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Palatalization in Mandarin Loanwords: An Optimality-Theoretic Approach

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ABSTRACT

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This study conducts an Optimality-Theoretic analysis on palatalization phenomenon in Mandarin loanwords borrowed from American English based on transliterated American state and city names. Because of the differences between Mandarin and American English in sound inventories and syllable structures, words introduced to Mandarin from American English may need to undergo some feature change. The present study focuses on the palatalization phenomenon of velar consonants, and the constraint-based theoretical framework provides an explanation. The constraints and their ranking accounting in this study are: 1) *COMPLEX, *VELAR-V(+front), MAX, IDENT(dorsal) >> IDENT(place), 2) *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$, DEP >> *VELAR-V(+front) >> IDENT(place). However, some other factors besides phonological ones, such as character choosing, and translation conventions, may lead to some counterexamples, and thus may need to be further studied.

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1 Introduction

Borrowing is a natural process of language change that occurs when one language adds new words to its lexicon by copying those words from another language. The words which are borrowed or copied are called loanwords (Haugen 1953). One of the main reasons for borrowing is that the recipient language may have a semantic gap in its lexicon, such as when there is no existing word with the same meaning in the recipient language, and thus would need to borrow a term from the donor language to express the necessary idea or concept (Trask 1996). Mandarin loanwords borrowed from American English are very common. Some examples are listed in (1). *Sprite* is a lemon-lime flavored soft drink created by the Coca-Cola Company. The word of *hacker* refers to someone who tries to break into computer systems to get secret information. *Broadway* is a road in New York City and best known for the professional theatres located along it. When *Sprite*, *hacker* and *Broadway* were first introduced in Mandarin Chinese, none of them had existing counterparts that can be used immediately and directly. That is, Mandarin lacked those concepts, and therefore it had to borrow them and somehow transform them according to its own regulations.

(1) a. Sprite [spraɪt] → xuebi[1] [ɕuepi]

b. hacker ['hækʰɚ] → heike [xəikʰɤ]

c. Broadway ['bɹɔdweɪ] → bailaohui [pailauxui]

[1] Tones in Mandarin Chinese are not discussed and thus not marked in the present study.

There are many principles and strategies to introduce loanwords into the recipient language. For example, the Mandarin expression for the English phrase *the United States of America* is *meilijian hezhong guo*, where *meilijian* is transliteration of *America*, *hezhong* is a semantic translation of *United States*, *guo* means 'country' which does not appear in the original expression, and the definite article *the* disappears in the Mandarin translation. From the illustration of the example, we can find four ways to introduce loanwords; those are semantic translation, transliteration, deletion and addition. Among those, the one involved in the present study is transliteration, in which the concept of a loanword is expressed purely based on the pronunciation of the word in the donor language, and the loanword and the original word share the same or similar phonetic characteristics. Since Mandarin and American English have different syllable structures and different sound inventories, loanwords need to be modified when they are borrowed from American English into Mandarin. As can be seen in (1), epenthesis, deletion and feature change are normally used by translators to transliterate from American English to Mandarin. In (1a), the consonant [s] in *Sprite* is changed to [ɛ] in Mandarin, [p] remains the same, the second half [raɪt] is deleted and the vowels [ue] [i] are added. In (1b), the feature of the first consonant and the vowels of *hacker* are changed from [h], [æ] and [ɚ] in American English to [x], [əi] and [ɤ] in Mandarin, respectively. In (1c) *Broadway*, features changes are involved in [b] → [p], [ɹ] → [l], [ɔ] → [au], [w] → [x] and [eɪ] → [ui]; epenthesis occurs in [ai] in Mandarin, and deletion occurs in [d] in American English.

In Mandarin, a sequence of [k] [g] and [h] followed by a front vowel is not permitted[1]. Therefore, when words with similar sound combinations are translated from American English into Mandarin phonetically, there will be sound changes involved. For example, the final syllable [ki] from the word of *Kentucky* becomes [tɕi] in Mandarin (Ma 2004). Another example is that the initial syllable [çju][2] from *Houston* is changed to [ɕiu]. Similar phenomenon can be seen from the first syllable [çɪl] of *Hillsboro*, where a sound change from [çɪ] to [ɕi] occurs.

The present study focuses on this palatalization phenomenon within the framework of Optimality Theory. Traditional phonological approaches, such as the analysis in Li (1999), take a derivational pattern. That is, a derivational approach identifies the underlying form of a certain word and lets it undergo phonological rules to reach the surface form. In these approaches, input and output are in one-to-one correspondence, thus it is a crucial factor which form is decided to be the underlying form. On the other hand, OT analysis mainly deals with surface structures, and that makes OT suitable to the description of loanword phonology. This is because the underlying structures are forced by the interaction of constraints to conform to the surface constraints in the loan language. By inspecting the surface forms, the constraints and their dominance or ranking can be discovered.

Among previous research which deals with Mandarin loanword phonology, only a

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[1] Synchronically, this is because these velar and glottal consonants are palatalized as [tɕ], [tɕʰ] and [ɕ] when they are followed by front vowels in Mandarin. These changes were first seen during the Ming Dynasty. Most of the [tɕ], [tɕʰ] and [ɕ] sounds in modern Mandarin come from [k], [kʰ] and [h]; the rest of them come from [ts], [tsʰ] and [s]. Therefore, some dialects in South China which have not been affected much by this type of palatalization still retain the same pronunciations as mediaeval Chinese. For example, Mandarin *jia* [tɕa] 'home' and *xia* [ɕa] 'down' are pronounced as [ka] and [ha] respectively in some dialects in South China.

[2] The voiceless palatal fricative [ç] is a relatively rare English sound. The sound occurs when /h/ precedes front vowels, such as the non-silent 'h' of *huge* as in most dialects of English (Roach 2009).

few use OT to conduct analysis. Yan and Cai (2004) study the acquisition of English[1] consonant clusters by Mandarin speakers with OT. In their experiment, six college students who are English majors were asked to read a list of words and phrases and were recorded. Each pronunciation of the words and phrases contains a consonant cluster, *the funny dwarf*, for example. Each pronunciation of the words and phrases read by the subjects was then classified and marked as R(right) if it is correct, W(wrong) if it is not correct, S(silent) if the word was not read by the subject. The pronunciations classified as W(wrong) are sub-classified as W1-epenthesis, W2-deletion, W3-substitution and W4-metathesis. The result shows that even though clusters are not allowed in Mandarin, Mandarin speakers pronounced the target English words with high accuracy. The wrong pronunciations were mainly of epenthesis, deletion and substitution, which are against the faithfulness constraints of DEP-IO, MAX-IO and IDENT-IO, respectively. Based on the result, they propose that the acquisition process undergoes the demotion of markedness constraints, as against the hierarchy of constraints that characterize the learners' native language. Guo (1999) examines how the consonant clusters and illicit codas are modified in Mandarin loanwords transliterated from English within an OT framework and argues that a purely constraint-based approach can explain the data. He used examples of American state names and typhoon names such as [æ.lə.bæ.mə]→[a.la.pa.ma], [del]→[tai.ɚ] and [baɹt]→[patʏ] as his data and found all the onset clusters in the data are faithfully parsed into Mandarin syllables, with inserting vowels to shun the cluster,

[1] However, they do not specify whether it is British English or American English they conduct the experiment on.

while the coda clusters and illicit codas are generally parsed except for the coda liquids which may be parsed in some cases but unparsed in others. According to the results, he reaches two constraint rankings: 1) CODACON >> FAITHFULNESS >> MINDW >> MAX-IO >> DEP-IO >> ONSET, IDENT(F); 2) CODACON, *COMPLEX >> MAX-IO. Similarly, Zhang (2003) also applies OT to syllable structures and analyzes the ranking of constraints for syllable acceptability of Mandarin loanwords. By analyzing examples such as *tank* [tænk] → [tankɤ], *modern* ['mɔdə˞n] → [muədəŋ], *jacket* ['ʤækɪt] → [tɕakɤ], *brandy* ['bɹændi] → [pailandi], he proposes the following interaction of constraints: *COMPLEX/CODA-CON >> *DEL ([σCC]) >> MINWD >> MAX-IO >> DEP-IO. However, neither of the above studies deals with Mandarin palatalization.

The research most related to the present study is Ma (2004), in which an analysis of [ki]→[tɕi] palatalization is conducted. According to Ma (2004), constraint *Velar-I triggers the palatalization of [k] to [tɕ] when [k] occurs right before [i] as illustrated in the following Tableau (2).

(2) [ki]→[tɕi] (Ma 2004)

Input: ki	*VELAR-I	IDENT-IO (place)	IDENT-IO (place)/ ONS
a. ki	*!		
b. →tɕi		*	*

However, the main purpose of Ma (2004) is to introduce OT, and does not specifically examine palatalization in Mandarin. The [ki]→[tɕi] pair is the only example used in the analysis. Other palatalization phenomena besides [ki]→[tɕi], such

as [ɕju]→[ɛiu], are not examined either.

As can be seen above, Mandarin palatalization, especially the phenomenon of velar consonants being palatalized, has not been studied sufficiently within an OT framework. Since OT can offer a reasonable and efficient explanation to loanword phonology as discussed above, the present research aims to apply OT to loanword adaptations to examine how the velar consonants are modified in Mandarin loanwords borrowed from American English. Which constraints are involved and how these constraints interact will be discussed.

In the next section, the sound inventories of Mandarin and American English will be briefly introduced and compared. Section 3 introduces the theoretical background of this study and conducts an analysis using an OT approach with the focus on palatalization, followed by the conclusion in Section 4.

2 Sound inventories of Mandarin Chinese and American English

Mandarin and American English vowel inventories can be seen in (3) and (4) respectively, while (5) and (6) represent the Mandarin and American English consonant inventories.[1]

[1] This study is basically following Duanmu (2007) with the Mandarin sound inventories and The Language Samples Project (2001) with the American English sound inventories. Changes can be seen in the following text.

(3) Mandarin vowel inventory[1]

	Front	Central	Back
High	i y		u ɯ
Mid	e	ə ɚ	ɤ
Low	a		

(4) American English vowel inventory[2]

	Front	Central	Back
High	i ɪ		u ʊ
Mid	e ɛ	ə ɚ ʌ	o ɔ
Low	æ		ɑ

(5) Mandarin consonant inventory[3]

	Bilabial	Labio-dental	Alveolar	Palatal	Retroflex	Velar
Stop	p p^h		t t^h			k k^h
Nasal	m		n			ŋ
Fricative		f	s	ɕ	ʂ	x
Affricate			ts ts^h	tɕ $tɕ^h$	tʂ $tʂ^h$	
Glide	w			j	ɻ	
Liquid			l			

(6) American English consonant inventory

	Bilabial	Labio-dental	Inter-dental	Alveolar	Alveo-palatal	Palatal	Velar	Glottal
Stop	p b			t d			k g	(ʔ)
Nasal	m			n			ŋ	
Fricative		f v	θ ð	s z	ʃ ʒ			h
Affricate					ʧ ʤ			
Glide	ʍ w			ɹ		j		
Liquid				l				

[1] Three vowels have been added to Duanmu (2007)'s vowel inventory: [e] as in *bie* [bie] 'do not', [ɯ] as in *si* [sɯ] 'think', [ɤ] as in *he* [xɤ] 'river'.
[2] The vowel [ɚ] is added to the cited chart as in hacker ['hækɚ].
[3] In Duanmu (2007)'s consonant inventory, the retroflex glide is identified as [ʐ] instead of [ɻ]. The palatal glide [j] is also added to this inventory.

It can be seen from the tables above that for front low vowels, Mandarin has [a] while American English has [æ]. Also, there are palatal affricates [tɕ], [tɕʰ] and the palatal fricative [ɕ] in Mandarin consonant inventory while the places are either not occupied in American English. For the velar consonants, Mandarin has the velar fricative [x] while American English does not. It is suggested by the differences between the two languages that there must be sound change involved when American English words are adopted by Mandarin.

3 Optimality Theory and Mandarin loanword palatalization

3.1 An overview of Optimality Theory

Optimality Theory was first presented by Prince and Smolensky (1993). The basic idea of OT is that the output is the result of a series of conflicts between constraints. The constraints are ranked and violable. The candidate which incurs the fewest violations of the highest-ranked constraint among all the candidates is the optimal output, which is the correct expression. The analysis of OT is often illustrated with a violation tableau as in (7).

(7) A violation tableau

Input	Const1	Const2	Const3
a. Cand1	*!	*	*
b. Cand2		*!	
c. Cand3			**
d. →Cand4			*

In the violation Tableau (7), Const1, Const2 and Const3 are constraints, and

Cand1, Cand2, Cand3 and Cand4 are candidates. Constraints on the left side dominate constraints on the right side. Violation of a constraint is marked by an asterisk '*' while satisfaction is indicated by a blank cell. The exclamation mark '!' signifies a crucial violation which is responsible for a candidate not being optimal. The arrow mark '→' indicates the optimal candidate. In the language given in (7), Const1 and Const2 are ranked higher than Const3. That means it is more important to satisfy Const1 and Const2 than to satisfy Const3. As the tableau shows, Cand1 violates all of the constraints and loses the possibility to be the winner first. Cand2 is also a losing candidate because it violates Const2 although it does not violate Const1 and Const3. Both Cand3 and Cand4 violate Const3. However, the fact that Cand4 violates Const3 only once while Cand3 violates twice makes Cand4 the winner, which is the output.

As mentioned above, unlike other phonology theories, OT focuses more on output instead of input, since it is believed in OT that all languages have the same set of input. There is no language-particular restriction on the input. This is called richness of the base, where the word "base" refers to the input to the grammar and the word "richness" is used in the sense of profusion (Prince and Smolensky 2004:225). Richness of the base means that every grammar can handle a wide range of inputs. Even though a language has no words that alternate in a way that would require some underlying form, the grammar still has to deal with the input of that form. The grammar must be designed so that it selects something other than the unpronounceable form. It is the grammar alone, rather than the grammar aided by restrictions on the lexicon, that accounts for the set of possible words or grammatical

sentences (McCarthy 2002:89).

There are two types of constraints in OT. Faithfulness constraints prohibit differences between input and output, while markedness constraints require the well-formedness of the output on the structure. Therefore, for a specific language, the fact that some input is not presented as the output is because some markedness constraints rank higher than faithfulness constraints, and prevent it happening. It is argued in OT that constraint ranking is the only way that languages differ (McCarthy 2002). In other words, the constraints are universal; the differences between languages are caused by different ways to rank these constraints. That is, in some languages, one constraint is ranked higher than another constraint on the hierarchy while in some other languages it may be ranked lower.

3.2 Data

The data used in the current study are collected from the names of states and well-known cities of the United States. The Mandarin translations of these names meet two conditions:

1) they have been used for a relatively long time, and

2) they have been well accepted with little possibility of change in a short time.

The examples that will be discussed are listed below in (8) with IPA transcriptions done by the author[1].

[1] For this study, six graduate students who are native Mandarin speakers from different parts of China were asked to produce the words, and they confirmed the author's phonetic transcription.

(8)	American English[1]		Mandarin Chinese	Gloss
a.	/kən.tʌ.ki/	→	/kʰən.tʰa.tɕi/	‘Kentucky’
b.	/ki.wɛst/	→	/tɕi.wei.sɯ.tʰɤ/	‘Key West’
c.	/kæ.lɪ.fɔɹ.nʲə/	→	/tɕa.li.fu.ni.ja/	‘California’
d.	/gæl.vɛs.tən/	→	/tɕa.ɻə.wei.sɯ.tən/	‘Galveston’
e.	/kæn.zəs/	→	/kʰan.sa.sɯ/	‘Kansas’
f.	/spoʊ.kæn/	→	/sɯ.bə.kʰan/	‘Spokane’
g.	/hju.stən/	→	/ɕiu.sɯ.tən/	‘Houston’
h.	/hɪlz.bə.ɹoʊ/	→	/ɕi.ɻə.sɯ.bə.lɤ/	‘Hillsboro’

3.3 A constraint-based analysis of Mandarin loanwords palatalization

The sound change in Example (8a) [kən.tʌ.ki] → [kʰən.tʰa.tɕi] ‘Kentucky’ will be discussed first. In this example, the palatalization [ki] → [tɕi] can be observed[2]. As it shows, the velar consonant [k] changes to the palatal consonant [tɕ] when it precedes the front vowel [i]. Moreover, based on the consistency of OT, there must be a one-to one correspondence between the input and the output on the place of articulation. Therefore, two constraints are needed here in (9) and (10):

[1] This is a phonemic transcription, and thus aspiration is not shown in the American English examples.

[2] It is noticeable that Example (8a) [kən.tʌ.ki] → [kʰən.tʰa.tɕi] ‘Kentucky’ has two velar consonants and only one of them changes to a palatal consonant.

(9) **IDENT(place)**: The distinctive features of two corresponding segments must be identical in place.

(10) ***VELAR-V(+front)**: Velar consonants are not allowed to be followed by a front vowel.

Tableau (11) compares the unfaithful winning candidate [kʰən.tʰa.tɕi] with the faithful losing candidate *[kʰən.tʰa.ki]. Since [kʰən.tʰa.tɕi] involves a place change, it violates IDENT(place). The faithful candidate obeys IDENT(place), of course, but it contains a velar followed by a front vowel [i]. This is a violation of the markedness constraint *VELAR-V(+front). In order for [kʰən.tʰa.tɕi] to win, *VELAR-V(+front) must dominate IDENT(place).

(11) *VELAR-V(+front) >> IDENT(place)

kən.tʌ.ki	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →kʰən.tʰa.tɕi				*
b. kʰən.tʰa.ki	*W			L

Tableau (13) presents a different sort of losing candidate. A possible output could be created by removing the last front vowel [i] to prevent the velar [k] from occurring before it. The form *[kʰən.tʰa.k] satisfies the high-ranking markedness constraint *VELAR-V(+front) by deletion. However, deletion is ruled out by the faithfulness constraint MAX, which has a description in (12). According to MAX, the losing candidate *[kʰən.tʰa.k] is in violation because it has undergone the deletion, while the winning candidate [kʰən.tʰa.tɕi] is faithful to that constraint. Because [kʰən.tʰa.tɕi] is

the winner, MAX is also ranked above IDENT(place).

(12) **MAX**: Every segment in the input must have a correspondent in the output (No Deletion).

(13) MAX >> IDENT(place)

kən.tʌ.ki	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →kʰən.tʰa.tɕi				*
b. kʰən.tʰa.k		*W		L

Another possible alternation *[kʰən.tʰa.ti] exists as a candidate. For it to be a losing candidate, another constraint IDENT(dorsal) needs to be introduced as in (14). This constraint is similar to IDENT(place), but specific enough to prevent *[kʰən.tʰa.ti] to be the winner. As in Tableau (15), the losing candidate *[kʰən.tʰa.ti] violates IDENT(dorsal) and IDENT(place), while the winning candidate [kʰən.tʰa.tɕi] violates IDENT(place). Therefore, IDENT(dorsal) must be ranked over IDENT(place).

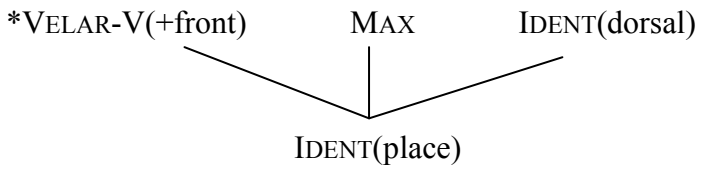
(14) **IDENT(dorsal)**: The distinctive features of two corresponding segments must be identical in the place of dorsal.

(15) IDENT(dorsal) >> IDENT(place)

kən.tʌ.ki	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →kʰən.tʰa.tɕi				*
b. kʰən.tʰa.ti			*W	*

Together, tableaux (11), (13) and (15) show that neither faithfully parsing the input as *[kʰən.tʰa.ki], nor deletion as *[kʰən.tʰa.k], nor greatly changing the place of articulation as *[kʰən.tʰa.ti] can lead to the correct output. The faithful parses require a consonant that violates *VELAR-V(+front), deletion requires an output that disobeys the faithfulness constraint MAX, and changing place from dorsal to coronal requires a consonant disobeys the constraint IDENT(dorsal). Thus, *VELAR-V(+front), MAX and IDENT(dorsal) must be undominated. Since the change of the place occurs instead of violating one of these constraints, all must dominate IDENT(place). That is, *VELAR-V(+front), MAX, IDENT(dorsal) >> IDENT(place) as shown in (16) with Hasse diagram. However, the ranking among *VELAR-V(+front), MAX and IDENT(dorsal) are not determined based on the data. The summary of this example is in Tableau (17).

(16) *VELAR-V(+front), MAX, IDENT(dorsal) >> IDENT(place)



(17) [kən.tʌ.ki] → [kʰən.tʰa.tɕi] summary

kən.tʌ.ki	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →kʰən.tʰa.tɕi				*
b. kʰən.tʰa.ki	*!			
c. kʰən.tʰa.k		*!		
d. kʰən.tʰa.ti			*!	*

Another example that supports the constraint ranking above is Example (8b)

[ki.wɛst] → [tɕi.wei.sɯ.tʰɤ] ‘Key West’. In the tableau shown in (18), the losing candidate *[ki.wei.sɯ.tʰɤ] violates *VELAR-V(+front) constraint because it contains the syllable [ki], where a velar consonant is followed by a front vowel. Another losing candidate *[i.wei.sɯ.tʰɤ] violates MAX because of the deletion. One more losing candidate *[ti.wei.sɯ.tʰɤ] violates IDENT(dorsal) and IDENT(place) because it contains a sound change from dorsal to coronal. On the other hand, [tɕi.wei.sɯ.tʰɤ] only violates IDENT(place), which ranks the lowest, making it the winning output.

(18)[ki.wɛst] → [tɕi.wei.sɯ.tʰɤ] summary

ki.wɛst	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →tɕi.wei.sɯ.tʰɤ				*
b. ki.wei.sɯ.tʰɤ	*!			
c. i.wei.sɯ.tʰɤ		*!		
d. ti.wei.sɯ.tʰɤ			*!	*

A similar situation can be observed in Example (8c) [kæ.lɪ.fɔɹ.nʲə] → [tɕa.li.fu.ni.ja] ‘California’. Since the American English vowel [æ] does not exist in the Mandarin vowel inventory, and the Mandarin vowel [a] shares the necessary features of [+low] and [+front], this is IDENT(place) causing an apparent change from the American English. In this case, [k] in [kæ.lɪ.fɔɹ.nʲə] again precedes a front vowel, so it violates the constraint *VELAR-V(+front). On the other hand, the candidate [tɕa.li.fu.ni.ja] violates IDENT(place) once because a place change occurs as [k] → [tɕ]. Therefore, for [tɕa.li.fu.ni.ja] to win, *VELAR-V(+front) which favors the winner must dominate IDENT(place) which favors the loser *[ka.li.fu.ni.ja]. This is illustrated in (19).

(19) *VELAR-V(+front) >> IDENT(place)

kæ.lɪ.fɔɪ.nʲə	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →tɕa.li.fu.ni.ja				*
b. ka.li.fu.ni.ja	*W			L

As can be seen in Tableau (20), an asterisk mark is put on the winning output [tɕa.li.fu.ni.ja] for it violates IDENT(place), while another mark is put on the losing output *[a.li.fu.ni.ja] for its violation of MAX. Therefore, MAX, which favors the winner, also needs to be ranked over IDENT(place) in this example.

(20) MAX >> IDENT(place)

kæ.lɪ.fɔɪ.nʲə	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →tɕa.li.fu.ni.ja				*
b. a.li.fu.ni.ja		*W		L

In Tableau (21), *[ta.li.fu.ni.ja] has one mark on IDENT(dorsal) and IDENT(place) respectively, while [tɕa.li.fu.ni.ja] has only one mark on IDENT(place). Therefore, IDENT(dorsal) must dominate IDENT(place) to make [tɕa.li.fu.ni.ja] the winner.

(21) IDENT(dorsal) >> IDENT(place)

kæ.lɪ.fɔɪ.nʲə	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →tɕa.li.fu.ni.ja				*
b. ta.li.fu.ni.ja			*W	*

While (19-21) offer a breakdown analysis, tableau (22) provides the summary of

Example (8c). The candidate of *[ka.li.fu.ni.ja] is discontinued because of its violation of *VELAR-V(+front), and the candidate of *[a.li.fu.ni.ja] is no longer considered as the winner since deletion violates MAX. Moreover, the candidate of *[ta.li.fu.ni.ja] cannot be the winner because it violates IDENT(dorsal). In this analysis, the winning candidate of [tɕa.li.fu.ni.ja] is favored by the three constraints above that are ranked higher than IDENT(place), which favors the losing candidates.

(22)[kæ.lɪ.fɔɪ.nʲə] → [tɕa.li.fu.ni.ja] summary

kæ.lɪ.fɔɪ.nʲə	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →tɕa.li.fu.ni.ja				*
b. ka.li.fu.ni.ja	*!			
c. a.li.fu.ni.ja		*!		
d. ta.li.fu.ni.ja			*!	*

Example (8d) [gæl.vɛs.tən] → [tɕa.ɻə˞.wei. sɯ.tən] ‘Galveston’ shows another piece of evidence for this point. As Tableau (23) shows, *VELAR-V(+front), MAX and IDENT(dorsal) which favor the winner [tɕa.ɻə˞.wei. sɯ.tən] must dominate IDENT(place) which favors the losing candidates.

(23)[gæl.vɛs.tən]→ [tɕa.ɻə˞.wei. sɯ.tən] summary

gæl.vɛs.tən	*VELAR-V(+front)	MAX	IDENT(dorsal)	IDENT(place)
a. →tɕa.ɻə˞.wei. sɯ.tən				*
b. ka.ɻə˞.wei. sɯ.tən	*!			
c. a.ɻə˞.wei. sɯ.tən		*!		
d. ta.ɻə˞.wei. sɯ.tən			*!	*

In Mandarin, palatalization does not occur unconditionally. The velars cannot be

palatalized in a syllable ending with [an]. In other words, there is no syllable structures such as *[tɕan], *[tɕʰan] or *[ɕan]. Therefore, another constraint needs to be introduced here in (24) to analyze Example (8e) [kæn.zəs] → [kʰan.sa.sɯ] 'Kansas'.

(24) ***[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$**: Syllables ending with a combination of a [+low], [+front] vowel and [n] right after a palatal are not allowed. A palatal consonant must precede a [-low], [+front] vowel if the vowel precedes the nasal.

For all the vowels in the Mandarin vowel inventory preceding a nasal consonant [n], only high front and mid front vowels can occur after palatal consonants. For example, *jin* [tɕin] 'gold', *qin* [tɕʰin] 'relative' and *xin* [ɕin] 'new' for high front unrounded vowel [i]; *jun* [tɕyn] 'army', *qun* [tɕʰyn] 'dress' and *xun* [ɕyn] 'fast' for high front rounded vowel [y]; *jian* [tɕen] 'see', *qian* [tɕʰen] 'thousand' and *xian* [ɕen] 'fresh' for mid front vowel [e]. Other combinations such as [un], [ɯn], [ɤn], [ən], [ɚn], including [an], are not allowed to follow a palatal consonant. This is also the case in Example (8a) [kən.tʌ.ki] → [kʰən.tʰa.tɕi] 'Kentucky' where [kʰ] cannot be palatalized.

In Example (8e), [æ] is replaced by [a] since it is the only correspondence for low front vowel in Mandarin, as shown above. Even so, by examining the output [kʰan.sa.sɯ], the velar consonant [kʰ] is not palatalized in this example. This is because since [a] is a low front vowel, [an] cannot occur right after a palatal within

the same syllable as described in the markedness constraint *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ above. That is, in Mandarin, the constraint *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ needs to be put in a high position on the ranking. In Tableau (25), the losing candidate *[tɕʰan.sa.sɯ] violates both constraints *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ and IDENT(place). Since the winning candidate [kʰan.sa.sɯ] violates *VELAR-V(+front), and *VELAR-V(+front) outranks IDENT(place), the newly introduced constraint *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ must dominate *VELAR-V(+front).

(25) *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ >> *VELAR-V(+front)

kæn.zəs	*[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$	DEP	*VELAR-V(+front)	IDENT(place)
a. →kʰan.sa.sɯ			*	
b. tɕʰan.sa.sɯ	*W		L	*W

Another losing candidate *[tɕʰian.sa.sɯ] is introduced in Tableau (27). A front vowel [i] is inserted between [tɕʰ] and [an] to make the candidate favored by *VELAR-V(+front). So as shown in the tableau, the winning candidate [kʰan.sa.sɯ] violates *VELAR-V(+front) but the losing candidate *[tɕʰian.sa.sɯ] does not. Therefore in this case, another constraint DEP in (26) is needed to prevent *[tɕʰian.sa.sɯ]; it must dominate *VELAR-V(+front). Because DEP requires the output not containing any segment that does not have a correspondent in the input, *[tɕʰian.sa.sɯ] is disfavored for it has an epenthesis of [i].

(26) **DEP**: Every segment in the output must have a correspondent in the input (No Epenthesis).

(27) DEP >> *VELAR-V(+front)

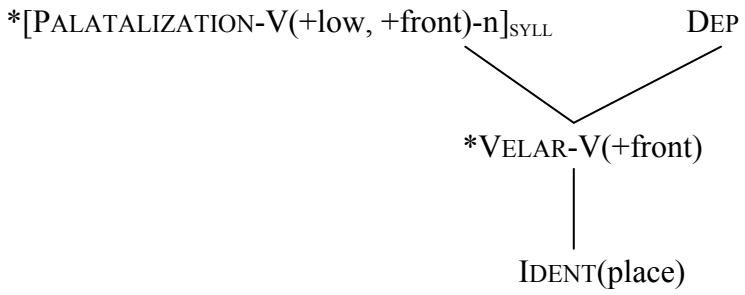
kæn.zəs	*[PALATALIZATION-V(+low, +front)n]$_{SYLL}$	DEP	*VELAR-V(+front)	IDENT(place)
a. →kʰan.sa.sɯ			*	
b. tɕʰian.sa.sɯ		*W	L	*W

The summary of Example (8e) is shown in Tableau (28). Constraints and their ranking are *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$, DEP >> *VELAR-V(+front) >> IDENT(place) as shown with Hasse diagram in (29). We should also notice that although *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ dominates *VELAR-V(+front), there is no evidence that it necessarily dominates MAX.

(28) [kæn.zəs] → [kʰan.sa.sɯ] summary

kæn.zəs	*[PALATALIZATION-V(+low, +front)n]$_{SYLL}$	DEP	*VELAR-V(+front)	IDENT(place)
a. →kʰan.sa.sɯ			*	
b. tɕʰan.sa.sɯ	*!			*
c. tɕʰian.sa.sɯ		*!		*

(29) *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$, DEP >> *VELAR-V(+front) >> IDENT(place)



Example (8f) [spoʊ.kæn] → [sɯ.bə.kʰan] 'Spokane' is another example for these constraints and their ranking in Mandarin. As shown in Tableau (30), the candidate of *[sɯ.bə. tɕʰan] loses because it violates the markedness constraint *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$, and the candidate of *[sɯ.bə.tɕʰian] loses because it violates the faithfulness constraint DEP. Both of the constraints above outrank *VELAR-V(+front) which was violated by the winning candidate [sɯ.bə.kʰan]. Since *VELAR-V(+front) ranks higher than IDENT(place) as discussed above, *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ and DEP also rank higher than IDENT(place).

(30) [spoʊ.kæn] → [sɯ.bə.kʰan] summary

spoʊ.kæn	*[PALATALIZATION-V(+low, +front)n]$_{SYLL}$	DEP	*VELAR-V(+front)	IDENT(place)
a. →sɯ.bə.kʰan			*	
b. sɯ.bə. tɕʰan	*!			*
c. sɯ.bə.tɕʰian		*!		*

The next example of (8g) [ɕju.stən] → [ɕiu.sɯ.tən] ‘Houston’ involves the palatal fricative [ɕ]. American English palatal fricative [ç] occurs when /h/ is followed by a high front vowel [i, ɪ] or a palatal glide [j]. In Mandarin consonant inventory, the closest consonant to the source [ç] is [x]. However, as in Tableau (31), the candidate *[xiu.sɯ.tən] with [x] is a losing candidate since it violates *VELAR-V(+front) constraint, which ranks higher than IDENT(place). Tableau (32) shows how another candidate *[iu.sɯ.tən] cannot be the winner. The candidate *[iu.sɯ.tən] violates MAX once since it has one deletion from the input to the output. Since MAX ranks over IDENT(place), which is violated by the winner, *[iu.sɯ.tən] cannot be the winning candidate. One more candidate *[sju.stən] is shown in Tableau (33). It loses here because it violates IDENT(dorsal) which is ranked higher than IDENT(place).

(31) *VELAR-V(+front) >> IDENT(place)

ɕju.stən	*COMPLEX	*VELAR-V(+front)	MAX	IDENT (dorsal)	IDENT (place)
a. →ɕiu.sɯ.tən					**
d. xiu.sɯ.tən		*W			**

(32) MAX >> IDENT(place)

ɕju.stən	*COMPLEX	*VELAR-V(+front)	MAX	IDENT (dorsal)	IDENT (place)
a. →ɕiu.sɯ.tən					**
d. iu.sɯ.tən			*W		L

(33) IDENT(dorsal) >> IDENT(place)

çju.stən	*COMPLEX	*VELAR-V(+front)	MAX	IDENT (dorsal)	IDENT (place)
a. →ɕiu.sɯ.tən					**
d. siu.sɯ.tən				*W	**

Example (8g) also involves another constraint (34) where syllables do not allow consonant clusters. In Tableau (35), the winning candidate [ɕiu.sɯ.tən] replaces one member [j] of the cluster [ɕj] with the closest vowel [i], while the losing candidate *[ɕju.sɯ.tən] remains unchanged. Both the winning candidate [ɕiu.sɯ.tən] and the losing candidate *[ɕju.sɯ.tən] violate IDENT(place), but neither of the two candidates violates other constraints mentioned above. Therefore *COMPLEX which is violated by the losing candidate must rank over IDENT(place) to make sure [ɕiu.sɯ.tən] is the winner.

(34) ***COMPLEX**: No consonant cluster is allowed within a syllable.

(35) *COMPLEX >> IDENT(place)

çju.stən	*COMPLEX	*VELAR-V(+front)	MAX	IDENT (dorsal)	IDENT (place)
a. →ɕiu.sɯ.tən					*
b. ɕju.sɯ.tən	*W				*

Tableau (36) shows the full analysis of Example (8g). The candidates of *[ɕju.sɯ.tən] and *[xju.sɯ.tən] violate the highest ranked constraint *COMPLEX. The candidate of *[xiu.sɯ.tən] violates *VELAR-V(+front). The candidate of *[iu.sɯ.tən]

violates MAX. The candidate of *[siu.sɯ.tən] violates IDENT(dorsal). All the constraints above rank higher than IDENT(place), which is violated by all the candidates including the winning one. Since the lowest ranked constraint IDENT(place) is the only constraint that the candidate of [ɕiu.sɯ.tən] violates, it is the winner of the set of candidates. However, one should note that although *COMPLEX dominates IDENT(place), it does not mean *COMPLEX must dominate *VELAR-V(+front), MAX or IDENT(dorsal).

(36)[çju.stən] → [ɕiu.sɯ.tən] summary

çju.stən	*COMPLEX	*VELAR-V(+front)	MAX	IDENT (dorsal)	IDENT (place)
a. →ɕiu.sɯ.tən					**
b. ɕju.sɯ.tən	*!				*
c. xju.sɯ.tən	*!				*
d. xiu.sɯ.tən		*!			**
e. iu.sɯ.tən			*!		**
f. siu.sɯ.tən				*!	**

By introducing *COMPLEX, the constraint ranking in (16) can be modified as in (37) with Hasse diagram.

(37)*COMPLEX, *VELAR-V(+front), MAX, IDENT(dorsal) >> IDENT(place)

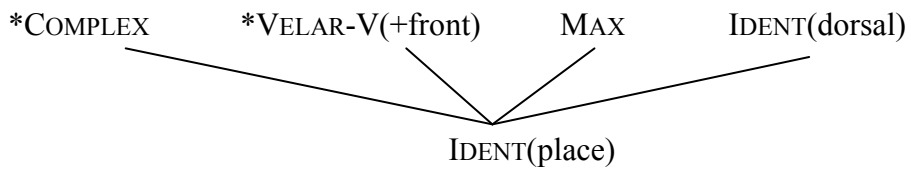


Tableau (38) gives another example (8h) [çɪlz.bə.ɹoʊ] → [ɕi.ʯɚ.sɯ.bə.lɤ] 'Hillsboro' to test the constraint ranking regarding to the palatalized [ɕ]. Because [ɪ] does not exist in Mandarin vowel inventory, it needs to be replaced with its correspondence [i]. Given the ranking of *COMPLEX, *VELAR-V(+front), MAX, IDENT(dorsal) >> IDENT(place), candidates *[ɕj.ʯɚ.sɯ.bə.lɤ] and *[xj.ʯɚ.sɯ.bə.lɤ] cannot be selected as the winner because they have a marker on the markedness constraint *COMPLEX respectively. Candidate *[xi.ʯɚ.sɯ.bə.lɤ] cannot win because it violates *VELAR-V(+front) for it has a velar consonant [x] preceding a front vowel [i]. The violation of MAX prevents the candidate *[i.ʯɚ.sɯ.bə.lɤ] winning because it has a deletion. *[si.ʯɚ.sɯ.bə.lɤ] cannot be a winning candidate since it violates IDENT(dorsal) from dorsal to coronal. Candidate [ɕi.ʯɚ.sɯ.bə.lɤ] only violates IDENT(place) which ranks lowest on the hierarchy. Therefore it is chosen as the winner, and this is consistent with the data.

(38)[çɪlz.bə.ɹoʊ] → [ɕi.ʯɚ.sɯ.bə.lɤ] summary

çɪlz.bə.ɹoʊ	*COMPLEX	*VELAR-V(+front)	MAX	IDENT (dorsal)	IDENT (place)
a. →ɕi.ʯɚ.sɯ.bə.lɤ					**
b. ɕj.ʯɚ.sɯ.bə.lɤ	*!				*
c. xj.ʯɚ.sɯ.bə.lɤ	*!				*
d. xi.ʯɚ.sɯ.bə.lɤ		*!			**
e. i.ʯɚ.sɯ.bə.lɤ			*!		**
f. si.ʯɚ.sɯ.bə.lɤ				*!	**

As mentioned above, in OT, the constraints are universal; the ranking of them is the only way that languages differ. The constraints proposed in the present study

include faithfulness constraints MAX, DEP, IDENT(dorsal), IDENT(place) and markedness constraints *COMPLEX, *VELAR-V(+front), *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$. MAX, DEP, IDENT(dorsal), IDENT(place) and *COMPLEX have been argued to be universal cross-linguistically by a number of scholars including McCarthy (2008). *VELAR-V(+front) is one of the assimilation constraints. When a velar consonant is followed by a front vowel, the tip of the tongue is also fronted, so that the velar will be naturally palatalized. The markedness constraint *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ can be proved functionally as well. The functional explanations for constraints in OT phonology generally involve reducing the burden on the speaker or hearer (McCarthy 2008:222). For a palatal consonant, the tip of the tongue is placed at the palatal which is a high position. When it is followed by a low vowel, the tongue needs to be lowered. When a nasal [n] follows this combination of [palatalization-V(+low, +front)], the tongue has to be raised again to the alveolar ridge. If these three sounds are in one single syllable, the speaker needs to lower the tongue from the palate once and raise it again within a relatively short time. Therefore, the constraint of *[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$ can be functionally demonstrated to occur cross-linguistically.

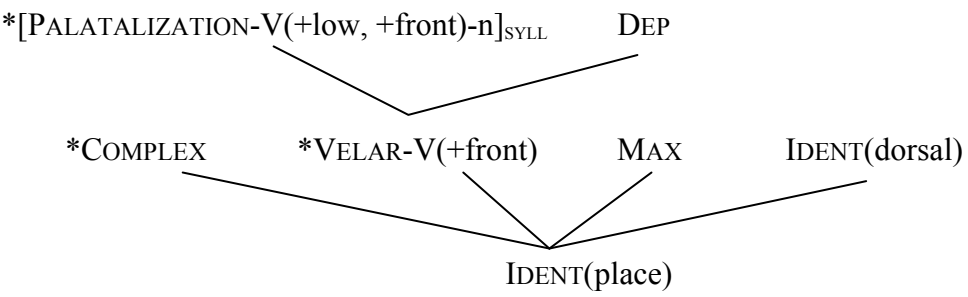
4 Conclusion

The current study conducts a constraint-based analysis on palatalization phenomena in Mandarin loanwords borrowed from American English based on transliterated American state and city names. Because of the differences between Mandarin and

American English in sound inventories and syllable structures, words introduced to Mandarin from American English need to undergo loanword adaptation mainly through three ways: epenthesis, deletion, and feature change. The present study focuses on the feature change, specifically, palatalization of velar consonants, and the theoretical framework of OT provides an explanation for that. The constraints and their ranking accounting in this study are listed below with Hasse diagram in (39).

(39) a. *COMPLEX, *VELAR-V(+front), MAX, IDENT(dorsal) >> IDENT(place)

b.*[PALATALIZATION-V(+low, +front)-n]$_{SYLL}$, DEP >> *VELAR-V(+front) >> IDENT(place)



However, some other factors besides phonological ones may interfere with the results as well, such as character choosing, semantics, translation conventions, and even the bias of the people who are translating. Take the loanwords in (1) as examples. The characters for *Sprite* [spraɪt] → *xuebi* [ɕuepi] are 雪碧, the first character of which literally means 'snow' and the second means 'green'. As a soft drink product, its Chinese name implies a cool feeling and creates consistency with the color of the bottle. The word *hacker* ['hækɚ] → *heike* [xeikʰɤ] has the characters of 黑客,

meaning ‘guest in black’; the Chinese characters for *broadway* [ˈbɹɔdweɪ] → *bailaohui* [pailauxui] are 百老汇, which has a similar meaning of ‘gathering hundreds of veterans’. In a practical application, the transliteration has a certain degree of flexibility. The meanings of the characters have influence on the character choosing process, and thus have influence on the transliteration process. If they are not taken into account for those examples, other alternatives which are more accordant with the transliteration rules may be chosen instead. As for the data collected for this study, *Hawaii* [həˈwaii] → *xiaweiyi* [ɕiaweiji] 夏威夷 is an example. The fact that [hə] is transliterated as [ɕia] instead of [xɤ], which is more consistent with the transliteration rules, is mainly because the chosen character of [ɕia] 夏 means ‘summer’ which vividly expresses the image of the place of Hawaii. Therefore, interfering factors such as these may lead to some counterexamples, and thus need to be further studied.

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