

Modeling Salience and Prosody in Loanword Adaptation: Cases of English [ɹ] in Mandarin*

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This paper probes the effects of phonetic salience and prosody on patterned lexical variation in word-loaning processes, regarding the retention/deletion of [ɹ] from English input to the corresponding underlying representations perceived by Mandarin speakers. Based on a sizable corpus, while the adaptation of English [ɹ] varies on a word-by-word basis, the percentage distribution of retention/deletion is observed to be conditioned by a handful of factors of phonetic salience, specifically position, sonority and similarity/dissimilarity, and prosodic preference for binary feet in Mandarin. The patterned distribution in loanword adaptation is appropriately modeled in stochastic evaluations (Boersma 1997, 1998, Boersma & Hayes 2001), which better capture this insight through the key notions of seeing constraints as ranges of value on a linear scale of strictness, and, insofar as the ranking values of two mutually contradictory constraints are close enough, overlapping is inevitable, i.e. the area where dominance between them may be reversed and which results in variation.

Key words: loanword adaptation, lexical variation, perception, salience, stochastic-OT

1. Introduction

Due to the key notions of violable constraints that suitably model the oftentimes conflicting forces of preservation of input information and obedience to the sound system of the output language, Optimality Theory (OT, Prince & Smolensky 1993/2004) has served as a mainstream framework to model loanword adaptation (Yip 1993, 2002, 2006, Paradis 1995, 1996, Kenstowicz 2003a, 2003b, Shinohara 2001, 2004, Labrune 2002, Kang 2003, Shih 2004, Miao 2005, Lu 2006, Lin 2007a, 2008a, 2008b, among many others). However, inevitable **lexical variation**¹ (Zuraw 2010) between retention (through vowel insertion) and deletion of an excess consonant from

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¹ Lexical variation in loanwords refers to the situation where an element, e.g. a segment, in foreign input may undergo a certain phonological process (say, deletion) to conform to native phonotactics, while the element in another foreign input in the same or similar phonetic context may undergo a different phonological process (say, vowel insertion). For example, the [ɹ] in English *Norman* is deleted as [.nwo53.man53.] in Mandarin, while the [ɹ] in *Hormone* is retained via schwa insertion as [.xɿ53.əɹ21.moŋ35.]. In free variation, on the other hand, a single foreign word has two or more adapted forms in the recipient language. For example, the English name *Truman* is adapted as [.tu53.lu21.mən35.] to refer to the American president, whereas it is adjusted as [.tʃu21.mən35.] in the Mandarin name of the Hollywood film *Truman Show*.

the source language (L_2) that is beyond the syllabic scope of the recipient language (L_1) is either left unanswered or deemed as exceptional to the pattern that is under investigation, as confined by the idea of fixed ranking in standard OT. In response, this paper proposes that the distribution of “normalities” and “exceptions” are in effect patterned by phonetic salience and prosody, and offers a resolution to the above theoretical inadequacy by employing Stochastic OT (Boersma 1997, 1998, Boersma & Hayes 2001). In this revised version of OT, universal constraints are viewed as ranges of value along a linear scale, and variation in input-output mapping is meant to happen insofar as the ranking values of two contradictory constraints are close enough to incur an overlapping area. The dominance between the two constraints may alternate in this area, and hence variation happens. The probability of variation rests on the precise distance between the respective ranking values of the two constraints. The theoretical background will be elaborated upon in Subsection 6.1.

Word-loaning processes involve nativization of a foreign input that originally may or may not be compatible with the native phonology segmentally or/and suprasegmentally. Amongst the representative works that persuasively make their claims for the word-loaning process (Paradis & LaCharité 1997, LaCharité & Paradis 2005, Peperkamp & Dupoux 2003, Silverman 1992, Yip 1993, Kenstowicz 2003b), the perception-production view in loanword adaptation can be dated back to Silverman (1992), where his multi-scansion model consists of two separate, ordered levels, namely the Perceptual Level (Scansion 1) and Operative Level (Scansion 2). Following Silverman, Yip (1993) agrees that the adapter’s perception is governed by the native phonotactics, while unlike Silverman, she provides a formal analysis by adopting a constraint-based framework, i.e. an early version of Optimality Theory, to account for the phonological processes in the Operative Level. Kenstowicz (2003b) takes a step further by sketching two separate OT-based grammars with different rankings: the “loan source” is first filtered by the perception grammar, resulting in a “lexical representation” (the underlying form), which is in turn subject to the production grammar, then leading to the eventual output of the target language. Based on these studies, we mildly remodel their perception-production standpoints to fit the focus of this paper, as schematized in Figure 1.

Perception and production are considered to play equal roles in the word-loaning process (Silverman 1992, Yip 1993, Kenstowicz 2003b, Broselow 2005), where L_1 phonology works at both levels—processing the acoustic information in perception and adjusting the underlying representation (henceforth UR, the output of perceptual processing) in production. In particular, this paper highlights the stage of perceptual processing, i.e. how perception and L_1 phonology determine the preservation and ignorance of a given element both individually and interactively.

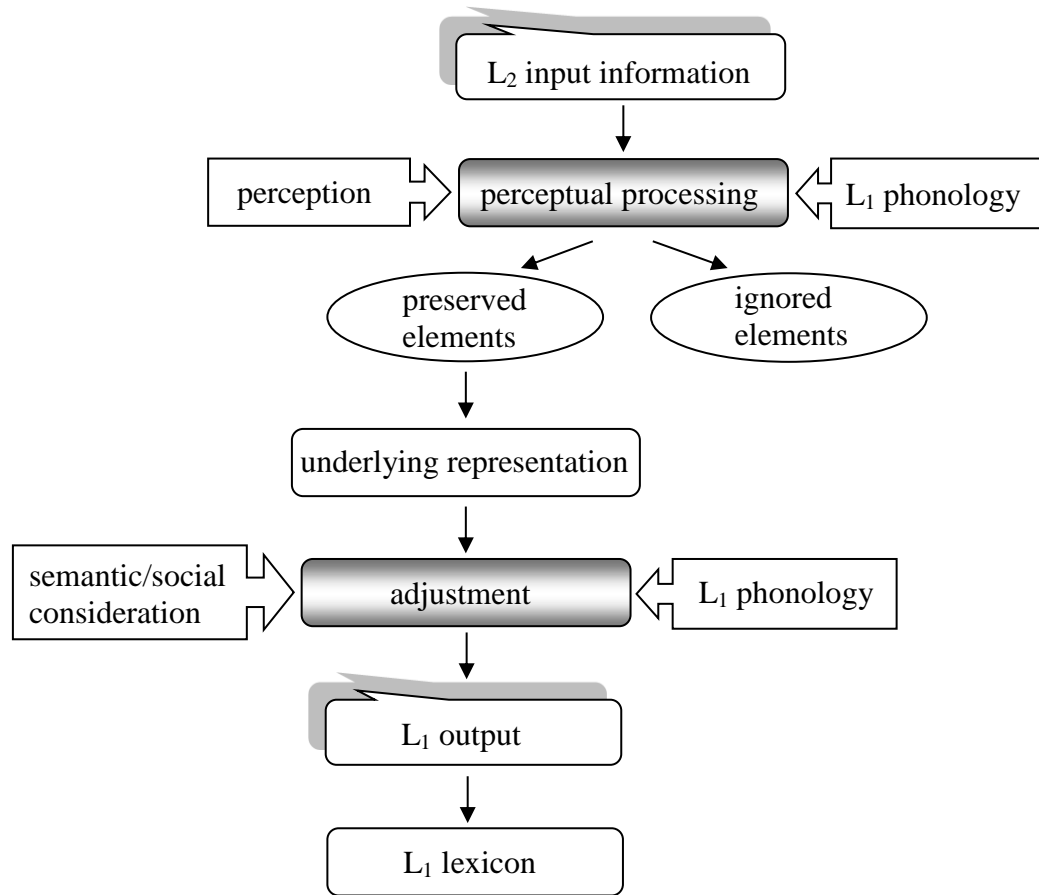


Figure 1. A perception-production model for loanword adaptation (adapted from Silverman 1992, Yip 1993, and Kenstowicz 2003b)

The data are Mandarin (L₁) adaptations of English (L₂) loanwords and transliterations. We concern factors of phonetic saliency and prosody that govern the retention/deletion of an input segment in the output form. Specifically, phonetic saliency is claimed to be correlated with position (onset/coda), sonority, and similarity/dissimilarity (to the neighboring sound). Prosody, on the other hand, refers to the preferred disyllabic feet in Mandarin. In the previous works on Mandarin loanword phonology (Miao 2005, Lin 2007a, 2008a, 2008b), little has been said in this regard. In this research, among the L₂ segments that are adapted by Mandarin speakers, the retention/deletion of the retroflex [ɿ] serves as an appropriate target of investigation on phonetic saliency due to its sonorancy and articulatory closeness to [+back] vowels. Detailed discussion will appear in Section 3.

The loanwords in question are based on a collection of 1,563 English-based loanwords and transliterations of proper nouns in Mandarin, among which 330 are monosyllabic and 1,233 polysyllabic. Sources containing [ɿ] in any position are observed and the retention/deletion of it in the Mandarin adaptation is recorded. It is

worth noting that for the investigation of the effects of phonetic salience on loanword adaptation, we observe only the polysyllabic sources, considering Mandarin adapters tend to retain most simplex coda consonants by inserting a vowel with a view to producing a minimally disyllabic L₁ output (Miao 2005, Lu 2006), regardless of the phonetic salience of the coda consonants. To clarify the extent of prosodic influence on adaptation, we consider monosyllabic sources instead since, presumably, the adapter has to choose between the two alternatives: either sacrificing the [ɹ] coda for its weak salience or rescuing it for an output with at least two syllables.

The discussion proceeds as follows. Section 2 gives a brief introduction to the phonotactic basics of the two languages in question, followed by Section 3, in which the data are presented to show various effects of phonetic salience, in the order of position, sonority, and similarity/dissimilarity. Section 4 gives the monosyllabic data to manifest the effect of similarity-prosody interaction. A conventional OT-based analysis is provided in Section 5, where multiple constraint rankings are initially proposed to indicate the paradoxical problems. In Section 6, data with lexical variation are submitted to a stochastic evaluation. Finally, Section 7 gives concluding remarks.

2. Phonotactic basics

The languages involved are English (L₂) and Mandarin (L₁). English has 24 consonants and allows maximally three consonants in onset, as in “[.splæʃ.] *splash*” and four consonants in coda, as in “[.t^hɛksts.] *texts*”. Mandarin has 21 consonants, and the maximal syllable structure is, in the standard view, in the form of CGVX (C: consonant, G: glide, V: vowel, X: C or V, Cheng 1973). Except for [ŋ], all consonants can be the onset, whereas only the alveolar nasal [n] and the velar nasal [ŋ] can be the coda consonants, as in “[.min35.] 民” (‘people’) and “[.miŋ35.] 明” (‘bright’). An exception is [ɹ] in a limited context, with the only possible nucleus being schwa [ə], as in “[.əɹ35.] 兒” (‘son’), “[.əɹ21.] 耳” (‘ear’), “[.əɹ53.] 二” (‘two’). No consonant is allowed in the onset of the structure [əɹ].

Liquids, if any, are obligatorily adjacent to the nuclear vowel, either prevocalic or postvocalic, under the government of SSP. In English, [ɹ] appears as a simplex onset ([.ɹe.] *ray*), the second ([.p^hɹe.] *pray*) or third onset ([.spɹe.] *spray*) following an obstruent in a complex onset, the simplex coda ([.ɑɹ.] *are*), or the first consonant in a complex coda ([.ɑɹt.] *art*). In Mandarin, however, the only position for [ɹ] is the onset, either as a simplex one ([.ɹan21.] 染, ‘dye’) or followed by a labial glide ([.ɹwan21.] 軟, ‘soft’) except for, as mentioned above, the simplex coda after a schwa. Thus, while L₂ [əɹ] may stay intact in L₁, e.g. “[.əɹg.] *Erg* → [.əɹ21.gɤ35.] 爾格”, any [ɹ]-

coda that is not preceded by a schwa in L₂ is bound to be systematically adjusted in L₁.

3. Phonetic saliency

In this section, the patterns regarding retention/deletion of [ɹ] are claimed to result from a handful of phonetic effects on saliency, in the order of position, sonority, and similarity/dissimilarity. As noted in Section 1, monosyllabic loanwords are filtered out in this section to keep the saliency-driven patterns simple. The prosodic factor will be discussed in Section 4.

3.1 Position

As discussed in Section 2, [ɹ] appears in both the syllable onset and coda positions and are obligatorily adjacent to the vowel in an L₂ syllable. The patterns of retention/deletion in L₁ are laid out in terms of this positional difference as illustrated in (1). Being irrelevant to the current issue, English stress and Mandarin tones are left out henceforth to avoid distraction and save space.

(1) Position-driven patterns²

a. Onset

<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
[.ɹæm.bo.] <i>Rambo</i>	/.lan.p ^h wo./ ³	Retention	100% (187/187)

b. Second/Third onset

<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
[.o.p ^h ɹɑ.] <i>Oprah</i>	/.ou.p ^h u.lɑ./	Retention	87.84% (65/74)
[.laɪ.k ^h ɹə.] <i>Lycra</i>	/.laɪ.k ^h a./	Deletion	12.16% (9/74) ⁴

² English input is presented in brackets since it is a true phonetic realization of the source, while the corresponding underlying forms in Mandarin are enclosed in slashes since they are the mental representations in the L₁ speaker's short-term memory. Note that the phonetic transcription of an L₁ UR may not necessarily be the authentic underlying form, which awaits further adjustment in production grammar that involves semantic and social factors. For convenience's sake, however, the L₁ output form is adopted as its L₁ UR, which should be harmless for a paper that simply deals with the issue of whether [ɹ] is retained or not, as determined early in perceptual processing.

³ Both English liquids [ɹ] and [l] in onset are predominantly adapted into [l], even though the former phonetically corresponds more closely to the identical [ɹ] (or at least the closer [ʒ]), also a permissible onset in Mandarin. Miao (2005) attributes it to the unmarkedness of [l]-initial syllables in Mandarin. Such an issue belongs to the production level and is thus beyond this paper's scope.

⁴ Significantly more examples (5 out of 9) of deletion are observed in [k^hɹ], [kɹ] and [gɹ] sequences, e.g. “[.maɪ.k^hɹo.fon.] *microphone* → [.maɪ.k^hɿ.fon.] 麥克風”. An explanation is that velar stops and the retroflex [ɹ] are both dorsal in place of articulation, leading to the weaker perceptual saliency of the latter.

c. Coda

<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
[.hɔɪ.mon.] <i>Hormone</i>	/.xɤ.əɪ.mon/	Retention	8.61% (39/453)
[.nɔɪ.mən.] <i>Norman</i>	/.nwo.man/	Deletion	91.39% (414/453)

In (1a), a simplex onset [ɪ] in L₂ is retained in the L₁ underlying representation without exception, either as /l/ or /ɪ/ (see Footnote 3). Alternations are found in the other two categories. In (1b), [ɪ] being the second/third onset, retention is still the main strategy, accounting for 87.84%. In the remaining 12.16%, however, [ɪ] is deleted. In (1c), contrary to onsets, 91.39% of [ɪ]-codas are deleted, with only 8.61% retained.

Syllable onsets, as word-initial materials, enjoy more perceptual privileges compared to syllable codas (Beckman 1998, Steriade 2001b). The “gradiance” of positional prominence is well illustrated in (1) in the sense that the retention rate is the highest in (1a), intermediate in (1b), and the lowest in (1c). Following Steriade’s (2001b) formula, if a speaker’s judgment of phonological similarity is deduced from observations of confusion, the salience hierarchy of [ɪ] in different positional contexts can be sketched in (2), denoting that the perceptual distinctiveness between [ɪ] and silence in the simplex onset position is greater than that in the second or third onset position, which in turn is greater than that in the coda position.

(2) Salience hierarchy by position (➤ = less confusable, more distinctive than)

[ɪ] vs. ∅ / _V ➤ [ɪ] vs. ∅ / .C(C)_V ➤ [ɪ] vs. ∅ / V_

It is noteworthy that in the realization of the second/third onset, a couple of alternatives, specifically in the sequences of [tɪ], [t^hɪ] or [dɪ], are excluded from our analysis for the reasons elaborated below.

When the onset cluster is [tɪ], [t^hɪ] or [dɪ] and is followed by a front vowel in the source, two other repair strategies are discovered. First, with 14 tokens, the alveolar stop, the first onset, is mapped to the alveolar affricate [ts^h], and the [ɪ] as the second onset is glided to [w], surfacing as “[ts^hwei.] 崔” in L₁. Examples of such are “[t^hɛ.vəɪ.] *Trevor* → [ts^hwei.fo.] 崔佛” and “[dɪæks.ləɪ.] *Drexler* → [ts^hwei.si.lɤ.] 崔斯勒”. Though [ɪ]-gliding (with the feature [+round] is retained) is widely attested in works on first language acquisition and speech errors, which may indeed influence the mapping. Another explanation is that the L₁ morpheme “[ts^hwei.] 崔” is a renowned family name among Chinese people, and thus transliteration from sources referring to people’s names to this morpheme is plausible. An example to illustrate this is “[.dʌŋ.k^hən.] *Duncan*” and “[.dʌn.lɑp.] *Dunlop*”, the first syllables of which

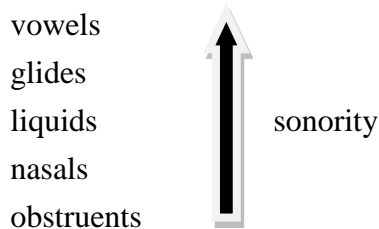
are similar. The former, an English family name, is transliterated as “[.təŋ.k^hən.] 鄧肯”, the first morpheme of which is also a well-known family name among Chinese. However, the latter, the brand name of a tire company, was transliterated as “[.təŋ.lu.p^hu.] 登錄普”, the first morpheme of which is a common morpheme, not a family name, though the syllable structure is identical to that of “鄧”. We intentionally leave out entries of this type since semantic/social factors are involved.

Second, with 7 tokens, the same sequences are “fused” into a single retroflex L₁ phoneme [tʂ^h] or [tʂ], as in “[.k^hæs.tʂo.] *Castro* → [.k^ha.si.tʂ^hu.] 卡斯楚” and “[.a.m.stʂaŋ.] *Armstrong* → [.a.mu.si.tʂwaŋ.] 阿姆斯壯”. A perceptual account of the fusion is presumed to be the feature [+coronal] that the two consecutive consonants [t] and [ɹ] have in common, which endows the sequence with a greater tightness in perception. Cases like this are excluded too for the status of [ɹ]’s retention/deletion is unclear in this process.

3.2 Sonority

The sonority of a sound refers to its loudness relative to that of other sounds with the same length, stress and pitch (Ladefoged 2001:227). The sonority scale that is widely agreed upon by most phonologists is shown in (3).

(3) Sonority scale of speech sounds



It is thus assumed that in isolation, vowels are most perceptible while obstruents are the least, with the other sounds placed in between, as scaled in (4).

(4) Saliency hierarchy by sonority

V vs. ∅ ➤ G vs. ∅ ➤ L vs. ∅ ➤ N vs. ∅ ➤ O vs. ∅

However, when a segment appears next to a vowel, namely in the context of either “_V” or “V_”, it is contended that the ranking of saliency concerning the sonority scale is reversed, since in that position, the more sonorant the segment is, the more similar it is to the adjacent vowel, contributing to less contrast between the vowel and the segment. This results in (5), indicating that the perceptual distinctiveness between

an obstruent and silence when adjacent to a vowel is the greatest, while that between a vowel and another vowel is the weakest, in the opposite order to (4).

(5) Salience hierarchy in the context of “_V” or “V_” by sonority

O vs. \emptyset / _V or V_ \triangleright N vs. \emptyset / _V or V_ \triangleright L vs. \emptyset / _V or V_ \triangleright G vs. \emptyset / _V or V_ \triangleright V vs. \emptyset / _V or V_

The effect is shown in the comparison between the retention rates of [ɹ] and stops from the loanword data, given in (6).

(6) Comparison between [ɹ] and stops in retention rate

a. Onset

[ɹ] (high sonority): 100% ([.ɹɑ.bi.] *Robby* → [.ɹwo.pi.] 羅比)

Stops (low sonority): 100% ([.bɑ.bi.] *Bobby* → [.pa.pi.] 巴比)

b. 2nd/3rd onset

[ɹ] (high sonority): 87.84% ([.fɹæn.k^hi.] *Frankie* → [.fa.lan.tɕi.] 法蘭基)

Stops (low sonority): 100% ([.stæn.fəɹd.] *Stanford* → [.ɕi.tan.fo.] 史丹佛)

c. Coda

[ɹ] (high sonority): 8.61% ([.dɑɹ.wɪn.] *Darwin* → [.ta.əɹ.wən.] 達爾文)

Stops (low sonority): 62.83% ([.ɛd.wɪn.] *Edwin* → [.ai.tɻ.ən.] 愛德恩)

As shown, the positional prominence of simplex onsets overrides any other effects, and hence in (6a), both [ɹ] and stops as onset are 100% preserved in L₁ without exception. Being the second or third onset in (6b), however, 12.16% of the [ɹ]’s undergo deletion ([.maɪ.k^hɹə.fon.] *microphone* → [.maɪ.k^hɻ.fon.] 麥克風), with 87.84% of them still retained. On the other hand, second onset stops are 100% retained in L₁. The most significant contrast is revealed in (6c), where [ɹ]-codas are usually deleted ([.hɑɹ.vəɹd.] *Harvard* → [.xa.fo.] 哈佛), and only less than 10 percent of them remain. In contrast, over 60% of the stops in the coda position are preserved in L₁, with the rest deleted ([.lɑ.dʒɹk.] *logic* → [.ɹwo.tɕi.] 邏輯).

English loanwords in Cantonese reveal a similar sonority effect on adaptation patterns and serve as a proper cross-linguistically comparable case. The data in (7) are cited from Silverman (1992:290, 301, 303) and Yip (1993:267, 270, 2006:953) yet slightly modified in phonetic transcription.

(7) English-based loanwords in Cantonese (Silverman 1992, Yip 1993, 2006)

a. [ɹ] in monosyllabic loanwords

(i) Retention

<u>English</u>	<u>Cantonese</u>
break	[.pik.lik.]
print	[.p ^h i.lin.]
cream	[.key.lim.]
brake	[.pik.lik.]
grand	[.ka:k.la:n.]
spring	[.si.pit.liŋ] (Yip 1993)

(ii) Deletion

<u>English</u>	<u>Cantonese</u>
price	[.p ^h aj.si.]
friend	[.fɛn.]
prom	[.p ^h ɒŋ.]
spring	[.si.pɛŋ.] (Yip 2006)
creep	[.kip.]

b. [ɹ] in polysyllabic loanwords

Deletion

<u>English</u>	<u>Cantonese</u>
printer	[.p ^h ɛn.t ^h a.]
broker	[.puk.k ^h a.]
freezer	[.fi.sa.]
professor	[.p ^h ow.fa.sa.]
proton	[.pow.t ^h an.]
strawberry	[.si.tɔ.pɛ.lej.]

c. Stops in monosyllabic and polysyllabic loanwords

Retention

<u>English</u>	<u>Cantonese</u>
stick	[.si.tik.]
stamp	[.si.tam.]
store	[.si.tɔ.]
Spielberg	[.si.p ^h i.wo.]
spanner	[.si.pa.la.]
spare	[.si.pe.]
strawberry	[.si.tɔ.pɛ.lej.]

Cantonese does not allow [ɹ] in any position (Bauer & Benedict 1997). As the English second or third onset in (7a, b), [ɹ]'s are retained only in (7a)(i), where the English sources are all monosyllabic. This is to meet the disyllabic preference as observed in most Chinese languages, though exceptions can still be found in (7a)(ii). In (7b), however, no retention appears when the English source has two or more syllables. In contrast, stops are always retained regardless of the syllable number of the source, as shown in (7c). As in Mandarin, the sonority effect plays a crucial role in Cantonese data.

3.3 Similarity/Dissimilarity

As discussed, coda is perceptually the weakest position and thereby a postvocalic [ɪ] is subject to deletion when borrowed into L₁. Closer investigation, however, reveals that backness of the preceding vowel is highly influential, as shown in (8).

(8) Similarity-driven patterns

a. V[-back] + [ɪ]

<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
[.k ^h æʃ.mi.ɪ.] <i>Kashmir</i>	/.k ^h ʁ.ʃi.mi.əɪ./	Retention	65.22% (15/23)
[.æm.p ^h ɪ.] <i>ampere</i>	/.an.p ^h ei./	Deletion	34.78% (8/23)

b. V[+back] + [ɪ]

<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
[.daɪ.wɪn.] <i>Darwin</i>	/.ta.əɪ.wən./	Retention	5.58% (24/430)
[.k ^h ɑɪ.mən.] <i>Carmen</i>	/.k ^h a.mən./	Deletion	94.42% (406/430)

Contrary to the general strategy of deletion for [ɪ]-codas, in context (a), where the nuclear vowel is [-back], 65.22% of the [ɪ]’s are retained through schwa insertion, and the rest, 34.78%, are deleted. In context (b), in which [ɪ] is preceded by a [+back] vowel, 94.42%⁵ of them are deleted, with only 5.58% being retained. The distributions of retention and deletion in (8a) and (8b) seem asymmetric in that the contrast in (8b) is significantly more drastic than that in (8a).

What critically conditions the distributions above is the context, specifically the backness of the preceding vowel. Simply put, similarity between a pair of neighboring segments contributes to the extent of their confusability. In producing a retroflex approximant, the tongue tip is curled back toward the hard palate, whether or not it actually makes contact there (Bickford & Floyd 2006). To produce a [+back] vowel, likewise, the tongue is close to the back surface of the vocal tract. A retroflex thus bears a certain similarity to a [+back] vowel in that the articulation of both involves the back part of the oral cavity or the backward movement of the tongue. Under this rationale, in the sequence of “V[+back] + [ɪ]”, the retroflex may in a sense “blend” with the precedent vowel, weakening the distinctiveness of the latter. Conversely, the ease of perception of [ɪ] when following a [-back] vowel, the production of which relies on the tongue root being rather forward, is therefore comprehensible.

In acoustic terms, the backness of vowels is primarily reflected in their second formant frequencies: front vowels have a high F2 and back vowels have a low F2. The

⁵ The asymmetry between the “lower” 65.22% of retention in the salient context of (8a) and the “higher” 94.42% of deletion in the unsalient context of (8b) should be attributed to the markedness of /ɪ/ as the coda in Mandarin. For this I thank an anonymous reviewer.

F2 of [ɹ], a liquid, is rather low, behaving like a [+back] vowel. This is shown in (9).

(9) F2 of [-back] vowels, [+back] vowels, and liquids (Ladefoged 2001:172, 185)

	<u>[-back] vowels</u>	<u>[+back] vowels</u>	<u>Liquids</u>
F2	1660-2250Hz	870-1100Hz	1000-1200Hz

In the sequence of “V[-back] + [ɹ]”, the F2 transition undergoes a sharp fall, i.e. from 1660-2250Hz to 1000-1200Hz, whereas that in the “V[+back] + [ɹ]” sequence is relatively flat, i.e. from 870-1100Hz to 1000-1200Hz, in the sense that F2 does not change but simply lasts a bit longer. The “sharp” fall in the sequence from the [-back] vowel to [ɹ] endows [ɹ] with more robustness, yet the “flat” F2 transition in the sequence of [+back] vowel plus [ɹ] contributes to higher confusability of the latter (see also Epsy-Wilson 1992 for further details on the acoustic properties of semivowels). On this ground, the higher rate of [ɹ] retention in a “V[-back] + [ɹ]” sequence than in “V[+back] + [ɹ]” is plausibly attributed to the saliency hierarchy below, saying that the perceptual distinctiveness between [ɹ] and silence before a [-back] vowel is greater than that before a [+back] vowel.

(10) Saliency hierarchy by similarity/dissimilarity

[ɹ] vs. ∅ /V[-back]_ > [ɹ] vs. ∅ /V[+back]_

4. When phonetic saliency encounters prosody

In 3.2, the prosodic preference for disyllabicity in Chinese languages is briefly discussed to explain the Cantonese data. In this section, we turn our attention back to Mandarin and see how phonetic saliency interacts with prosody in loanword adaptation. Meanwhile, with a view to gaining a clearer picture that shows both effects, we confine the data to monosyllabic source words with [ɹ]-codas,⁶ since the disyllabic tendency in Mandarin may be rendered invisible if the source word has more than one syllable already (the vowels are bound to be realized, and hence a polysyllabic underlying form is obligatory). The patterns are given in (11).

⁶ An analysis on monosyllabic loanwords is inevitable if we are to investigate the possible militating forces between phonetic saliency and prosody, even though the number of monosyllabic tokens with [ɹ]-codas is relatively small. Like most Chinese languages, Mandarin has been claimed to be quantity-sensitive and is strongly constrained by the requirement of minimally binary feet, as supporting studies on loanword adaptation have been found in the literature (Silverman 1992, Yip 1993, Miao 2005, Lu 2006).

(11) Patterns by similarity-prosody interaction

a. V[-back] + [ɹ]

<u>Context</u>	<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
(C)VR	[.k ^h wiɹ.] <i>queer</i>	/.k ^h u.əɹ./	Retention	100% (1/1)
With a cluster	[.p ^h iɹs.] <i>Pierce</i>	/.p ^h i.əɹ.si./	Retention	100% (4/4)

b. V[+back] + [ɹ]

<u>Context</u>	<u>L₂ input</u>	<u>L₁ UR</u>	<u>Process</u>	<u>Percentage</u>
(C)VR	[.θoɹ.] <i>Thor</i>	/.swo.əɹ./	Retention	100% (2/2)
With a cluster	[.maɹk.] <i>Mark</i>	/.ma.k ^h ɹ./	Deletion	100% (33/33)

Also discussed in 3.3, the backness of the preceding vowel plays a crucial role in the confusability of the [ɹ]-coda, and hence we classify the data into [ɹ]-codas with a [-back] preceding vowel and those with a [+back] preceding vowel. Each category is further divided in terms of contexts: one where [ɹ] is the simplex coda, and the onset, if any, is also a single consonant; the other where [ɹ] is embedded in a complex coda, or where [ɹ] is the simplex coda but the onset of that syllable is complex. The demarcation of whether or not there exists a consonant cluster either as the onset or as the coda in the source is to manifest the contrast. Without a cluster in the L₂ syllable, disyllabicity will force the [ɹ]-coda to be realized as the second syllable in the L₁ underlying form. If there is a cluster, however, the consonant(s) excluding [ɹ] suffices for the second syllable without the need to realize the postvocalic [ɹ]. Thereby, what solely determines the retention/deletion of the postvocalic [ɹ] is its phonetic salience.

Unlike other categories discussed so far, no “exceptions” are spotted in the data driven by similarity-prosody interaction.⁷ When the preceding vowel is [-back], as in (11a), [ɹ] is always retained, whether or not there is a cluster in the L₂ input. In (11b), however, where the vowel is [+back], contrastive results are shown in the two contexts: if there is no consonant cluster, namely “(C)VR”, [ɹ] is retained in both cases, but if there is a consonant cluster, [ɹ] is deleted, which happens in all 33 cases.

The interaction between phonetic salience and prosody is obvious here. Preceded by a [-back] vowel, [ɹ] is so salient that it is always realized even if there is a cluster, which means that there is another consonant(s) to choose from, within the monosyllabic word. Following a [+back] vowel, more interestingly, [ɹ] bears a great

⁷ Possible exceptions are English *bar*, *beer*, *car*, *tsar*, and even *tart*, with a cluster, all of which surface as monosyllabic but are attached to “[.pa.] 吧” in “[.tɕjou.pa.] 酒吧” (‘wine bar’) and “[.ʃa.la.pa.] 沙拉吧” (‘salad bar’), “[.p^hi.] 啤” in “[.p^hi.tɕjou.] 啤酒” (‘beer wine’), “[.k^ha.] 卡” in “[.k^ha.tʂɿ.] 卡車” (‘car vehicle’), “[.ʃa.] 沙” in “[.ʃa.xwaŋ.] 沙皇” (‘tsar emperor’), and “[.t^ha.] 塔” in “[.tan.t^ha.] 蛋塔” (‘egg tart’). They are excluded since their lexicalization relies on another morpheme that explicates its category in semantics, and the surface form turns out to be a polysyllabic word in L₁, which still respects the MINIMALWORD constraint in most Chinese languages. The chance to hear L₁ speakers say these monosyllabic words in isolation is slim.

similarity to the vowel, and hence tends to be ignored when it is embedded in a complex coda or when the onset is complex. If there is no cluster in the syllable (i.e. there is no other consonant to choose from), however, the disyllabic preference in L₁ forces [ɿ] to surface as the second syllable through vowel insertion, despite its low phonetic saliency granted by the neighboring [+back] vowel.

5. An OT analysis⁸

This section provides a standard OT-based analysis for the retention/deletion of English [ɿ]’s in the Mandarin speakers’ mental representations, as discussed in the above two sections. As we will see, conventional OT may find it infeasible to capture the insight of the “patterned” lexical variation between retention and deletion of [ɿ] when the data reveal inconsistency, though it still successfully offers a sound resolution to the “absolute” patterns found in simplex onsets and those from monosyllabic source words.

5.1 Position-driven patterns

In 3.1, the effect of syllable positions on the saliency of [ɿ] has been observed to condition the retention/deletion patterns of [ɿ]. In the following subsections, we discuss how the patterns are treated within the OT framework.

5.1.1 Simplex onset

As elaborated in 3.1, [ɿ] as the simplex onset enjoys perceptual privilege and is always retained in L₁ UR, either as [l] or [ɿ]. The tableau in (12) gives a standard Optimality-Theoretic account for this.

(12) Max-R(._V), Ident-[liquid] (Retention: 100%)

[.ɹæm.bo.]	Max-R(._V)	Ident-[liquid]
a. φ .lan.p ^h wo.		
b. .an.p ^h wo.	*W	
c. .tan.p ^h wo.		*W

Max-R(._V) forbids deletion of simplex onset [ɿ] and Ident-[liquid] requires liquid-to-liquid mapping, with no crucial ranking in between. Compared to the winner,

⁸ For the detailed mechanism of OT, refer to Prince & Smolensky (1993/2004) for the original work and McCarthy & Prince (1995) for their further development of Correspondence Theory.


Candidate (b) is disfavored by Max-R(_V) for its deletion of [ɹ]. Ident-[liquid] favors the winner over Candidate (c) since [ɹ] is mapped to a stop. A potential winner is /.ɹan.p^hwo./, but as elaborated in Footnote 3, the preference for [l] in L₁ output should be attributed to the wider distribution of [l]-initial syllables in the L₁ lexicon, i.e. constrained by the production grammar, and is out of our focus. For consistency, we adopt the intact L₁ output form as the L₁ UR (see Footnote 2 for details).

5.1.2 Second/third onset

When [ɹ] is embedded as the second/third consonant within a complex onset, the probability of retention is rather high, at 87.84%, though it is lower than the perfect retention rate of simplex [ɹ]-onsets. The other process found in this position is deletion, which accounts for 12.16% of the data. In OT, it is a typical conflict between Max and Dep, and thereby two constraint rankings are needed.

On the one hand, 87.84% of the second/third onset [ɹ] is retained. Confined by the L₁ syllable structure, the first onset (mostly a stop, e.g. [.o.p^hɹa.] *Oprah*, or [f], e.g. [fɹo.do.] *Frodo*) or both the first and second onsets (mostly a fricative-stop sequence, e.g. [stɹæs.bæɪg.], *Strasberg*) in the source have to be retained in L₁ via vowel insertion, since the onset of the target syllable in L₁ is already “possessed” by the adjacent [l] (e.g. “[.ou.p^hu.la.] 歐普拉”, “[.fo.lwo.two.] 佛羅多” and “[.ʃi.t^hɹ.la.si.pau.] 史特拉斯堡”, from *Oprah*, *Frodo* and *Strasberg* respectively). The constraint ranking and the tableau in (13) illustrate this point.

(13) *CC >> Ident-[liquid], Max-R(.C(C)_V) >> Dep-V (Retention: 87.84%)

[.o.p ^h ɹa.]	*CC	Ident-[liquid]	Max-R(.C(C)_V)	Dep-V
a.  .ou.p ^h u.la.				*
b. .ou.p ^h ɹa.	*W			L
c. .ou.p ^h u.ta.		*W		L
d. .ou.p ^h a.			*W	L

Mandarin allows no complex margin in any position, so the structural constraint *CC ranks at the top. Max-R(.C(C)_V), prohibiting deletion of the second/third onset [ɹ], ranks at the middle with Ident-[liquid]. Dep-V is ranked at the bottom, owing to the inevitable vowel epenthesis for the retention of the first (or both the first and second) onset obstruent. With this ranking, Candidate (b) is disfavored by the undominated *CC and was ruled out. Ident-[liquid] favors the winner over Candidate (c) in that [ɹ] is realized as a stop. Max-R(.C(C)_V) favors the winner over Candidate (d) since the latter deletes the second onset [ɹ] from the input. Candidate (a) wins the evaluation though Dep-V at the bottom favors all losers.

To account for the remaining 12.16% that undergo deletion, on the other hand, Dep-V is promoted to the middle with Ident-[liquid] and Max-R(.C(C)_V) is demoted to the bottom, See (14).

(14) *CC >> Ident-[liquid], Dep-V >> Max-R([C(C)_V] (Deletion: 12.16%)

[.lai.k ^h ɿə.]	*CC	Ident-[liquid]	Dep-V	Max-R(.C(C)_V)
a. ☞ .lai.k ^h a.				*
b. .lai.k ^h ɿa.	*W			L
c. .lai.k ^h a.ta.		*W	*W	L
d. .lai.k ^h a.la.			*W	L

Candidate (b), with a complex onset, is disfavored by the highest *CC. Candidates (c) and (d) are penalized by Dep-V for the epenthetic /a/ in /k^ha/, though they are both favored by the loser-favoring Max-R(.C(C)_V). The winning Candidate (a) is favored by all constraints except for the bottomed Max-R(.C(C)_V).

The percentage of 12.16% is too significant to be deemed exceptional. The only way out in standard OT is to re-rank the constraints, which not only vacuously leads to multiple grammars, but also fails to capture the effects of phonetic saliency that influence the distribution. We will see more such cases as we move on.

5.1.3 Coda

Adaptation of [ɿ]-codas reflects a mirror image to that of [ɿ]-onsets, in which deletion is the major process (91.39%) and retention is found in significantly fewer cases (8.61%). The different outcomes, likewise, demand two independent ranking arguments, as illustrated in (15) and (16).

(15) CodaCon >> Dep-V >> Max-R(V_) (Deletion: 91.39%)

[.noɿ.mən.]	CodaCon	Dep-V	Max-R(V_)
a. ☞ .nwo.man.			*
b. .noɿ.man.	*W		L
c. .nwo.əɿ.man.		*W	L

(16) CodaCon >> Max-R(V_) >> Dep-V (Retention: 8.61%)

[.həɿ.mon.]	CodaCon	Max-R(V_)	Dep-V
a. ☞ .xɿ.əɿ.mon.			*
b. .xɿ.mon.	*W		L
c. .xɿ.mon.		*W	L

The structural constraint CodaCon acts as a package that assigns a violation mark to any single segment that does not conform to the requirement for a well-formed coda (a single [ŋ], [ŋ], or [ɹ] in the [əɹ] syllable, see Section 2 for details) in Mandarin. Like *CC, which regulates the onset structure, CodaCon should be undominated too. In (15) and (16), CodaCon disfavors both candidate (b)’s, since, as noted in Section 2, [ɹ] is an illicit coda except for the syllable [əɹ]. In (15), Dep-V ranks higher than Max-R(V₋), so deletion results, while in (16), Max-R(V₋) dominates Dep-V and therefore the candidate in which the [ɹ] is retained via vowel insertion wins.

5.2 Sonority-driven patterns

Subsection 3.2 gives the rationale that adjacency to a vowel induces a reversed salience hierarchy when compared to the standard sonority scale; that is, the more sonorant a segment is, the less salient it is in “_V” and “V_” contexts, and vice versa. This assumption is later illustrated by the comparison between adaptations of [ɹ] and stops, repeated here: 1) as the simplex onset, both consonants are 100% retained, 2) as the second or third onset, [ɹ] is retained 87.84% of the time, and stops are retained in all cases, and 3) as the coda, [ɹ] is retained in only 8.61% of the cases, while for stops retention occurs in 62.83% of the cases. Within OT, likewise, a fixed single ranking suffices to cope with an absolute pattern with no variation involved, but constraint re-ranking becomes inevitable in tackling optionality. To pinpoint the discrepancy between [ɹ] and stops in phonetic salience, we give an analysis of codas, i.e. the position where the most noticeable difference in phonetic salience can be observed. Since [ɹ]-codas are discussed in 5.1.3, let us consider the stop codas in (17) and (18).

(17) CodaCon >> Max-T(V₋) >> Dep-V (Retention: 62.83%)

[.gɑɹ.nɪt.]	CodaCon	Max-T(V ₋)	Dep-V
a. $\text{t}^{\text{h}}\text{ɕja.nai.t}^{\text{h}}\text{ɕ}$.			*
b. $\text{t}^{\text{h}}\text{ɕja.nait}$.	*W		L
c. $\text{t}^{\text{h}}\text{ɕja.nai}$.		*W	L

(18) CodaCon >> Dep-V >> Max-T(V₋) (Deletion: 37.17%)

[.dʒæ.nɪt.]	CodaCon	Dep-V	Max-T(V ₋)
a. $\text{t}^{\text{h}}\text{ʒən.ni}$.			*
b. $\text{t}^{\text{h}}\text{ʒən.nit}$.	*W		L
c. $\text{t}^{\text{h}}\text{ʒən.ni.t}^{\text{h}}\text{ɕ}$.		*W	L

Like [ɹ]-codas, retention or deletion of a stop coda relies on the mutual ranking between Max and Dep; that is, provided that Max-T(V₋) ranks over Dep-V, retention

happens, but when Dep-V outranks Max-T(V₋), deletion results. Both constraint rankings are thus required to account for loanwords like (17) and (18). Contrary to [ɪ]-codas, as exemplified in (15) and (16), the main adaptation for stop codas is retention, with deletion the secondary tendency.

5.3 Similarity/Dissimilarity-driven patterns

As discussed in 3.3, the retention/deletion of a [ɪ]-coda is highly conditioned by the backness of the preceding vowel; i.e. retention occurs more often (65.21%) when the vowel is [-back], whereas deletion takes place in overwhelmingly more cases (94.41%) when the vowel is [+back]. The asymmetric distributions in the two contexts are assumed to be patterned by the similarity/dissimilarity between the two adjacent sounds: [ɪ] is less similar to a [-back] vowel, i.e. more distinctive, so it tends to be retained in the context of “V[-back] + [ɪ]”, while it is more similar to a [+back] vowel, i.e. more confusable, and thus subject to deletion in the “V[+back] + [ɪ]” context. The two seemingly separate contexts can be considered within a constraint set if Max-R(V₋) breaks down into Max-R(V[-back]₋) and Max-R(V[+back]₋).

In (19.1), in which the nuclear vowel is [-back], candidate (a), where [ɪ] is retained by inserting a schwa, wins out since Max-R(V[-back]₋) ranks over Dep-V. On the contrary, in (19.2), where [ɪ] is preceded by a [+back] vowel, deletion results due to the dominance of Dep-V over Max-R(V[+back]₋). Reverse ranking, however, leads to the opposite outcomes, as shown in (20).

(19) CodaCon >> Max-R(V[-back]₋) >> Dep-V >> Max-R(V[+back]₋)

(19.1) V[-back] + [ɪ] (retention: 65.22%)

[k ^h æʃ.mi.ɪ.]	CodaCon	Max-R(V[-bk] ₋)	Dep-V	Max-R(V[+bk] ₋)
a. ^ɤ .k ^h ʁ.ʃi.mi.əɪ.			*	
b. .k ^h ʁ.ʃi.mi.ɪ.	*W		L	
c. .k ^h ʁ.ʃi.mi.		*W	L	

(19.2) V[+back] + [ɪ]: (deletion: 94.42%)

[k ^h aɪ.mən.]	CodaCon	Max-R(V[-bk] ₋)	Dep-V	Max-R(V[+bk] ₋)
a. ^ɤ .k ^h a.mən.				*
b. .k ^h aɪ.mən.	*W			L
c. .k ^h a.əɪ.mən.			*W	L

(20) CodaCon >> Max-R(V[+back]_) >> Dep-V >> Max-R(V[-back]_)

(20.1) V[-back] + [ɪ] (Deletion: 34.78%)

[.æm.p ^h ɪ.]	CodaCon	Max-R(V[+bk]_)	Dep-V	Max-R(V[-bk]_)
a. [☞] .an.p ^h ei.				*
b. .an.p ^h ei.	*W			L
c. .an.p ^h ei.ə.			*W	L

(20.2) V[+back] + [ɪ] (Retention: 5.58%)

[.daɪ.wɪn.]	CodaCon	Max-R(V[+bk]_)	Dep-V	Max-R(V[-bk]_)
a. [☞] .ta.əɪ.wən.			*	
b. .taɪ.wən.	*W		L	
c. .ta.wən.		*W	L	

With Max-R(V[+back]_) outranking Dep-V, an [ɪ] following a [+back] vowel is retained by way of vowel epenthesis, yet a [ɪ] after a [-back] vowel is deleted, a result that is contrary to (19) and is found in fewer cases.

5.4 Patterns by similarity-prosody interaction

In this subsection, we discuss what happens when an L₁ speaker has to make a choice between phonetic salience and prosodic preference if meeting one requirement inevitably goes against the other. Noted in Section 4, the data are confined to monosyllabic L₂ words for the effect to stand out. Unlike most patterns that show lexical variations, all the tendencies are absolute (i.e. no exceptions are found) and can be analyzed through a single categorical constraint ranking. The tableaux in (21) show the constraint ranking in action.

(21) CodaCon, MinimalWord >> Max-R(V[-back]_) >> Dep-V >> Max-R(V[+back]_)

(21.1) V[-back] + [ɪ]: (C)VR (Retention: 100%)

[.k ^h wɪ.]	CodaCon	MinWd	Max-R(V[-bk]_)	Dep-V	Max-R(V[+bk]_)
a. [☞] .k ^h u.ə.				*	
b. .k ^h u.	*W	*W		L	
c. .k ^h u.		*W	*W	L	

(21.2) V[-back] + [ɪ]: with a cluster (Retention: 100%)

[.p ^h iɪs.]	CodaCon	MinWd	Max-R(V[-bk]_)	Dep-V	Max-R(V[+bk]_)
a. [☞] .p ^h i.əɪ.si.				**	
b. .p ^h iɪ.si.	*W			*L	
c. .p ^h i.si.			*W	*L	

(21.3) V[+back] + [ɹ]: (C)VR (Retention: 100%)

[.θoɹ.]	CodaCon	MinWd	Max-R(V[-bk]_)	Dep-V	Max-R(V[+bk]_)
a. ㄆ .swo.ㄨ.				*	
b. .swoɹ.	*W	*W		L	
c. .swo.		*W		L	*W

(21.4) V[+back] + [ɹ]: with a cluster (Deletion: 100%)

[.maɹk.]	CodaCon	MinWd	Max-R(V[-bk]_)	Dep-V	Max-R(V[+bk]_)
a. ㄆ .ma.k ^h ɹ.				*	*
b. .maɹ.k ^h ɹ.	*W			*	L
c. .ma.ㄨ.k ^h ɹ.				**W	L

That obedience to prosody takes precedence over phonetic saliency is obvious here. MinimalWord, prohibiting the output from having less than two syllables, stands at the top⁹ with CodaCon, for it is never violated in the data. Retention is the strategy in both (21.1) and (21.2), showing that [ɹ] is retained insofar as the preceding vowel is [-back], whether or not there is a cluster in the input. This indicates that the saliency of [ɹ] is granted by the preceding [-back] vowel. However, when the preceding vowel is [+back], it becomes less distinctive. In (21.3), it survives in the “(C)VR” context since [ɹ] is the only consonant to be realized as the second syllable in L₁ through vowel insertion. In (21.4), on the contrary, it is simply ignored when the speaker has another consonant that is perceptually more prominent, i.e. an obstruent, to retain as the second syllable through vowel insertion.

5.5 Summary

As observed thus far, pure phonetic factors that contribute considerably to the extent of saliency (i.e. position, sonority, and similarity/dissimilarity) are mapped to the speaker’s perception grammar, demonstrating a “Markedness >> Faithfulness” fashion. In general, markedness constraints that regulate the L₁ structure both segmentally and suprasegmentally are undominated (*CC, CodaCon, and MinimalWord). What follows is the faithfulness constraints (Max, Dep, and Ident family), within which the ranking between Max-R and Dep-V reflects the saliency of [ɹ] endowed by either the external contexts (position and the preceding vowel) or the internal acoustic intensity (sonority). What constitutes a theoretical problem to a

⁹ Readers may argue that MinimalWord may not always rank the highest throughout Mandarin loanword phonology, with evidence found in “[.dan.] *Don* → [.t^hɑŋ.] 唐”, “[.jaŋ.] *Young* → [.jaŋ.] 楊”, “[.p^hɑʊnd.] *pound* → [.paŋ.] 磅”, “[.t^hʌn.] *ton* → [.tun.] 噸”, and the like, most of which, however, are terms of family names or units of measurement. We plausibly assume that extragrammatical (social/semantic) factors may be influential. If this assumption is correct, such monosyllabic output must pertain to production, rather than perception.

standard OT-based analysis, as given in this section, is the paradoxical ranking arguments proposed to deal with variations. It is thus claimed that adopting a stochastic view toward the data with systematic optionality may provide a parsimonious account with a single grammar. Moreover, it makes reference to the precise probability via the numerical position of a constraint relative to the others on the linear scale.

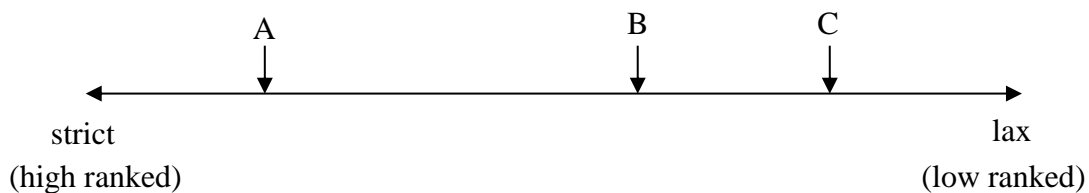
6. A Stochastic-OT analysis

In this section, we first give a brief introduction to the key ingredients of Stochastic OT, and reexamine the data that involve variations with probabilities as discussed in the previous section. As we will see, with its crucial notions of viewing constraints as ranges of value on a continuous scale, rather than points, and the inevitable overlapping area, i.e. where free rankings occur, that is incurred by the closeness of two neighboring constraints, Stochastic OT serves as a tenable model to encode the lexical variations in loanword adaptation.

6.1 A brief introduction to stochastic evaluation

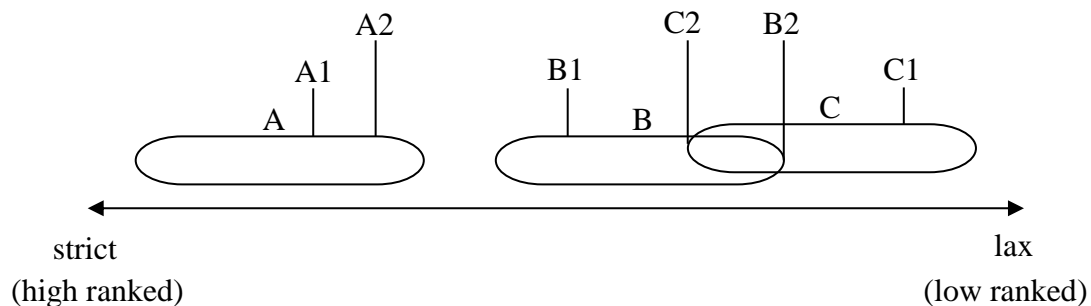
Stochastic candidate evaluation originally appears in the development of Boersma’s (1997, 1998) Gradual Learning Algorithm (GLA) and Boersma & Hayes’s (2001) empirical application of GLA, an error-driven algorithm that simulates the phonological learning of a (fragment of a) constraint-based grammar. What is unique to the algorithm is the type of Optimality-theoretic grammar it advocates. Rather than a set of ranked constraints that are essentially discrete from one another, it features a continuum of constraint strictness on which each constraint is assigned a certain value. Higher values correspond to higher-ranked, less violable constraints, and vice versa. The schema in (22) presents a categorical ranking, where Constraint A \gg Constraint B \gg Constraint C, though it might be said that Constraint A outranks Constraint B more than Constraint B outranks Constraint C.

(22) A continuous ranking scale (categorical) (Boersma & Hayes 2001:3)



Under no circumstances will the ranking alter provided each constraint falls on a **point** of the scale. The continuous scale, however, is of more theoretical significance if each constraint is equally assigned a **range** of value, rather than a single point on the scale. The assumption is realistically grounded in that at *evaluation time*, i.e. the moment of speaking, a random positive or negative value of noise is added to the *ranking value* (the permanent central point on a constraint range), and the resultant value used at actual evaluation time is termed the *selection point*. In this scenario, the dominance between two constraints may be less fixed if their ranking values are close enough to cause an overlapping area, where the ranking between them is unspecified, depending on which selection points are chosen as the real values. This is shown below:

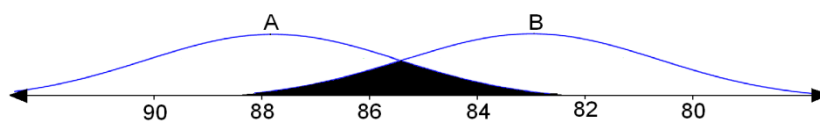
(23) A continuous ranking scale with ranges (Boersma & Hayes 2001:3)



As depicted in (23), Constraint A is too far from the other constraints to overlap with them, and hence it is ranked the highest in both evaluations. In the first evaluation time (Selection Point 1), B1 is higher than C1, a ranking that takes place in most cases for the higher ranking value of Constraint B. In the second evaluation, however, C2 outranks B2, because it happens that the speaker chooses the bottom value of Constraint B and the top value of Constraint C. Such a ranking, though possible, will still be rare since it may only occur in the comparatively small overlapping area.

A noteworthy concept along these lines is that the random noise perturbation, namely the constraint range in this realm, that takes place in the real world can be properly portrayed as bell-curved *normal (/Gaussian) distribution*, where 68.27% of the selection points reside within one standard deviation (σ) from the mean (μ) on both sides, 95.45% within two σ 's, and 99.73% within three. Any probability falling beyond $\mu \pm 3\sigma$ becomes vanishingly low. The event of overlapping ranking distributions is illustrated below:

(24) Overlapping ranking distributions (Boersma & Hayes 2001:5)



Stochastic evaluation is in nature applied to simulated learning algorithms in which relative constraint positions that are in conflict with the current ranking hypothesis may shift on the ranking scale as the algorithm is “fed” with more correct linguistic input. In our study, this mechanism is found to be highly workable on the lexical variations with optionality in loanword adaptation. The difference, however, is that the adult speaker’s grammar in dealing with loanwords should be fixed (though the selected values within the overlapping area vary), unlike the moveable ranking values of constraints as those working in GLA. Another discrepancy lies in the claim that the “fixed” loanword phonology is hardly acquired or learned, at least in the phase of “perceptual processing” (Figure 1) to decide between retention and deletion of an input segment, but instead judged by both phonetic cues and native phonology.

6.2 Probabilistic variations by position

In 5.1, the phonetic salience of [ɹ] is assumed to be partially determined by its position in the syllable. In this subsection, we give a Stochastic-OT resolution to the patterned variation in respect of syllable position, which is found in [ɹ]’s as the second/third onset and coda.

6.2.1 Second/third onset

In 5.1.2, we propose two ranking arguments within OT to account for the alternation between retention and deletion of [ɹ] as the second/third onset in the input. The rankings, along with their percentages of occurrence, are repeated here in (25).

(25) Variable rankings for second/third onsets

Strategy	Constraint ranking	Percentage
Retention	*CC >> Ident-[liquid], Max-R(.C(C)_V) >> Dep-V	87.84%
Deletion	*CC >> Ident-[liquid], Dep-V >> Max-R(.C(C)_V)	12.16%

From a stochastic viewpoint, the ranking values of Max-R(.C(C)_V) and Dep-V have to be close enough to incur an overlapping area, the overlapping “degree” of

which, however, is judged by the involved probability of each ranking. Following the convention of most Stochastic-OT works, we adopt an arbitrary value of 2.0 as the evaluation noise (σ), and thus the whole range should cover 12 units (nearly 100% fall in 3 σ 's on each side, equating 6 units). The initial state of constraints is given the arbitrary value of 100. Though there should be no “starting point” (Boersma 1997, 1998, Boersma & Hayes 2001) in the current fixed adult grammar, we place the constraints in this neighborhood for the sake of consistency. Through mathematical calculation, the ranking values are obtained and listed in (26).

(26) Ranking for second or third onsets

Constraint	Ranking value
*CC	135.56
Ident-[liquid]	102.63
Max-R(.C(C)_V)	102.63
Dep-V	93.55

*CC is arbitrarily assigned the ranking value 135.56 so it is sufficiently high to avoid overlapping with the other constraint ranges. The ranking value 102.63 for both Ident-[liquid] and Max-R(.C(C)_V), and 93.55 for Dep-V, however, incur an overlapping area of 24.32% of each, indicating that the lower Dep-V may still 12.16% (half of 24.32%) possibly outrank Ident-[liquid] and Max-R(.C(C)_V). In (27), we apply the ranking values to genuine loanword data with hypothetical selection points. A common selection results in retention of [ɹ] through Max-R([C(C)_V] >> Dep-V, while a rare yet possible choice is deletion of [ɹ] via the reversed ranking.

(27) Hypothetical selection points and results from (26) (CSP: common selection points, RSP: rare selection points)

	Max-R(.C(C)_V)	Dep-V	Result	Example
CSP	103.92	98.87	Retention	[.o.p ^h ɹɑ.] → /.ou.p ^h u.lɑ./
RSP	97.38	99.23	Deletion	[.lɑi.k ^h ɹə.] → /.lɑi.k ^h ɑ./

6.2.2 Coda

Subsection 3.1 discusses how codas, as opposed to onsets, bear the least phonetic prominence within a syllable. In 5.1.3, likewise, two ranking arguments are responsible for the patterned variation. This is repeated in (28).

(28) Variable rankings for codas

Strategy	Constraint ranking	Percentage
Deletion	CodaCon >> Dep-V >> Max-R(V_)	91.39%
Retention	CodaCon >> Max-R(V_) >> Dep-V	8.61%

Based on the distribution, like what is done in 6.2.1, we provide a stochastic resolution to the otherwise paradoxical problem:

(29) Ranking for codas (first version)

Constraint	Ranking value
CodaCon	135.56
Dep-V	93.55
Max-R(V_)	83.62

CodaCon is ranked at the same height as *CC for inviolability. Max-R(V_) is assigned a value that is lower than Dep-V but overlapping is still inevitable. With the ranking values assigned to Dep-V and Max-R(V_), the overlapping area will be 17.22% of each, so the odds that Max-R(V_) outranks Dep-V is 8.61%. In (30), likewise, we illustrate both the common and rare results. It should be noted that the ranking in (29) will be revised in 6.4 as we revisit this issue by taking the backness of the preceding vowel into consideration.

(30) Hypothetical selection points and results from (29)

	Dep-V	Max-R(V_)	Result	Example
CSP	97.1	86.45	Deletion	[.nɔɪ.mən.] → /.nwo.man./
RSP	88.78	89.35	Retention	[.hɔɪ.mon.] → /.xɾ.əɪ.moŋ./

6.3 Probabilistic variation by sonority

As discussed in Subsection 3.2, with a lower position on the sonority scale, stops are presumably more phonetically distinctive when adjacent to a vowel. The effect is observable in the coda position. Subsection 5.2 provides the responsible rankings, reconstructed in (31):

(31) Variable rankings for stop codas

Strategy	Constraint ranking	Percentage
Retention	CodaCon >> Max-T(V_) >> Dep-V	62.83%
Deletion	CodaCon >> Dep-V >> Max-T(V_)	37.17%

Again, judged from the probabilistic distribution, (32) lists the ranking values of the relevant constraints. The close ranking values of Max-T(V_{_-}) and Dep-V induce a large overlapping area of 74.34% of each, and the probability that the selection point of the lower Dep-V is higher than Max-T(V_{_-}) is then 37.17%. Likewise, a hypothetical prediction based on (32) is given in (33).

(32) Ranking for stop codas

Constraint	Ranking value
CodaCon	135.56
Max-T(V _{_-})	96.63
Dep-V	93.55

(33) Hypothetical selection points and results from (32)

	Max-T(V _{_-})	Dep-V	Result	Example
CSP	100.58	92.7	Retention	[.gɑɪ.nɪt.] → /.tɕja.nai.tʰɻ./
RSP	93.2	97.66	Deletion	[.dʒæ.nɪt.] → /.tʂən.ni./

Comparing (26) with (32), although retention is the major strategy for both [ɹ]- and stop codas due to the “Max >> Dep” dominance, the overlapping extent of Max-T(V_{_-}) and Dep-V is greater than that of Max-R(.C(C)_V) and Dep-V. This reveals that the probabilities of retention/deletion in stop codas are closer to a fifty-fifty distribution than that in [ɹ]-codas (notionally two completely overlapping constraints incur a fifty-fifty probabilistic distribution of one dominating the other).

6.4 Probabilistic variation by similarity/dissimilarity

Subsection 5.3 formulates the asymmetric patterns of [ɹ]-codas induced by the backness of the preceding vowel, and the distribution reveals a remarkable contrast due to the effects of similarity/dissimilarity. This is repeated in (34) below.

(34) a. Constraint ranking 1: CodaCon >> Max-R(V[-back]_) >> Dep-V >> Max-R(V[+back]_)

Context	Strategy	Percentage	Example
V[-back]+[ɹ]	Retention	65.22%	[.kʰæʃ.mɪɹ.] → /.kʰɻ.ʂi.mi.əɹ./
V[+back]+[ɹ]	Deletion	94.42%	[.kʰɑɪ.mən.] → /.kʰa.mən./

b. Constraint ranking 2: CodaCon >> Max-R(V[+back]_) >> Dep-V >> Max-R(V[-back]_)

Context	Strategy	Percentage	Example
V[-back]+[ɹ]	Deletion	34.78%	[.æm.p ^h ɹ.] → /.an.p ^h ei./
V[+back]+[ɹ]	Retention	5.58%	[.daɹ.wɪn.] → /.ta.əɹ.wən./

What is for sure is that Dep-V is sandwiched between Max-R(V[-back]_) and Max-R(V[+back]_), while their respective ranking values are determined by to what extent the two Max-R constraints overlap with Dep-V on each side. Based on the data, the responsible ranking values are listed as follows, which is the final version for [ɹ]-codas:

(35) Ranking for codas (final version)

Constraint	Ranking value
CodaCon	135.56
Max-R(V[-back]_)	97.2
Dep-V	93.55
Max-R(V[+back]_)	82.89

As mentioned in 6.1, the closer the ranking values are, the larger the resultant overlapping area will be, which in turn infers a higher probability for the reversed ranking to occur. This is well illustrated in this case, where the percentage of [ɹ]-deletion after a [-back] vowel (34.78%) is much higher than that of [ɹ]-retention after a [+back] vowel (5.58%).

6.5 Summary

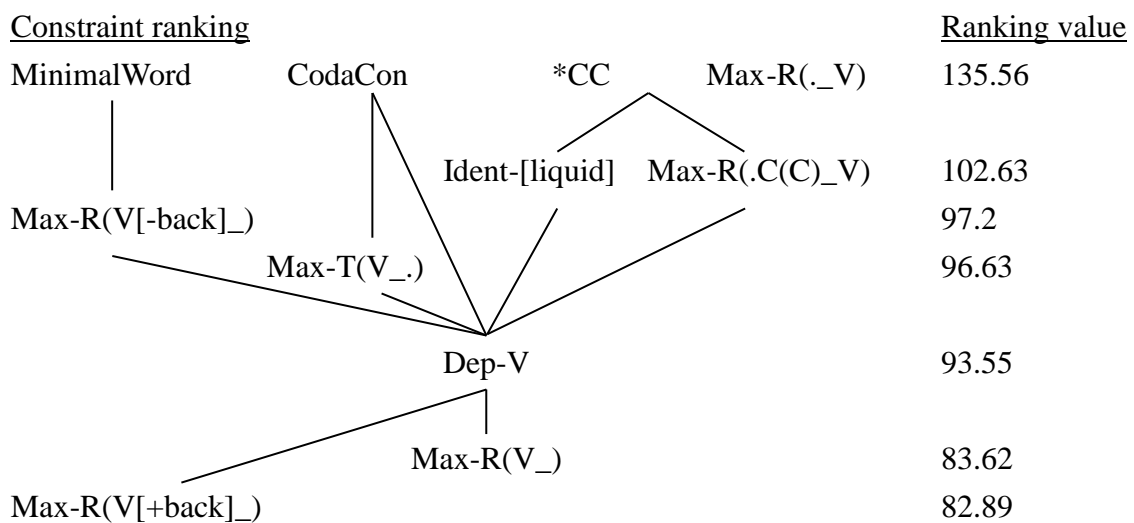
This section begins with a brief introduction to the working mechanism in stochastic candidate evaluations. The ranking paradoxes confronted in a standard-OT analysis in Section 5 are resolved from a Stochastic-OT viewpoint. The ranking values obtained thus far are summarized in (36), including the categorical rankings derived from 5.1.1 for simplex onsets and 5.4 for similarity-prosody interaction.

(36) Summary ranking values

Constraint	Ranking value
Max-R(._V)	135.56
*CC	135.56
CodaCon	135.56
MinimalWord	135.56
Ident-[liquid]	102.63
Max-R(.C(C)_V)	102.63
Max-R(V[-back]_)	97.2
Max-T(V_)	96.63
Dep-V	93.55
Max-R(V_)	83.62
Max-R(V[+back]_)	82.89

The relative positions of the constraints can be presented more clearly through combining them with the style of a Hasse diagram, as sketched below:

(37) Ranking values in a Hasse diagram



Unlike the linear scale as used in GLA, whereby the ranking is presented horizontally, the above hierarchy is displayed in a vertical manner and therefore both the dominance relationship and the precise numerical ranking values can be manifested.

7. Conclusion

Based on a thorough investigation into Mandarin adaptation of English loanwords,

the seemingly contradictory strategies of retention/deletion of [ɿ] are answered from the perspective of phonetic salience and its interaction with Mandarin prosody, as reflected in the percentage distribution of retention/deletion. Specifically, it is claimed that position, sonority and similarity/dissimilarity determines, at least partially, the degree of salience. First onsets are perceptually the most prominent compared to second/third onsets and codas, stops are more distinctive than [ɿ] in the context of “_V” or “V_” for their lower sonority on the scale, and finally [ɿ] is phonetically more similar to, and thus more confusable with, a [+back] vowel. A more distinctive element is plausibly more subject to retention and a less distinctive one to deletion. Though lexical variations are widely found, the proportion is patterned by the above effects. As somewhat against the general tendency to retain a phonetically salient segment, when faced with a dilemma between low phonetic salience and the prosodic preference for binary feet, Mandarin speakers seem without exception to sacrifice the former and form a minimally disyllabic output.

The various effects of phonetic salience are mapped to the interaction of Max-R constraints and Dep-V in the OT framework. The dominance of Max-R over Dep-V leads to retention of [ɿ], and the reverse results in deletion of it. Due to the restriction of strict dominance between constraints in standard OT, the only solution to lexical variation is constraint re-ranking, which lacks the theoretical consistency and predictability of the probabilistic distribution between the two repair strategies.

A Stochastic-OT approach, however, has successfully dealt with the paradoxical problems posed by conventional OT. The advantages are twofold. First, Stochastic OT holds a single ranking by viewing constraints as ranges of value on a continuous strictness scale, and the overlapping area of two constraints, where free ranking may occur, becomes inevitable when the ranking values are sufficiently close to one another. Second, inheriting its superiority in modeling altering rankings in an error-driven learning algorithm, stochastic candidate evaluation also accounts for the probabilistic lexical variations in loanword adaptation.

What may need to be done to verify the effects of phonetic salience in loanword adaptation is an experimental research into the perception of [ɿ] in different contexts. A phoneme monitoring test, for example, may be appropriate for the perceptual salience of a postvocalic [ɿ] after vowels of different backness values. The results of the recorded RTs and error rates submitted to measures of ANOVAs, if they meet our expectations, will further provide our arguments with solid experimental grounds.

References

Anttila, Arto. 1997. Deriving variation from grammar. *Variation, Change and*

- Phonological Theory*, ed. by Frans Hinskens, Roeland van Hout and Leo Wetzels, 35-68, Amsterdam /Philadelphia: John Benjamins.
- Anttila, Arto. 2002. Morphologically conditioned phonological alternations. *Natural Language and Linguistic Theory* 20:1-42.
- Bauer, Robert S. and Paul K. Benedict. 1997. *Modern Cantonese Phonology*. Berlin: Mouton de Gruyter.
- Beckman, Jill. 1998. Positional Faithfulness. Doctoral dissertation, University of Massachusetts, Amherst.
- Boersma, Paul. 1997. How we learn variation, optionality, and probability. *Proceedings of the Institute of Phonetic Sciences*, 21:43-58. Amsterdam: University of Amsterdam.
- Boersma, Paul. 1998. Functional Phonology: Formalizing the Interactions between Articulatory and Perceptual Drives. Doctoral dissertation, University of Amsterdam. LOT International Series. 11. The Hague: Holland Academic Graphics.
- Boersma, Paul, and Bruce Hayes. 2001. Empirical tests of the gradual learning algorithm. *Linguistic Inquiry* 32.1:45-86.
- Broselow, Ellen. 2005. Stress adaptation in loanword phonology: Perception and learnability. Paper presented in the Workshop of "Speech perception within or outside phonology?" Cologne, Germany.
- Cheng, Chin-Chuan. 1973. *A synchronic Phonology of Mandarin Chinese*. The Hague: Mouton.
- Espy-Wilson, Carol Y. 1992. Acoustic measures for linguistic features distinguishing the semivowels /w j r l/ in American English. *Journal of the Acoustical Society of America* 92:736-757.
- Inkelas, Sharon, and Cheryl Zoll. 2007. Is grammar independence real? A comparison between cophonological and indexed constraint approaches to morphologically conditioned phonology. *Linguistics* 45.1:133-171.
- Kang, Yoonjung. 2003. Perceptual similarity in loanword adaptation: English postvocalic word-final stops in Korean. *Phonology* 20:219-273.
- Kenstowicz, Michael. 2003a. Saliency and similarity in loanword adaptation: a case study from Fijian. Manuscript, MIT.
- Kenstowicz, Michael. 2003b. The role of perception in loanword phonology. A review of *Les emprunts linguistiques d'origine européenne en Fon* by Flavien Gbéto, Köln: Rüdiger Köppe Verlag, 2000. *Studies in African Linguistics* 32:95-112.
- Labrune, Laurence. 2002. The prosodic structure of simple abbreviated loanwords in Japanese: a constraint-based account. *Journal of the Phonetic Society of Japan*

6.1:98-120.

- LaCharité, Darlene, and Carole Paradis. 2005. Category preservation and proximity versus phonetic approximation in loanword adaptation. *Linguistic Inquiry* 36:223-258.
- Ladefoged, Peter. 2001. *A course in phonetics*. 4th ed. Fort Worth, Tex: Harcourt Brace Jovanovich College Publishers.
- Lin, Yen-Hwei. 2007a. Loanword adaptation of English vowels in standard Mandarin. *NACCL-18: Proceedings of the 18th North American Conference on Chinese Linguistics*, ed. by Janet Xing, 331-342. Los Angeles, CA: University of Southern California.
- Lin, Yen-Hwei. 2007b. *The Sounds of Chinese*. Cambridge: Cambridge University Press.
- Lin, Yen-Hwei. 2008a. Variable vowel adaptation in Standard Mandarin loanwords. *Journal of East Asian Linguistics* 17:363-380.
- Lin, Yen-Hwei. 2008b. Patterned vowels variation in Standard Mandarin loanword adaptation: Evidence from a dictionary corpus. *NACCL-20: Proceedings of the 20th North American Conference on Chinese Linguistics*, ed. by Marjorie Chan and Hana Kang, 175-184. Columbus, Ohio: East Asian Studies Center, The Ohio State University.
- Lu, Mingchang. 2006. An Optimality Theory Approach to English and Southern Min Loanwords in Mandarin. MA Thesis, National Taiwan Normal University, Taiwan.
- McCarthy, John, and Alan Prince. 1995. Faithfulness and Reduplicative Identity. *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, ed. by Jill Beckman, Laura Walsh Dickey & Suzanne Urbanczyk, 249-384. Amherst: GLSA.
- McCarthy, John J. 2008. *Doing Optimality Theory*. Malden, MA & Oxford: Blackwell.
- Miao, Ruiqin. 2005. Loanword Adaptation in Mandarin Chinese: Perceptual, Phonological and Sociolinguistic Factors. Doctoral dissertation, Stony Brook University, New York.
- Paradis, Carole. 1995. Derivational constraints in phonology: Evidence from loanwords and implications. *Proceedings of the Chicago Linguistics Society*, ed. by Audra Dainora, Rachel Hemphill, Barbara Luka, Barbara Need and Sheri Pargman, 360-374. Chicago: CLS.
- Paradis, Carole. 1996. The inadequacy of filters and faithfulness in loanword adaptation. *Current Trends in Phonology*, ed. by Jacques Durand and Bernard Laks. Salford: University of Salford Publications.

- Paradis, Carole and Darlene LaCharité. 1997. Preservation and minimality in loanword adaptation. *Journal of Linguistics* 33.1:379-430.
- Peperkamp, Sharon, and Emmanuel Dupoux. 2003. Reinterpreting loanword adaptations: the role of perception. *Proceedings of the 15th International Congress of Phonetic Sciences*, ed. by M.J. Solé, D. Recasens and J. Romero, 367-370. Barcelona: Causal Productions.
- Prince, Alan, and Paul Smolensky. 1993/2004. *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden, MA: Blackwell Pub.
- Shih, Lijen. 2004. Consonantal and Syllabic Adaptations in English Loanwords in Mandarin. MA thesis, Michigan State University, Michigan.
- Shinohara, Shigeko. 2001. Emergence of universal grammar in foreign word adaptations. *Fixing Priorities: Constraints in Phonological Acquisition*, ed. by Rene Kager, Joe Pater and Wim Zonneveld. Cambridge: Cambridge University Press.
- Shinohara, Shigeko. 2004. Perceptual effects in consonant deletion patterns in loanword phonology. Manuscript, CNRS.
- Silverman, Daniel. 1992. Multiple scansion in loanword phonology: Evidence from Cantonese. *Phonology* 9:289-328.
- Steriade, Donca. 2001b. The phonology of perceptibility effects: the p-map and its consequences for constraint organization. Manuscript, UCLA.
- Yip, Moira. 1993. Cantonese loanword phonology and optimality theory. *Journal of East Asian Linguistics* 1.1:261-291.
- Yip, Moira. 2002. Necessary but not sufficient: Perceptual loanword influences in loanword phonology. *The Journal of the Phonetic Society of Japan. Special issue on Aspects of loanword phonology* 6.1:4-21.
- Yip, Moira. 2006. The symbiosis between perception and grammar in loanword phonology. *Lingua* 116:950-975.
- Zuraw, Kie. 2010. A model of lexical variation and the grammar with application to Tagalog nasal substitution. *Nat Lang Linguist Theory* 28:417-472.

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顯著性與韻律在借字調整中之模式化： 以國語中英語借字的[ɪ]為例

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本文探討顯著性與韻律如何影響借字過程中型態化的詞彙變異，並以英語[ɪ]在國語中對應調整的保留與刪除為例。在語料庫的基礎上，儘管[ɪ]在國語中的去留呈現變異，然其比例分配卻由數個語音顯著性及韻律的因素決定，前者為位置、響度與相似度/相異度，後者為國語的雙音節韻律傾向。此借字調整的型態化分配，適合以機率優選理論（Boersma 1997 & 1998, Boersma & Hayes 2001）模式化。該理論將制約視為在線性化嚴格度上量化的範圍，而兩個衝突制約排序值之間的距離，可決定兩範圍值是否重疊或重疊的程度，此重疊區也是支配關係可以反轉，進而造成變異的區域。

關鍵詞：借字調整、詞彙變異、感知、顯著性、機率優選理論