

24.964

Phonetic Realization

Tone

Readings for next time:

- Kenstowicz, Abu Mansour and Törkenczy (2000). Two notes on laryngeal licensing.
- Kang, Y-J. (2003) Perceptual similarity in loanword adaptation: English postvocalic word-final stops in Korean. *Phonology* 20.

Realization of lexical tone - Mandarin

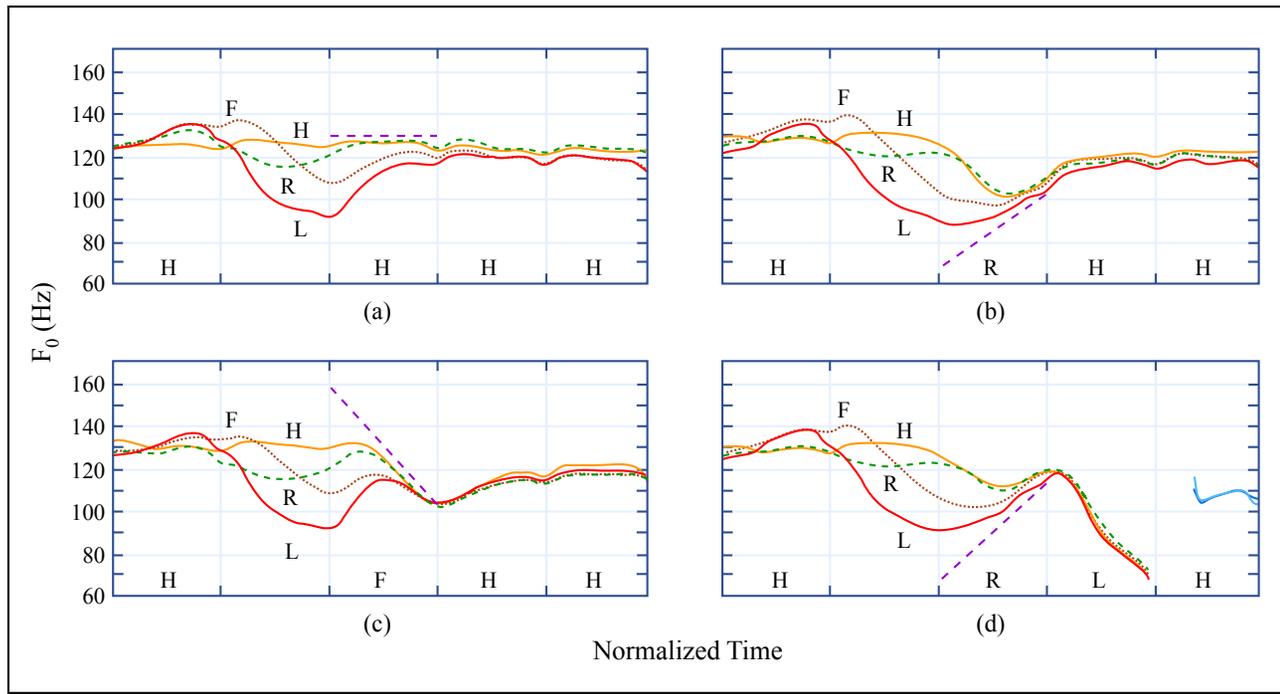


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Speech Melody as Articulatory Implemented Communicative Functions." *Speech Communication* 46 (2005): 220-251.

- Substantial variation in tone on syll3 depending on syll2 tone (carryover coarticulation).
- Variation in tone on syll3 is larger earlier in the syllable.
 - transition from syll2, converging on a target for syll3.

Realization of lexical tone - Mandarin

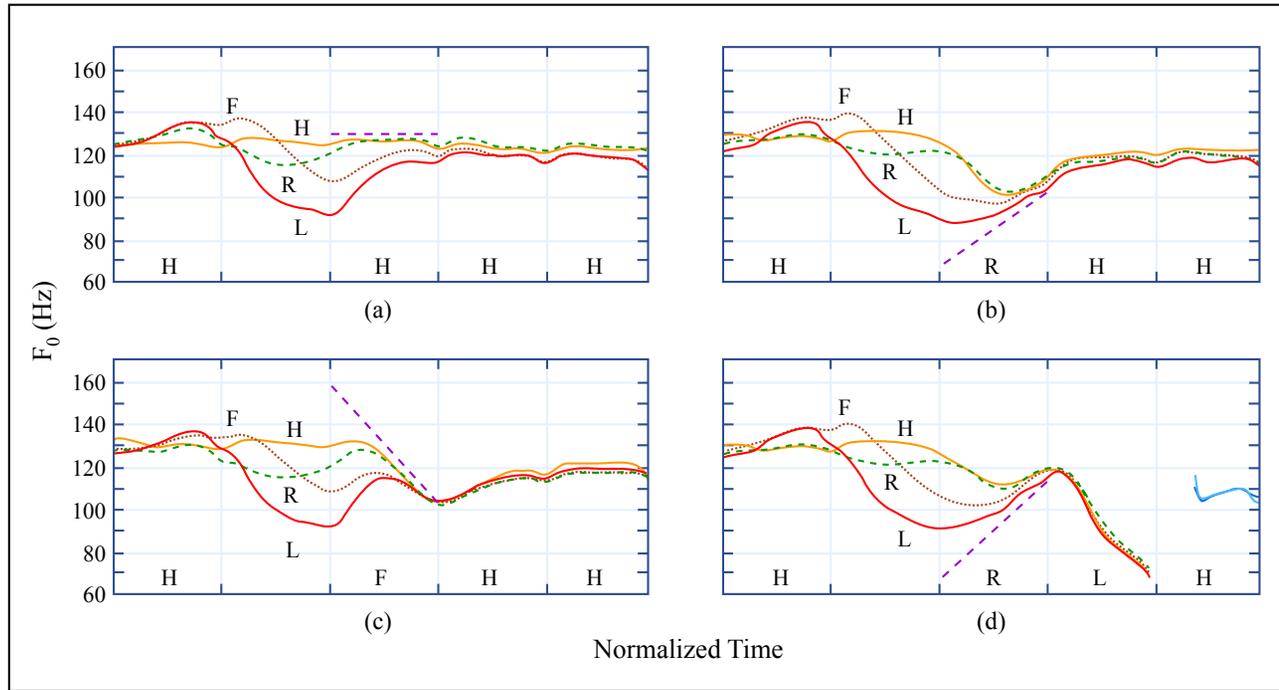


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Speech Melody as Articulatory Implemented Communicative Functions." *Speech Communication* 46 (2005): 220-251.

- Minimal variation in H tone on syll 1 (minimal anticipatory coarticulation).
- Main anticipatory affect seems to be dissimilatory raising of H preceding L.

Realization of lexical tone - Mandarin

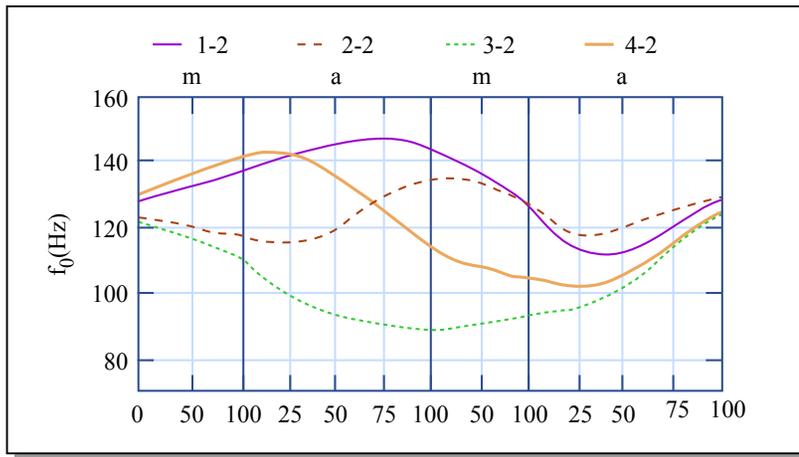


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Contextual Tonal Variations in Mandarin." *Journal of Phonetics* 25 (1997): 61-83.

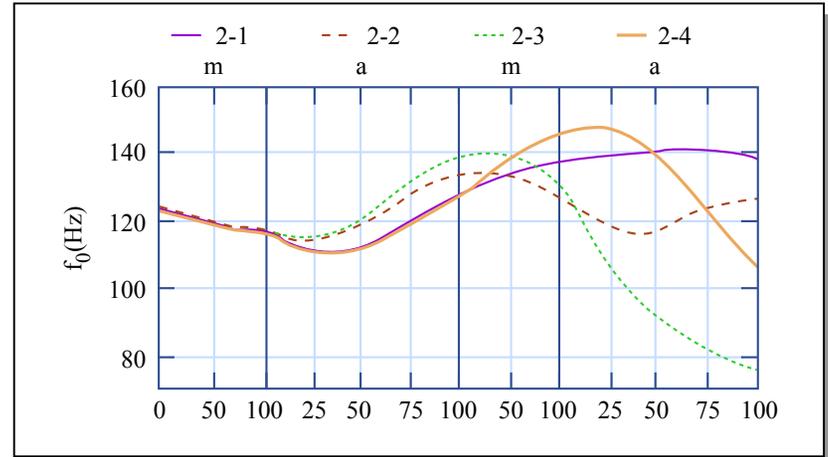


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Contextual Tonal Variations in Mandarin." *Journal of Phonetics* 25 (1997): 61-83.

Same points based on data from Xu (1997)

- Substantial carryover coarticulation.
- Minimal anticipatory coarticulation.

Syllable-synchronized sequential target approximation

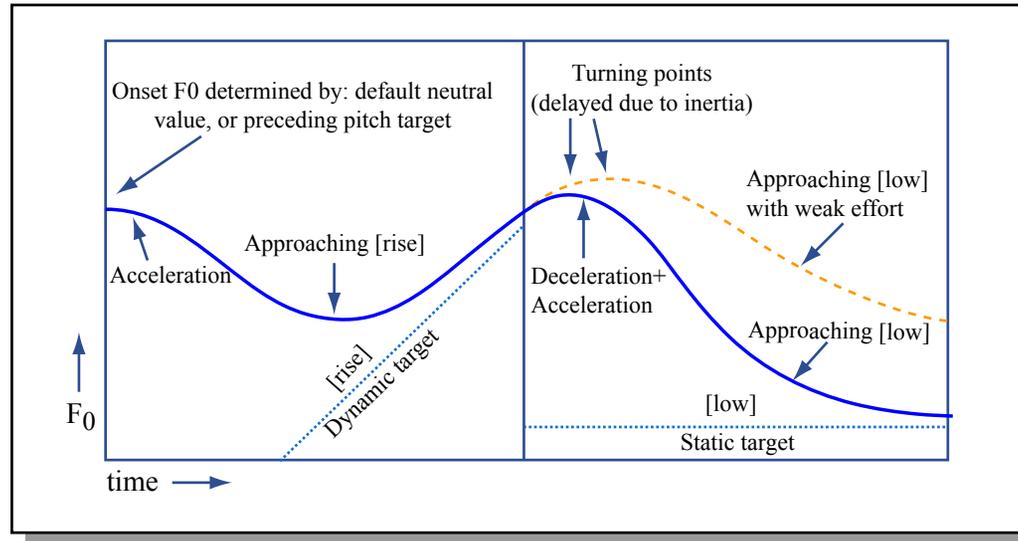


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Speech Melody as Articulatorily Implemented Communicative Functions." *Speech Communication* 46 (2005): 220-251. Also, Xu, Y., and Q. E. Wang. "Pitch Targets and Their Realization: Evidence from Mandarin Chinese." *Speech Communication* 33 (2001): 319-337.

Xu and Wang (2001), Xu (2005)

- Linear tone targets.
- Tone targets are coextensive with syllables.
- f_0 approaches tone target asymptotically while target is active (no look-ahead).

Target approximation - Mandarin

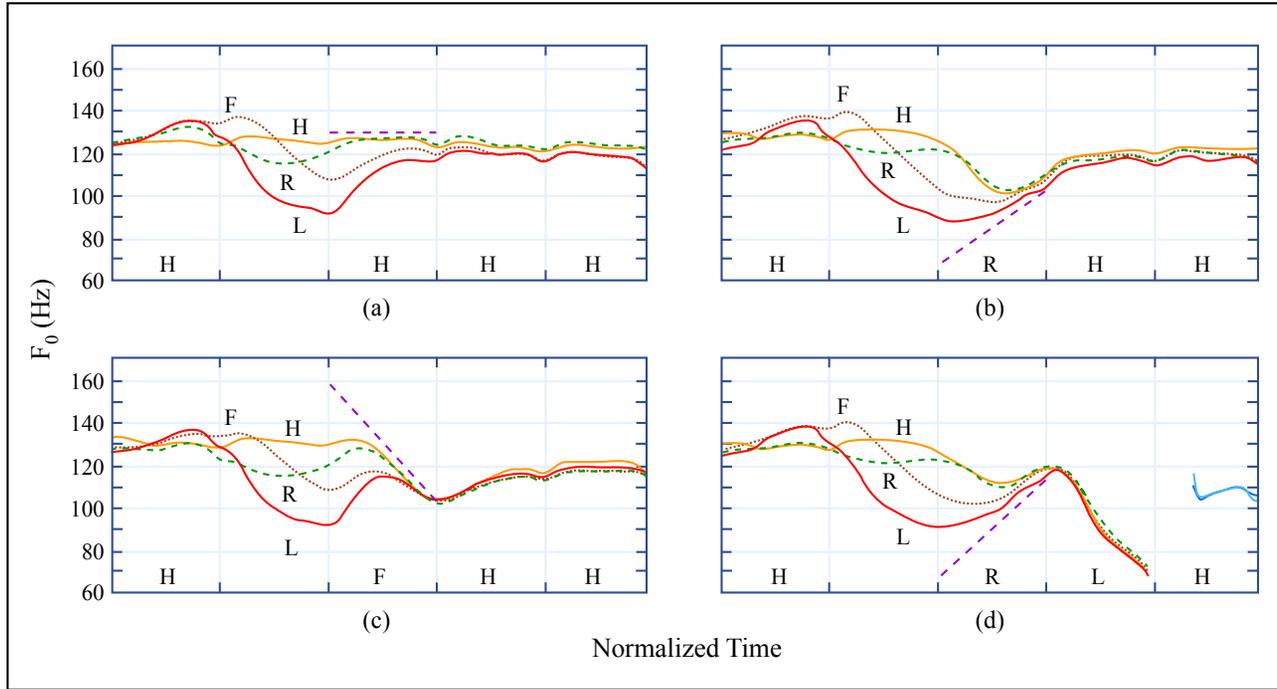


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Speech Melody as Articulatory Implemented Communicative Functions." *Speech Communication* 46 (2005): 220-251.

- Dashed lines show estimated tone targets for third syllables.

Syllable synchronization

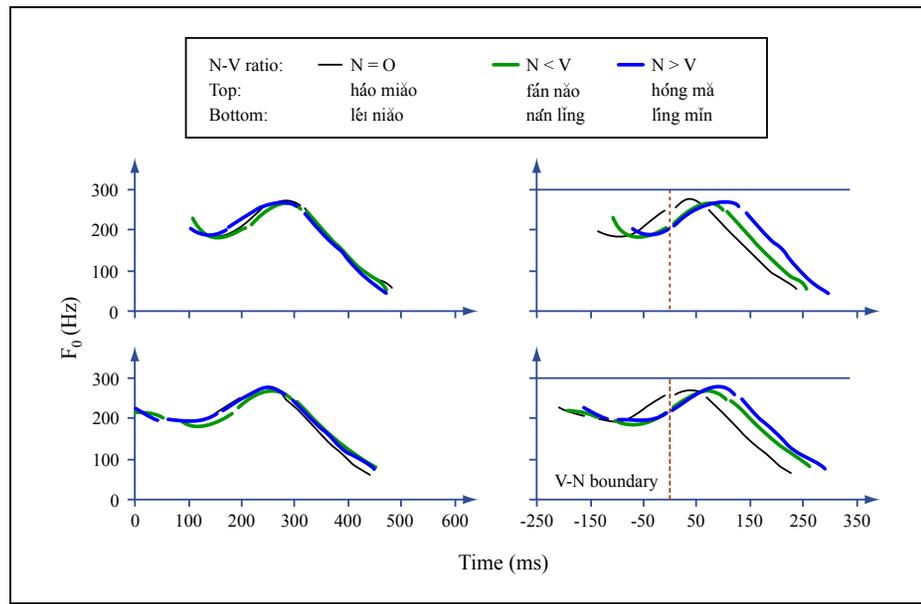


Image by MIT OpenCourseWare. Adapted from Xu, Y. "Speech Melody as Articulatory Implemented Communicative Functions." *Speech Communication* 46 (2005): 220-251.

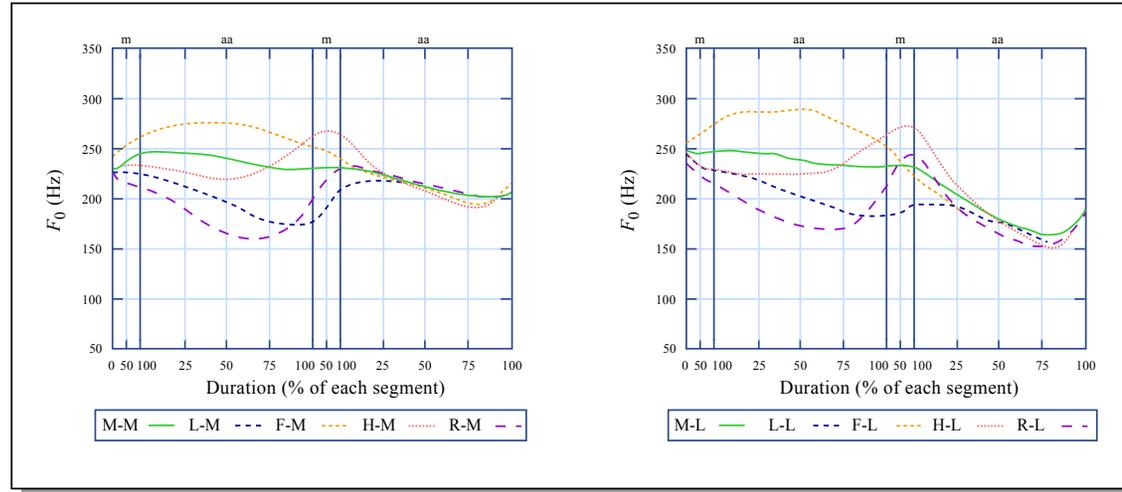
- The same tone sequence (RL) results in very similar f_0 contours regardless of the relative duration of V and coda N in syllable 1.
- Right panels show less consistency when contours are aligned at the offset of V_1 .

Anticipatory vs. carryover coarticulation in Thai

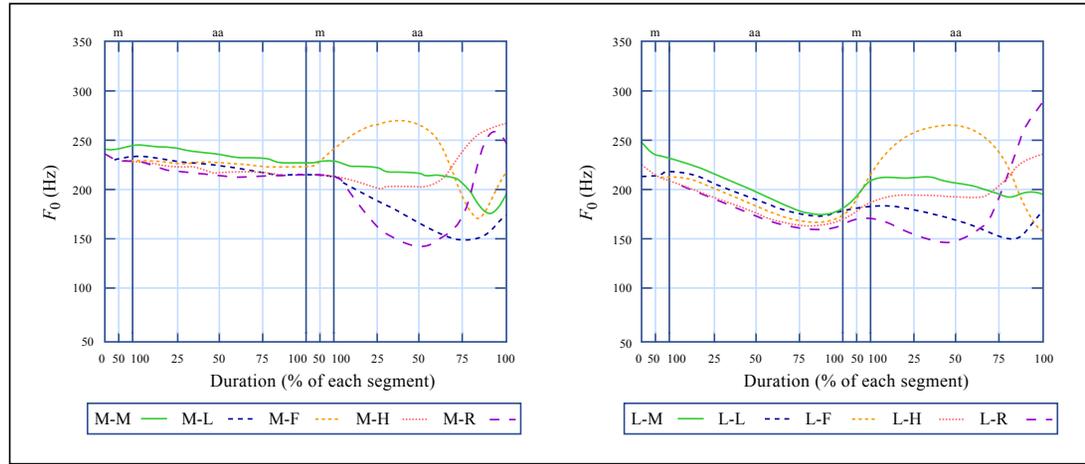
- Thai is also reported to show more carryover than anticipatory coarticulation, but there is anticipatory coarticulation (Gandour et al 1994).
- Data from one speaker in Nuttakorn (2002) suggests that anticipatory coarticulation primarily affects overall pitch range of tones, whereas carryover coarticulation involves a transition from the endpoint of the preceding tone.

Nuttakorn (2002)

Carryover



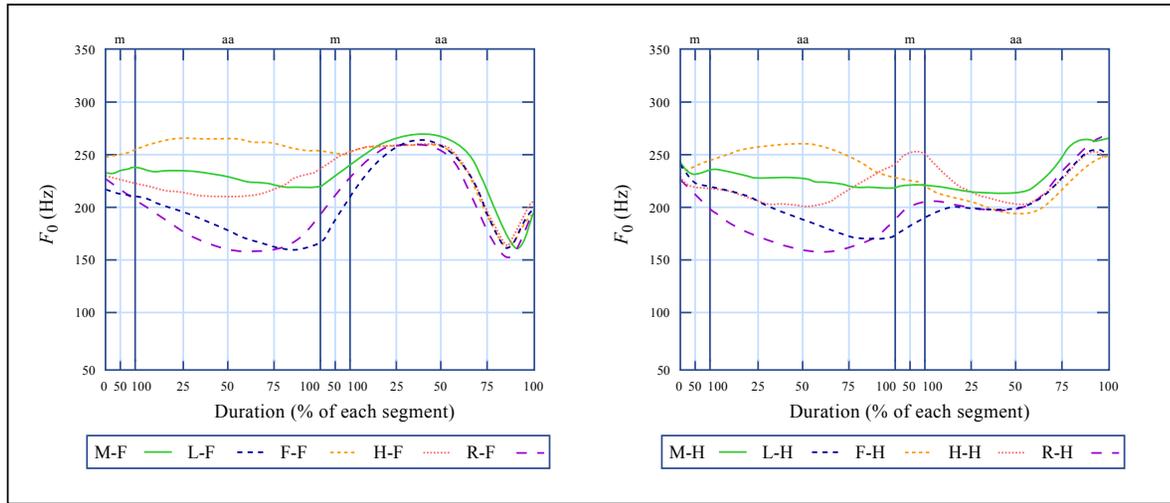
Anticipatory



Images by MIT OpenCourseWare. Adapted from Thubthong, Nuttakorn, Boonserm Kijirikul, and Sudaporn Luksaneeyanawin. "Tone Recognition in Thai Continuous Speech Based on Coarticulation, Intonation and Stress Effects." International Conference on Spoken Language Processing (ICSLP2002), Colorado, USA, September 16-20, 2002, pp. 1169-1172.

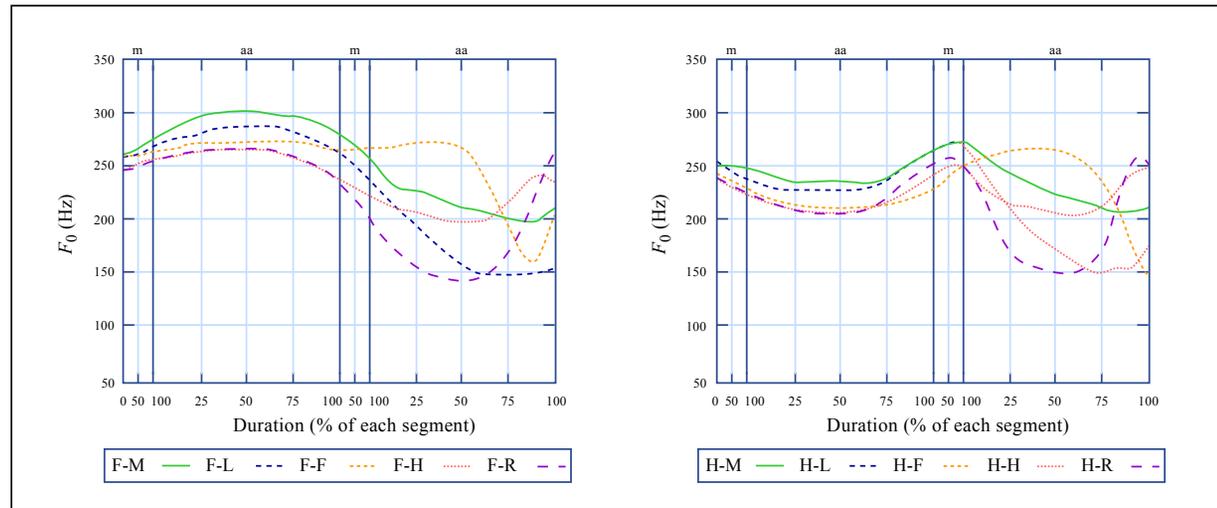
Nuttakorn (2002)

Carryover



Anticipatory

- Note F-F



Images by MIT OpenCourseWare. Adapted from Thubthong, Nuttakorn, Boonserm Kijirikul, and Sudaporn Luksaneeyanawin. "Tone Recognition in Thai Continuous Speech Based on Coarticulation, Intonation and Stress Effects." International Conference on Spoken Language Processing (ICSLP2002), Colorado, USA, September 16-20, 2002, pp. 1169-1172.

Anticipatory vs. carryover coarticulation in Cantonese

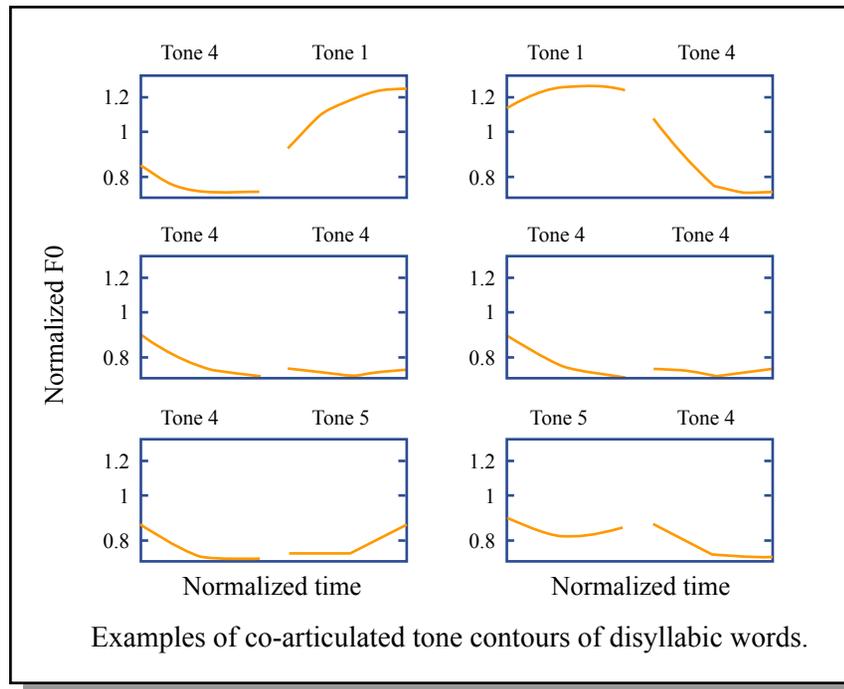


Image by MIT OpenCourseWare. Adapted from Li, Yujia, Tan Lee, and Yao Qian. "Analysis and Modeling of F0 Contours for Cantonese Text-to-Speech." *ACM Transactions on Asian Language Information Processing (TALIP)* 3, no. 3 (September 2004): 169-180.

- Cantonese also shows carryover articulation but minimal anticipatory coarticulation (Li et al 2004).

Li et al (2004)

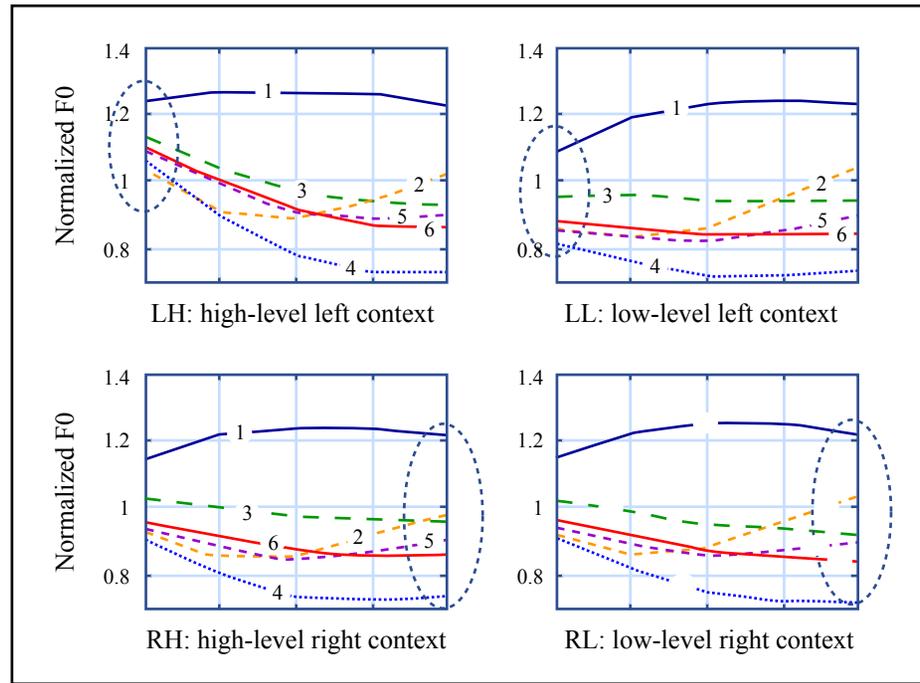


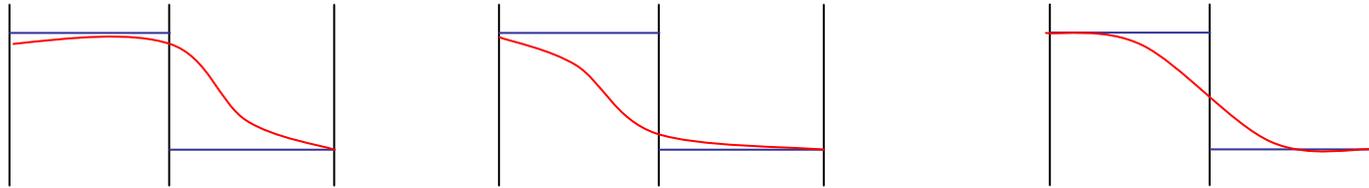
Image by MIT OpenCourseWare. Adapted from Li, Yujia, Tan Lee, and Yao Qian. "Analysis and Modeling of F0 Contours for Cantonese Text-to-Speech." *ACM Transactions on Asian Language Information Processing (TALIP)* 3, no. 3 (September 2004): 169-180.

- Averaged tone contours, divided according to height of preceding/following tone.
- “for almost all tones, the beginning section has a much larger variance than the ending one. This suggests that co-articulation from the left tone is more significant than that from the right. In general, the third and the fourth sections have the smallest variance”

Anticipatory vs. carryover coarticulation

- Predominance of carryover coarticulation is reported in Vietnamese (Brunelle 2003).
- Apparently in Igbo also (Akinlabi & Liberman ??, NELS 31), although with an interesting twist (below).

Asymmetry in coarticulation



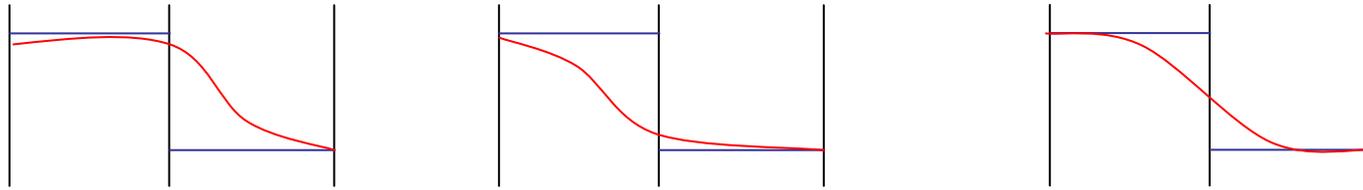
Carryover

not: anticipatory

symmetrical

- Xu attributes asymmetry to an imperative to keep tonal gestures in phase with syllables (cf. Goldstein, Nam etc).
 - i.e. onset of tone gesture coincides with onset of syllable
 - but what is the syllable gesture? Jaw?
 - In Browman & Goldstein (1990), there is no gesture coextensive with the syllable.
 - Why is the offset of the gesture coordinated with the offset of the syllable?

Asymmetry in coarticulation



Carryover

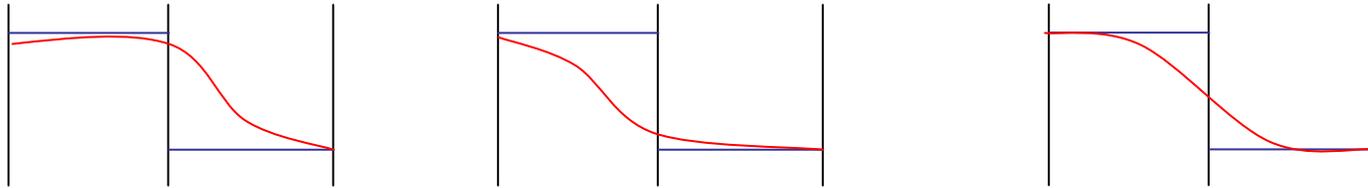
not: anticipatory

symmetrical

Alternatives:

- Syllable rhyme provides a better basis for realization of tonal contrasts because onset may be obstruent,
 - Only codas in Mandarin are nasals. Different patterns with obstruent codas?
 - In Mandarin, same pattern obtains with glide onset (Xu ??).
- Basic idea: tonal targets are weighted according to position - late targets have higher weights.
 - variant: tonal targets are only assigned the ends of syllables (cf. Akinlabi & Liberman) - doesn't work for contour tones.

Asymmetry in coarticulation



- Xu's model of tonal realization seems very compatible with a weighted constraint formulation.
- Implementation is easier if coarticulatory asymmetries follow from positional weighting of targets.
- Targets with extended duration (as opposed to point targets) are required.
 - Possibly also dynamic targets, but cf. Potisuk et al (1997) who model tone implementation in Thai with sequences of level targets.
 - Slope targets are motivated by evidence that tone slope is perceptually salient (Gandour 19

Anticipatory tonal coarticulation in Taiwanese - Peng (1997)

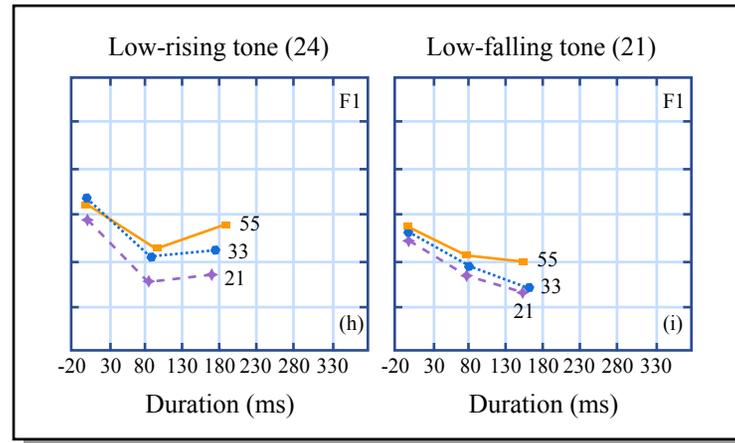


Image by MIT OpenCourseWare. Adapted from Peng, Shu-hui. "Production and Perception of Taiwanese Tones in Different Tonal and Prosodic Contexts." *Journal of Phonetics* 25 (1997): 371-400.

- Only examined anticipatory tonal coarticulation.
- Substantial effects for one speaker, smaller but significant effects with others (especially for high falling 51 tone).

Anticipatory tonal coarticulation in Kinyarwanda

Myers (1998)

- Kinyarwanda contrasts L, H, LL, HL, LH
- Contour tones only permitted on long vowels
 - umwáana ‘child’
 - umwaámi ‘king’
 - umuunhu ‘person’
 - ururími ‘language’
- Rise for H, HL begin during preceding syllable.

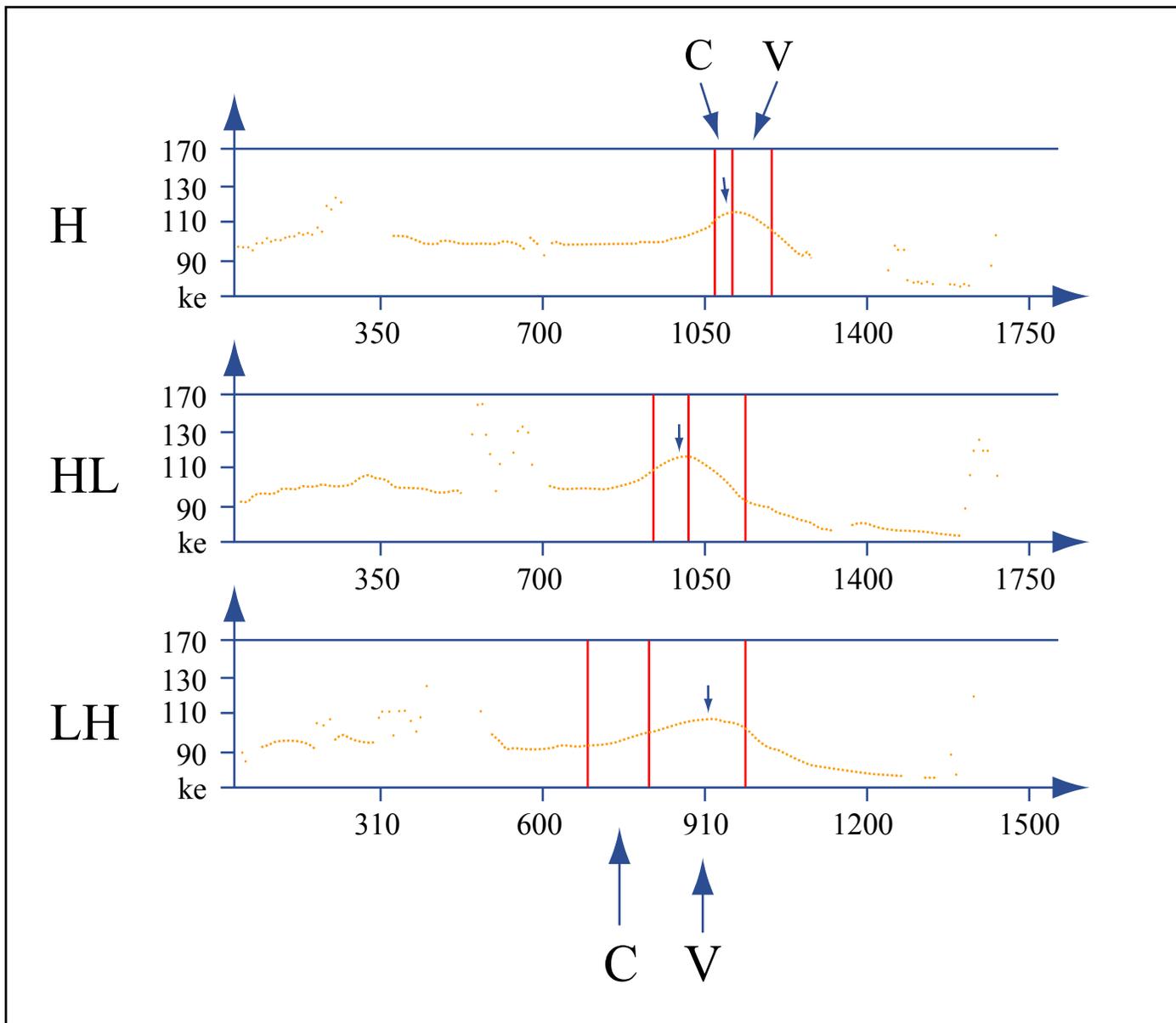


Image by MIT OpenCourseWare. Adapted from Myers, S. "F0 Timing in Kinyarwanda." *Phonetica* 60 (2003): 71-97.

Kinyarwanda - Myers (1998)

- Rise for H, HL begin during preceding syllable.
- Timing of onset of rise as a proportion of the *preceding* syllable duration:

Speaker	H	HL	LH
1	0.317	0.457	1.560
2	0.402	0.182	1.606
3	0.185	0.323	1.325
4	0.336	0.511	1.419

Image by MIT OpenCourseWare. Adapted from Myers, S. "F0 Timing in Kinyarwanda." *Phonetica* 60 (2003): 71-97.

- Rise begins about 100 ms before f0 peak.
- With word-final, phrase-final H syllables, f0 peak can precede the syllable.

Kinyarwanda - Myers (2003)

- Kinyarwanda tones also differ from Mandarin tones in that the alignment of the f₀ peak within a high-toned syllable varies substantially:
 - Earlier in phrase-final words than in phrase-medial words.
 - Earlier in phrase-final syllables than in phrase-medial syllables.
 - H peak tends to be earlier the shorter the distance to the next H ('crowding') (no such effect for HL, LH).

ururími rgwaan je^h

No following H

irarúm umḡána^h

H follows after 1 syllable

ururími runíni^h

H follows after 2 syllables.

- Similar factors affect the timing of f₀ peaks for H* pitch accents in English (Silverman & Pierrehumbert 1990) and Spanish (Prieto et al 1995).

Kinyarwanda vs. Mandarin

- Why does Kinyarwanda work so differently from Mandarin and the other SE Asian languages cited above?
- Fewer tones? Only two levels HL.
- Asymmetry between L and H - L is phonologically inert. Analyzed by Myers as phonologically absent (cf. Chichewa, Myers 1998).
 - Realization of L has a low weight?
- Behaviour similar to Mandarin can be observed in a 3-toned African language, Yoruba (Akinlabi & Liberman).
 - L, M, H.
 - M often analyzed as absence of tone.

Yoruba

- A&M: Simple tones are assigned a target at the end of the syllable.
- If there is a sequence of syllables with the same tone, a target is assigned to the end of the last syllable.
- Initial mid target.
- Interpolate between targets.
- Igbo is much the same.

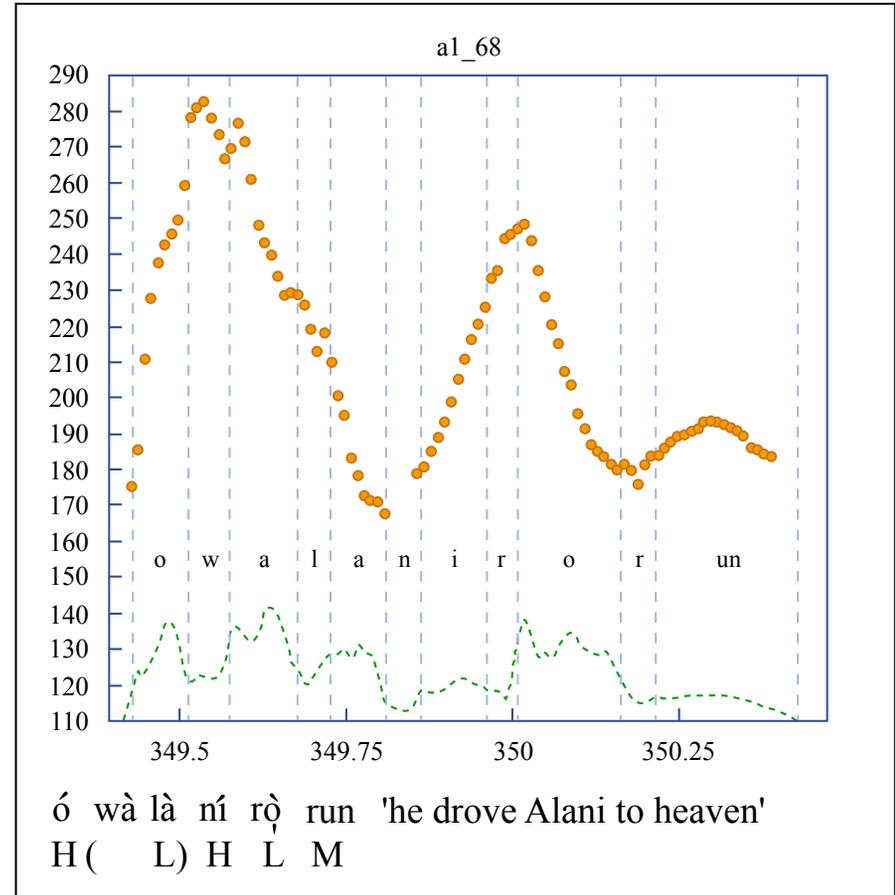
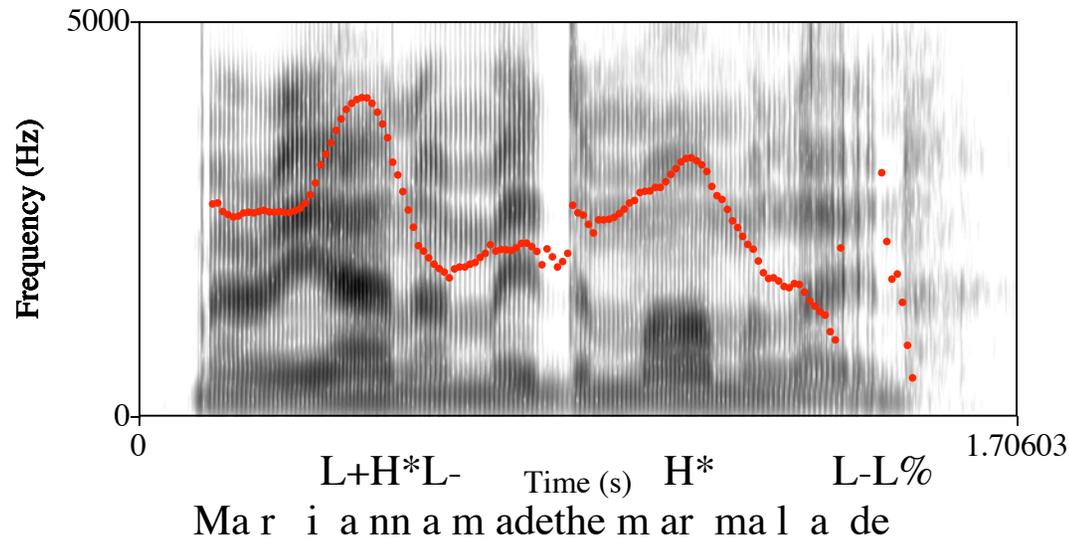


Image by MIT OpenCourseWare. Adapted from Akinlabi, A., and M. Liberman. "Tonal Complexes and Tonal Alignment." *NELS 31* (2000).

Tonal anticipation in intonation



- Near-linear interpolation from L- to H* across [meɪdðə].
 - If H* were synchronous with its syllable, no movement should occur until onset of [mɑ].
- Note also movement from H* to final L- is ‘early’.

Phonetics and phonology of tone

- Some patterns that have been analyzed as tone spread are better analyzed in terms of the details of tonal realization.
 - Kinyarwanda has been described as having leftwards spread of H tone, e.g. /umusóre/ -> umúsóre (Sibomana 1974).
- Many phonological processes have been described that resemble progressive tonal coarticulation, e.g. Yoruba

(a) Yoruba rising example àlá (LH) → àǎ (L LH)	'dream'
(b) Yoruba falling example rárà (HL) → rárâ (H HL)	'elegy'
(c) Edo (Bini) falling example ékpò (HL) → ékpô (H HL)	'bag'

Image by MIT OpenCourseWare.

- H tone spread tends to be rightwards (Myers).

Phonetics and phonology of tone

- These processes may well be phonological - in some cases they are neutralizing. But they are also probably motivated by the same constraints that motivate tonal coarticulation.
- E.g. In Kinyarwanda, f_0 peak for H is early in phrase-final syllables. In Chichewa, final H retracts to the penult in phrase-final position (Myers 1998).

References

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- Prieto, P.; Santen, J. van; Hirschberg, J. (1995) Tonal alignment patterns in Spanish. *J. Phonet.* 23: 429–451.
- Silverman, K.; Pierrehumbert, J. (1990) The timing of prenuclear high accents in English; in Kingston, Beckman, Papers
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