F0 Transitions as a Perceptual Cue of Lexical Tones in Mandarin

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Tonal Domain

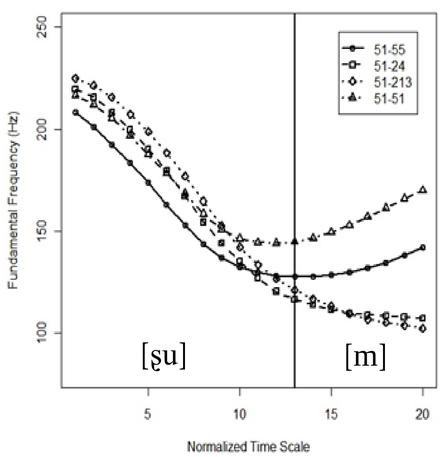
- What is the nature of the tonal domain in Mandarin?
- Howie (1974) claims that the vowel is the tonal domain for a syllable in Mandarin.
- Xu (1998, 2001, et seq.) finds that tonal offsets strictly align with the right boundary of the syllable.

Goal of the Study

- What cues are used to recognize tone/meaning?
- Tonal coarticulation creates different F0 transitions on sonorant onset and coda (e.g. Xu 1997).
- If the syllable is the tonal domain, sonorant transitions should provide perceptual cues to tone (cf. Lin 1995).
- Tonal identification tasks were designed to test whether F0 transitions are used in identification.
- Is the articulatory domain = perceptual domain = syllable?

Fo Transition

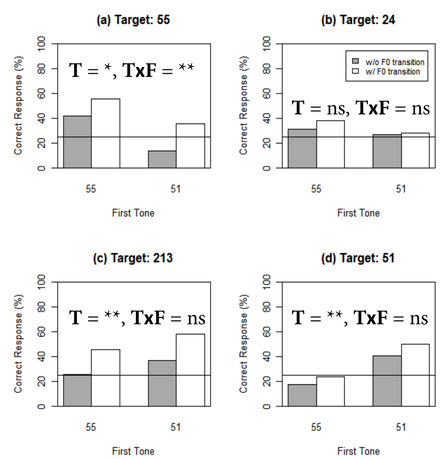
- Four lexical tones in Mandarin: 55, 24, 213, and 51.
- F0 transitions can be level, falling, and rising, e.g., 51-55 has a rising transition across the tonal boundary.



- The vertical line represents the syllable boundary.
- On the left are F0 contours of the first syllable [ʂu].
- On the right are F0 contours for the onset of the second syllable [mɑ].
- A three-way distinction.

Experiment I

- **Stimuli**:
  - Naturally produced [CV^{55}-NV(V)] and [CV^{51}-NV(V)] nonsense sequences by a male Mandarin speaker
  - The second syllable is one of the four lexical tones
  - Stimuli With F0 Transition: [CV^{55}-N]
  - Stimuli Without F0 Transition: [CV^{55}]
  - Average length of sonorant: 70.3 ms (*sd* = 11.1)
  - Trial number = 2 Transition Conditions X 24 Disyllabic Sequences X 5 Repetitions = 240
- **Procedure**:
  - Identify the lexical tone on the second syllable in a four-alternative forced-choice task
- **Participants**:
  - 28 native Mandarin speakers enrolled as undergraduate student at the University of Alberta

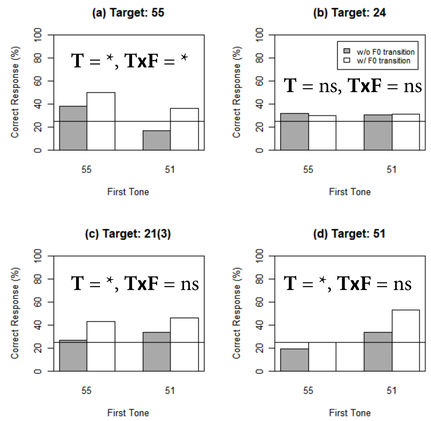


- The number of correct responses are analyzed with linear mixed effects logistic regression.
- Crucial predictor **Transition** (T) and interaction **TransitionXFirstTone** (TxF).

* = $p \leq .05$, ** = $p \leq 0.01$, ns = not significant.

Experiment II

- **Stimuli**:
  - Same stimuli produced in a carrier sentence [ʐɤ^{51} kə^{0} toŋ^{55} çi^{55} ʂɤ^{51} kə^{0} ____] 'this is a ____'.
  - Average length: 53.1 ms (*sd* = 12.5); i.e. shorter F0 transitions.
- **Procedure and Participants:**
  - Same as Experiment 1



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Summary and Conclusion

- Identification of lexical tones is influenced by the presence of F0 transitions in addition to other cues.
- Error responses of 24 are often 213 since their F0 transitions are very similar.
- When the preceding tone is 51, F0 transitions may be perceptually more salient.
- The perceptual tonal domain is syllable, which is in line with the articulatory studies (e.g. Xu 1998, 2001, et seq.).
- Listeners will use all cues possible to access the possible meaning.

Selected References

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APhL Alberta Phonetics Laboratory

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