Production of corrective focus in Xiangshan Wu Chinese

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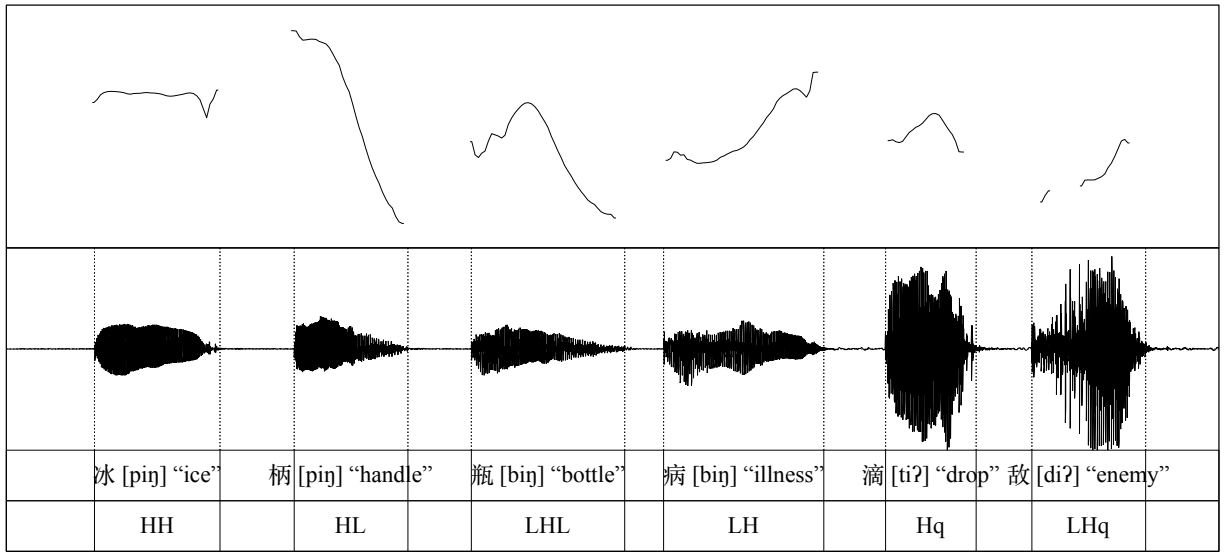
Background: Xiangshan (象山)

- Xiangshan dialect:
  a member of Northern Wu dialects

Map of Chinese dialects identified in *Language Atlas of China* (1987).

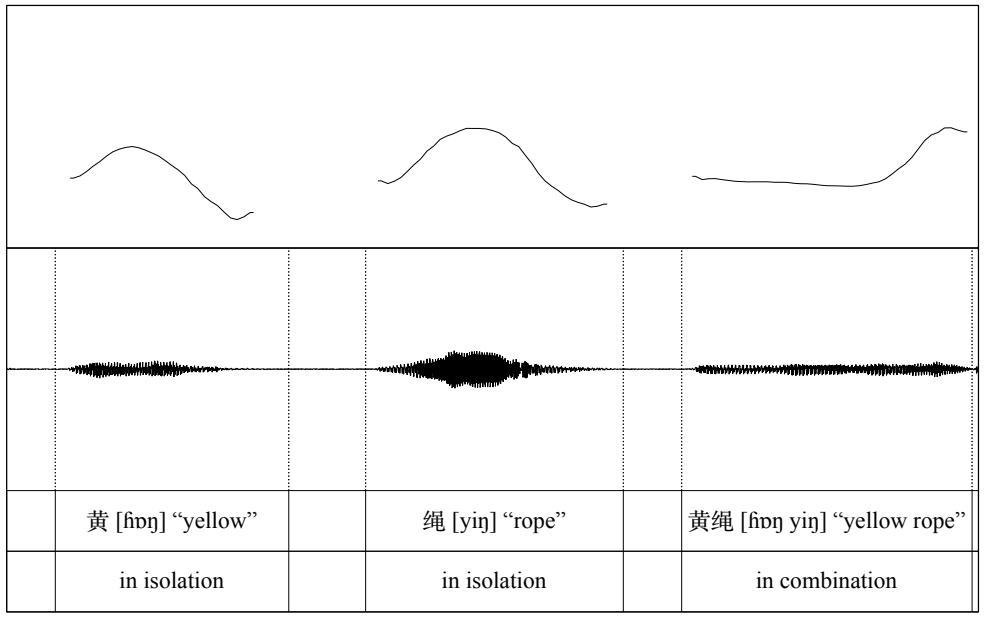
Background: Tones in Xiangshan Wu Chinese

- 6 tones in total
- 4 Non-checked tones: HH, HL, LHL, LH
- 2 Checked tones: Hq, LHq



Background: Tone sandhi

- ***An example in Xiangshan Wu Chinese***
- 黄 ‘yellow’ LHL+ 绳 ‘rope’ LHL
- In combination: 黄绳 L+LH



Background: Focus

- Focus usually serves to emphasise a part of the utterance

- typically realised through *expanded pitch range, lengthened duration, and increased intensity* on the focused elements (e.g. Cooper et al. 1985, Baumann & Steindamm 2006)
- potentially cause prosodic re-phrasing

  e.g. New Chongming (Chen 2000)

not	*eat*	*rice*	
MH	Lq	L	Underlying tones
(◦	Lq)	(L)	Basic sandhi
MH	◦	◦	Focus on the first syllable

Research questions

- ***How is corrective focus realised in Xiangshan Wu Chinese?***

  - **Gradient acoustic cues**: intensity, duration;
  - (Potential) **changes in tone sandhi patterns**;
  - **Interaction between the two**
    - If there is a sandhi change under focus, do other acoustic cues still change, and if so, at a larger or a smaller magnitude?

Experiment: Speakers & Stimuli

- ***Speakers***
- 8 native Xiangshan speakers
- 4 female, age range: 47-53, mean age: 50

- ***Stimuli***
- **Tones:** HH, HL, LHL, LH (non-checked tones); HH/LHL-σ2 combinations; 8 tone combinations in total
- **Morphosyntactic structures:** lexical compounds, Modifier+Head phrases, Verb+Object phrases
- 38 disyllabic tokens in total

Experiment: Procedure

- **Stage I (broad focus):**
  - Speakers read the tokens as naturally as possible presented in a Microsoft PowerPoint presentation

- **Stage II (corrective focus):**
  - The target tokens presented in a Microsoft PowerPoint presentation
  - Accompanied by an audio recording containing a different token
  - Speakers asked to correct the utterance they heard by using the token they saw on the screen

Focus	Recording	Desired output
σ_1	These words are CB.	No, they are ***A***B.
σ_2	These words are AD.	No, they are A***B***.
$\sigma_1\sigma_2$	These words are EF.	No, they are ***AB***.

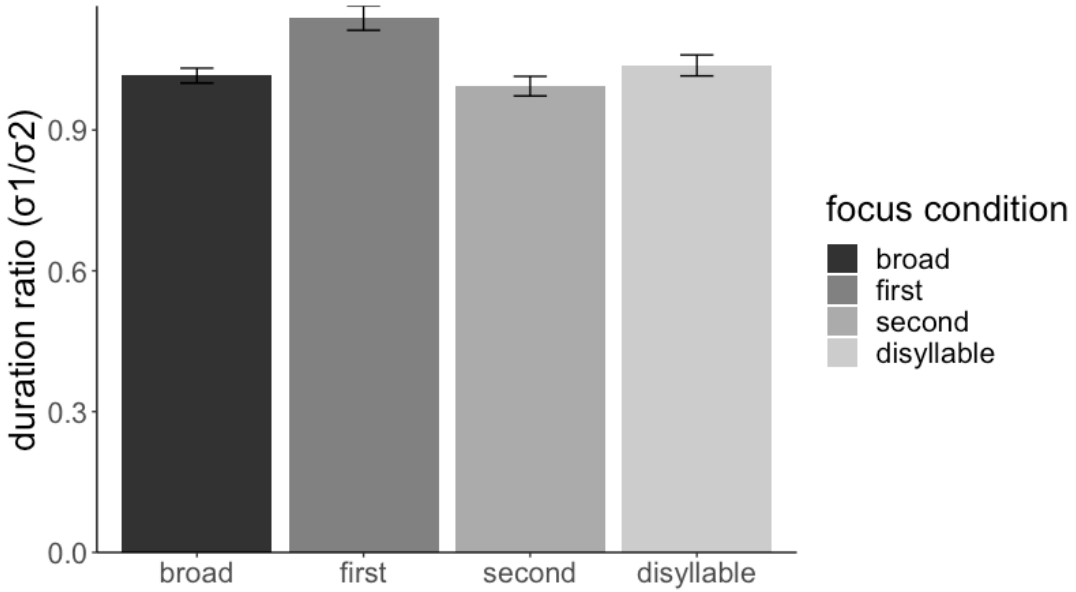
Experiment: Data analysis

- ***Parameters measured***
- **Gradient acoustics**
  - Mean intensity differences (σ1 - σ2)
  - Duration ratio (σ1/σ2)
- **Sandhi patterns**
  - F0 at 10 equidistant measurement points for each rhyme

- ***Data normalisation***
  - F0: log-z-score normalised within each speaker
  - Duration ratio: actual duration / average duration for syllables in the same position within each speaker

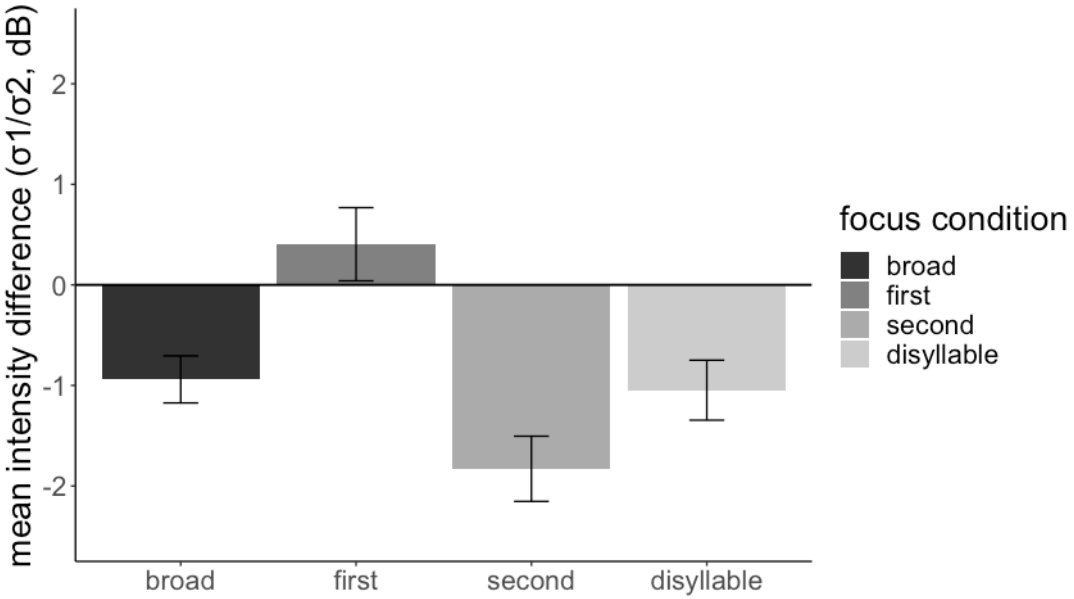
- ***Data analysis***
- Linear mixed effects model (LMM) for gradient acoustics comparisons (all tokens analysed)
- F0 visualisation for tone sandhi patterns (only LHL-σ2 lexical compounds & Modifier-Head phrases analysed)

Results: Gradient acoustic cues



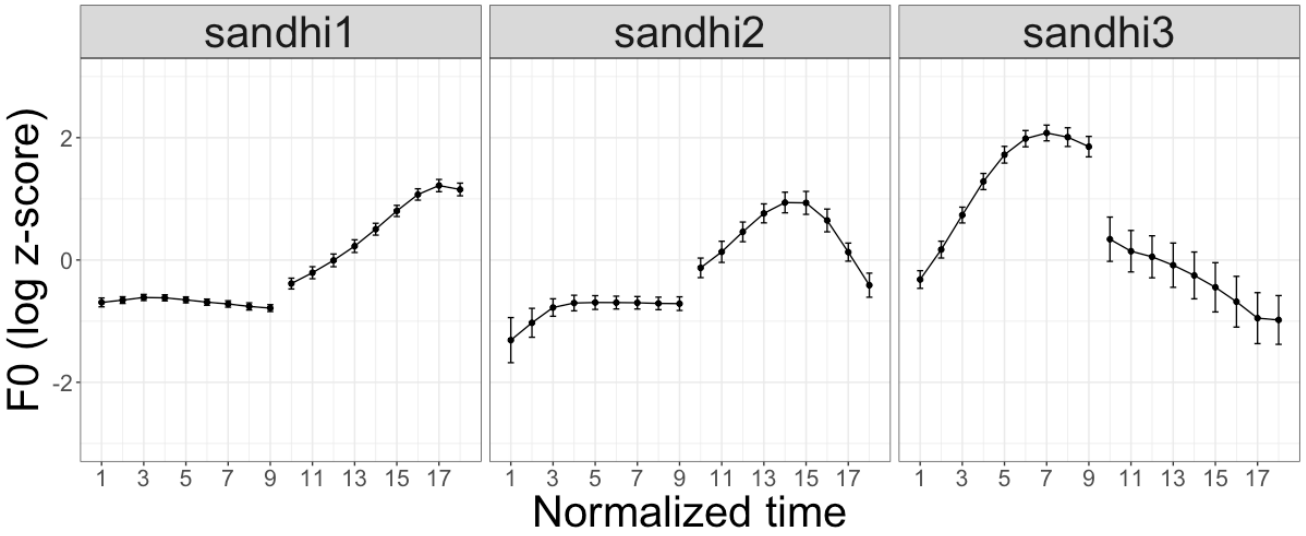
- ***Duration ratio (σ1/σ2):***
  - ***Focus lengthens the relative duration of the focused syllable***
  - Focus on the first syllable significantly increases the duration ratio (Estimate = 0.06, t = 2.93, p < 0.01**)
  - Focus on the second syllable significantly decreases the duration ratio (Estimate = -0.08, t = -3.98, p < 0.001***)
  - Focus on the whole disyllable does not affect the duration ratio significantly (Estimate = -0.03, t = -1.66, p = .10)

Results: Gradient acoustic cues



- ***Mean intensity difference (σ1 - σ2):***
  - ***Focus increases the relative intensity of the focused syllable***
  - Focus on the first syllable significantly increases the difference (Estimate = 1.02, t = 3.4, p < 0.001***)
  - Focus on the second syllable significantly decreases the difference (Estimate = -1.15, t = -3.88, p < 0.001***)
  - Focus on the whole disyllable does not affect the intensity difference significantly (Estimate = -0.33, t = -1.1, p = .27)

Results: Tone sandhi ***without*** corrective focus



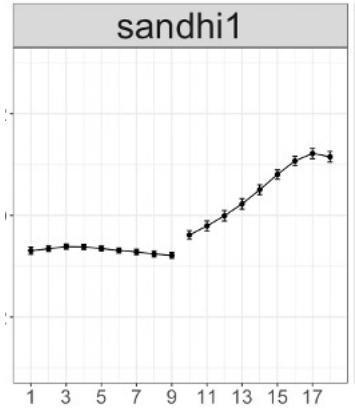
- ***Tone sandhi patterns for LHL-σ2 Lexical compounds & Modifier-Head phrases***
  - LHL-HH, LHL-HL, LHL-LHL, LHL-LH

- **LHL-HH/LHL/LH:**
  - ***Sandhi1*** as the predominant pattern (78.7%)
  - Sandhi2 as another pattern

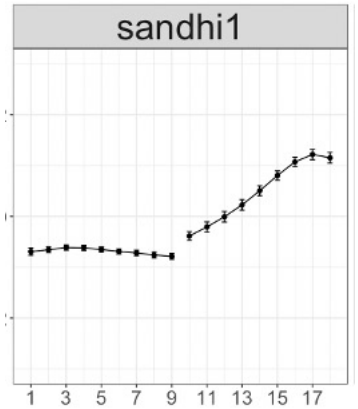
- **LHL-HL:**
  - ***Sandhi3*** exclusively found for this combination, predominant pattern (76.5%)
  - Sandhi1 as another pattern

Results: Tone sandhi ***with*** corrective focus

No focus



Corrective focus

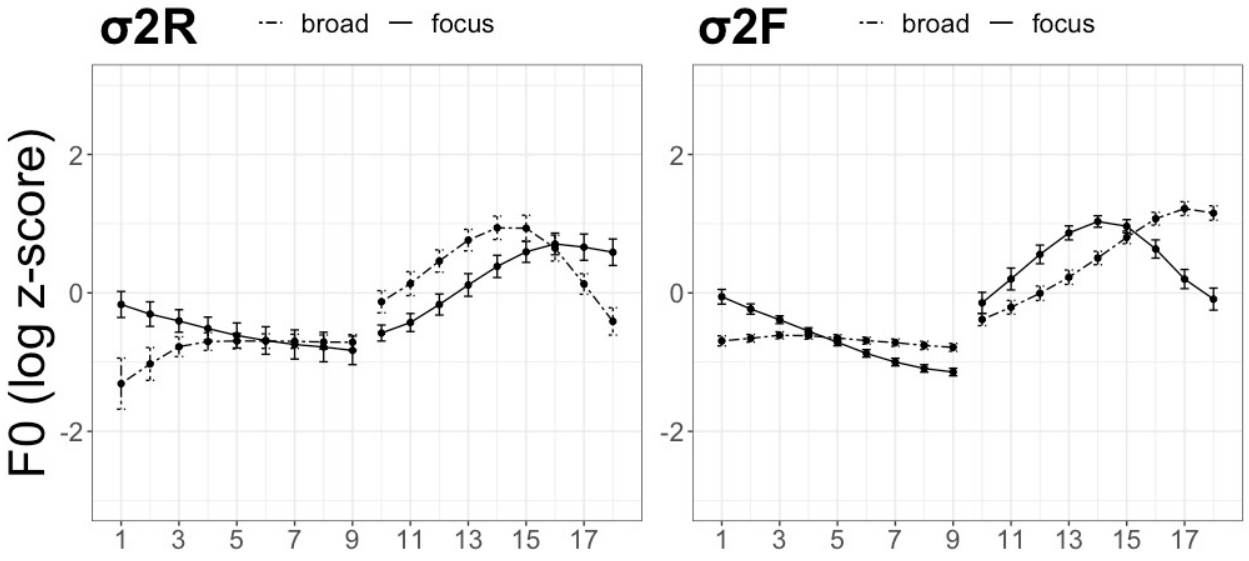


- ***Four possible outcomes***

(1) Broad sandhi (BS, 73%):

Sandhi patterns remain the same under focus

Results: Tone sandhi ***with*** corrective focus



- ***Four possible outcomes***

(1) Broad sandhi (BS, 73%):
Sandhi patterns remain the same under focus

(2) Focus realising σ2 as a rise (σ_2R, 13%)
2nd syllable changes from LHL to LH

(3) Focus realising σ2 as a fall (σ_2R, 9.9%)
2nd syllable changes from LH to LHL

Results: Tone sandhi ***with*** corrective focus

Focus	UR tones	Broad sandhi	Focus sandhi
σ_1	LHL-HL	LH-ML	**LHL**-ML
σ_1	LHL-H	L-LH	**LHL**-LH
σ_2	LHL-HL	LH-ML	L-**HL**
σ_2	LHL-H	L-LH	L-**H**

- ***Four possible outcomes***

(1) Broad sandhi (BS, 73%):
Sandhi patterns remain the same under focus

(2) Focus realising σ2 as a rise (σ_2R, 13%)
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2nd syllable changes from LH to LHL

(4) Focused syllable carrying its underlying tone (UT, 4.1%)

Results: Interaction between gradient acoustics and sandhi changes

- **Linear mixed effects model**
  - Dependent measures: duration ratio (σ1/σ2), mean intensity difference (σ1 - σ2)
  - Fixed effects: FOCUSCONDITION (broad, first, second, disyllable), SANDHITYPE (BS, σ_2R, σ_2R, UT)
  - Random effects: speaker, item

- **Mean intensity difference (σ1 - σ2)**
  - Significant interaction between FOCUSCONDITION and SANDHITYPE (χ2(8) = 21.428, p = 0.006**)
  - Pairwise comparisons: *UT* sandhi type displays significantly *lower* mean intensity differences ($\sigma_1 - \sigma_2$) compared to the other three sandhi types (σ_2R, σ_2F, BS) (σ_2F – UT: Estimate = 6.103, t = 3.233, p = 0.008**; σ_2R – UT: Estimate = 5.359, t = -2.605, p = 0.049*; BS – UT: Estimate = 5.85, t = 3.734, p = 0.002**).

- **Duration ratio (σ1/σ2)**
  - no statistical significance is found for the main effect of SANDHITYPE (χ2(3) = 5.301, p = .151) or the interaction between FOCUSCONDITION and SANDHITYPE (χ2(8) = 11.07, p = 0.198)

Conclusion

- **Gradient acoustics**
  - Corrective focus in Xiangshan Wu Chinese induces a higher relative intensity and lengthened duration on the focused syllable

- **Sandhi changes**
  - Tone sandhi patterns can be realised differently under corrective focus
  - In some cases focus applies broad sandhi to the underlying disyllable, determining the shape of the unfocused syllable, and then to realise the focused syllable with its underlying tone

- **Interaction between the two**
  - potential cue-trading relation between sandhi changes and gradient acoustic cues
  - UT sandhi change type shows significantly lower intensity difference

References

- Baker, Hugh D.R (1993). "*Language Atlas of China*". *Bulletin of the School of Oriental and African Studies*. **56** (2): 398–399. doi:10.1017/S0041977X0000598X.
- Bates D, Mächler M, Bolker B, Walker S (2015). "Fitting Linear Mixed-Effects Models Using lme4." *Journal of Statistical Software*, **67**(1), 1–48. doi:10.18637/jss.v067.i01.
- Baumann, S., Grice, M., & Steindamm, S. (2006, May). Prosodic marking of focus domains-categorical or gradient. In *Proceedings of speech prosody* (Vol. 2006, pp. 301-304). Germany: Dresden.
- Boersma, Paul (2001). Praat, a system for doing phonetics by computer. *Glot International* **5:9/10**, 341-345.
- Chen, M. Y. (2000). *Tone sandhi: Patterns across Chinese dialects* (Vol. 92). Cambridge University Press.
- Cooper, W. E., Eady, S. J., & Mueller, P. R. (1985). Acoustical aspects of contrastive stress in question–answer contexts. *The Journal of the Acoustical Society of America*, *77*(6), 2142-2156.
- R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.