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Phonetics and function in diachronic conflict: The case of rising tones

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Introduction

- When asked to do so at maximum speed, experimental subjects can lower their pitch *faster* than they can raise their pitch (Sundberg 1973, 1979, Ohala 1979): pitch-raising takes more time.
- No phonological system ever demands of speakers that they encounter their physiological limits during speech production, but physiological limitations may nonetheless be reflected phonologically in a number of ways.
- Languages often evolve strategies which, while accommodating to physiological pressures, nonetheless maintain rising pitch patterns such as V^{LH}.

Pattern (A) Languages may spread/displace the high tone.

$[V^{HL}V^{M}]$ but $/V^{LH}V^{M}/$ $\rightarrow$ $[\underline{V^{LH}V^{HM}}]$ or $[\underline{V^{L}V^{HM}}]$

Pattern (B) Languages may possess the rising contour only on *longer* vowels/sonorous rimes, in comparison to vowels/sonorous rimes associated with falling contours (Zhang 2001). This may be a distributional property, or may result from alternation.

$[V^{HL}]$ but $/V^{LH}/$ $\rightarrow$ $[\underline{V\text{ː}^{LH}}]$ or $[\underline{V\text{ˑ}^{LH}}]$

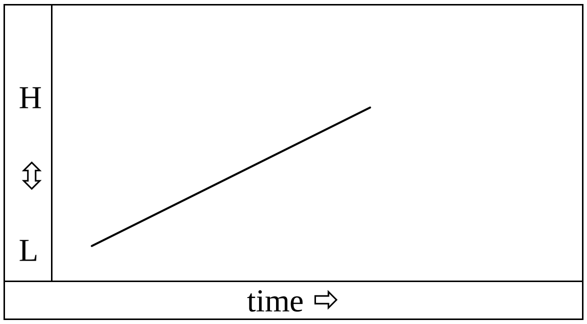
Pattern (C) The rise in pitch of a rising contour may be somewhat smaller than the fall in pitch of a falling contour. Again, this may be a distributional property, or may result from alternation.

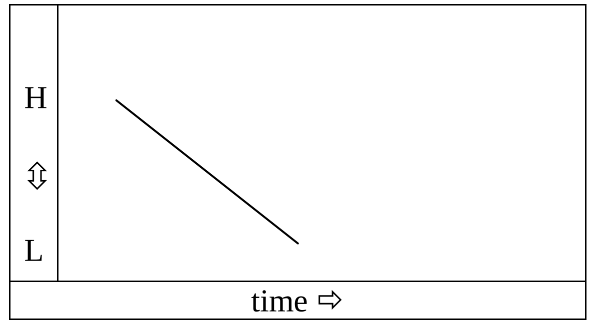
$[V^{HL}]$ but $/V^{LH}/$ $\rightarrow$ $[\underline{V^{LM}}]$

- All three of these disparate phonological patterns may be seen as ultimately related to one another when considering how physiological and functional factors may diachronically interact with each other.

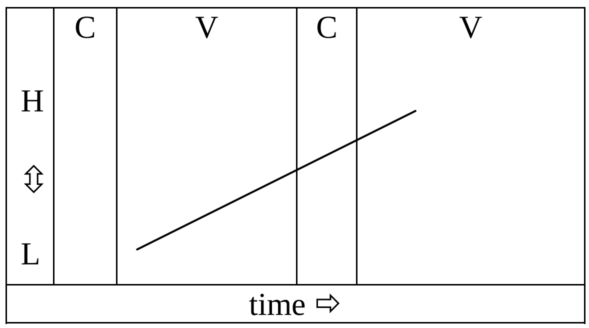
Phonetic underpinnings

- Pitch rises take longer to implement than do pitch falls (Sundberg 1973, 1979, Ohala 1979)

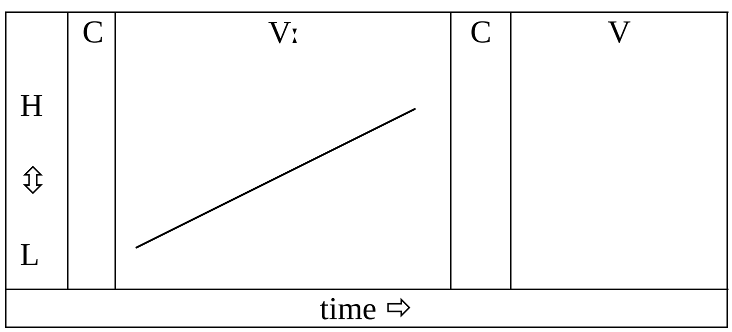




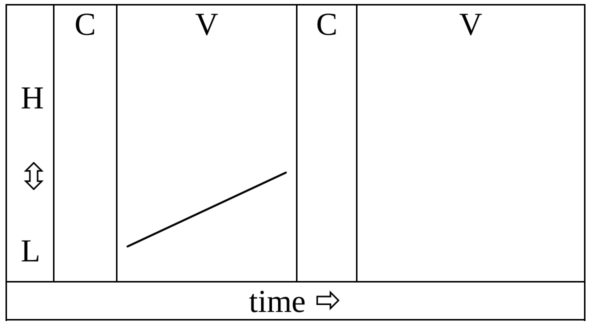
Pattern (A) Given the sluggishness of pitch rises in comparison to pitch falls, a following consonant might be made *before* the pitch rise is fully achieved: after release, the high pitch is achieved. As suggested by Ohala (1978:31), "...[S]ince falling tones can be produced faster than rising tones...they might be less likely to 'spill over' onto the next syllable."



Pattern (B) Alternatively, high tones may be limited in their distribution to long vowels/sonorous rimes (either phonemically or subphonemically).



Pattern (C) Alternatively again, the pitch rise may be shallower.



- These three patterns may now be seen as intimately related to each other: they are different responses to an identical phonetic limitation.

Exemplification of Pattern (A)

Comaltepec Chinantec tone sandhi (Anderson, Martinez, and Pace 1990, Pace 1989, Silverman 1997)

- High tones spread rightward from Low-High syllables

(1)	kwa˩˥	toː˩	→	kwa˩˥ toː˥˩	‘give a banana’
	kwa˩˥	ŋɨh˩	→	kwa˩˥ ŋɨh˥˩	‘give a chayote’
	kwa˩˥	kuː˧	→	kwa˩˥ ku:˥˧	‘give money’
	kwa˩˥	ⁿdʒuː˧	→	kwa˩˥ ⁿdʒuː˥˧	‘give a jug’

Chiquihuitlan Mazatec tone sandhi (Jamieson 1977)

- Main sandhi pattern: rising and higher tones spread their high(er) component rightward. (1=highest; 5=lowest)

<table>
<tr><td>target→
trigger↓</td><td>31</td><td>3</td><td>34</td><td>target→
trigger↓</td><td>4</td></tr>
<tr><td>1</td><td rowspan="4">1</td><td rowspan="4">1</td><td rowspan="4">14</td><td>1(4)</td><td rowspan="4">14</td></tr>
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2.	sua^{1} ‘I give’ + rki^{3} ‘medicine’	→	sua^{1} rki^{1}
	kih^{31} ‘went’ + -nka^{3} ‘again’ + mu^{3}su^{14} ‘hired worker’	→	kih^{31}nka^{1}mu^{1}su^{14}
	ŋku^{2} ʔɲu^{2} ‘rapidly’ + hbæ^{3} ‘it finishes’	→	ŋku^{2} ʔɲu^{2} hbæ^{2}

ŋku^{2} ‘one’ + nta^{3}ʔŋka^{34} ‘corncrib’	→	ŋku^{2} nta^{2}ʔŋka^{24}
ho^{1} ‘two’ + khua^{4} ‘word’	→	ho^{1} khua^{14}
le^{4}ʔba^{14} ‘hoe’ + ne^{4} ‘uh’	→	le^{4}ʔba^{14} ne^{14}
nu^{2} ‘year’ + ne^{4} uh	→	nu^{2} ne^{24}
kuiʔ^{42} ‘will drink’ + me^{4} ‘they’	→	kuiʔ^{42} me^{24}
koh^{3} ‘with’ + me^{4} ‘they’	→	koh^{3} me^{34}
ʃu^{3}ma^{34} ‘poor’ + hnu^{4} ‘corn plant’	→	ʃu^{3}ma^{34} hnu^{34}

- Downdrift is found between adjacent level tones, except upon tone spread, where downdrift is blocked, especially when the spreading tone is high.

Zulu (Cope 1966, Russell 2000)

- “Depressor” consonants have been characterized as phonetically and/or historically breathy-voiced; they induce significant pitch lowering.
- Following depressor consonants, high-tones on short vowels are displaced from their vowel of origin to a following vowel: DV˦ CV˧ → DV˩ CV˥˩

3.	i˧ si˥ ɬaː˧ lo˧	‘chair’	→	i˧ zi˩ ɬaː˥˩ lo˧	‘chairs’
	i˥↓ nsiː˧ zwa˩	‘young man’	→	ji̤˩ nsiː˥˩ zwa˩	‘by a young man’
	i˥ ɲoː˧ nɨ˧	‘bird’	→	ne̤˩ ɲoː˥˩ nɨ˧	‘with a bird’

Quiotepec Chinantec (Gardner and Merrifield 1990)

- An arbitrary set of open, “ballistic” syllables possessing M or LM tones is raised to H in the context of a preceding LH or MH contour (“ˊ ” = ballistic syllable):

4.	non-sandhi context:			sandhi context:	gloss:
	kʷó˧˥	tṹ˧	→	kʷó˧˥ tṹ˥	‘give (me) two’
	cỵ́ː˧˥	tʲỵ́˩˧	→	cỵ́ː˧˥ tʲỵ́˥	‘good earthen jar’
	sí̇ː˩˥	dʲá˧	→	sí̇ː˩˥ dʲá˥	‘shave down ten’
	ʃỵ́ʔ˩˥	tʲúj˧	→	ʃỵ́ʔ˩˥ tʲúj˥	‘good armadillo’
	ʃỵ́ʔ˩˥	bṍ˧	→	ʃỵ́ʔ˩˥ bṍ˥	‘stupid armadillo’

Mbui Bamileke (Hyman and Schuh 1974)

- High tones often shift from a leftward syllable to a rightward syllable:

5.	non-sandhi context:			sandhi context:	gloss:
	lɔ̀ɔ́	bə̀sə́ŋ	→	lɔ̀ɔ̀ bə́sə́ŋ	‘look for the birds’
	lɔ̀ɔ́	tìè	→	lɔ̀ɔ̀ tíè	‘look for the pot’
	lɔ̀ɔ́	sə́ŋ	→	lɔ̀ɔ̀ sə́ŋ	‘look for the bird’

Digo (Kisseberth 1984, Yip 2002)

- High tone verbs spill their high component into the suffix domain, except when a voiced obstruent blocks its propagation. (Actually, *any* preceeding high tone migrates to the penult-final border region.)

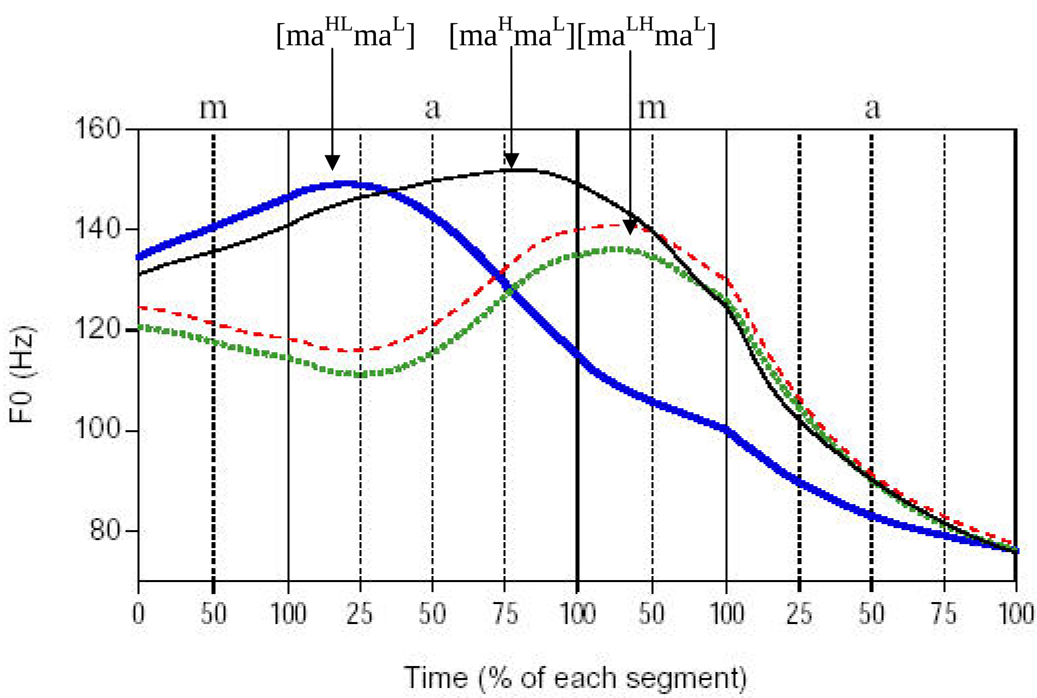
6.

toneless verbs:		high-toned verbs	
ku-rim-a	‘to cultivate’	ku-aru˩˥k-a˥˩	‘to begin’
ku-ambir-a	‘to tell’	ku-furuku˩˥t-a˥˩	‘to move restlessly’
ku-ɡandamiz-a	‘to press’	ku-fuki˧z-a	‘to apply heat’

Beijing Mandarin (Xu 1997, Xu and Wang 2001)

- Tones with high offsets typically peak only after the following consonant has been implemented; tones with low offsets show a significantly lesser effect in these same contexts (pitch track kindly provided by Yi Xu).

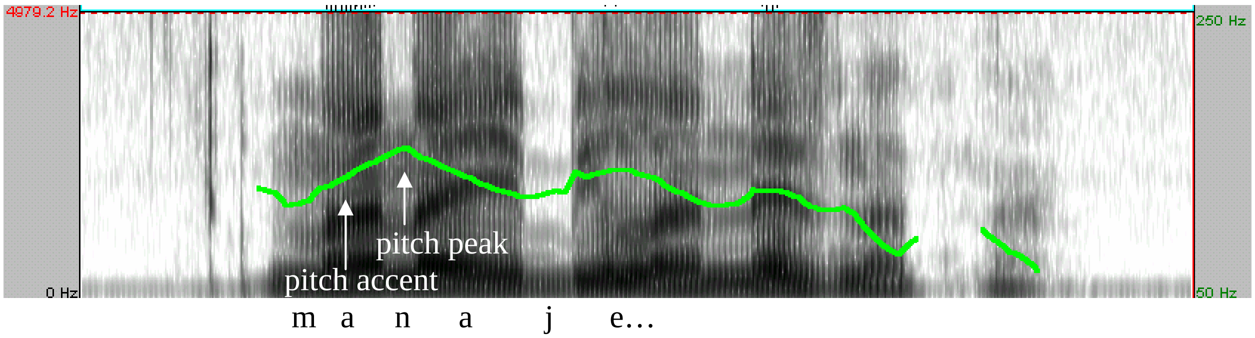
7. [mama]



Zagreb Croatian (Lehiste and Ivic 1986)

- High pitch-accented syllables possess a rising pitch contour, pitch peaks being realized on the post-tonic syllable, rather than on the accented syllable itself (spectrogram kindly provided by Rajka Smilanic).

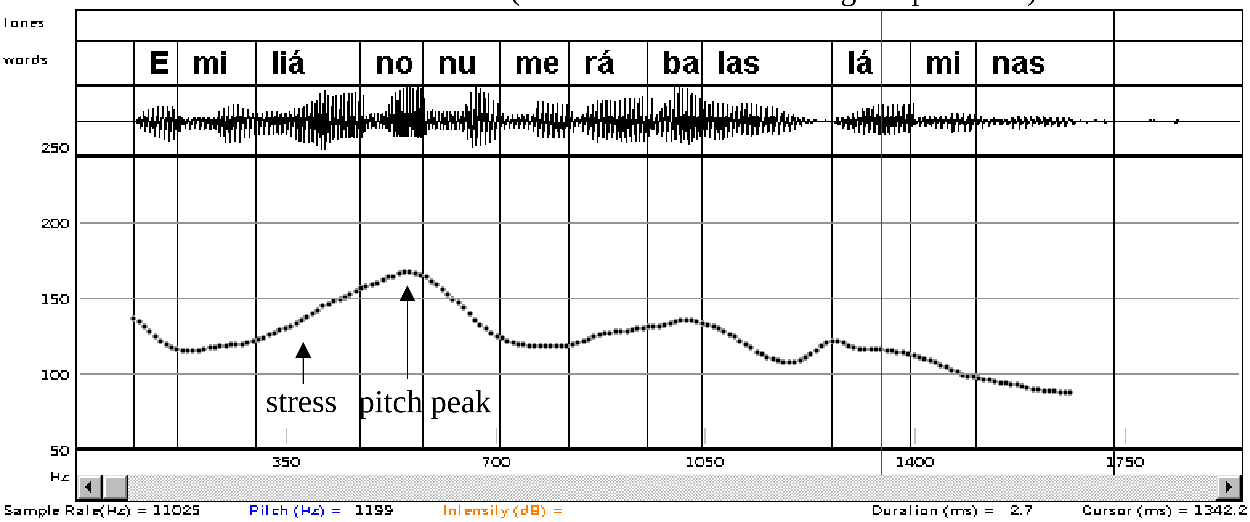
8. Manaje bila neznatna (“A fault was insignificant”)



Peninsular Spanish (Navarro-Tomás 1944, Fant 1984, Prieto, van Santen, and Hirschberg 1995

- Stressed syllables typically possess a pitch rise, with the pitch peak being realized on the post-stressed syllable (pitch track kindly provided by Jose Ignacio Hualde).

9. Emiliano numeraba las láminas ("Emiliano was numbering the pictures")



Exemplification of Pattern (B)

- Observing lengthening of vowels with rising tones typically requires a phonetic investigation. Consequently, this pattern is not likely to be noted in phonological descriptions. However, it is likely to be quite common.

Cantonese (Yu 2003)

- Checked syllables with (derived) rising tones are significantly longer than checked syllables with level tones.

10. Morphologically-derived mid-rising tones on checked syllables:

saː˥ <u>kɔˑk˺˧˥</u>	(a type of food)	<u>tsʰaˑt˺˧˥</u> tsʰat˺˧	'to brush a little'
tsʊk˺˥ <u>tsʰaˑt˺˧˥</u>	'a bamboo brush'	<u>pʰaˑk˺˧˥</u> pʰak˺˧	'to hit a little'

(Right column heading: Sandhi-derived rising tones rises on checked syllables:)

pɔ˥ pʰaˑk̚˧˥	‘a ball racket’	kɛˑp̚˧˥ kɛp̚˧	‘to clip a little’
pui˥ tɔˑk̚˧˥	‘a cup stand’	tʰɔˑk̚˧˥ tʰɔk̚˧	‘to support a little’
fɔŋ˥ kaˑk̚˧˥	‘a square’	kaˑk̚˧˥ kak̚˧	‘to separate a little’
kʌːm˥ tʃʰaˑp̚˧˥	‘a golden insert’	tʃʰaˑp̚˧˥ tʃʰap̚˧	‘to insert a little’
kʌːm˥ tsɔˑk̚˧˥	‘a golden chisel’	tsɔˑk̚˧˥ tsɔk̚˨	‘to chisel a little’
kɛi˥ jiˑp̚˧˥	‘propeller’	tiˑp̚˧˥ tip̚˨	‘to pile up a little’

Mitla Zapotec (Briggs 1961)
- Four tones: high, low, rising, falling. “The vowel of a stem-final syllable having a low-high glide is somewhat lengthened. “ (p.2).

Thai (Gandour 1977)
- Vowels with rising tones are longer than other vowels.

Zulu (Russell 2000)
- Vowels with rising tones flanked by depressor consonants—which do not displace the high component—are subphonemically lengthened.

11. i˨ ziˑ˩˥ᶢǃʰoː˩ ko˨ ‘hats’

Zhang’s report (2001):

-Ga (Paster 1999)
- LH tones on final vowels trigger lengthening.

-Kɔnni (Cahill 1999)
- Rising tones can only occur on final CVN or CVVN syllables, whereas HL may be found on final CV syllables.

-Tiv (Pulleyblank 1986)
- Contour tones are restricted to word-final position. HL may occur on CV, but LH may occur only on CVR.

Pattern (C)

- Reduced pitch rises typically require a phonetic investigation. Consequently, this pattern is not likely to be noted in phonological descriptions. However, it is likely to be quite common, For example, in Mandarin Chinese.

Conclusion
- So, physical properties of the speech mechanism—phonetic factors—may induce a delay in achieving higher pitch in the context of preceding lower pitch.
- But independent functional factors may induce
  (A) High tone spread or displacement

(B) Lengthening of the associated vowel
(C) A reduction in the pitch change in comparison to falling tone

- All of these patterns may salvage the otherwise jeopardized pitch rise.
- These three patterns may be seen as intimately related by considering the diachronic interaction of phonetic and functional forces on phonological systems.

(complete list of references to appear in final version—sorry!)