

Vowel Space, The [r]-suffix Alternations, and the Tone3 Alternations in Mandarin Chinese

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3. Following the literature (Duanmu 2000, 2007), in the current study I assume a five-vowel system for the Mandarin Chinese in its underlying form. The five vowels are:

High: [i y u]

Mid: [ə]

Low: [a]

The mid Vowel is realized with five variants, where [E] denotes a vowel that is higher than [ε] but lower than [e](S.Xu 1980:33):

[o] [e] [ɤ] [ə] [E]

And the low vowel has five variants, where [A] is a central low vowel, [ɐ] is a central-mid low vowel (Xu 1980:33):

[a] [æ] [ɐ] [A] [ɑ]

Here I give a list of words that are read in the recorded speech sample, with transcriptions, the measured vowel tokens and the measured F1, F2 values for each token (LPC setting for number of formants: 4). As is shown in the first tier of the Textgrid, the word list is designed so that the first part focuses on the vowels, and the second half provides the samples for the [r] suffix alternation that will be discussed below. I also measured vowels in the second half when possible.

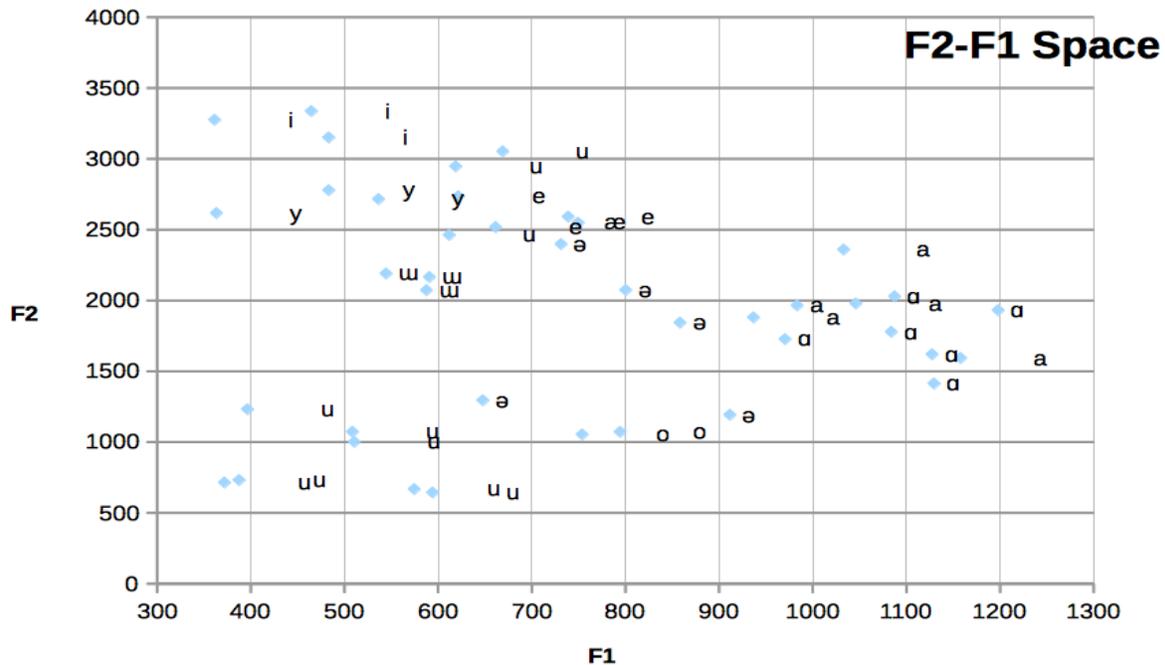
¹The current study discusses the vowel space, [r] suffixation phonological alternations, and the Tone 3 alternations in Mandarin Chinese. Speaker is female, native of Beijing. Speaker reads from a word list, and is recorded on Praat software on with the Logitech C300 USB Headset Microphone. LPC formant analysis is done with a Praat script that I designed, under the setting where 4 formants are returned.

Gloss	Tone	Word Transcription	Vowel token Number	Vowel	F1	F2
Clothes	1,2	ifu	1	i	359.4801312	1003.330282
			2	u	462.865791	839.8562659
Fish skin	2,2	yphi	3	y	472.7043283	1472.652625
			4	i	469.9334924	731.4588565
Recording	4,1	luin	5	u	383.5118445	1167.122109
			6	i	513.0277227	2004.279529
Emerald	3,3,4 >>2, 3,4	zumuly	7	u	466.1515615	945.9179512
			8	u	495.4075914	847.6547346
			9	y	524.4328959	1937.765135
Jade	4,2	yʂr	10	y	356.1431908	1063.36363
Self	4,3	tsz(ʍ)-sz(ʍ)	11	ʍ	527.6100146	1997.336578
			12	ʍ	575.6594654	1722.203585
Eat	1,4	ʈr-ʂan	13	a	896.0701443	1285.293412
Poet	1,2	ʂr-rən	14	ə	702.3960969	1715.292252
Me	3	wo	15	ə	789.277756	1228.607618
Leaf	4	jE	16	E	711.3665321	1669.961142
Song	1	kɣ	17	ɣ	635.0283141	1269.248411
Fly	1	fei	18	e	645.7452726	1659.158194
Door	2	mən	19	ə	785.4589193	1508.729355

Eight	1	pA	20	A	831.805641	1483.558027
Peach	2	thau	21	ɑ	951.4178037	1084.794206
Open	1	khai	22	a	861.5708317	1498.622918
Salt	2	jæɪn	23	æ	731.9610289	1586.029951
Round	2	jwən	24	ɐ	971.4883154	1959.586153
Little Si (proper name)	3,4	ɕau-sz(ɯ)	25	ɯ	572.1270494	1771.194341
Little Si	3,4	ɕau-szr	26	ə	773.7595703	1762.136944
Little Ba	3,1	ɕau-pɑ	27	ɑ	967.1503473	1615.978256
Little Ba	3,1	ɕau-par	28	ɑ	911.1607381	1373.648307
Little White	3,2	ɕau-pai	29	ɑ	1007.579687	1723.838224
Little White	3,2	ɕau-par	30	ɑ	991.6670641	1568.018657
Wooden board	4,3	mwu:-pan	31	u	525.1153999	811.7547474
			32	a	991.6205108	1651.363088
Wooden board	4,3	mwu:-par	33	u	414.1731614	803.9011683
			34	a	994.8569619	1550.306043
Little Gu	3,4	ɕau-ku	35	u	369.7227347	732.9563961
Little Gu	3,4	ɕau-kur	36	u	363.7862622	711.7508493
Available	3,4	jəu-k ^{hw} uŋ	37	o	651.4202452	1034.389708
Available	3,4	jəu-k ^{hw} uŋr	38	o	643.9961168	1031.314096
Tree leaf	4,4	ʂu-je	39	u	508.3093171	896.0023303
		ʂu-je	40	e	604.7650442	1700.441669

Tree leaf	4,4	ʂu-jeər	41	u	483.7074246	984.4616491
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The vowel space is graphed as follows:



6. The [-r] suffixation alternations².

The use of [-r] suffix is a main characteristic of the Beijing dialect of Mandarin Chinese. Historically it was related to the word [øər] 'son', which can also mean 'smallness', for which reason the [r] suffix has also been called diminutive suffix (in this context I use /r/ represents the retroflex r /ɻ/ following the literature³). However, [r] can also be added to adjectives and some verbs, which undergo the same merger progress (Duanmu 2000: 195). In addition to denoting smallness and not-seriousness, the main meaning contrast between a word without and with the [r] suffix is often nuanced, sociolinguistic, and pragmatic one (although in my word list that I came up with, many compound-words did contain the word 'little' /çau/, in the in regular noun or proper noun. Also note that many of these words in isolation form instead of compound form will not usually be subject to

² The alternations (segmental and tonal) in this paper are in general described in the literature (since there are few alternations in Chinese in general due to poor morphology). However, the analysis put forward here is unique and original and markedly different from any analysis in literature. The pros and cons of the current analysis is discussed when possible as compared to the literature.

³ Some authors such as Duanmu (2007) has a different analysis and use /ə/ to represent the suffix. Here I use /r/ in accordance with my analysis. Later in my discussion I assume an analysis where /ə/ is the underlying form of the /r/ suffix.

suffixation of [r]). Since it is not mandatory to add the suffix in Standard Mandarin in most cases, speakers outside of Beijing often drop the suffix and rarely cause difficulty in communication in lexical meaning.

Certain lexical items in Beijing dialect, however, require the obligatory suffixation of [r]. For instance, /ç¹an/ ‘fillings (such as in dumpling) is always pronounced as /ç¹ar/. In these cases, [r] suffixation may contrast lexical meaning, e.g., /ç^hi-zau/ ‘take a bath’ vs. /ç^hi-zaur/ ‘wash a date (fruit)’, /p^hi/ ‘leather’ vs. /p^hiər/ ‘skin’. Nonetheless, no matter what semantic function it serves, the phonology of [r] suffixation follows the same rules, as observed in the data below.

The phonological alternation of the suffixation of [r] is observed in the current data (see below). More examples are also provided in the following form:

	glossary	unsuffixed	suffixed	Notes
1	Xiaosi (proper name, 'Little Si')	çau-sz	çau-sər (or çau-szər)	Syllabic /z/ replaced with /ər/
2	my niece	wo:-tʂr ⁴	wo:-tʂər (or wo:-tʂər)	Syllabic /r/ replaced with /ər/
3	Xiaobei (propoer name)	çau-pəi	çau-pər	Final /i/ replaced with /r/
4	wash basin	l'an-p ^h ən	l'an-p ^h ər	Final /n/ replaced with /r/
5	Xiaobai(proper name)	çau-pai	çau-par	Final /i/ replaced with /r/
6	Xiaoba(proper name)	çau-pa	çau-par	+/r/
7	wooden board	m ^w u:-pan	m ^w u:-par	Final /n/ replaced with /r/
8	a bunch (of people)	i-p ^w o	i-p ^w or	+/r/
9	Xiaogu(proper name)	çau-ku	çau-kur	+/r/
10	little river	çau-xə	çau-xər	+/r/
11	Xiaobao(proper name)	çau-pau	çau-paur	+/r/

4 The syllabic /r/ as the rhyme of the syllable is not a retroflex r, which is denoted by /r/ in the current context.

12	little dog	çau-kəu	çau-kəur	+/r/
13	Xiaopeng(proper name)	çau-p ^h əŋ	/çau-p ^h əŋr/ (or /çau-p ^h əŋr̃/)	+/r/(?Final /ŋ/ weakened or deleted, leaving preceding vowel nasalized) ⁵
14	rear of the boat	tʂ ^{hw} an-paŋ	tʂ ^{hw} an-paŋr (or tʂ ^{hw} an-pār)	+/r/(?Final /ŋ/ weakened or deleted, leaving preceding vowel nasalized)
15	available	jəu-k ^{hw} uŋ	jəu-k ^{hw} uŋr (or jəu-k ^{hw} ūr)	+/r/(?Final /ŋ/ weakened or deleted, leaving preceding vowel nasalized)
16	tree leaf	ʂu-je	ʂu-jeər	+/ər/
17	little aunt (younger sister of mother)	çau-i	çau-iər	+/ər/
18	Xiaobi(proper name)	çau-pi	çau-piər	+/ər/
19	shade of a tree	ʂu-in	ʂu-iər	Final /n/ replaced with /ər/
20	little fish	çau-y	çau-yər	+/ər/

Some initial observations:

- (i) The alternation between /r/ (5,6,7,8,9,11,12,13,14,15) and /ər/ (1,2,16,17,18,19,20), or cases that could be either +/r/ because the word ends with /ə/, or simply +/ər/, which inserts the /r/ and replaces the original ending (3,4,10)⁶;
- (ii) The deletion of final / z i r n i y e/ (1,2,3,4,5,7,19,20) but not /u ə a o u ŋ/ (8,9,10,11,12,16);
- (iii) Word final /i y e/ is deleted in heavy syllables (3,5) but not light ones (16,17,18,19);

⁵ Please see footnote 7 for discussion on whether the final velar nasal is deleted.

⁶ Although considering that the /r/ or / ər/ suffixation is never observed to affect the penultimate segment, it is reasonable to classify these into the /r/ group.

(iv) The preservation of nasality before /ŋ/ deletion⁷ (13,14,15), but not /n/ deletion (4,7,19) (as explained in footnote 5, it is not clear that /ŋ/ is deleted, therefore (iv) can be represented in observation (ii) ;

Some authors have argued that the suffix [+retroflex] /r/ can be analyzed as a morpheme, or it can be analyzed as the addition of a [+retroflex] feature (Duanmu 2000). In either case, it is clear that (i) and (ii) above can be explained by stating that any word-final segments that are not compatible with the [+retroflex] feature will be eliminated first. Here I also follow the consensus in literature to specify a [+Coronal, -retroflex] feature for the front vowels /i y e/ (Duanmu 2007: 218).

In this case we consider the segments with a [Coronal] feature (assuming [coronal] is a unitary feature), therefore word final /i/ /y/ /n/ will be eliminated before the suffixation (1,2,3,4,5,7,19,20). However, we observed that this is not always the case, as in (iii) above. Instead, we observe that word final /i y e/ are deleted in heavy syllables (3,5) but not in light ones⁸ (17,18,19) (to explain the contrast between (ii) and (iii), /n/ is always deleted because a syllable with coda /n/ must be a heavy syllable. Therefore, (iii) does not apply to /n/).

Meanwhile, any word-final segments that do not have [Coronal] feature will be preserved, which are compatible with the [+retroflex] feature of the suffix [r]. These are the cases (8,9,10,11,12,16), which explain the contrast in (ii) above.

This leaves to explain the observation (i) above, which is the alternation between [r] and [ər] forms. In general, when the word-final segment is compatible with the retroflex feature of [r], a simple [r] is added to formulate the suffixed form (5,6,7,8,9,11,12,13,14,15, as well as 3,4,10).

There are several sub-cases with the presence of [ər] in the suffixed forms. In case one, which is exemplified by (16,17,18,19,20), the final segment in a light syllable is [Coronal], which is incompatible with the [+retroflex] feature of [r]. In this case, [ər] is inserted instead of [r] to ensure that the preceding vowel (penultimate segment) in the suffixed form is compatible with the [retroflex] feature of [r].

⁷ According to Y.Xu (1986) and J.Wang (1993), oral closure is not required for Mandarin nasal codas. As will be discussed below, there are evidence in the literature that indicates that it is not clear in this case whether the /ŋ/ is deleted or not. Thus the suffixed form for 13, for example, is transcribed as /çau-p^hə̃r/ in come literature and /çau-p^hə̃ŋr/ in others.

⁸ Since Mandarin does not contrast short /i/ vs. long /i:/, it is assumed here that the /i/ is a light syllable, in contrast with the diphthongs, such as /ai/ which is treated as the heavy syllable in the current study. Even though either /i:/ or /i/ maybe found in the variation of actual speech, it is not relevant to the contrast made here: /i/ is treated as taking one rhyming slot, and diphthogal/ai/ is treated as taking two. This is sufficient in the working of the current analysis.

In case two, which actually coincide with a sub-case of the [r] case above, as exemplified in 3,4,10, the word-final segment before the suffixation happens to be /ə/. In this case, since the word-final /ə/ is compatible with retroflex /r/, a simple /r/ is added. The surface form happens to be /ər/.

The third sub-case is special, as illustrated in (1,2). These involve the syllabic /z/ and /r/ as the sole segment in the rhyme of /sz/ and /ʃr/. Since both segments are word-final and [Coronal], they have to be deleted before the suffixation, leaving /s/ and /ʃ/ as the bare consonants in the root. In this case, it seems we can explain the insertion of /ər/ instead of /r/ by the requirement of a word in Mandarin to have a vowel.

A problem of the handling of these two syllables persists: articulatorily it is not clear whether the rhyme segment (such as syllabic /z/) is deleted in suffixation. That is, we may consider the transcriptions /szər/ and /ʃrər/ for the suffixed form. This problem is rooted in the special phonetic properties of these two sounds (/sz/ and /ʃr/). In terms articulation (and in Mandarin L2 teaching), the nuclei of these two syllables are best described as a voiced continuation of the initial sound of /s/ and /ʃ/ (thus /sz/ and /ʃr/, but without the audible onset of /z/ and /r/), with practically no other gestural change. For this reason, it is difficult to identify whether the syllabic /z/ and /r/ are deleted in the suffixed form, because they are merely a continuation of the initial consonant /s/ and /ʃ/, with not gestural change except for voicing. If we do adopt the transcription of the suffixed form as /szər/ and /ʃrər/, we can then explain them as a case of a non-heavy syllable, where /ər/ is simply surfaced (Please see footnote 9 for a important discussion on yet another alternative I proposed)⁹.

As to why /ə/ is inserted as the vowel, further discussion is required. One explanation is to assume that /ər/ is the underlying form of the suffix [r], and it will surface only if the word-final segment that precedes the suffix is incompatible with the [+retroflex]. When the word-final segment is [+retroflex] compatible, /ə/ is deleted after the insertion of /r/. Articulatory-wise, since /ə/ is the most unmarked neutral tongue position, it can be the most compatible candidate with /r/.

However, there is one problem with this hypothesis: if the underlying form of the suffix is [ər], then /r/ is already preceded by a non-coronal consonant that is compatible with the retroflex feature

⁹ Another analysis I put forward involves a completely different transcription of these two sounds in the root word in the first place (/sz/ and /ʃr/). I disagree with the convention in the literature to transcribe these two sounds using syllabic consonants. Rather, a slower, more discrete articulation would reveal that the nuclei of these two sounds are actually vowels, more specifically, unrounded high back vowel [u]. One evidence of this transcription is that this sound ('si' in Chinese roman letter system) is perceptually almost identical to the Japanese syllable /suɨβ/ ('su' in Japanese roman letter system), which involves a rounded (spread rounding lips) high back vowel, often compared with the English /ʊ/ sound—rounded (protruded rounding lips) high back vowel. Further articulatory study will confirm this. In the current analysis, if this is assumed, then the case of these two sounds would be non-coronal and compatible with the [retroflex] feature of the [r] suffix, therefore explains the surface of /ər/.

of /r/, and there is no reason to delete any of the word-final segments no matter those segments are [+Coronal] or not. Thus for instance, we will not expect for the final /i/ to be deleted in /pai+r/ → /par/.

To solve this issue, I follow the analysis of Duanmu (2007). In this analysis, as I briefly mentioned before, /r/ is not treated as a segment to be added to the root. Rather, it is underlyingly a retroflex feature attached to the segment (underlying form) /ə/, here represented as /ə^r/. Since /r/ is the retroflex feature of the segment /ə^r/, we will still need to expect the word-final segment to be compatible with the feature of /ə^r/. Any incompatible segments will be deleted ([+coronal]). Likewise, in the case where a retroflex-compatible feature is found in word-final segment, the /ə/ is not required and it alone will be deleted and the feature will attach to the final segment (e.g., /pa+r/ → /pa^r/).

Here I summarize the processes and rules discussed so far in the current analysis of [r] suffixation:

a. Plain English

The underlying form of the suffix is /ə^r/. In the process of suffixation:

1. A word-final Coronal segment will be deleted before the suffixation in a heavy syllable.
2. Otherwise, if the word-final segment is non-coronal, the suffix will surface as /r/ as a retroflex feature attached to the segment.
3. Otherwise, the suffix is /ə^r/.

b. SPE Formalism

The underlying form of the suffix is /ə^r/.

Here I assume a binary feature for [+/-Coronal]. In the process of suffixation:

1. A word-final (root-final) coronal segment is deleted in heavy syllables.

[+Coronal] → ø/V__#

2. [ə] is deleted in the suffixed form of the word if the unsuffixed root-final segment is non-coronal (retroflex feature is retained).

[ə] → ø/ [-Coronal](#)¹⁰_r #

Here I give derivations for represented words in the data:

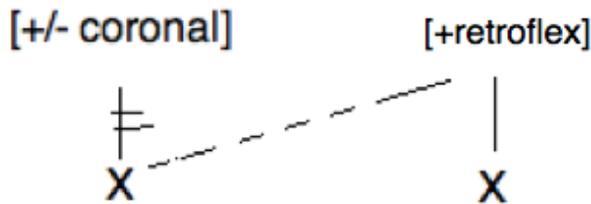
¹⁰ (#) denotes the original word boundary between the root and the suffix.

	pəi+əʳ	sz+əʳ	pʰən+əʳ	pɑ+əʳ	pʰəŋ+əʳ	pi+əʳ
(1)Coronal deletion (heavy syll)	pəəʳ	--	pʰəəʳ	--	--	piəʳ
(2)/ə/ deletion	pəʳ	--	pʰəʳ	pɑʳ	pʰəŋʳ	--

c. Autosegmental Formalism

The r-suffixation process, viewed in autosegmental perspective, essentially requires that in the suffixed form of the word, the penultimate segment (vowel) must be compatible (agree) in [+/- Coronal] with the final [r], which has a [+retroflex] feature.

In autosegmental formalism, we can simply view this as the following process, where the second segment is the [r]:



Graph c1

d. OT formalism

These constraints are proposed for the suffixed form of the word:

(1) Markedness Constraints

- *[-Coronal][-Coronal]#: sequence of two [-Coronal] segments at the end of the word is prohibited.
- *VVV: Heavy rhymes consisting of three vowel slots are prohibited.
- *[+Coronal]#: suffixed word-final segment must not be [+Coronal].

(2) Faithfulness Constraints

- MAX(PS): The Penultimate Segments in the UR input must not be deleted in the SR.
- DEP: Segments in the SR of the suffixed form are all present in the UR.
- IDENT(Retroflex): segments in UR and SR have the same [+/- retroflex] feature.

Here I give the OT evaluation for the suffixed form of these three words: /pai/, /pa/, /pi/.

pai+əʳ	*[+Coronal]#	IDENT(retroflex)	*VVV	*[-Coronal][-Coronal]#	MAX(PS)	DEP
paieʳ			*!			
paəʳ				*!		
paʳ					*	
pa		*!				
paiʳ	*!					
paə		*!				

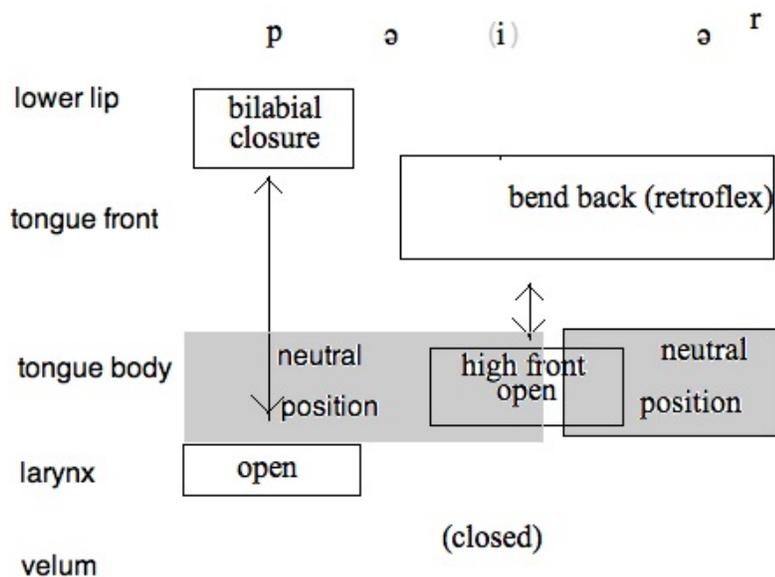
pa+əʳ	*[+Coronal]#	IDENT(retroflex)	*VVV	*[-Coronal][-Coronal]#	MAX(PS)	DEP
paəʳ				*!		
paʳ						
pəʳ					*!	
pa		*!				
paə		*!				

pi+əʳ	*[+Coronal]#	IDENT(retroflex)	*VVV	*[-Coronal][-Coronal]#	MAX(PS)	DEP
pieʳ						
piʳ	*!					
pəʳ					*!	
pi		*!				
pie		*!				

e. Articulatory Phonology

Articulatorily, the suffixation process is characterized by the hiding of gestures (deletion) of the root-final gesture that is not compatible with the retroflex tongue position, in which case the coronal tongue position of the sound (e.g., /i/) in a heavy syllable is significantly overlapped with the following retroflex tongue position and is therefore hidden. Here I give examples of the gestural scores of three words:

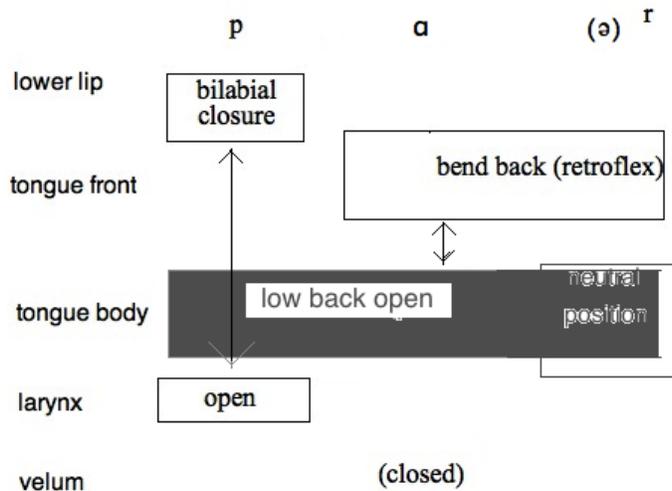
(1) /pəi+əʳ/ → /pəʳ/ (Graph e1). In this case, /i/ (high front) is incompatible with the hidden by the tongue tip bending backward and the continued neutral position of the tongue body, which also blend the two /ə/ sounds into one. Here, it is observed that the gestural score revealed an additional incompatibility of /i/ with /əʳ/: in addition to the frontness of /i/ that is incompatible with the bending back of the tongue tip of the retroflex, /i/ is also in a high tongue body position that is incompatible with the lower neutral tongue body position of /əʳ/. However, considering the fact that /i/ must be deleted by /u/ is fine, so we can refute the observation here about /i/'s height. In other words, the contrast between /i/ and /u/ in terms its compatibility with the suffix segment reveals that the crucial point of the suffixation is the retroflex feature, not the segment /ə/ that carries the feature in the underlying form.



Graph e1 /pəi+əʳ/ /pəʳ/

Graph e1. High front open gesture of the tongue body is hidden by the continuous neutral position throughout the articulation of the suffixed word.

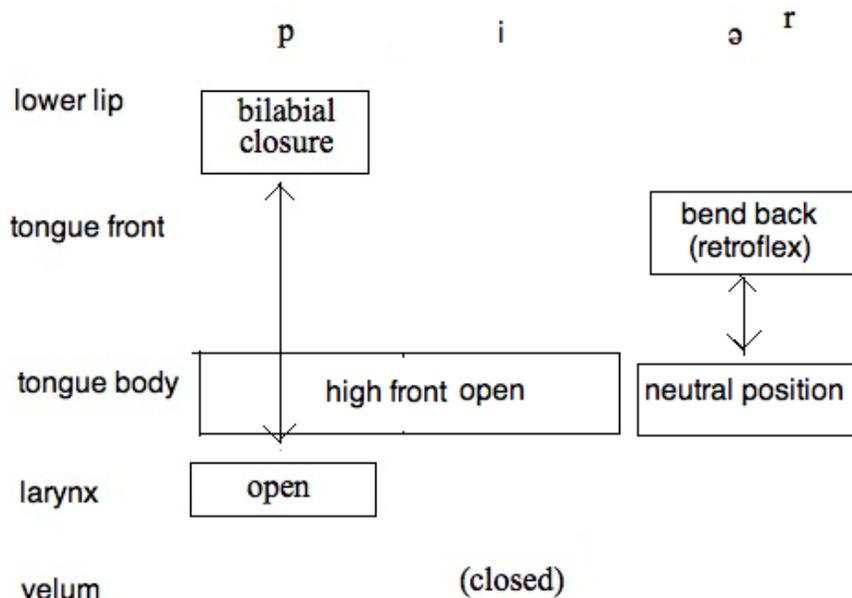
(2)/pa+əʳ/→/pɑʳ/ (Graph e2). In this case, the root final segment is compatible with the retroflex feature of the suffix and therefore prevails the tongue position throughout, hiding the neutral tongue position for the segment /ə/ in the underlying form of the suffix.



Graph e2 /pa+əʳ/→/pɑʳ/

Graph e2. The neutral tongue body position in the underlying form of the suffix is hidden by the low back open gesture of the tongue body, a gesture already compatible with the [-coronal] feature of the suffix.

(3)/pi+əʳ/→/piəʳ/(Graph e3). In this case, the root word is a light syllable so all segments remain in its original position and timing without overlapping.



Graph e3 /pi+əʳ//piəʳ/.

Graph e3. All the gestures in the root word and the underlying form of the suffix is observed in surface articulation.

7. Discussion

The compatibility of retroflex feature has been sufficient to capture alternations in most cases and most approaches, and it does have a phonetic grounding in its unmarkedness. In addition to the discussion of the pros and cons of each approach along the way (and what they have revealed about the alternation), here I discuss several questions specifically related to the specific approaches: (1) In SPE formalism, why are incompatible features deleted in heavy syllables and not light ones? (2) In OT markedness constraints, why is [-Coronal][-Coronal]# sequence prohibited? (3) In OT faithfulness constraints, why does the first of the [-Coronal][-Coronal]# sequence have to stay from UR to SR (MAX(PS))?

The answer to the first question rests in the phonology of Chinese language in general. Consider the words with a heavy syllable /pai/ and with a light syllable /pi/. When suffixation happens, two strategies can be possible, since the root-final segment is incompatible with the retroflex feature: either (1) delete /i/ and attach /əʔ/, or (2) simply add the suffix /əʔ/. However, the second option will lead to the occurrence of /paiəʔ/ in the heavy syllable root case, a rhyme pattern that is virtually non-existent in the sound inventory and prohibited in Chinese phonology because it is too heavy (*VVV). Therefore the preferred strategy in this case is to choose the deletion of /i/ in the heavy syllable. OT provides a plausible explanation for this question.

I already discussed the second question previously by stating that it is really the feature that is being suffixed. In other words, /əʔ/ will only surface when the root-final sound is incompatible with the retroflex feature (and when that segment is preferred not to be deleted due to the MAX constraint). This finds its grounding in the Gestural score: if the root-final word is incompatible with the retroflex that is being attached, articulation dictates that a transitional sound /əʔ/ will be added as the final segment to carry the retroflex feature. In other words, the retroflex gesture simply cannot be directly linked to the frontal tongue position that occurs in the root-final segment. This gestural based explanation also extends to the third question: since the root-final segment is already retroflex-compatible, there is no need to add another carrier sound /əʔ/.

Finally, starting with the SPE rules, I have assumed a [+/-Coronal] feature instead of assuming a unitary feature for [coronal], as I did in previous discussion. In this case the [+/- Coronal] as a binary feature is useful in writing the SPE formalism in a simple and concise form. Also, given the current observation on the behavior of the r-suffixation, it seems that the binary feature is indeed useful in the analysis.

8. Mandarin Tone Alternation: Tone 3

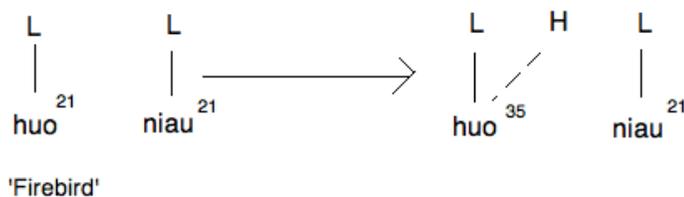
The four tones of Mandarin are often transcribed as: Tone 1 (55, H), Tone 2 (35, LH), Tone 3 (21, L) or (214, LH), and Tone 4 (51, HL). Tone 3 has several unique characteristics among the four tones. First, Tone 3 is realized as 214 (LH) in the canonical form (as in L2 teaching and elementary Chinese courses in Chinese schools), which only surfaces in monosyllables in isolation cases, and in sentence-final position among some speakers. In most non-final and non-isolation cases, Tone 3 is realized as 21, the low tone (L). Second, when realized as 214, Tone 3 is considerably longer than other tones (Duanmu 2000: 220), and is represented as having three moras (Woo 1969, Shih 1997), comparing to other tones, which are represented as having 2 moras. Consider the empirical fact that the actual realization of 214 in Tone 3 is statistically rare, I follow Duanmu (2000:221) here and assume that the underlying form of Tone 3 is 21 [L]. Duanmu (2000) argues that the H in [214] and on the weak syllable after a Tone 3 comes from a polarity constraint that requires L to be followed by H in a disyllabic foot. Finally, it is well known that Tone 3 has a Sandhi phenomenon when preceding another Tone 3: Tone 3 → Tone 2 / __ Tone 3. This is often explained as the OCP effect: $L + L \rightarrow L + H + L$ ¹¹.

a. plain English

1. Tone 3 is realized as Tone 2 (LH, 35) when followed by another Tone 3 (L).
2. Tone 3 is realized as LH (214) in monosyllables.
3. Otherwise, Tone 3 is realized as L (21).

b. Autosegmental representation for tone

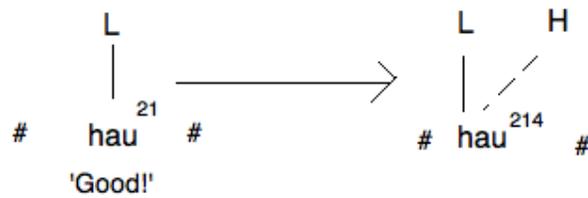
1. Tone Sandhi: Tone 3 → Tone 2 / __ Tone 3



Tone 3 Sandhi

¹¹ The realization of tone 3 in more than 2 consecutive Tone 3 syllables is complex, and is related to the prosodic domain (metrical foot, stress, etc) and syntax. Here I will not discuss this complex phenomenon.

2. L21 → LH214 / #_#



Tone 3 as 214 in isolation

c. OT Formalism

1. Tone Sandhi

[Markedness Constraint]

OCP: neighboring identical elements (tones) are prohibited.

*#L#: a low tone in a monosyllable is prohibited.

[Faithfulness Constraint] DEP: All tone segments in SR are represented in UR.

L+L	OCP	*#L#	DEP
LL	*!		
LHL			*
LLL	*!		
LLH	*!		

2. L21 → LH214 / #_#

L	OCP	*#L#	DEP
L		*!	
LH			*
LL	*!		

9. Discussion

In both the autosegmental and OT representation, one problem is that the surface form of Tone3 as 214 in isolation is not clearly demonstrated as having a good phonetic grounding. One option is to consider the temporal aspect: that a monosyllable in isolation cannot be too short (such as occupying only one mora). However, this is not clear in the case of Mandarin because there are many instances that the third tone also surface as 21 in isolation, and other tones, such as the first tone (High Tone 55), always surface as H. Therefore, it is not clear why #L# is prohibited while #H# is not (and there are many cases of #L# in Mandarin as well). As mentioned above, the realization of Tone 3 is complex and often related to prosody and syntactic properties of the utterance. Therefore, it is beyond the scope of the current paper to give a well-rounded explanation for this phenomenon.

Reference

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