, to wrap
6	雹	bao	tone2	ao	hail
7	保	bao	tone3	ao	to defend, to protect
8	抱	bao	tone4	ao	to hold, to carry
9	舟	zhou	tone1	ou	boat
10	轴	zhou	tone2	ou	axis, axle
11	肘	zhou	tone3	ou	elbow
12	咒	zhou	tone4	ou	variant of, incantation
13	勒	lei	tone1	ei	to strap tightly
14	雷	lei	tone2	ei	thunder, mine (weapon)

15	蕾	lei	tone3	ei	bud
16	肋	lei	tone4	ei	rib

Appendix B. List of Mandarin loanwords

*The words that contain one or more of the target diphthong are boldfaced.

No	Hanzi	Pinyin	Gloss	Sentence
1	游戏厅	you2xi4ting1	game room	()에 놀러가자.
2	啤酒	pi2jiu3	beer	()을 마시자
3	停水	ting2shui3	suspend supply water	()돼서 물이 안 나온다
4	保险	bao3xian3	insurance	차를 샀으면 ()에 들어라.
5	卡片儿	ka3pianr4	card; postcard	()을 가방에 넣어라.
6	早餐	zao3can1	breakfast	()을 일찍 먹는다.
7	放学	fang4xue2	dismiss school	()하면 바로 집에 와라.
8	地暖	di4nuan3	floor heating	()이 안돼서 춥다.
9	网球儿	wang3qiur2	tennis	()을 치러 가자.
10	延边大学	yan2bian1da4xue2	Yanbian University	()에 들어갔다.
11	世界杯	shi4jie4bei1	world cup	()를 봤다.
12	签证	qian1zheng4	visa	()을 만들어라.
13	空调	kong1tiao2	air-conditioner	()를 켜라.
14	松下	song1xia4	Matsushita (Panasonic)	()에서 만든 물건을 샀다.
15	号码	hao4ma3	number	()를 알려줘라.
16	索尼	suo3ni2	SONY	()에서 만든 물건을 샀다.
17	开关儿	kai1guanr1	switch	()을 켜라.
18	香辣鸡翅堡	xiang1la4ji1tui3bao3	spicy chicken hamburger	()를 먹으러 가자.
19	高跟鞋	gao1gen1xie2	High, tall	()를 신으면 발이 아프다.
20	煤气	mei2qi4	gas, gas fittings	()를 켜서 밥을 해라.
21	薯条	shu3tiao2	French fries	()를 사서 먹어라.

22	电脑游戏	dain4nao3you2xi4	vedio game	()를 너무 많이 하지 마라.
23	短裤	duan3ku4	short pants	()를 입으면 시원하다.
24	代购	dai4gou4	generation gap	()를 해 주는 사람이 많다.
25	老板	lao3ban3	boss, the responsible supervisor	()이 온다.
26	老头儿	lao3tour2	old male person	()이 오신다.
27	校长杯	xiao4zhang3bei1	school cup	학교에서 () 경기가 열렸다.
28	暖气楼	nuan3qi4lou2	apartment with heating	이 빈관은 ()이다.
29	退货	tui4huo4	returning goods	필요 없으면 ()해라.
30	签字	qian1zi4	sign	여기에 ()해라.
31	电饭锅	dian4fan4guo1	rice cooker	()에 밥을 해라.
32	下课	xia4ke4	(a class) ending, leaving school	()하면 놀러 가자.
33	世界名著	shi4jie4ming2zhu4	world masterpiece	()를 읽었다.
34	高清	gao1qing1	HD	() 펜스를 사왔다.
35	充电	chong1dian4	charge (a battery)	써우지 ()해라.
36	羊肉串儿	yang2rou4chuanr4	lamb kabob	()을 먹으러 가자.
37	喂	wei2	Hello (on the phone)	전화가 오면 ()하고 받는다.
38	采购	cai3gou4	purchase	직장에서 ()하고 있다.
39	牛仔褲	niu2zai3ku4	jeans	()를 입으면 덥다.
40	朴智星	piao2zhi4xing1	Korean soccer player	()이 족구를 잘한다.
41	暖气片儿	nuan3qi4pianr4	heating apparatus	()이 있으면 따뜻하다.
42	游戏	you2xi4	game	아이가 ()를 많이 한다.
43	遥控器	yao2kong4qi4	remote control	()가 어디 있냐?
44	面包车	mian4bao1che1	city bus, car	()를 타고 가자.
45	下载	xia4zai3	download	멤노에서 ()해라.
46	加班儿	jia1banr1	overtime work	()을 하고 나니 피곤하다.
47	照顾	zhao4gu0	pay attention to	아이를 ()해 줘라.

48	专家	zhuan1jia1	expert	()에게 물어봐라.
49	电子	dian4zi3	electron	삼성은 ()회사다.
50	电池	dian4chi2	battery	()를 새거로 바꿔라.
51	巧克力	qiao3ke4li4	chocolate	()이 맛이 좋다.
52	挂号儿	gua4haor4	apply for medical examination	병원에 가면 ()해야한다.
53	盗版	dao4ban3	pirate edition	()를 사서 펜노에 넣었다.
54	手机	shou3ji1	cell phone	()로 전화를 쳐라
55	充电器	chong1dian4qi4	battery charger	()가 어디에 있니?
56	贷款	dai4kuan3	lending; loan	은행에서 ()한다.
57	回扣	hui2kou4	rebate	()를 달라.
58	下班儿	xia4banr1	come home from work	()하고 놀자.
59	电脑	dian4nao3	computer	()를 써서 일한다.
60	菜单	cai4dan1	menu	()을 가져와라.
61	广播	guang3bo1	broadcast; radio	()에서 노래가 나온다.
62	白干儿	bai2ganr1	spirits; liquor	()을 많이 마시지 말아라.
63	观众	guan1zhong4	audience	()이 많아서 시끄럽다.
64	分配	fen1pei4	divide	똑같이 ()해라.
65	成宝	cheng2bao3	Chengbao department store	() 초시에 가서 물건 사라.
66	海贼王	hai3zei2wang2	One-piece Japanese cartoon	아이들이 ()을 좋아한다.
67	镇痛片儿	zhen4tong4pianr4	pain killer tablet	머리 아프면 ()을 먹어라.
68	面包	mian4bao1	bread	()가 맛있다.
69	馒头	man2tou0	Chinese-style steamed bread	()를 먹어라.
70	耐克	nai4ke4	Nike	() 신발을 사라.
71	倒霉	dao3mei2	bad luck	오늘은 정말 ()다.
72	薯片	shu3pian4	chips	()을 사와라.
73	微波炉	wei1bo1lu2	microwave	()를 돌려서 익혀라.
74	臭豆腐	chou4dou4fu0	smelly touf	()에서 냄새가 난다.

75	淘汰	tao2tai4	throw away old things	롱구에서 ()됐다.
76	包子	bao1zi0	dumpling	()가 맛있다.
77	剪票	jian3piao4	examine tickets	기차를 타려면 ()를 받아라.
78	丰田	feng1tian2	TOYOTA	()차가 비싸다
79	感觉	gan3jue2	sense, feel	()이 좋지 않다.
80	电视台	dian4shi4tai2	television station	()에 가봤다.
81	白酒	bai2jiu3	spirits; liquor	()를 마시면 취한다.
82	讲义气	jiang3yi4qi0	have a keen sense of duty	형제는 ()해야 한다.
83	唠嗑儿	lao4ker1	chat	동무들과 ()했다.
84	篮球	lan2qiu2	basketball	키가 커야 ()를 잘한다.
85	诈骗	zha4pian4	fraud	나쁜 사람에게 ()을 당했다.
86	少林寺	shao4lin2si4	Shaolin temple	()에 가보고 싶다.
87	高级	gao1ji2	high-quality	() 빈관에서 잤다.
88	战斗机	zhan4dou4ji1	warcraft	()가 하늘을 난다.
89	报销	bao4xiao1	cost sharing	단위에서 ()해 준다.
90	雪糕	xue3gao1	ice cream	()를 사먹어라.
91	希腊神话	xi1la4shen2hua4	Greek mythology	()가 재미있다.
92	画画儿	hua4huar4	painting	아이가 ()을 좋아한다.
93	录音带	lu4yin1dai4	recording tape	()로 음악을 들어라.
94	快板儿	kuai4banr3	a kind of mass entertainment	몹스에서 ()를 봤다.
95	电视	dian4shi4	television	()를 많이 본다.
96	邮箱	you2xiang1	mailbox	()으로 소식을 보내라.
97	停电	ting2dian4	blackout	()돼서 불이 꺼졌다.
98	多伦多	duo1lun2duo1	Toronto	()에 가고 싶다.
99	肿瘤	zhong3liu2	tumor	()가 생겨 병원에 갔다.
100	通宵	tong1xiao1	staying up all night	어제 ()해서 피곤하다.
101	香	xiang1	sweet-smelling	꽃 냄새가 ()하다.

102	跑调儿	pao3diaor4	out of tune	노래를 못해 ()한다.
103	面子	mian4zi0	honor; face	아이 때문에 ()가 없다.
104	不够意思	bu2gou4yi4si0	cruel; harsh; reserved	잘 안 돌봐줘서 ()다.
105	英雄联盟	ying1xiong2lian2men g2	League of Legend	뎌노로 ()을 한다.
106	家教	jia1jiao4	private teacher	()를 청해 공부시켜라.
107	三国演义	san1guo2yan3yi4	Romance of the Three Kingdoms	()를 읽었다.
108	教授	jiao4shou4	professor	()에게 배워라.
109	酸菜	suan1cai4	pickles	()를 먹어라.
110	保安	bao3an1	security	단위에서 () 일을 한다.
111	犯规	fan4gui1	breaking the rules	경기를 할 때 ()하지 마라
112	暖气	nuan3qi4	heating	()가 들어와 따뜻하다.
113	过敏	guo4min3	allergy	피부에 ()이 났다.
114	国贸	guo2mao4	International trade building	()에 가서 물건을 사라.
115	长白山	chang2bai2shan1	Changbai Mountain	()에 가보고 싶다.
116	汉堡包	han4bao3bao1	hamburger	()를 사 먹어라.
117	存款	cun2kuan3	saving money	은행에 가서 ()해라.
118	跑车	pao3che1	sport car	()가 빠르다.
119	彩票	cai3piao4	lottery ticket	()를 사라.
120	白山大厦	bai2shan1da4sha4	Baishan hotel	()에서 일하다.
121	护照	hu4zhao4	passport	()를 보여줘라.
122	老百姓	lao3bai3xing4	the people	()에 위해 일해라.
123	本田	ben3tian2	HONDA	()차가 비싸다.
124	塑料	su4liao4	vinyl	물병은 ()로 만들었다.
125	谢谢	xie4xie4	thank	고마울 때 ()라고 말한다.
126	菜刀	cai4dao1	knife	()로 배추를 썬다.
127	黑社会	hei1she4hui4	gangsterdom	()는 나쁜 사람들이다.
128	干杯	gan1bei1	drinking a toast	다같이 ()하자.

Appendix C. Stimuli for online adaptations

No	Hanzi	Pinyin	Gloss	Sentences
1	改成	gai3cheng2	change	질을 팔로()한다.
2	北非	bei3fei1	North Africa	()에 가 봤다.
3	清炒	qing1chao3	fried	배채를()한다.
4	悲愁	bei1chou2	sad	슬픈 드라마 보고()한다.
5	颤抖	chan4dou3	trembling	추워서()한다.
6	修改	xiu1gai3	modify	틀려서()한다.
7	炒汇	chao3hui4	speculation	은행에서()한다.
8	解剖	jie3pou1	anatomy	동물을()한다.
9	支配	zhi1pei4	dominate	자금을 잘 ()해라.
10	妯娌	zhou2li0	sister-in-law	그 사람이 내()다.
11	扣分	kou4fen1	deduction points	시험에서() 당했다.
12	开办	kai1ban4	start	유치원을()한다.
13	桃酥	tao2su1	peach cake	()를 먹고 싶다.
14	改道	gai3dao4	diverted	길이 안 좋으니()해라.
15	靠近	kao4jin4	near	위험해서 ()하지 말아라.
16	板材	ban3cai2	plate	건물을()로 만들었다.
17	开采	kai1cai3	mining	산을()한다.
18	战斗	zhan4dou4	fighting	()에서 죽었다.
19	陪伴	pei2ban4	accompany	아이가() 필요하다.
20	入寇	ru4kou4	invade	()들이 들어왔다.
21	口袋	kou3dai4	pocket	돈을()에 넣어라.
22	带累	dai4lei3	involve	()해서 미안하다.
23	弹头	dan4tou2	warhead	()를 맞아서 죽었다.
24	被绑	bei4bang3	tied	사장이()됐다.
25	走路	zou3lu4	walk	멀지 않으니()해서 가라.

26	地帶	di4dai4	zone	여기는 위험한 ()다.
27	皮帶	pi2dai4	belt	바지가 크면 () 써라.
28	告病	gao4bing	asking for sick leave	단위에 ()했다.
29	栽赃	zai1zang1	frame	사장에게()했다.
30	开炮	kai1pao4	fire	시합이()했다.
31	白痴	bai2chi1	moron	저 사람은 ()다.
32	该着	gai1zhao2	deserve	()선생님 칭켜한다.
33	安培	an1pei2	ampere	전류의 세기는()를 쓴다.
34	头版	tou2ban3	Front page	신문()에 올랐다.
35	周报	zhou1bao4	weekly	()를 봤다.
36	被告	bei4gao4	defendant	이 사건에는 저 사람이()다.
37	构成	gou4cheng2	constitute	이 집은 나무로()됐다.
38	胚胎	pei1tai1	embryo	수업에서()를 관찰했다.
30	渗透	shen4tou4	penetration	물이 방에()됐다.
40	该当	gai1dang1	deserved	죄를 지어()감옥에 간다.
41	菜豆	cai4dou4	kidney bean	()을 먹었다.
42	理该	li3gai1	rationaly	이 일은 네가() 책임을 져라.
43	头彩	tou2cai3	Head color	채표를 사서()로 당첨됐다.
44	靠近	kao4jin1	near	위험하니()하지 말아라.
45	不周	bu4zhou1	not satisfactory	아이를 보살펴 줬는데()했다.
46	超标	chao1biao1	excessive	예산이()했다.
47	斑白	ban1bai2	gray	머리카락이()하다.
48	才具	cai2ju4	talented	()가 있다.
49	开刀	kai1dao1	surgery	아파서()해야 한다.
50	案头	an4tou2	desk	책을()에 놓아라.
51	配备	pei4bei4	provide, equipment	기차 안에 뎀쓰를()했다.
52	书包	shu1bao1	school bag	()를 들고 학교에 가라.

53	安排	an1pai2	arrangement	빈관을()해 줘라.
54	更改	geng1gai3	change	약속 시간을 ()하지 말아라.
55	贼心	zei2xin1	thieves heart	()이 있으면 안 된다.
56	带电	dai4dian4	charged	뎨쓰가()돼서 위험하다.
57	外逃	wai4tao2	fled	도둑이()했다.
58	薄层	bao2ceng2	Thin layer	()은 매우 얇다.
59	开口	kai1kou3	open	신발이()됐다.
60	白菜	bai2cai4	Chinese cabbage	()로 김치를 만들었다.
61	配菜	pei4cai4	side dishes	주방에서()한다.
62	超拔	chao1ba2	overtake	우리 선생님은 재능이()하다.
63	构架	gou4jia4	architecture	이 건물은()가 좋다.
64	眼泡	yan3pao1	eyebrows	잠을 못 자서()가 부었다.
65	剖析	pou1xi1	analysis	어려운 말을()해 줘라.
66	剖白	pou1bai2	explain oneself	솔직하게()해라.
67	保藏	bao3cang2	preservation	과일을 뽕상에()해라.
68	炒家	chao3jia1	speculator	때관을 못 값아서()당했다.
69	悲惨	bei1can3	tragic	운명이()하다.
70	保费	bao3fei4	premium	보호해 줬으니()를 내라.
71	报恩	bao4en1	thanksgiving	고마우면()해라.
72	难保	nan2bao3	hard to protect	이 일이 잘 될지()하다.
73	煎炒	jian1chao3	fried	이 채소를()해서 먹어라.
74	卷轴	juan3zhou2	reel	()를 열어라.
75	非得	fei1dei3	have to	이 일을 ()해라.
76	菜畦	cai4qi1	vegetable bed	()에서 채소를 기른다.
77	北斗	bei3dou3	big dipper	밤새()를 봤다.
78	薄片	bao2pian4	sheet	이 채소를()으로 잘라라.
79	得亏	dei3kui1	suffer	()사장이 도와줘서 성공했다.

80	满口	man3kou3	mouthful	이 사람은()욕이다.
81	被单	bei4dan1	bed sheet	()을 깨끗하게 빨아라.
82	下周	xia4zhou1	next week	()에 놀러 가자.
83	扣除	kou4chu2	deduction	월급에서 벌금을()해라.
84	包孕	bao1yun4	include	편지에 감정을()했다.
85	口岸	kou3an4	port	()에 가서 배를 타라.
86	炮制	pao2zhi4	concocted	이거와 같이()해라.
87	周长	zhou1chang2	perimeter	머리의()이 얼마나?
88	配备	pei4bei4	equipped, equipment	기차에 뎀쓰를()했다.
89	麦胚	mai4pei1	wheat germ	()를 사 와라.
90	开拍	kai1pai1	shooting	새 드라마가()했다.
91	采购	cai3gou4	buy	직장에서 ()하고 있다.

Competing Interests

The authors have no competing interests to declare.

References

- Ahn, Sang-Cheol & Gregory K. Iverson. 2007. Structured imbalances in the emergence of Korean vowel system. In Joseph C. Salmons & Shannon Dubenion-Smith (eds.), *Historical Linguistics 2005 (Current Issues in Linguistic Theory, Vol. 284)*, 275-293, Amsterdam & Philadelphia: John Benjamins Publishing Co.
- Barnes, Jonathan. 2006. *Strength & weakness at the interface: Positional neutralization in phonetics and phonology*. Vol. 10. Walter de Gruyter.
- Bates, Douglas & Martin Maechler. 2009. lme4: Linear mixed-effects models using S4 classes. R package version 0.999375-32. Online: <http://cran.r-project.org/web/packages/lme4/index.html>.
- Best, Catherine T., & Michael D.Tyler. 2007. Nonnative and second language speech perception: commonalities and complementarities. In O. Bohn and M.J. Munro (Eds.) (eds.), *Language experience in second language speech hearing: in honor of James Emil Flege* 13-34. Amsterdam: John Benjamins Publishing Company.

- Boersma, Paul & David Weenink. 1992-2011. Praat: Doing phonetics by Computer. <http://www.praat.org>.
- Boersma, Paul & Silke Hamann. 2009. Loanword adaptation as first-language phonological perception. *Loan phonology* 307, 11.
- Bundgaard-Nielsen, Rikke L., Catherine T. Best & Michael D. Tyler. 2011. Vocabulary Size Matters: The Assimilation of Second-Language Australian English Vowels to First-Language Japanese Vowel Categories. *Applied Psycholinguistics* 32(1). 51-67.
- Casali, Roderic F. 1996. *Resolving hiatus*. Doctoral dissertation. University of California Los Angeles.
- Chao, Yuen-Ren. 1968. *A Grammar of Spoken Chinese*. Berkeley and Los Angeles: University of California Press.
- Cheng, Chin-Chuan. 1973. *A Synchronic phonology of Mandarin Chinese*. Vo1.4. Walter de Gruyter.
- China. 2006. *Zhongguo yuyan wenzi shiyong qingkuang diaocha ziliao* [Data from the survey of language and script use in China]. Beijing: Yuyan Press.
- Choi, Woo-Gil. 2001. The Korean minority in China: The change of its identity. *Development and Society* 30(1). 119-141.
- Cui, Jin-Yi. 2011. *Investigations and studies on the use of language of Korean nationality discourse community in Dandong area*. MA thesis. Bohai University.
- Duanmu, San. 2007. *The Phonology of Standard Chinese*, second ed. Oxford: Oxford University Press.
- Dreher, John J. & Pao-chen Lee. 1968. Instrumental investigation of single and paired Mandarin tonemes. *Monumenta serica*. 343-373.
- Han, Sung woo. 2011. The language identity of Korean-Chinese society in Qungdao, China [in Korean]. *Journal of Korean dialectology* 14. 113-135.
- Han, Sung woo. 2014. The language change of Korean-chines society in China [in Korean]. *Korean Studies* 32. 411-438.
- Howie, John Marshall. 1976. *Acoustical Studies of Mandarin Vowels and Tones*. Cambridge: Cambridge University Press.
- Haugen, Einar. 1950. The analysis of linguistic borrowing. *Language* 26, 210-231.
- Hsieh, Feng-fan, Michael Kenstowicz & Xiaomin, Mou. 2005. *Mandarin adaptations of coda nasals in English loanwords*. Unpublished Manuscript, MIT.
- Ito, Chiyuki & Michael Kenstowicz. 2009a. Mandarin Loanwords in Yanbian Korean II: Tones. *Language Research* 45(1). 85-109.
- Ito, Chiyuki & Michael Kenstowicz. 2009b. Mandarin Loanwords in Yanbian Korean I: Laryngeal Features. *Phonological Studies* 12. 61-72.
- Jin, Wenhua. 2008. *Sounds of Chinese Korean: A variationist approach*. Doctoral dissertation. University of Texas at Arlington.
- Johnstone, Barbara & Scott F. Kiesling. 2008. Indexicality and experience: Exploring the meanings of /aw/-monophthongization in Pittsburgh1. *Journal of sociolinguistics* 12(1). 5-33.

- Julien, Eychenne & Tae-Yeoub Jang. 2015. On the merger of Korean mid front vowels: Phonetic and phonological evidence. *Journal of the Korean society of speech sciences* 7. 119-129
- Kang, Hyeon-Seok. 1997. *Phonological variation in glides and diphthongs of Seoul Korean: Its synchrony and diachrony*. Columbus, OH: Ohio State University dissertation.
- Kang, Yoonjung. 2003. Perceptual similarity in loanword adaptation: English post- vocalic word-final stops in Korean. *Phonology* 20. 219-273.
- Kang, Yoonjung. 2010a. The emergence of phonological adaptation from phonetic adaptation: English loanwords in Korean. *Phonology* 27. 225-253.
- Kang, Yoonjung. 2010b. Tutorial overview: Suprasegmental adaptation in loanwords. *Lingua* 120(9). 2295-2310.
- Kang, Yoonjung, Sung-Woo Han, Jessamyn Schertz & Na-Young Ryu. 2016. A competition of local and supralocal norms in two Chinese Korean dialects: a case study of /y/. Paper presented at *New Ways of Analyzing Variation-Asia Pacific* 4.
- Kang, Yoonjung, Jessamyn Schertz & Sungwoo Han. 2015. Vowels of Korean dialects. Poster presented at *the 169th Meeting of the Acoustical Society of America*.
- Kenstowicz, Michael. 2003. The role of perception in loanword phonology. *Studies in African Linguistics* 32. 95-112.
- Kenstowicz, Michael & Hyang-Sook Sohn. 2001. *Accentual adaptation in North Kyungsang Korean*. In Michael Kenstowicz (ed.) *Ken Hale: a life in language*. Cambridge, Mass: MIT Press. 239-270.
- Kim, Hyunsoon. 2015. A diachronic change of vibration in vowel insertion after word-final English and French postvocalic plosives in Korean adaptation: A sociolinguistic account. Paper presented at *the joint meeting the ICKL (International circle of Korean Linguistics) and the Harvard-ISOKL (International Symposium on Korean Linguistics)*, University of Chicago.
- Kim, Soohee & Emily Curtis. 2002. Phonetic duration of English /s/ and its borrowing in Korean. *Japanese/Korean Linguistics* 10. 406-419.
- Kwon, Harim. 2017. Language Experience, Speech Perception and Loanword Adaptation: Variable Adaptation of English Word-Final Plosives into Korean. *Journal of Phonetics* 60. 1-19.
- LaCharité, Darlene & Carole Paradis. 2005. Category preservation and proximity versus phonetic approximation in loanword adaptation. *Language* 36. 223-258.
- Labov, William, Sharon Ash & Charles Boberg. 2006. *Atlas of North American English*. Berlin/New York: Mouton deGruyter.
- Lee, Ki-Moon & S. Robert Ramsey. 2011. *A history of the Korean language*. Cambridge: Cambridge University Press.
- Lin, Yen-Huwi. 2007. *The Sounds of Chinese*. Cambridge: Cambridge University Press.

- Martinet, André. 1952. Function, structure, and sound change. *Word-Journal of the international linguistic association* 8(1).1-32.
- Nomura, Jun & Keiichi Ishikawa. 2016. Effects of First Language Processes and Representations on Second Language Perception: The Case of Vowel Epenthesis by *Japanese Speakers International Journal of Bilingualism*.
- Nordenhake, Magnus & Jan Olof Svantesson. 1983. Duration of standard Chinese word tones in different sentence environments. *Lund University Working papers in Linguistics*. Vol 25. 105-111.
- Paradis, Carole & Darlene LaCharité. 1997. Preservation and minimality in adaptation. *Journal of Linguistics* 33. 379-430.
- Paradis, Carole & Darlene LaCharité. 2008. Apparent phonetic approximation: English loanwords in Old Quebec French. *Journal of Linguistics* 44. 87-128.
- Paradis, Carole & Antoine Tremblay. 2009. Nondistinctive features in loanword adaptation. *Loan Phonology*. Amsterdam: John Benjamins. 211-224.
- Park, Jeong-Woon. 1994. Variation of vowel length in Korean. *Theoretical issues in Korean linguistics*. 175-187.
- Peperkamp, Sharon & Emmanuel Dupoux. 2003. Reinterpreting loanword adaptations: the role of perception. *Proceedings of the 15th international congress of phonetic sciences*. 367-370.
- Poplack, Shana. 2001. Code-switching (linguistic). *International encyclopedia of the social and behavioral sciences*. 2062-2065.
- Poplack, Shana, David Sankoff & Christopher Miller. 1988. The social correlates and linguistic processes of lexical borrowing and assimilation. *Linguistics* 26. 47-104.
- Prince, Alan & Paul Smolensky. 1993. Optimality Theory: Constraint Interaction in Generative Grammar. *Rutgers University Center for Cognitive Science Technical Report* 2. ROA 537-0802.
- R Development Core Team. 2011. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.
- Schertz, Jessamyn, Yoonjung Kang & Sungwoo Han. 2017. Cross-language correspondences in the face of change: phonetic independence vs. convergence in two Korean-Mandarin bilingual communities. *International Journal of Bilingualism*.
- Sereno, Joan, Hyungjung Lee & Allard Jongman. 2015. Effects of speaking rate and context on the production of Mandarin tone. *Proceedings of the 18th International Congress of Phonetic Sciences*. Glasgow, UK: University of Glasgow.
- Silva, David James & Wenhua Jin. 2008. The merger of non-high front vowels in Korean: mission accomplished. Paper presented at *the 16th International Conference on Korean Linguistics*, Cornell University.
- Silverman, Daniel. 1992. Multiple scansion in loanword phonology: evidence from Cantonese. *Phonology* 9. 289-328.

- Simonović, Marko. 2017. Inter-language mappings and why we can't have nice theories about them. Paper presented at the Workshop on Phonetics and phonology in loanword adaptation. Cologne, Germany.
- Shin, Jiyoung, Jieun Kiaer & Jaeun Cha. 2012. *The sounds of Korean*. Cambridge: Cambridge University Press.
- Smith, Jennifer L. 2006. Loan phonology is not all perception: evidence from Japanese loan doublets. In Timothy J. Vance & Kimberly A. Jones (eds.) *Japanese/Korean Linguistics* 14. Palo Alto: CLSI. 63–74.
- Sohn, Ho-Min. 1999. *The Korean language*. Cambridge: Cambridge University Press.
- Vendelin, Inga & Sharon Peperkamp. 2006. The influence of orthography on loanword adaptations. *Lingua* 116(7). 996-1007.
- Wu, Fei & Michael Kenstowicz. 2015. Duration reflexes of syllable structure in Mandarin. *Lingua* 164. 87-99.
- Xu, Yi. 1997. Contextual tonal variations in Mandarin. *Journal of Phonetics* 25. 61-83.
- Wu, Hsiao-hung Iris. 2006. Stress to tone: a study of tone loans in Mandarin Chinese. *MIT Working Papers in Linguistics* 52. 227–253.
- Yip, Moira. 1993. Cantonese loanword phonology and optimality theory. *Journal of East Asian Linguistics* 9. 261-291.
- Yip, Moira. 2002. Necessary but not sufficient: Perceptual loanword influence in loanword phonology. *The journal of the phonetic society of Japan, special issue on aspects of loanword phonology* 4. 4-21.
- Yoon, Tae-Jin, Yoonjung Kang, Sungwoo Han, Hyeseon Maeng, Jiae Lee & Kyoung-hue Kim. 2015. A corpus-based approach to dialectal variation in Korean vowels. *Proceedings of the 18th International Congress of Phonetic Sciences*.