A STUDY OF THE PHONETICS AND PHONOLOGY OF NEUTRAL TONES IN URUMQI CHINESE

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In this paper, we investigate neutral tones in Urumqi Chinese from the instrumental and theoretical perspectives. Our major finding contradicts a popular view in that neutral tones are primarily cued by shorter phonetic length. In this language, tonal neutralization is thus also attributable to difficulties in maintaining contrasts in a durationally diminished syllable. An OT analysis is subsequently provided to account for the phenomena found in the Urumqi Chinese data. In particular, we argue that there is a need for the notion of Kenstowicz's (1996) UNIFORM EXPONENCE in analyzing phonetic realization of underlying tonal targets.

1. Introduction

This paper is a preliminary study of the phonetics and phonology of neutral tones in Urumqi Chinese (henceforth UC). A cover term such as "stresslessness" or the like is often used to explain why underlying tones are neutralized in neutral toned syllables (Chao 1968, among many others). We may also say that tonal neutralization in "non-prominent/weak" syllables of this sort is motivated by shorter phonetic duration and/or lower intensity (Lin and Yan 1980, among many others). Regarding UC neutral tones, it has been claimed in the literature that neutral tones in UC, unlike their counterparts in Mandarin Chinese, have "longer" phonetic length (e.g. Wang 2002), even though tonal neutralization still occurs in neutral toned syllables in UC. The first goal of this paper is thus to investigate the acoustic properties of UC neutral tones and to see if the peculiarities of UC neutral tones are also observed in our phonetic study, to which we shall return in sections 2 and 3. In section 4, an OT analysis is proposed for the phenomena we discover from our experiments. In particular, we shall argue that the notion of Kenstowicz's (1996) UNIFORM EXPONENCE is in need for an appropriate analysis of phonetic realization of underlying tonal targets. Finally, section 5 concludes this paper.

2. Acoustic Properties of Urumqi Chinese Citation Tones

Before we move onto the phonetic data, some background knowledge is provided as follows. Urumqi Chinese is a dialect of Mandarin (or Guanhua 'speech of officials'). According to Liu and Zhou (1986), there are two varieties

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of Urumqi Chinese: the first variety is spoken by the Han Chinese people, belonging to the Lan-Yin group of Mandarin (or, Lan-Yin Guanhua), while the other variety is exclusively spoken by the Hui people, classified as the Zhongyuan group of Mandarin (or, Zhongyuan Guanhua). These two varieties have substantial phonetic differences in their citation tones, disyllabic (lexical) tone sandhi patterns, and neutral tones (see Zhang 2002 for more details). Notice that UC in this paper refers to the variety spoken by the Han Chinese people (see also Wei 2001 for another phonetic study of neutral tones in UC).

2.1 Pitch Tracings and Tone Levels

UC has three tones in citation, namely, Tone 1/*Yinping* (44), Tone 2/*Yangping* (51) and Tone 3/*Shang* (213). We present the results from acoustic measurements of the tokens extracted from the recordings of one male speaker in old generation in Zhou's (1998) *The Phonetic Database of Urumqi Chinese*. Normalized F0 values, rime duration and mean intensity of the tokens were obtained with the help of Yi Xu's praat script (_TimenormalizeF0.praat, version 2.6.6; available at http://www.phon.ucl.ac.uk/home/yi/tools.html). F0 values in Hz were subsequently converted to logarithmic Z-score (abbreviated as LZ throughout this paper. The reader is referred to Zhu 1999 for more discussion of the issues concerning F0 normalization.

The tokens were produced in isolation. All of them are CV or CVN syllables. There are 29 tokens for Tone 1, 24 for Tone 2 and 23 for Tone 3. See Appendix for the complete wordlist.

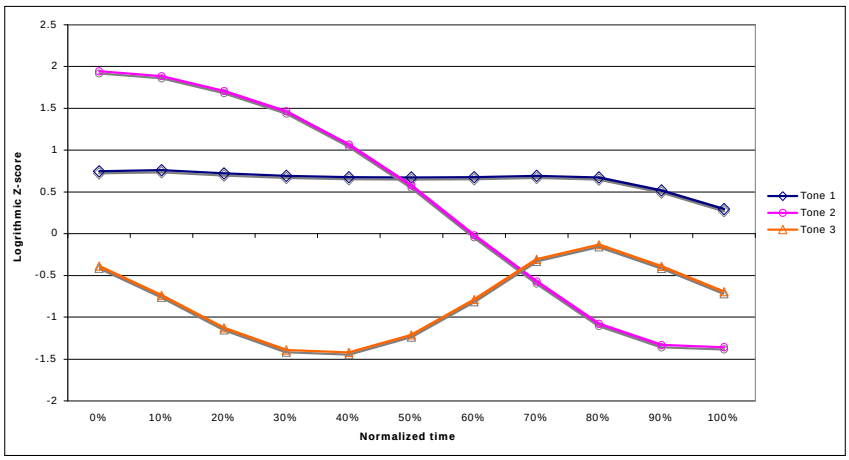


Figure 1. *Normalized F0 contour (in LZ) for citation tones*

From Figure 1, the three citation tones are transcribed at the five-point scale (a.k.a. Chao's tone letters) in (1).

(1) Citation tones transcribed at the five-point scale

Tone 1	44	(Yinping)
Tone 2	51	(Yangping)
Tone 3	213	(Shang)

Each of Chao's tone letters can be defined according to the logarithmic Z-scores reported in the above F0 tracks in Figure 1.

(2) Tone letters and their corresponding logarithmic Z-score ranges

Tone letters	LZ ranges
5	above 1
4	1 ~ 0
3	0 ~ -0.5
2	-0.5 ~ -1
1	below -1

Chao's tone letters are used to transcribe tones throughout this paper. But this does *not* mean that there are five (phonologically contrasting) tone levels in UC. We propose that there are three distinct tones levels in this language, and their logarithmic Z-score ranges are provided below.

(3) Tone levels (*Phonologically contrasting*)

Tone levels	Tone letters	LZ ranges
H	5, 4	above 0
M	3, 2	0 ~ -1
L	1	below -1

In other words, while UC is of the three-tone level system, tone letters represents the "finer-tuned" phonetic forms of a tonal target. Tone 1 (44) can thus be treated as an underlying level H tone, Tone 2 (51) an underlying falling HL tone and Tone 3 (213) an underlying concave MLM tone.

2.2 Duration

The mean absolute duration of rime for each of the citation tones are plotted in Figure 2. As we can see, Tone 1 (44) and Tone 3 (213) have roughly identical phonetic length, while Tone 2 (51) is the shortest isolation tone.

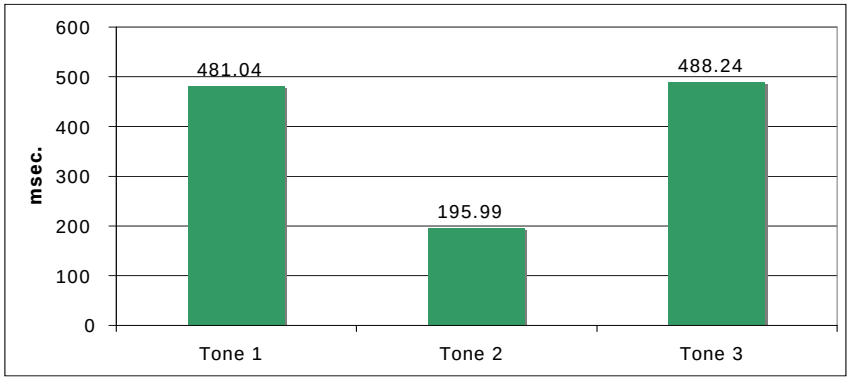


***Figure 2**. Absolute duration (in msec.) for citation tones*

This completes our discussion of the acoustic properties of UC citation tones. Let us now turn to the acoustic properties of neutral tones.

3. Acoustic Properties of Neutral Tones

3.1 Preliminaries

In Sino-Tibetan languages, phonetic realization of neutral tone can be derivationally sketched as follows.

(4) Neutral tone: derivational processes

UR		Tone loss		Tone redistribution
σ σ		σ σ		σ σ
| |	→	|	→	\/\
T_1T_2		T_1		T_1(T%)

Some discussion is in order. At least for most Mandarin dialects, neutral tone takes place in domain-final position. As we can see in (4), the final syllable loses its underlying tone (dubbed "tone loss" above). The surface pitch pattern is determined by the preceding full lexical tone (dubbed "tone redistribution" above). In some cases, the surface F0 trajectory may come from the interpolation between a preceding lexical tone and a boundary tone (represented as T% above). As we have mentioned at the outset, the "tone loss" process in (4) is normally attributed to "stresslessness," a term whose definitions might be based on either of the extreme points of a spectrum, e.g. (abstract) metrical stress and (physical) phonetic duration and intensity. It is beyond the scope of this paper to explain how and why neutral tones occur at all in UC, or, more broadly, in Mandarin dialects. For present purposes, it is beneficial to look into

the phonetic characteristics of neutral tones, to which we shall turn in the following section.

3.2 Phonetic Correlates

We have learned that one of the most distinctive traits of UC neutral tones, mainly based on impressionistic transcription, is that UC neutral tones are significantly longer than their counterparts in other Mandarin dialects (Wang 2002). The results of our acoustic measurements indicate that this does not seem to be true, however. Observe now Figure 3.

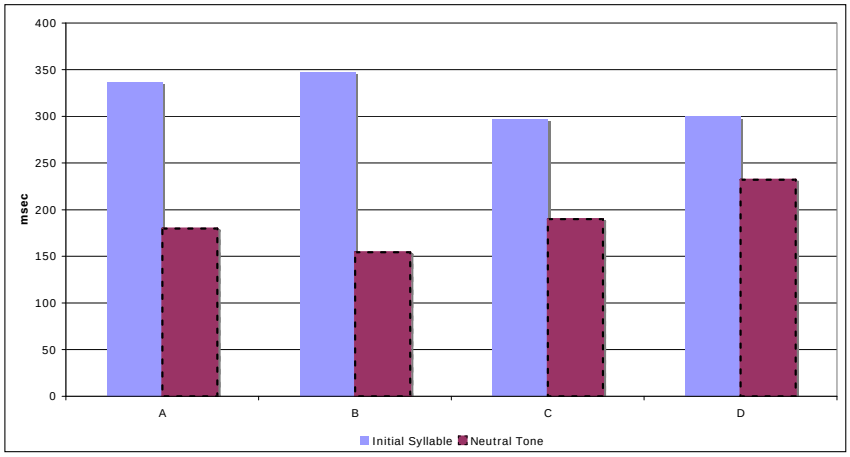


Figure 3. *Rime duration (in msec.) for syllables carrying a lexical or a neutral tone in the disyllabic frame (where A, B, C, and D stand for the four attested surface patterns. See (7) for details.)*

The length contrast between the "full-toned" syllables (dubbed "Initial Syllable" above) and the "neutral-toned" syllables (dubbed "Neutral Tone" above) is more or less similar to what have been reported for Mandarin Chinese (Lin and Yan 1980, Li 2003, among many others). More precisely, the relevant ratios are illustrated below.

(5) Ratios of Rime (Initial syllable) to Rime(Neutral Tone)

Patterns	Ratios
A	0.53
B	0.44
C	0.64
D	0.77

Furthermore, we present in (6) the ratios of the rime duration of the first syllable to the rime duration of the final syllable in disyllabic (lexical) tone sandhi. Our hypothesis is that domain-final syllables are longer than neutral-toned syllables. In other words, phonetic length should be the primary factor for neutralization in neutral-toned syllables. Consider now the following data.[1]

(6) Disyllabic (Lexical) Tone Sandhi: Ratios of Rime(Initial Syllable) to Rime(Final Syllable)

Initial tones	Final tones	Ratios	Token #
Tone 1 (385 ms)	Tone 1 (350 ms)	0.9	9
Tone 1 (385 ms)	Tone 2 (193 ms)	0.5	11
Tone 1 (385 ms)	Tone 3 (447 ms)	1.2	5
Tone 2 (263 ms)	Tone 1 (329 ms)	1.2	7
Tone 2 (263 ms)	Tone 2 (205 ms)	0.7	16
Tone 2 (263 ms)	Tone 3 (382 ms)	1.4	10
Tone 3 (324 ms)	Tone 1 (333 ms)	1	8
Tone 3 (324 ms)	Tone 2 (209 ms)	0.6	17
Tone 3 (324 ms)	Tone 3 (397 ms)	1.2	7

(Where Tone 1 = 44, Tone 2 = 51, Tone 3 = 213.)

As we can see, final tones are generally longer than initial tones in disyllabic (lexical) tone sandhi. The only (systematic) exception is when Tone 2 (51) appears in final position. Recall from Figure 2 that Tone 2 (51) is the shortest tone among UC citation tones. So this should not be a surprising result.

In summary, there should be no doubt that neutral tones are substantially shorter than (domain-final) lexical tones in UC, which is to a great extent similar to what we have learned about Standard Chinese. Finally, for completeness, let us consider another important cue for stress, intensity. Our experiment results are plotted as follows.

[1] According to our phonetic data, there are no substantial, categorical tonal alternations in UC when two full-toned syllables form a disyllabic compound/phrase. So relevant F0 tracings are not provided here. For ease of understanding, however, we still use the term “disyllabic (lexical) tone sandhi” throughout.

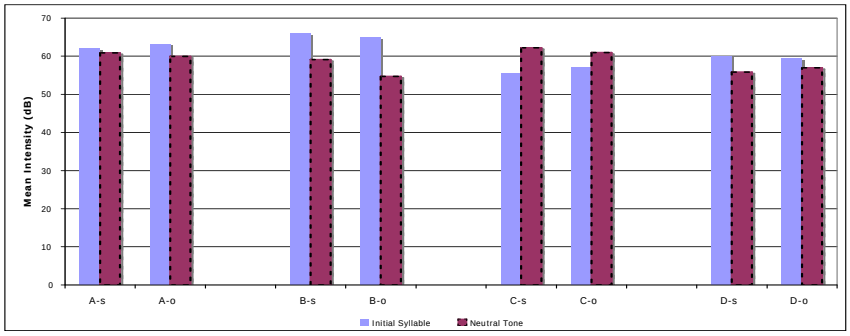


Figure 4. *Mean intensity (in dB) for syllables carrying a lexical or a neutral tone in the disyllabic frame (where A, B, C, and D stand for the four attested surface patterns; "s"= sonorant interlude; "o"=obstruent interlude. See also (7) for details)*

It should be obvious from Figure 4 that neutral tones are not uniformly cued by intensity. The reason is straightforward: if we look at Pattern C (see (7)), the mean intensity of the neutral-toned syllables is greater than that of the initial (full-toned) syllables by around 5 (max.) ~ 3 (min.) dB. In other words, neutral tones do not always bear lower intensity.

In summary, our major finding is that rime duration serves as the primary cue for UC neutral tones, while other cues such as pitch or intensity do not qualify as a reliable cue.

3.3 Pitch Tracings

Recall from Figure 1 that there are three lexical tones in isolation, namely, Tone 1 (44), Tone 2 (51) and Tone 3 (213). But here we see that there are four output tone patterns (call them Patterns A, B, C and D). That is, a domain-initial Tone 2 has two allotonic variations, Patterns B and C.

(7) Surface patterns of UC neutral tones

Patterns	Underlying Tone Sequence	Phonetic realization	Token #
A	44-T (Tone 1-initial)	44-51	21
B	***51-T*** (Tone 2-intial)	***55-31***	39
C	***51-T*** (Tone 2-initial)	***33-51***	25
D	213-T (Tone 3-initial)	31-23	26

(Where T=any tone)

The tokens were also produced in isolation by one male speaker. See Appendix for the wordlist. The F0 tracks of the above four patterns are plotted below. Notice again that raw F0 values were converted to logarithmic Z-score (LZ). Observe now Figure 5.

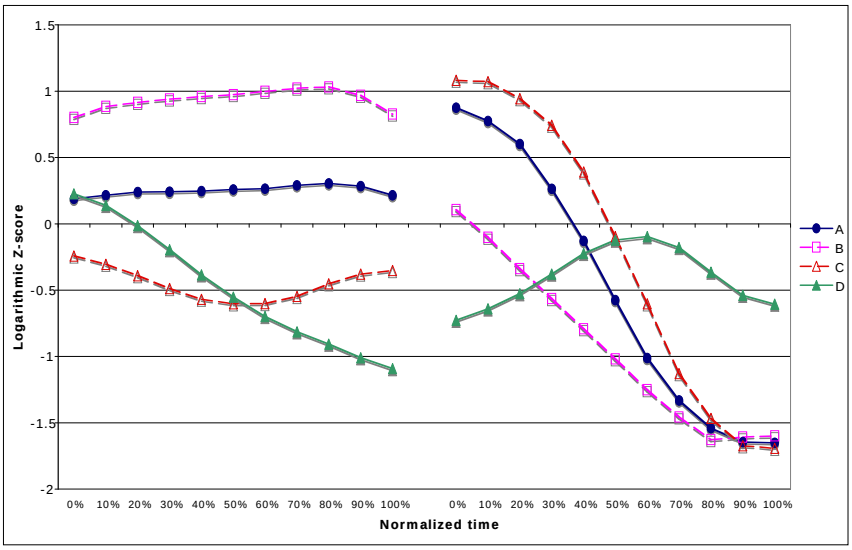


Figure 5. *Normalized F0 contours (in LZ) for Full Tone-Neutral Tone sequences*

The trajectories on the left hand side indicate the pitch contours on initial syllable and the F0 values of the final syllables are represented with the contours on the right hand side. The blank area between two tones stands for a hypothetical transition. See also section 2.1 for discussion of tone levels, tone letters and their corresponding LZ ranges.

3.4 Discussion

Let us begin our discussion with Patterns A and D (i.e. trajectories marked with a solid line and a filled shape). These two patterns can be easily explained. Recall from (4) that the surface pitch contour of a neutral tone is in general determined by its preceding full (lexical) tone and a boundary tone. Given these assumptions, for Pattern A, we can say that the initial H spreads onto the initial portion of the second syllable, and then the pitch contour goes down in order to realize a boundary low tone. The final dip in Pattern D can also be analyzed in the same vein. As for Pattern D, it is remarkable that the initial underlying tone is 213 and the surface pitch contours are 31-23. In other words, it is safe to say that the gross concave contour of Tone 3, namely, Mid-Low-Mid, is superimposed on a disyllable.

The above are straightforward and simple cases. A thorny issue arises when Patterns B and C are taken into consideration, however. As mentioned previously, there are two allotones for Tone 2 (51) in the current environment: Pattern B: 55-31 and Pattern C: 33-51. For Pattern B, it is not difficult to understand why this should be the case. As we have discussed earlier, 55-31 (i.e.

Pattern B) can also be analyzed as the underlying falling contour of Tone 2 "stretching out" onto the following syllable on the surface. But the same diagnosis is not easily applicable as far as Pattern C is concerned. For ease of discussion, the relevant patterns are provided again as follows.

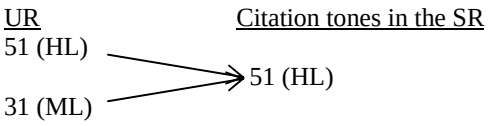
(8) Pattern B vs. Pattern C

Patterns	UR	SR
B	51-T	55-31
C	51-T	33-51

One possible interpretation for Pattern C is that the underlying falling contour migrates from the initial host to the final syllable. Contour movement of this sort is amply attested in a handful of Wu Chinese languages (see Chen (2000) and Yip (2002) for an overview). We argue that Pattern C cannot be analyzed as contour movement. First of all, contour movement is normally a byproduct of the attraction-to-the-stressed-position process (see, for example, Zhenhai Chinese in Chen (2000) and Li (2003)). Therefore, it is highly unlikely that weak elements like neutral tones induce contour movement. More importantly, there is no apparent reason why "contour movement" is not possible for Pattern B, since both Patterns B and C are supposed to have an identical underlying HL tone (i.e. Tone 2 (51)) in initial position.

Another potential analysis runs as follows. It is not impossible to postulate that there is absolute neutralization for Tone 2 (51) in the citation tone inventory (e.g. Wang 2002). It is well known that most Mandarin dialects have four tones in citation. So the three-tone inventory of UC must be an outcome of neutralization-induced inventory reorganization. Therefore, we may posit that there are two falling tones in the UR and for some reason they are completely neutralized in the SR, as shown below.

(9) Absolute neutralization of Tone 2 (51)



We believe that (9) is a plausible solution to the present puzzle. More precisely, a Mid-to-Low falling tone (31) in the UR provides a better account for why there is an initial Mid tone (or, 33) in Pattern C. But, again, this cannot be the end of the story. More specifically, if we posit that the underlying tone sequence for Pattern C is /31-T/ (where T = any tone), then we would expect a (unattested) surface form *[33-31], rather than the actual output form [33-51] (see also Figure 5). For clarity, let us use tone levels (H, M, L) to describe the issue at hand (see also section 2.1 for relevant discussion):

(10) The unexpected H in Pattern C

UR	SR		Remarks
ML-T (31-T)	M-ML	(33-31 or 33-21)	Unattested
ML-T (31-T)	M-**H**L	(33-51)	Attested

(where T = any tone)

Given (10), our puzzle now boils down to this: why is there a H tone in Pattern C? If there is a uniform analysis of neutral tones in (4), then the H tone in (10) is a glaring exception. Again, we see no obvious reason why this should be so if only Input-Output faithfulness is taken into consideration, as in (10).

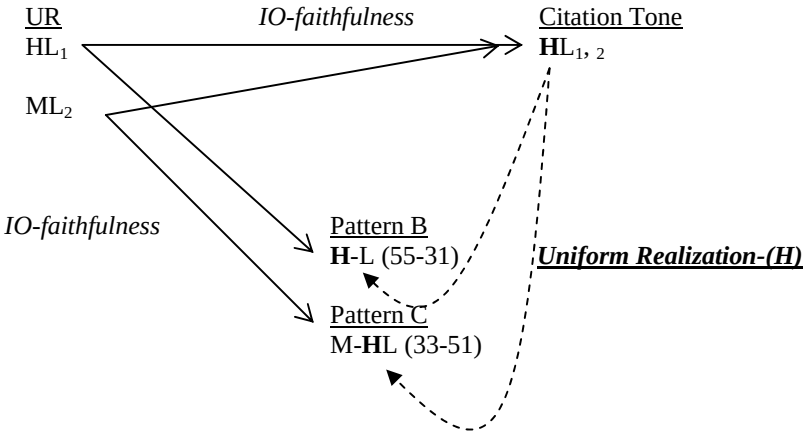
4. Uniform Realization-(H)

We have shown that IO faithfulness does not work for the present case. It should be noted that Output-Output Correspondence (Benua 2000, among others) won't work, either. The reason is that OO Correspondence is defined as Correspondence from one input to different outputs that are *morphologically* derived from it. Remarkably, the "morphologically-relatedness" is the essential property of OO Correspondence. For example, a typical OO Correspondence relationship is established between an unaffixed base and an affixed form (i.e. an affixed base).

Returning to the UC neutral tone data, it appears that those tones are not "morphologically related" in the sense we just mentioned. Therefore, we believe that it is inappropriate to invoke OO Correspondence to deal with the present case. Rather, a more viable analysis should incorporate the key notion of Kenstowicz's (1996) UNIFORM EXPONENCE (abbreviated as UEXP here), "minimize the differences in the realization of a lexical item (morpheme, stem, affix, word)." It is fair to say that UEXP can be understood as an anti-allomorphy constraint (cf. Burzio 1996). In the same vein, the constraint UNIFORM REALIZATION may be invoked for the Pattern C problem. The UNIFORM REALIZATION-(HIGH TONE) constraint is formally defined as follows.

(11) UNIFORM REALIZATION-(H(IGH TONE))

"Let High tone H be lexically specified in surface form F_A in the output.
Let surface form F_B be lexically related to F_A in the output.
Assign a violation mark to F_B if it is not lexically specified with High tone H in the output."



As we can see from the dashed arrows in the above diagram, the UNIFORM REALIZATION-(H) constraint regulates the correspondence relation between citation tones and full tone-neutral tone sequences (e.g. Patterns B and C). Consequently, we expect that the H portion of the HL citation tone (i.e. Tone 2 (51)) is realized in full tone-neutral tone sequences (especially in Pattern C), if UNIFORM REALIZATION-(H) is an active constraint.

In sum, our analysis crucially hinges on the requirement of the identical realizations of a lexical item (High tone here). It is important to reiterate that faithfulness of this sort is accessed with neither IO Correspondence nor OO Correspondence.

5. Conclusion

In this paper, we have presented the results of acoustic measurements of the UC tonal system. Our major finding is that neutral tones in UC have affinities with their counterparts in Standard Chinese. Tonal neutralization is basically motivated by difficulties in keeping (paradigmatic) contrasts in phonetically shorter syllables. Another important point is that neither IO nor OO faithfulness is sufficient for the UC case. A constraint that requires the identical realization of a lexical item forms an indispensable part of an adequate analysis of the phenomenon in question.

Appendix: A full list of tokens used in these experiments

A. Citation tones

Tone 1 (44)

CV	tsʰu (粗)	fei (飛)	xei (黑)	ɕi (惜)	tʂʰu(初)	tʂu(朱)	pa(巴)
	tsʰu(粗)	tʂʰu(初)	tsɨ(資)	tʂɨ(知)	tsʰu(粗)		
CVN	ʂaŋ(傷)	faŋ(方)	tɕyŋ(軍)	tsʰaŋ(倉)	tʂʰaŋ(娼)	tɕiŋ(今)	tɕiŋ(斤)
	tɕiŋ(京)	ɕiŋ(心)	ɕiŋ(新)	ɕiŋ(星)	xan(預)	tsaŋ(髒)	kɤŋ(跟)
	san(三)	tuŋ(東)	fɤŋ(風)				

Tone 2 (51)

CV	ku (古)	tʂʰɔ(丑)	tɕy (局)	ʐa (染)	tʂʰu(鋤)	tʂu(煮)	fu(符)
	fu(斧)	ʂɤ(蛇)	tsɨ(子)	tʂɨ(直)	tsʰɨ(此)	tʂʰɨ(恥)	ʂɨ(十)
	ʂɨ(食)	ku(鼓)					
CVN	faŋ(房)	ɕiɤ(斜)	faŋ(仿)	xan(鹹)	tʂʰaŋ(長)	tɕʰyŋ(窮)	ʐɤŋ(人)
	xan(寒)						

Tone 3 (213)

CV	tʂu(柱)	tʂu (竹)	pa(壩)	ʂɤ(社)	sɨ(四)*3	ʂɨ(世)	pa(八)
	sɨ(濕)	ɕi(細)	xɤ(和)	tsɨ(只)	kɤ(擱)	tʰi(替)	tɕʰi(七)
CVN	tɕyŋ(俊)	faŋ(放)	kuŋ(貢)	tan(淡)	pʰaŋ(胖)	tɕiŋ(近)	fan(飯)

B. Full tone+Neutral tone sequences

Pattern A	ɕiŋ-ɕiɤu (星宿); ɕiŋ-ɕiŋ (星星); tuan-vu (端午); tɕiŋ-tʰian (今天); mei-tsɨ (麥子); pɤ-tsʰai (菠菜); tʂʰuaŋ-xu (窗戶); tʂʰuaŋ-tsɨ (窗子); fu-fu (叔叔); ia-tʰɤu (丫頭)*2; pɔ-tsɨ (包子); tʰa-mɤŋ (他們); nei-ta (那達); nai-ta (那達); nei-kɤ (那個); nai-kɤ (那個); kɔ-tʰɤu (高頭); kan-tɕiŋ (乾淨); tʰuɤ-luɤ (托洛); tʂuŋ-vu (中午); tʂɨ-ʂɨ (知識)
Pattern B	miŋ-ŋjan (明年); lai-ŋjan (來年); miŋ-tʰian (明天); tsuɤ-tʰian (昨天); kʰuei-xua (葵花); tɕʰiɤ-tsɨ (茄子); xu-lu (葫蘆); faŋ-tsɨ (房子)*2; mɤŋ-kʰan (門檻); mɔ-faŋ (茅房); lɤu-tʰi (樓梯); pi-tsɨ (鼻子); pɤ-tsɨ (脖子); tsuɤ-ʂɤu (左手); tʂʰuei-tʰɤu (捶頭); pa-pa (爸

	爸); iɤ-iɤ (爺爺); pei-pei (伯伯); ta-ta (達達); pa-pa (爸爸); nan-ʐɻɤŋ (男人); ə-tsɨ (兒子); mɤ-mɤ (饃饃); xuŋ-tʰuŋ (餛飩); nan-ʐɻɤŋ (男人); tʂʰu-tsɨ (廚子); tɕʰyɤ-tsɨ (瘸子); ŋʲa-mɤŋ (哪們); tsa-mɤŋ (咱們); pʰian-i (便宜); zɻa-sɨ (熱斯)*2; li-xua (犁鏵); pʰi-pʰa (琵琶); nɤŋ-nai (能耐); xuɤ-luɤ (活絡); mɔ-tɔ (毛稻); lɔ-sɔ (牢騷)
Pattern C	mu-tʂu (母豬); mu-tɕi (母雞); lɔ-tʂʰu (老鼠); nai-nai (奶奶); ʂɤŋ-ʂɤŋ (嬸嬸); lɔ-xan (老漢)*2; lɔ-pʰɤ (老婆); ŋy-ə (女兒); ŋy-ʐɻɤŋ (女人); sɨ-liɤ (死咧); vɤ-mɤŋ (我們); ŋʲ-mɤŋ (你們); tsa-tsa (這這); na-ta (那達); na-kɤ (那個); ti-xa (底下); tsuɤ-ʂɤu (左手); iɤu-ʂɤu (右手); li-tʰɤu (裡頭); kʰɔ-ʐɻu (烤肉); ʂɤu-ʂɨ (首飾); tɕiɤ-tɕiɤ (姐姐); ŋʲɔ-tiɔ (咬掉)
Pattern D	tʰai-iaŋ (太陽); yɤ-liaŋ (月亮); tɕʰy-ŋʲan (去年); iɤ-tʰian (夜天); ta-tɤu (大豆); tʂʰɤu-sei (臭虱)*2; tʂuɤ-tsɨ (桌子); tsɨ-tɕia (指甲); ta-ma (大媽); tɕiɤu-tɕiɤu (舅舅); tɕiɤu-mu (舅母); kʰuai-tsɨ (筷子); tai-fu (大夫); piŋ-liɤ (病咧); kɤ-ʐɻɤŋ (個人); kɤ-tɕia (個家); tsɨ-tɕia (自家); ʂaŋ-tʰɤu (上頭); xa-tʰɤu (下頭); vai-tʰɤu (外頭); zɻ-tsɨ (日子); ku-kuai (骨拐); pɤ-xɤ (薄荷); miɔ-tɕʰiɔ (妙巧)

c. Full tone+full tone sequences

Tone1+Tone1	tʂuŋ-tɕʰiɤu (中秋); kuŋ-tʂu (公豬); kuŋ-tɕi (公雞); ʂaŋ-fɤŋ (傷風); tsʰuan-ɕi (穿稀); taŋ-tʂuŋ (當中); sɤŋ-tɕiaŋ (生薑); kʰuei-kʰuŋ (虧空); xiŋ-xiŋ (新星)
Tone1 + Tone2	tɕiŋ-ŋʲan (今年); ian-tʰuŋ (煙筒); pɤŋ-liɤu (崩樓); kaŋ-tsʰai (剛才); pʰɔ-ŋʲiɤu (匏牛); kan-lɤŋ (乾冷); la-luŋ (拉攏); ʂɔ-ʂɤu (燒手); kʰai-kʰɔ (開考); tian-ŋɤ (天鵝); ʂɤŋ-tsʰɤŋ (深層)
Tone1 + Tone3	piŋ-pɔ (冰雹)*2; tɕʰiŋ-tɕiaŋ (清醬); kʰai-tian (開店); tɕyŋ-yŋ (軍用)
Tone2 + Tone1	tɕʰi-fɤŋ (起風); lɔ-tiɤ (老爹); mɤ-tɔ (磨刀); va-vu (瓦屋); mɤŋ-fɤŋ (門風); iŋ-piŋ (迎兵); luŋ-kʰuŋ (輪空)
Tone2 + Tone2	ta-luei (打雷); xuŋ-fu (紅薯); xuɤ-faŋ (伙房); lɔ-ŋʲaŋ (老娘); ɕian-ian (鹹鹽); pɔ-mu (保母); liaŋ-li (兩里); mɔ-faŋ (茅房); xɔ-pa (火把); pɔ-mu (保母); lai-liŋ (來臨); ŋʲ-ŋʲɤu (泥牛); mɤ-xɤ (磨合); tɕyɤ-ɕyɤ (絕學); tɕʰyŋ-ɕyŋ (群雄); tʂʰu-faŋ (廚房)

Tone2 + Tone3	ʂan-tian (閃電); iaŋ-y (洋芋); ʂɨ-i (十一); ʂɨ-ə (十二); xɔ-xuai (好壞); zɻaŋ-tʂaŋ (嚷仗); pai-pu (擺佈); $t^hɔ$-$t^huɤ$ (逃脫); nɔ-nu (惱怒); ŋɔ-yɤ (熬藥)
Tone3 + Tone1	tɕiɤ-piŋ (結冰); tuŋ-piŋ (凍冰); kua-fɤŋ (刮風); ə-t^hian (二天); la-ɕi (拉稀); ta-ɕiaŋ (大香); tʂu-k^huaŋ (竹框); tsɨ-ʂi (自私)
Tone3 + Tone2	xa-y (下雨); ta-mi (大米); iɤu-ʂɤu (右手); tɕiaŋ-iɤu (醬油); tsɨ-tɕi (自己); ə-ʂɨ (二十); ə-li (二里); ə-liaŋ (二兩); $tɕ^h$ia-p^han (恰胖); ɕi-t^hai (戲台); miŋ-k^hu (命苦); tuei-ta (對打); t^ha-t^hɤu (塌頭); tsɨ-$ts^hɨ$ (字詞); zɻ-ʂɨ (日食); suɤ-t^huɤ (嘮砣); xuŋ-t^huŋ (混同)
Tone3 + Tone3	xa-ɕyɤ (下雪); k^han-piŋ (看病); ku-i (故意); ti-i (第一); ti-ə (第二); mɤŋ-xua (夢話); ɕyɤ-yɤ (雪月)

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