Voice quality of coarticulated Mandarin tones

Yaqian Huang and Yuan Chai | Department of Linguistics, UC San Diego

UC San Diego

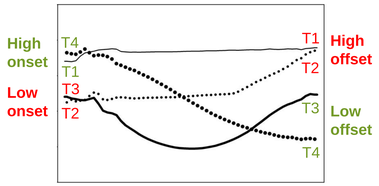
yah101@ucsd.edu, yuc521@ucsd.edu | sites.google.com/ucsd.edu/yaqianhuang

Acoustical Society of America Fall Meeting 2019

INTRODUCTION

- Tonal coarticulation often induces changes in F0 [1, 7] and voice quality [3].
- In Mandarin, coarticulation has both anticipatory and carry-over effects on F0 [6, 7]:
  - Lowering of F0 when **preceding** tone has low offset;
  - Raising of F0 when **following** tone has low onset.

Resynthesized F0 contour of Mandarin four tones [4]



Low Offset High Onset	High Offset Low Onset
T3 (21[4]), T4 (51) X T1 (55), T4 (51)	T1 (55), T2 (35) X T2 (35), T3 (21[4])
F0 lowering environments	F0 raising environments
T3-X-T1 T3-X-T4 T4-X-T1 T4-X-T4	T1-X-T2 T1-X-T3 T2-X-T2 T2-X-T3

- In Mandarin, voice quality covaries with F0:
  - Creaky voice is associated with low F0 [2, 5];
  - Low F0 is used by listeners for citation tone identification [4].
- **Research question: How will F0 raising and lowering due to Mandarin tonal coarticulation affect voice quality?**
- **Hypotheses:**
  - **Lowering of F0 → increase in creakiness (more constricted);**
  - **Raising of F0 → decrease in creakiness (more modal).**

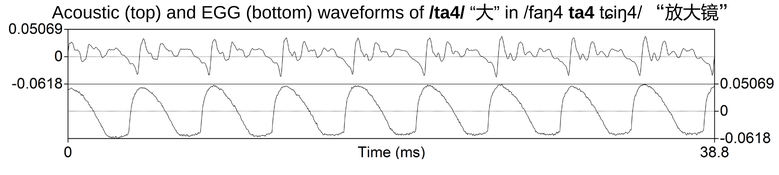
METHODS

- Audio & EGG recordings of tritone sequences
- Target stimuli: trisyllabic Mandarin compounds; each of the four Mandarin tones is flanked by varying Tones 1-4, for a full range of contextual variation of 4*4*4=64 combinations

收割机	ʂou1 **kɤ1** tɕi1	'Harvester'
齐白石	tɕʰi2 **pai2** ʂʅ2	'Baishi Qi'
老古董	lau3 **ku3** toŋ3	'Old-fashioned'
放大镜	faŋ4 **ta4** tɕiŋ4	'Magnifier'

- Stimuli are embedded in a carrier sentence:
  - *Wǒ jiāo nǐ TARGET zěn me shuō* 'I teach you TARGET how to say.'
- Participants: 14 native Mandarin speakers (7M)
- Each participant uttered two repetitions of the 64 sentences = 128 tokens per speaker
- F0 and Contact Quotient (measured from the EGG signal) obtained from VoiceSauce and EggWorks
  - z-scored and time-normalized each measure's values over nine equal intervals (9 points/syllable)
- Higher values of CQ = more constricted → creakier

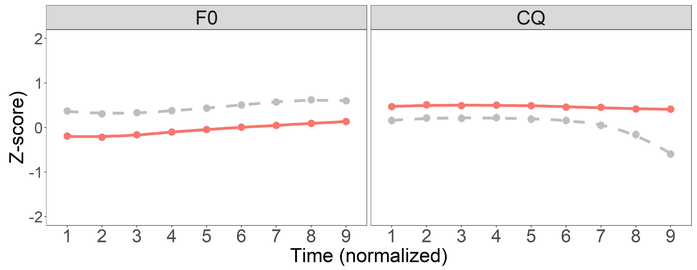
Acoustic (top) and EGG (bottom) waveforms of **/ta4/** "大" in /faŋ4 **ta4** tɕiŋ4/ "放大镜"



SAMPLE RESULTS FOR COARTICULATED TONES

- - - dashed: grand mean contour

Tone 1 (55) in 3- **1** -1 sequences



Lowering Environment:

Low offset – T1 – High onset

Results:

F0 of Tone 1 ↓

CQ of Tone 1 ↑

Tone 2 (35) in 4- **2** -4 sequences

Lowering Environment:

Low offset – T2 – High onset

Results:

F0 of Tone 2 ↓

CQ of Tone 2 ↑

Tone 3 (21[4]) in 2- **3** -2 sequences

Raising Environment:

High offset – T3 – Low onset

Results:

F0 of Tone 3 ↑

CQ of Tone 3 ↓

(excluding x-**3**-3 sequences)

Tone 4 (51) in 1- **4** -2 sequences

Raising Environment:

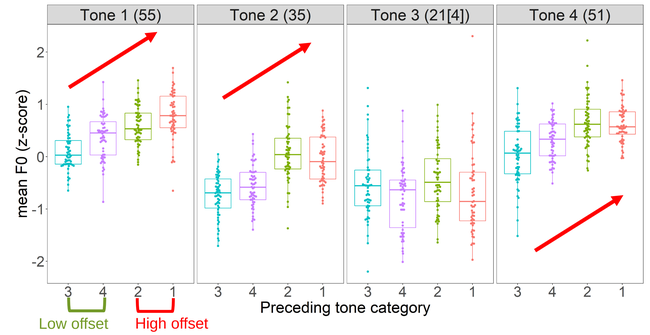
High offset – T4 – Low onset

Results:

F0 of Tone 4 ↑

CQ of Tone 4 ↓

CARRYOVER & ANTICIPATORY EFFECTS



DISCUSSION & CONCLUSION

- In a tritone sequence, preceding tones have a different effect than following tones: assimilatory or dissimilatory, which largely accord with Xu (1997).
- Every tone can undergo F0 raising or lowering, depending on the tonal environment.
- Raising of F0 results in a more modal voice quality;
- Lowering of F0 results in a more constricted voice quality.
- Voice quality is dependent on F0 in Mandarin, more than on tone (Kuang, 2017).

REFERENCES

[1] Brunelle, M. (2009). Northern and Southern Vietnamese tone coarticulation: A comparative case study. *Journal of Southeast Asian Linguistics*, *1*(1), 49-62.
[2] Chai, Y. (2019). The source of creak in Mandarin utterances. 19th ICPhS, Melbourne, Australia 2019 (pp. 1858-1862).
[3] DiCanio, C. T. (2012). Coarticulation between tone and glottal consonants in Itunyoso Trique. *Journal of Phonetics*, *40*(1), 162-176.
[4] Huang, Y. (2019). The role of creaky voice attributes in Mandarin tonal perception. 19th ICPhS, Melbourne, Australia 2019 (pp. 1465-1469).
[5] Kuang, J. (2017). Covariation between voice quality and pitch: Revisiting the case of Mandarin creaky voice. *The Journal of the Acoustical Society of America*, *142*(3), 1693-1706.
[6] Sun, Y. & Shih, Chilin (2019). Anticipatory tonal coarticulation: How, when and why it occurs. 19th ICPhS, Melbourne, Australia 2019 (pp. 196-200).
[7] Xu, Y. (1997). Contextual tonal variations in Mandarin. *Journal of Phonetics*, *25*(1), 61-83.