AN EMA STUDY OF ER-SUFFIXATION IN NORTHEASTERN MANDARIN MONOPHTHONGS

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ABSTRACT

This paper investigates the articulatory characteristics of *Er*-(diminutive) suffixation in Northeastern Mandarin using an NDI Wave. We compared temporal changes of the tongue configurations at different deciles of the duration of both unsuffixed and *Er*-suffixed monophthongal stems. In addition, the vowel phoneme /ɚ/ (rhotic schwa) is included for comparison. Results show that, details aside, *Er*-suffixation predominantly involves a retraction of the tongue body (i.e., a bunched tongue configuration exhibiting a positive value of the Tongue Tip Angle (TTA) index across the board), while a raising of Tongue Tip (TT) is found in the articulation of the rhotic schwa /ɚ/. Diachronically, the *Er*-suffix is derived via adding the rhotic schwa to a stem. So, the well-known retroflex vs. bunched distinction of /ɹ/ in American English is replicated in Northeastern Mandarin, albeit in a different fashion.

Keywords: Electromagnetic Articulography, Er-suffixation, Articulation, Northeastern Mandarin

1. INTRODUCTION

Er-(diminutive) suffixation is one of the most extensively studied morpho-phonological processes in Mandarin Chinese. It has long been noted in previous impressionistic studies that the phonetic realization of the *Er*-suffix is contextually determined ([7, 11, 15], among others). When the stem ends with a high front vowel, *Er*-suffix is realized as a subsyllabic /-ɚ/, as in (a) in Table 1. On the other hand, (b) in Table 1 illustrates the "fusional" realization of *Er*-suffixation (i.e., a rhotacized stem; [11]), when the stem ends with a non-front vowel.

Table 1: Patterns of *Er*-suffixation in Mandarin Chinese monophthongs

	Stem	*Er-suffixed forms*	*Gloss*
(a)	$\text{p}^{\text{h}}\text{i}^{35}$	$\text{p}^{\text{h}}\text{iɚ}^{35}$	'skin'
	tɕy^{55}	tɕyɚ^{55}	'pony'
(b)	pu^{51}	pu˞^{51}	'step'
	$\text{k}^{\text{h}}\text{ɤ}^{35}$	$\text{k}^{\text{h}}\text{ɤ˞}^{35}$	'shell'

Regarding the articulatory properties of *Er*-suffixation in Mandarin Chinese, it is fair to say that little is known about the overall tongue configuration and temporal changes thereof. In two previous EMA studies, for example, [18] confines his discussion to the tongue tip and [8]'s major finding is that curling of the tongue tip is not found. Therefore, in addition to tongue tip, the first goal we set out is to investigate the overall tongue configuration and in particular the role of tongue dorsum positioning in *Er*-suffixation.

The second research question is to understand the kinematic differences between the rhotacized and subsyllabic allomorphs of *Er*-suffix, as in Table 1. The tongue configurations of the unsuffixed and *Er*-suffixed stems are compared to see if there is any shared articulatory trait for *Er*-suffixation. The third research question is: although it is uncontroversial that the *Er*-suffix is diachronically derived via attaching the content word /ɚ^{24}/ 'son' to a stem (i.e., the "rhotic schwa"), little is known about articulatory differences between the *Er*-suffix and the rhotic schwa in the literature. This study helps fill the gap.

In this study, the variety of Mandarin Chinese under investigation is Northeastern Mandarin spoken in Liaoning Province, although most, if not all, previous studies of *Er*-suffixation are based on Beijing Mandarin. We believe that is not a problem since the general impression is that the *Er*-suffixed forms are not perceptually distinguishable for most cases between these two varieties of Mandarin Chinese. On the other hand, this study also helps better understand if there is any cross-dialectal difference with respect to *Er*-suffixation.

2. METHOD

2.1. Data collection

The kinematic data were collected with the help of an NDI Wave at the phonetics laboratory at National Tsing Hua University, Taiwan. Three native speakers of Northeastern Mandarin from Liaoning, (S1, male, aged 25 y.o.; S2, male, 26 aged y.o.; S3, female, aged 24 y.o.) participated in this study. No hearing and speech impairments were self-reported. The EMA data were collected at a sampling rate of 100 or 400 Hz and the acoustic data were recorded at 22 kHz.

2.2. Material

The recording material includes both *Er*-suffixed and unsuffixed meaningful monosyllables containing the seven (surface) monophthongs, including the so-called "apical vowels": /ɑ, i, y, u, ɤ, ɹ̩, ɻ̩/. The onset consonants are set to be /p/ or /p^{h}/, and /ɕ, s, ʂ/ are used when the nucleus is /y, ɹ̩, ɻ̩/. The rhotic sounds /ɚ/ and /ʐɻ̩/ (i.e., *er* and *ri* in Pinyin respectively) are included in the wordlist as well. Participants were asked to read a randomized list of the stimuli from a computer screen for five times, yielding 240 tokens in total (= 16 words × 5 repetitions × 3 speakers).

The target words were embedded in the carrier phrase: __, *mà* __ *ba* '__, 'scold __ PARTICLE', whereby only the second occurrences of a target word were analyzed and reported in this work.

2.3. Data analysis

The EMA data were post-processed and analyzed with the help of MView, a Matlab script developed by Mark Tiede at Haskins Laboratories. Vertical and horizontal positional coordinates were extracted at the acoustically defined portion of a rime for the sensors (in particular, Tongue Tip (TT), Tongue Body (TB) and Tongue Dorsum (TD)). Subsequently, a custom-made Matlab script is used to extract the positional coordinates at deciles of the duration of a rime for the temporal changes of the tongue postures. In adddition, the positional coordinates were *z*-score normalized within speakers and dimensions of EMA sensors (high-low and front-back). Average *z*-scores were converted back into millimeter values for ease of visualization of the kinematic data.

3. RESULTS

3.1. Temporal changes of the tongue configurations

In Figures 1~4, the temporal changes of the overall tongue postures are illustrated. Only the results from S1 and S2 are reported here because of space limit. As a matter of fact, S3 produced similar results, too. Figures 1a-b and 2a-b are concerned with the cases whereby an open syllable contains the front vowels /i, y/. The tongue positions of the unsuffixed forms (represented with a green dashed line throughout) are higher than those of *Er*-suffixed forms (represented with solid lines throughout). In these contexts, we may say that the *Er*-suffixation predominantly involves tongue retraction. Regarding the so-called apical vowels /ɹ̩, ɻ̩/, Figures 1c and 2c refer to the cases of the plain, "non-rhotacized" apical vowel (/ɹ̩/). Here tongue retraction is also robustly attested and it is equally remarkable that the tongue positions of an unsuffixed apical vowel are lower than those of *Er*-suffixed forms, unlike what we have witnessed in Figures 1a-b and 2a-b. Finally, only TD is slightly lowered in the cases of the "rhotacized" apical vowel (/ɻ̩/), as shown in Figures 1d and 2d. Otherwise, there is no obvious temporal change of the tongue configurations (i.e., no "vowel gliding"), especially in the anterior portion of the tongue, as far as the *Er*-suffixed rhotacized apical vowels are concerned.

Figure 1: Temporal changes of S1's tongue configurations of *Er*-suffixed forms (a) /p^{h}i/-*Er* "skin"; (b) /ɕy/- *Er* "hair"; (c) /sɹ̩/-*Er* "Four (nickname)"; (d) /ʂɻ̩/-*Er* "issue"

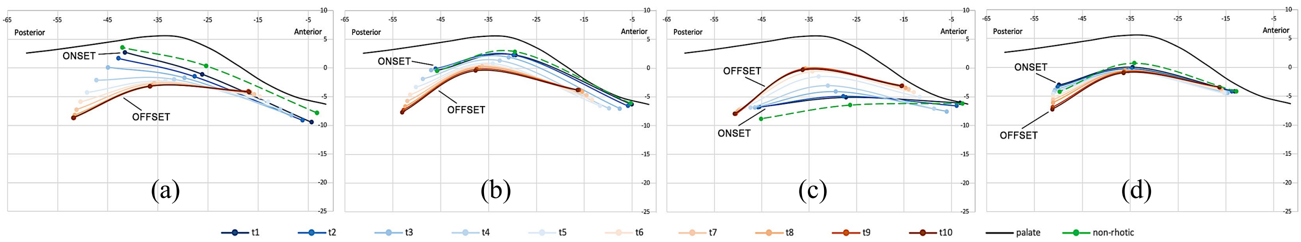
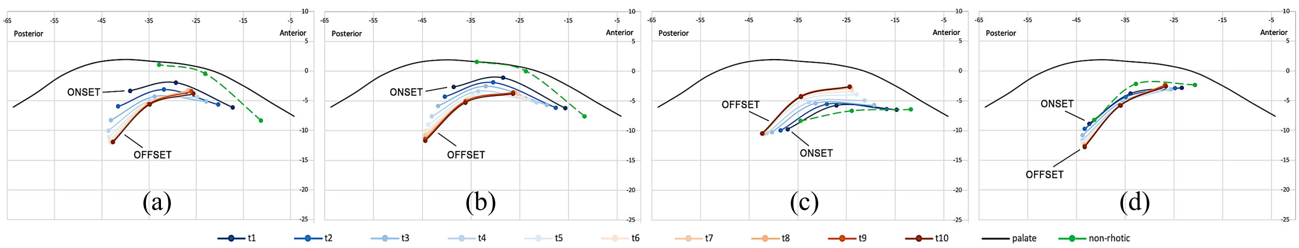


Figure 2: Temporal changes of S2's tongue configurations of *Er*-suffixed forms (a) /p^{h}i/-*Er* "skin"; (b) /ɕy/-*Er* "hair"; (c) /sɹ̩/-*Er* "Four (nickname)"; (d) /ʂɻ̩/-*Er* "issue"



A measurement index "Tongue Tip Angle" (TTA) is proposed in [14] to differentiate the retroflex /ɹ/ from the bunched /ɹ/ in American English. Our results show that the *Er*-suffixed front vowels have a positive TTA, meaning that the *Er*-suffix is not a genuine retroflex sound here (i.e., TB is higher than TT). Indeed, a casaul comparison with [17]'s taxonomy of the /ɹ/-related tongue shapes suggest that S1 (and S3)'s tongue configurations are more like type A, and S2's are more like type B, both referring to a bunched /ɹ/ configuration.

Figures 3 and 4 illustrate the kinematic data for the *Er*-suffixed vs. unsuffixed back vowels (/ɑ, u/). We can see that the tongue positions of an unsuffixed back vowel are lower (green dashed line) than those of the *Er*-suffixed forms. The *Er*-suffixed back vowels have significantly higher TT and TB (i.e., the anterior part of the tongue) than those of the unsuffixed forms, suggesting that *Er*-suffixation is implemented via TT raising and, to a lesser extent, TB raising, when the nucleus vowel is non-front. It is also remarkable that there seems no "gliding" in *Er*-suffixed forms here (cf. Figures 1d and 2d), unlike what we have seen for the cases of *Er*-suffixed front vowels (/i, y, ʅ/) in Figures 1a-c and 2a-c.

Figure 3: Temporal changes of S1's tongue configurations of *Er*-suffixed back vowels: (a) /pu/-*Er* "step"; (b) /pɑ/-*Er* "handle".

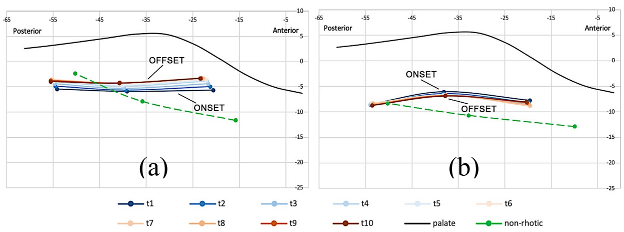
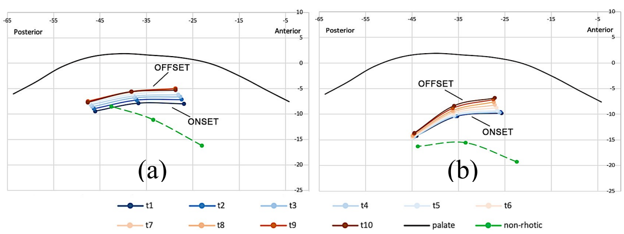


Figure 4: Temporal changes of S2's tongue configurations of *Er*-suffixed back vowels: (a) /pu/-*Er* "step"; (b) /pɑ/-*Er* "handle".



Unlike Standard Chinese, vowel /ɤ/ undergoes substantial gliding (diphthongization) in Northeastern Mandarin. Therefore, this vowel phoneme is not included in our discussion of the results, although our observation is that /ɤ/ does pattern alike with respect to *Er*-suffixation. See also Figure 8 in section 3.3. for more discussion.

3.2. More on the phonetic realization of *Er*-suffix

What is left untouched in the preceding sections is to see if there is any shared articulatory trait of the *Er*-suffix, in particular, when the stem ends with a high front vowel. Therefore, an articulatorily defined onset of the *Er*-suffix is needed for this purpose. To do so, again, with the help of a custom-made Matlab script, we managed to extract the positional coordinates of an *Er*-suffixed rime in the mid point between the time point when TT passes half way and the end point of a rime (roughly the sixth or the seventh decile, or, *t6* or *t7* in the figures). Consider now Figures 5 and 6.

Figure 5: Onsets of the *Er*-suffix (S1)

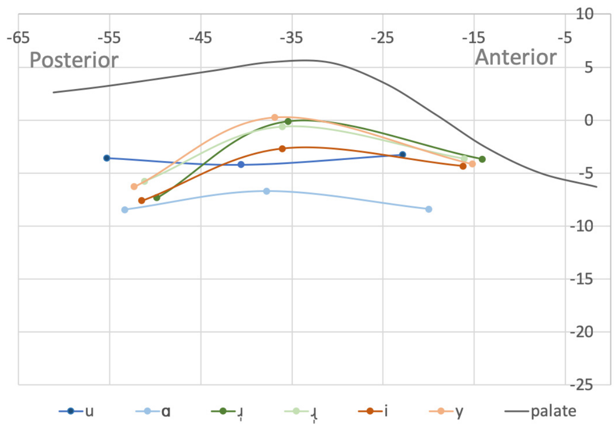
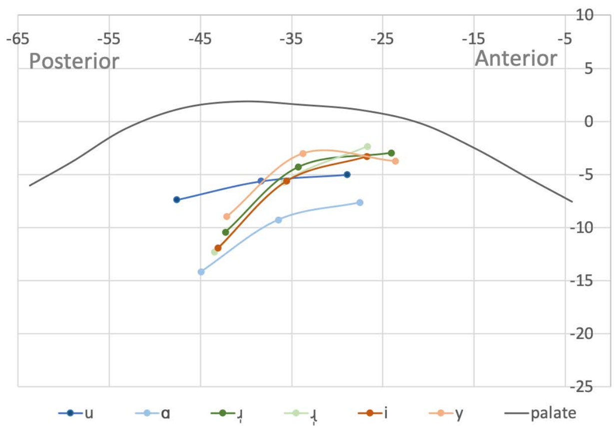


Figure 6: Onsets of the *Er*-suffix (S2)



Front and non-front vowels, as we have seen in Figures 5 and 6, form two distinct clusters. Regarding the front vowels, we can see that the onset of the overall tongue shapes of the *Er*-suffix is more similar to a bunched /ɹ/. A positive TTA ([14]) is obtained in the data, indicating that TB, but not TT, plays a more active role in the realization of the *Er*-suffix attached to a high front vowel. On the other hand, the *Er*-suffix does not involve TT/TB raising, when the stem contains a back vowel. Therefore, the present results confirm that a "curled-up" TT is not found in *Er*-suffixation in Northeastern Mandarin, just like its counterpart in Beijing Mandarin (as in [8]).

3.3. The “rhotic schwa” vs. *Er*-suffix

In Northeastern Mandarin, /ɚ/, or, the (unsuffixed) rhotic schwa, just like its plain, “non-rhoticized” counterpart /ɤ/, undergoes robust diphthongization (or, gliding) as well. In Figure 7, we can see that TT raising is the shared feature for this (unsuffixed) rhotic vowel. In contrast, Figure 8 shows that TT raising is absent in the *Er*-suffixed vowel /ɤ˞/ (note that vowel gliding occurs only in unsuffixed vowel /ɤ/ in Northeastern Mandarin). Rather, the *Er*-suffixed vowel /ɤ˞/, albeit heavily diphthongized, features an elevated tongue configuration, just like the other back vowels (see also Figures 3~4) Taken together, the present data reveal that, articulatorily speaking, *Er*-suffix and the rhotic schwa are not identical, at least in Northeastern Mandarin.

Figure 7: Temporal changes of the tongue configurations of the rhotic schwa /ɚ/ ‘son’: S1 (left) and S2 (right)

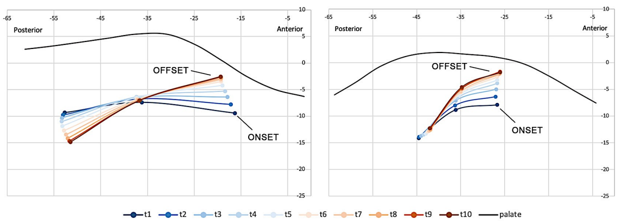
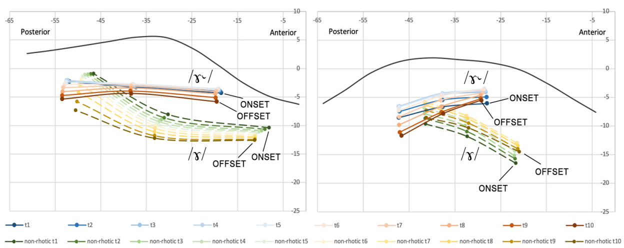


Figure 8: Temporal changes of the tongue configurations of /ɤ/ and /ɤ˞/: S1 (left) and S2 (right)



4. DISCUSSION

4.1. The non-retroflex nature of *Er*-suffixation

The results of our EMA study confirm that *Er*-suffixation does come into two types, a “subsyllabic” [-ɚ] and a “rhotacized” vowel (i.e., the fusional type) ([11]), as in Table 1. For the high front vowels, *Er*-suffixation often results in gliding because of tongue retraction (Figures 1a-c, 2a-c). Impressionistically, gliding of this sort may be perceived as a subsyllabic [-ɚ]. On the other hand, Figures 3~4 show that vowel gliding is not found in the cases of *Er*-suffixed back vowels. Instead, the only difference between the unsuffixed and *Er*-suffixed forms lies in the overall height of the tongue postures. To this end, we may conclude that *Er*-suffix does not involve a retroflex tongue configuration. The Tongue Tip Angle (TTA) index values calculated for the *Er*-suffixed forms also lends support to this view: TTAs are positive in 103 out of 105 tokens, meaning that no curling up of the anterior portion of the tongue is attested. So, we can say that TT is not the only major articulator for *Er*-suffixation (contra [2, 4, 18]). Instead, *Er*-suffixation is primarily implemented by a retraction of the tongue body, at least in Northeastern Mandarin.

4.2. Diachrony vs. Synchrony

We have shown that TT plays a very limited role in *Er*-suffixation. However, TT is found to be the major articulator responsible for the unsuffixed vowel phoneme rhotic schwa /ɚ/ (Figure 7). This finding is, to a great extent, reminiscent of the well-established fact that the /ɹ/-related sounds in English come into two broad types, namely, the retroflex /ɹ/ and bunched /ɹ/ [3, 5, 17], together with substantial intra- and inter-speaker variation [1, 3, 5, 13]. Interestingly enough, the present results seem to suggest a potentially possible evolution path for *Er*-suffixation. Precisely, *Er*-suffix is historically originated from adding the word /-ɚ^{24}/ ‘son’ to a stem to form a diminutive. Through the process of grammaticalization, it is not unlikely that the phonological representation of the *Er*-suffix becomes different from that of the (unsuffixed) rhotic schwa, as evidenced in Section 3.3.

5. CONCLUSION

This paper is an attempt to investigate the articulatory characteristics of *Er*-suffixation in Northeastern Mandarin, one of the most well-studied morpho-phonological processes in Chinese phonology. Needless to say, the present results are inconclusive in many respects. For example, EMA is not capable of tracking the movement of the lower tongue root. Some important information of TD retraction may be lost. Also, the small number of the participants prevents us from exploring whether intra- and inter-speaker variation is also found in *Er*-suffixation, just like the case of /ɹ/ in American English. We will leave these problems for more studies in the future, by employing the co-collection of the EMA and ultrasound technologies and collecting data from more native speakers of Mandarin Chinese.

6. ACKNOWLEDGEMENTS

This study is supported by a research grant (MOST 107-H-107-2410-H-007-038-) awarded to Yueh-chin Chang, to which we are grateful. This study has been approved by the National Tsing Hua University’s Research Ethics Committee (#10712HS104).

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