Tonogenesis

An introduction

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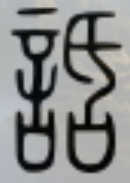
In the Beginning was the Sino-Tibetan monosyllable, arrayed in its full consonantal and vocalic splendor. And the syllable was without tone and devoid of pitch. And monotony was on the face of the mora. And the Spirit of Change hovered over the segments flanking the syllabic nucleus.

And Change said, "Let the consonants guarding the vowel to the left and the right contribute some of their phonetic features to the vowel in the name of selfless intersegmental love, even if the consonants thereby be themselves diminished and lose some of their own substance. For their decay or loss will be the sacrifice through which Tone will be brought into the world, that linguists in some future time may rejoice."

And it was so. And the Language saw that it was good, and gradually began to exploit tonal differences for distinguishing utterances -- yea, even bending them to morphological ends. And the tones were fruitful and multiplied, and diffused from tongue to tongue in the Babel of Southeast Asia.



*[g]$^{w\varsigma}$rats → 話 *huà*

Matisoff, 1973; Baxtar & Sagart, 2014

Where does tone come from?

- The diachronic development of tones is called **tonogenesis** (Matisoff 1973).

- Tone typically (but not always) involves the transphonologization of the acoustic properties associated with the laryngeal gestures of **consonants**.

Transphonologization: the standard model

Stage I	*Stage II*	*Stage III*
pá [˧˥]	pá [˧˥]	pá [˧˥]
bá [˩˧]	bă [˩˨˧]	pă [˩˨˧]

- Stage I: **intrinsic** coarticulatory differences
- Stage III: Intrinsic differences are enhanced and become **extrinsic** (“phonologization”)
- Stage III: source environment disappears (“phonemicization”)

after Hyman, 1976

The classical model of tonogenesis: Haudricourt

- Proposed by Haudricourt (1954) for Vietnamese on the basis of Sino-Vietnamese tone correspondences by Maspero (1912)

- Haudricourt noticed a number of correspondences between the **tones** of Vietnamese and the laryngeal properties of **consonants** in the Austroasiatic languages.

Haudricourt, 1954; 1961/1972; 1965

Tonogenesis in Vietnamese

No Tone Early CE	3 tones 6th CE	6 Tones 12th CE
pa	pa	pa
ba	ba	pà
pah	pà	pả
bah	bà	pã
pa?	pá	pá
ba?	bá	pạ

simplified from Haudricourt (1954)

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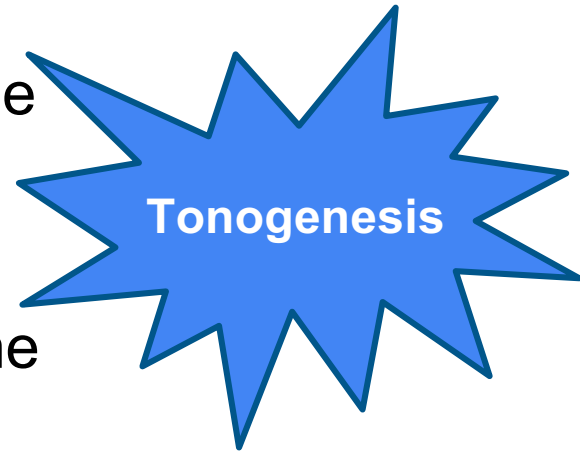
- Final -h > **L** tone
- Final -? > **H** tone



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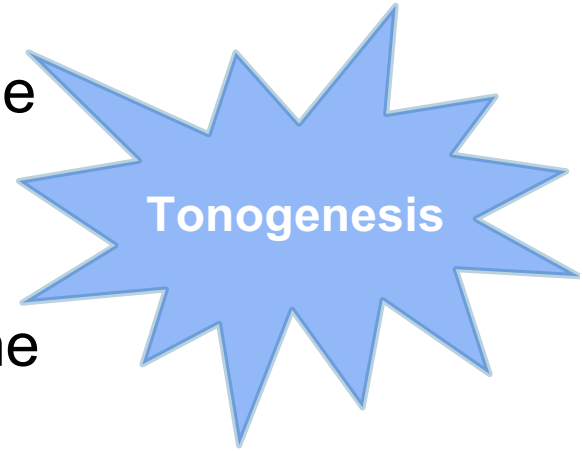

- Final -h > **L** tone
- Final -ʔ > **H** tone
- Initial p- > **H** register
- Initial b- > **L** register

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simplified from Haudricourt (1954)

- Final -h > **L** tone
- Final -ʔ > **H** tone

Tonogenesis

- Initial p- > **H** register
- Initial b- > **L** register

Tone split

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baʔ	bá	pạ

simplified from Haudricourt (1954)

- Final -h > **L** tone
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Tonogenesis

- Initial p- > **H** register
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simplified from Haudricourt (1954)

- Final -h > **L** tone

*why these **segments**?*

- Final -ʔ > **H** tone

- Initial p- > **H** register

*why these **directions**?*

- Initial b- > **L** register

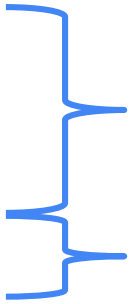
Microprosody

- Hombert et al. (1979) is largely about the different kinds of segmental influences on fundamental frequency which could underpin tonogenesis.

- These are often collectively referred to as **microprosodic** effects.

- H79 discuss the microprosody of four main classes of segments:

1. prevocalic voicing
2. postvocalic voicing
3. glottal codas
4. vowels



***co-intrinsic* effects (CF_0)**

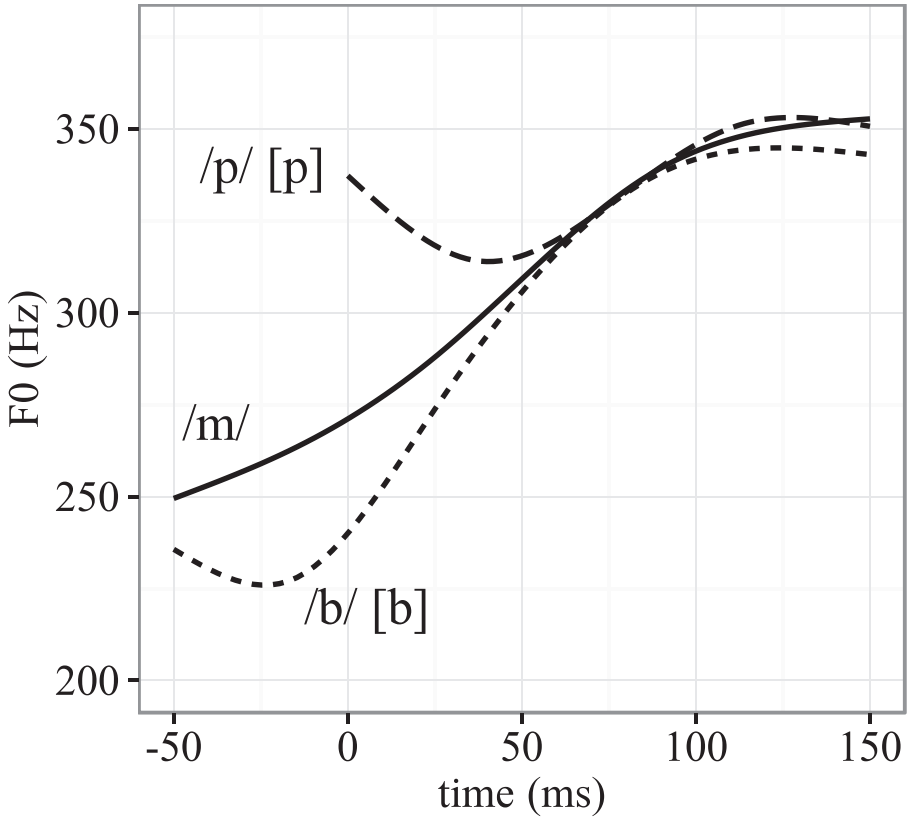
***intrinsic* effects (IF_0)**

di Cristo & Hirst, 1986

Voicing of prevocalic obstruents

Microprosodic effects of prevocalic obstruents

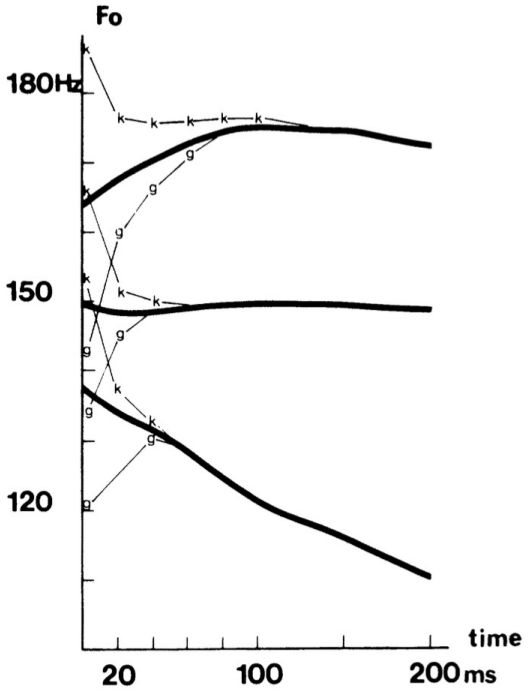
- **Voicelessness** > high F_0
- **Voicedness** > low F_0
- **Direction** of effect is cross-linguistically robust, regardless of how voicing is implemented
- (Voiced) sonorants typically (but not always) **neutral**



Kirby & Ladd, 2016

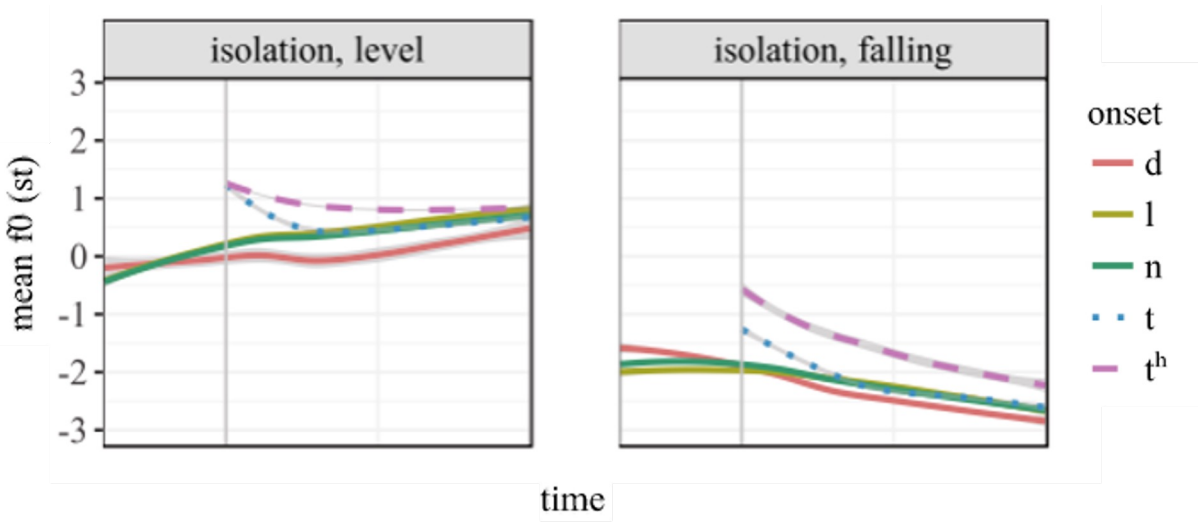
Microprosodic effects of prevocalic obstruents

- Effects are also seen in tonal languages, but typically attenuated



Yoruba (Hombert et al 1979)

Vietnamese (Kirby 2018)



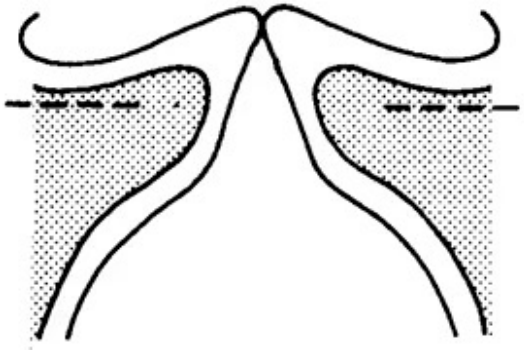
Hombert et al., 1979; Kirby, 2018

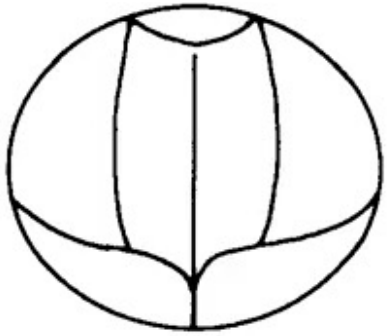
Where do CF_0 effects come from?

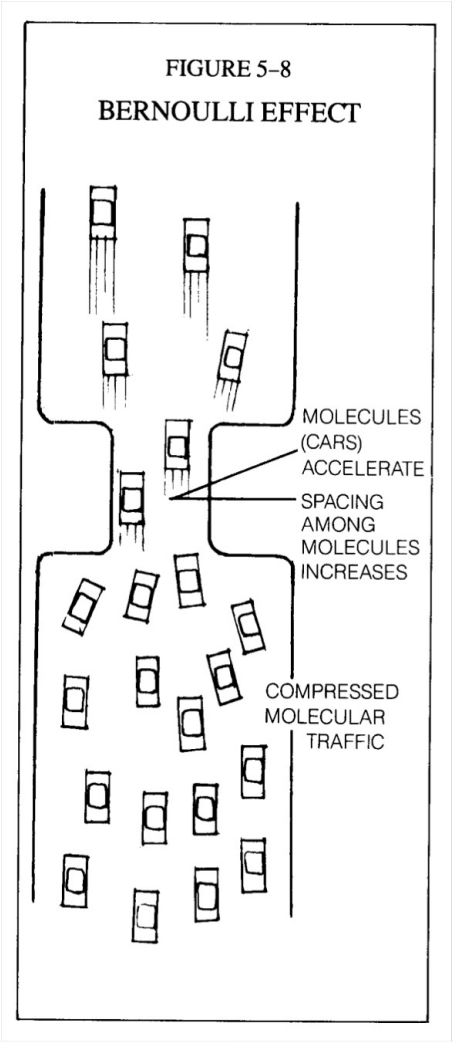
H79 discuss three hypotheses:

1. Aerodynamic
2. Horizontal-tension
3. Vertical-tension

Aerodynamic hypothesis





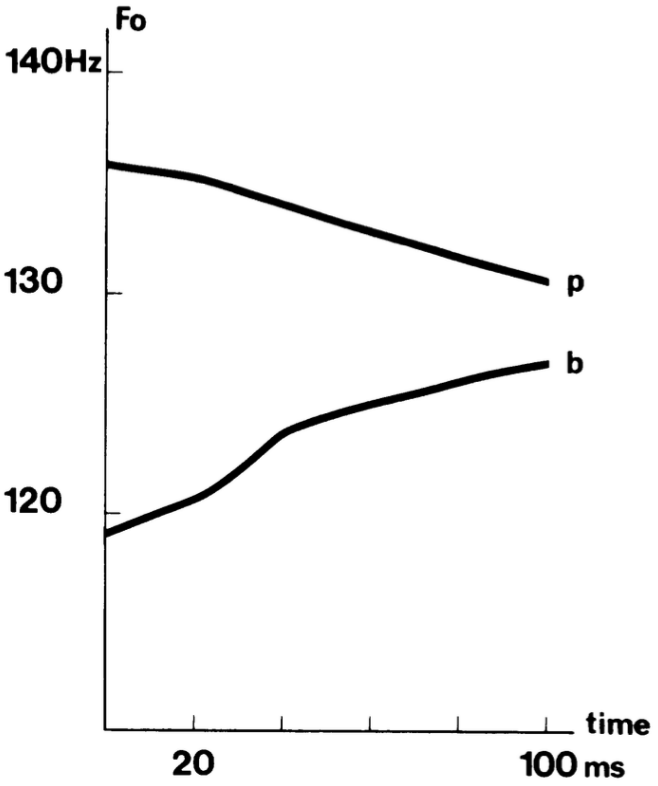


For voiceless (aspirated) stops, higher airflow across vocal folds after release > increased Bernoulli force > increased rate of VF vibration > higher F_0

Hirano, 1981 (animation by Phil Hoole); Perkins & Kent, 1991

Aerodynamic hypothesis: objections

- Prevocalic CF_0 can persist for 100 ms or longer
- Is flow rate Q independent of subglottal pressure P_s ?
- A (potentially small) aerodynamic effect is possibly always present (Kohler 1985)



Hombert et al., 1979

Horizontal-tension hypothesis

- Slack vocal folds > **lower** pitch
- Stiff vocal folds > **raised** pitch

	1	2	3	4	5	6
obstruents	b_1	b	p	p_{Korean}	b^h	p^h
glides	w, y				ɦ	h, W, Y
vowels	V	V̀	V́	voiceless vowels	breathy vowels	
spread glottis	-	-	-	+	+	+
constricted glottis	-	-	-	-	-	-
stiff vocal cords	-	-	+	-	-	+
slack vocal cords	-	+	-	-	+	-

Halle & Stevens, 1971

Horizontal-tension hypothesis: objections

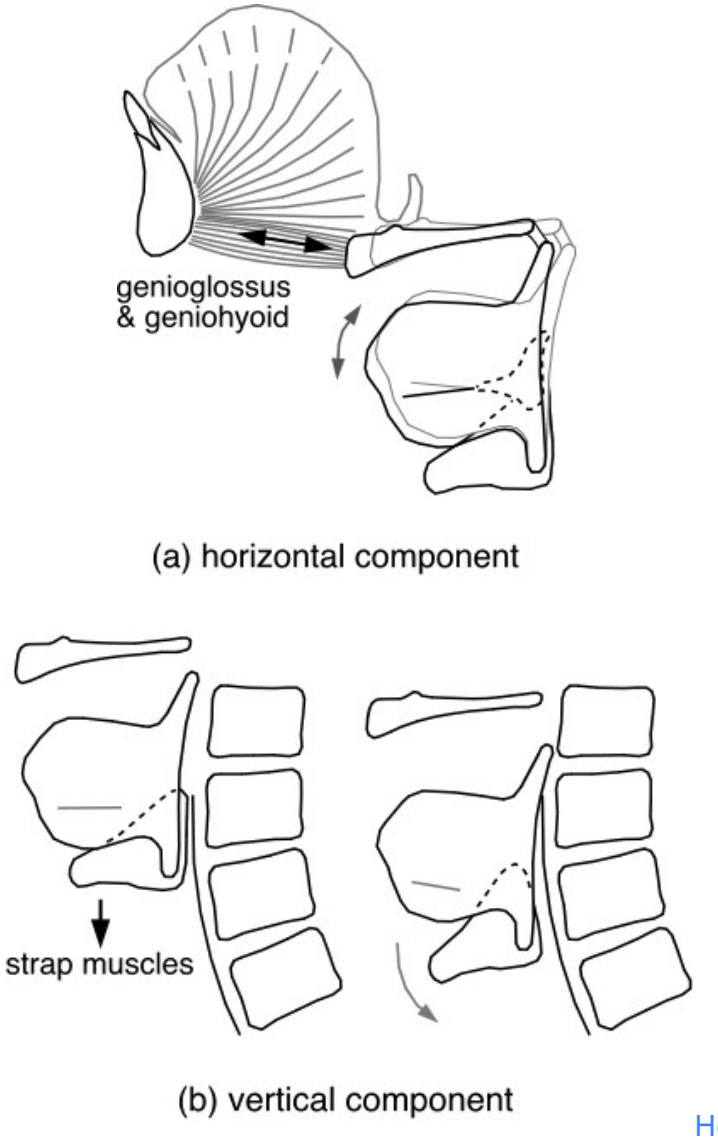
- Slack vocal folds > **lower** pitch
- Stiff vocal folds > **raised** pitch
- Predicts that F_0 should also be affected in the **preceding** vowel
- H79 cite lack of EMG data indicating CT activity (but cf. Löfqvist et al. 1989)

	1	2	3	4	5	6
obstruents	b_1	b	p	p_{koreon}	b^h	p^h
glides	w, y				ɦ	h, W, Y
vowels	V	V̀	V́	voiceless vowels	breathy vowels	
spread glottis	-	-	-	+	+	+
constricted glottis	-	-	-	-	-	-
stiff vocal cords	-	-	+	-	-	+
slack vocal cords	-	+	-	-	+	-

Halle & Stevens, 1971

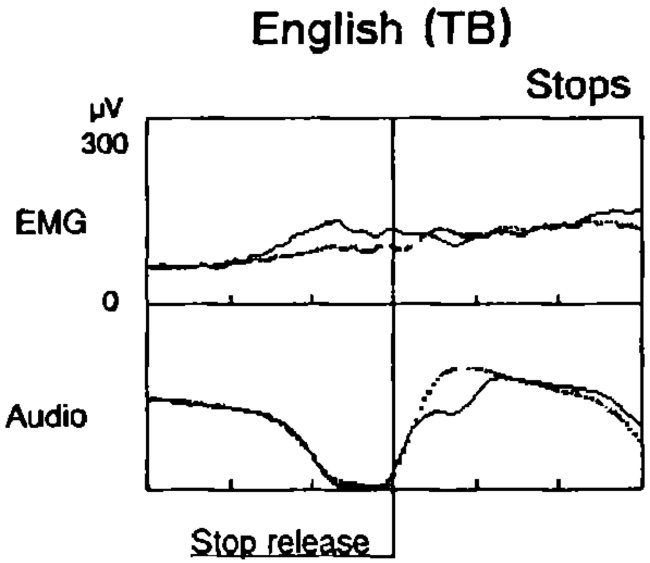
Vertical-tension hypothesis

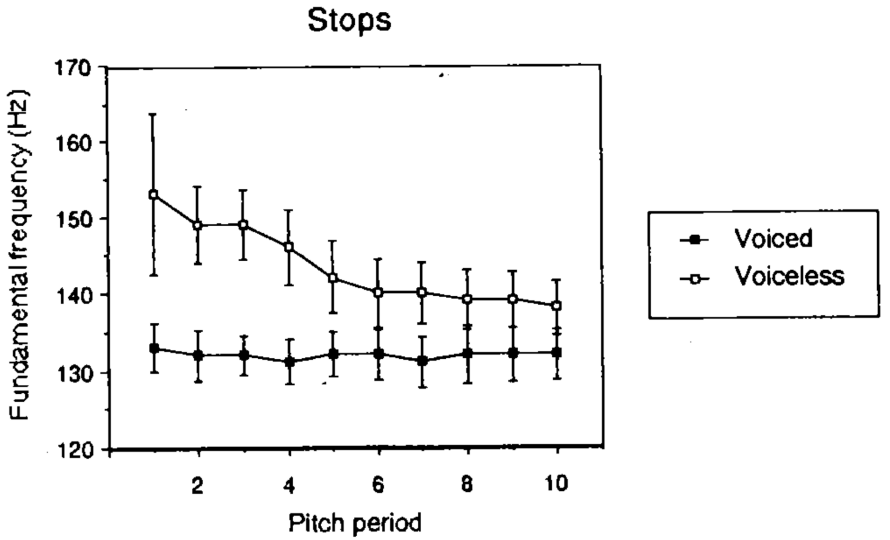
- Lower F_0 linked to larynx lowering (Honda et al. 1999)
- But: larynx lowering not consistently observed when F_0 is low



Honda et al. 1999

Horizontal tension, again



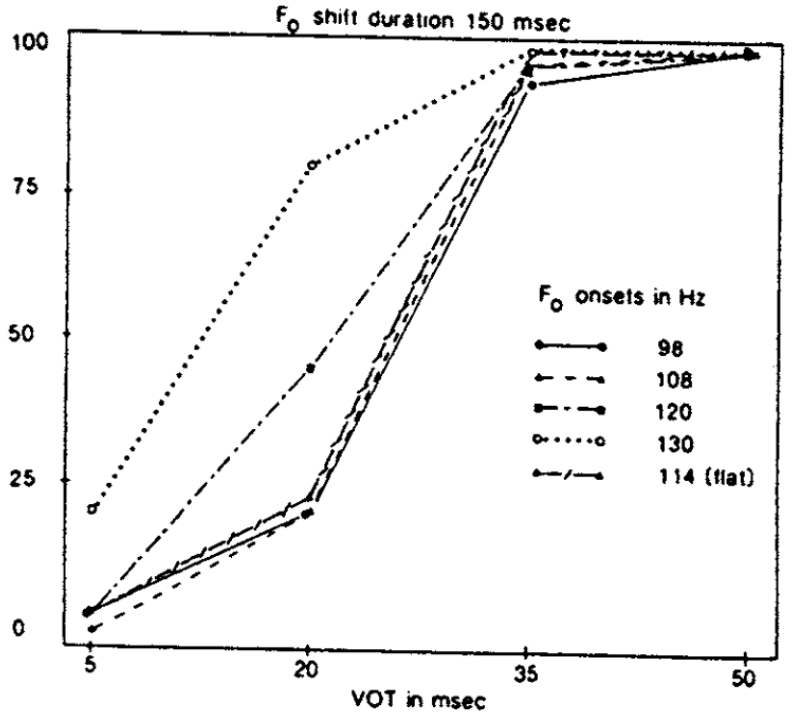


- Longitudinal tension seems to act to suppress voicing and is correlated w/raised F_0 (Löfqvist et al. 1989)
- How exactly this works is an open question (see e.g. Hoole & Honda 2011)

Perceptibility of CF_0

- Lots of evidence from (re)synthesized speech that CF_0 perturbations effect the perception of onset voicing

- H79 discuss a (slightly strange) experiment about minimal perceptible perturbations



Whalen et al., 1993

Prevocalic obstruents: summary

- General behaviour of prevocalic obstruents in tonogenesis is consistent with their perceptual salience and acoustic effects
- Jury is still out on the precise physiological details
- What governs enhancement of magnitude and temporal extent?

Voicing of postvocalic obstruents

Postvocalic obstruents

- Basically no clear cases of tone emerging from a **voicing** contrast in postvocalic obstruents (e.g. *tab, tap* > *tà, tá*)

- Postvocalic voicing can affect vowel **length** which could influence F_0 contour

Glottal codas

Tone from **codas**

No Tone Early CE	3 tones 6th CE	6 Tones 12th CE
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simplified from Haudricourt (1954)

- Final -h > **L** tones 
- Final -? > **H** tones 
- Initial p- > **H** register 
- Initial b- > **L** register 

Microprosody of (glottal) codas

> “The final fricative became a laryngeal **h** produced by an abrupt slackening of the larynx. The slackening of the vocal folds produced a drop in the pitch of the preceding vowel, i.e. a falling tone…”

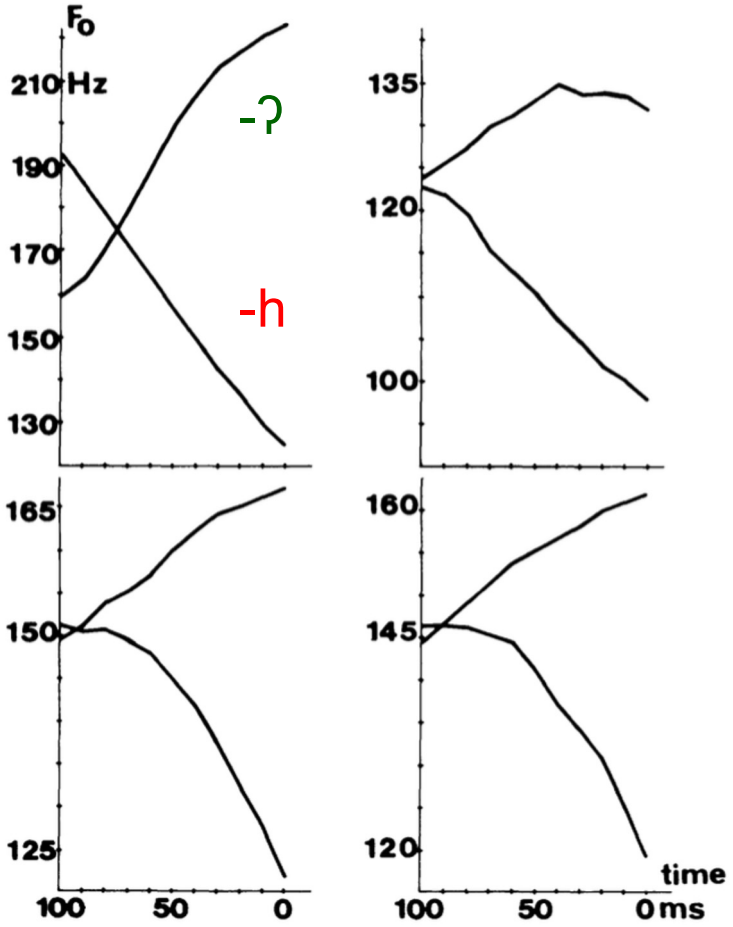
Haudricourt, 1954 (trans. Brunelle, 2018)

Microprosody of (glottal) codas

"...[a] glottal stop following a vowel is produced by an increase in vocal fold tension (the opposite of what we have seen for final **h**)...the increase in vocal fold tension in anticipation of the coda glottal stop produces a rising tone."

Haudricourt, 1954 (trans. Brunelle, 2018)

Coda microprosody in Arabic



- Final -ʔ > **F_0 rise**
- Final -h > **F_0 fall**

Hombert, 1976

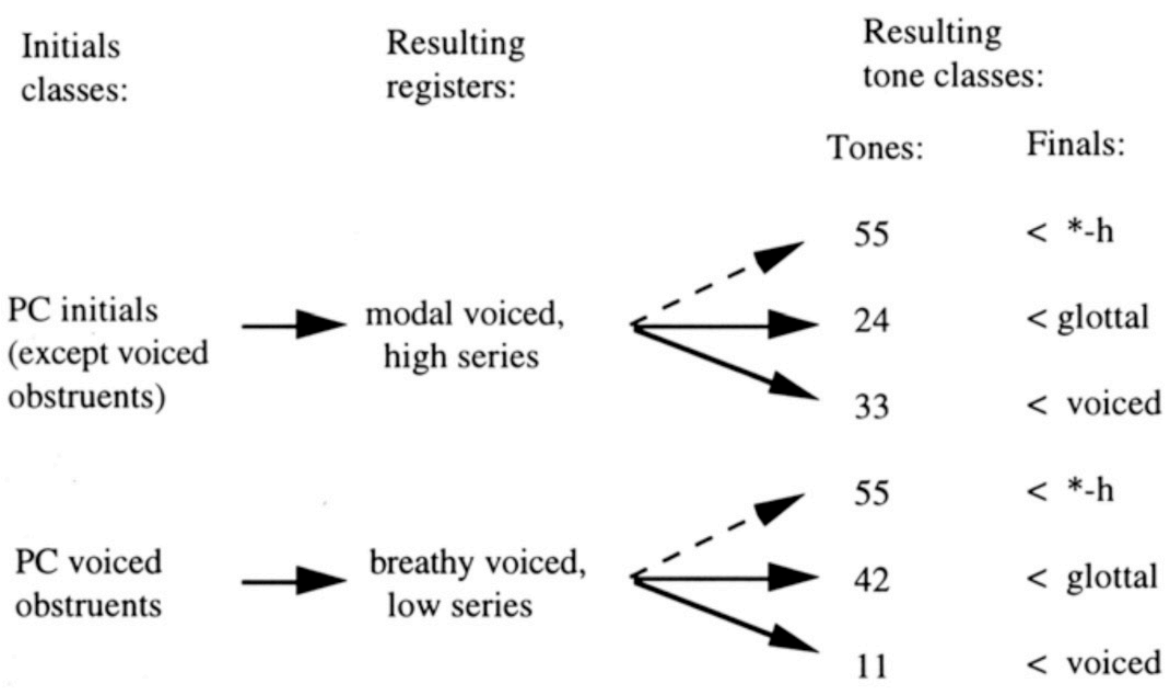
Unlike onset effects, direction not cross-linguistically robust

	/-ʔ/	/-h/
Arabic	Rising F_0	Falling F_0
Lhasa Tibetan	Falling F_0	
Itunoyso Trique		Falling F_0
Tsat, Rục, Punjabi	(variable)	High F_0

Bhatia 1975, Hombert 1976, Thurgood 1996, Hu & Xiong 2010, DiCanio 2012, Tạ 2023

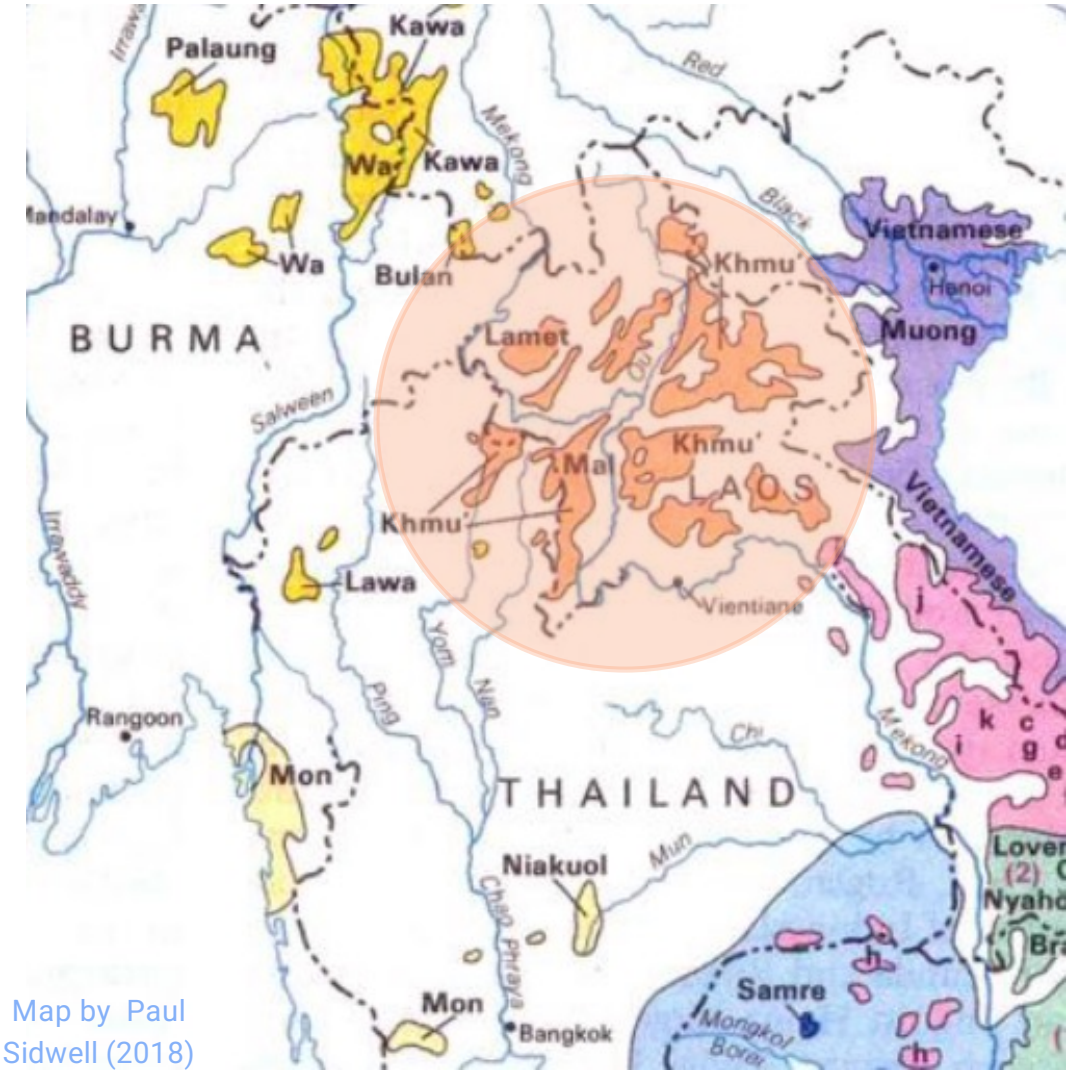
When codas don't behave as expected: Tsat (Chamic)

Figure 18: Tsat tonogenesis in monosyllables



- -h results in a high-**rising** tone, regardless of the initial
- The glottal stop yields a rising tone in the low register, but a **falling** tone in the low register

Thurgood, 1999



Map by Paul Sidwell (2018)

Eastern Khmu

- Austroasiatic language of Laos, Thailand, Vietnam
- ~ 800,000 speakers; stable
- Highly conservative syllable inventory

Kirby et al. 2024

Eastern Khmu

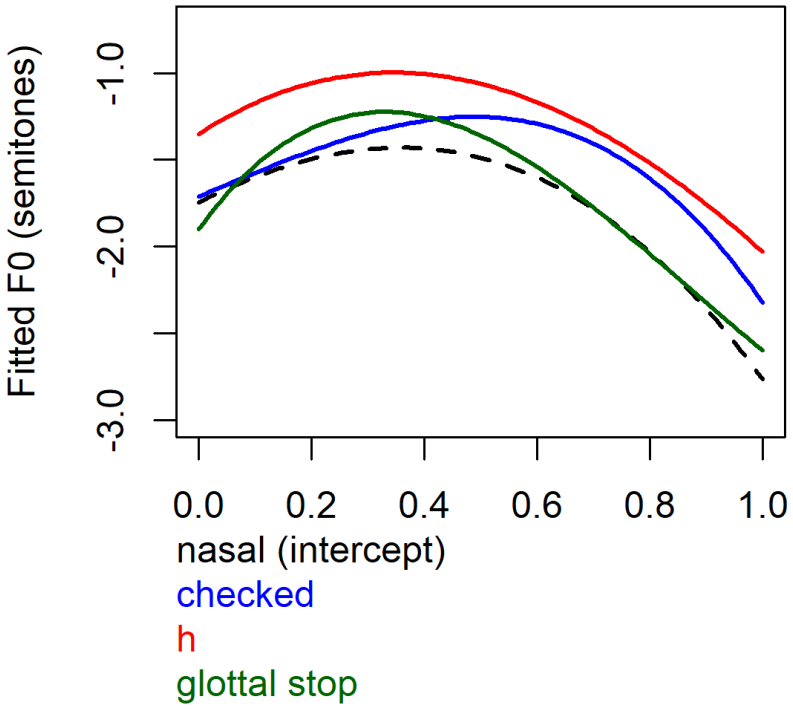
EK retains a **voicing contrast in onsets** as well as **5-way contrast in coda type,** similar to pre-tonal Vietnamese

	open	**sonorant**	**checked**	**-h**	**-ʔ**
voiced	buː	buː**m**	buːc	buh	buʔ
voiceless	puː	puː**n**	puːt	pɔh	puʔ

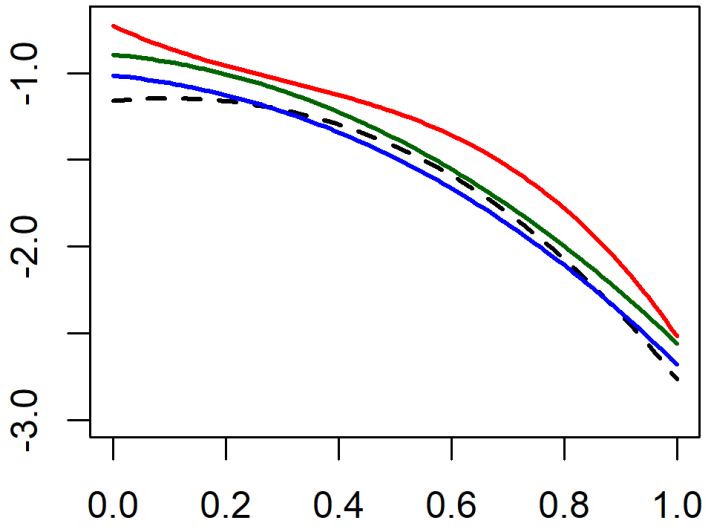
Kirby et al. 2024

Both /-h/ and /-ʔ/ **raise** F_0 throughout the trajectory

Voiced onset



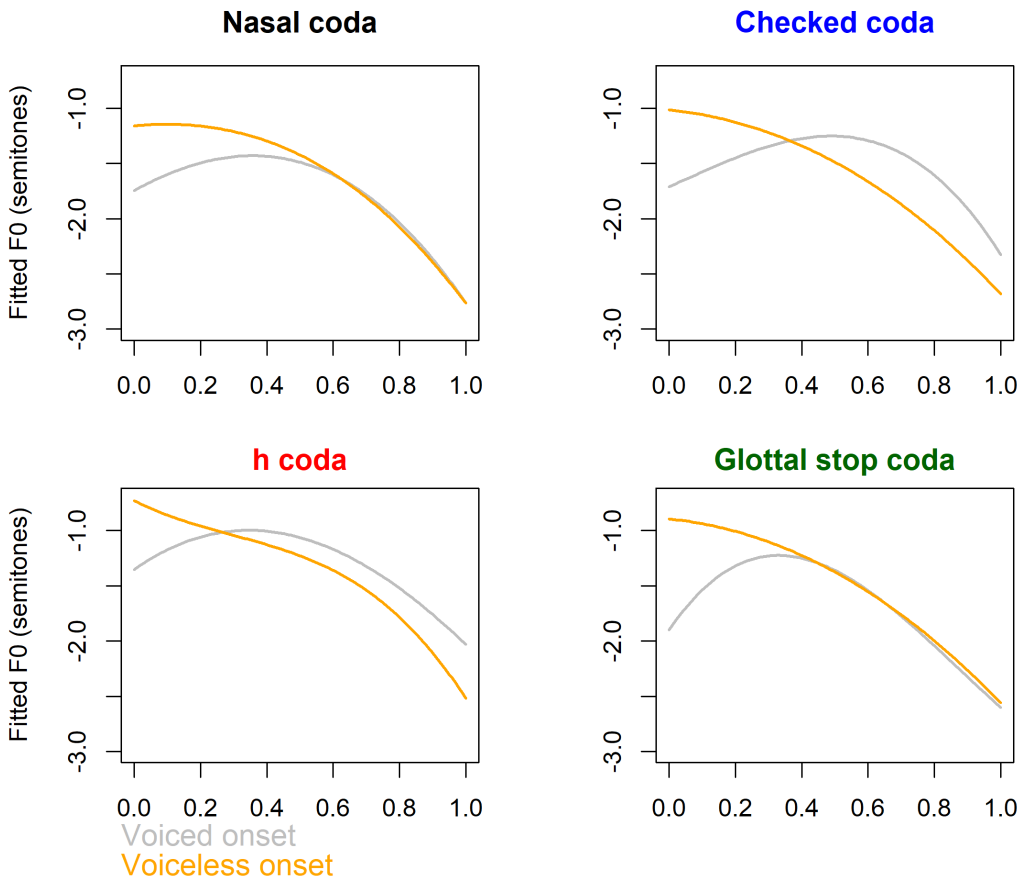
Voiceless onset



Effect is **smaller** after **voiceless onsets**

Kirby et al. 2024

Effect of onsets is temporally limited



Effect of **voiceless** onsets most prominent **early** in trajectory

Effect of **checked codas** most pronounced when onset is **voiced**

Kirby et al. 2024

Eastern Khmu: Summary

1. In Eastern Khmu, **both** /-h/ and /-ʔ/ **raise** F_0 at vowel **onset**

   *(/-h/ has **opposite** effect as predicted by Haudricourt)*

2. Effects most prominent after **voiced** onsets

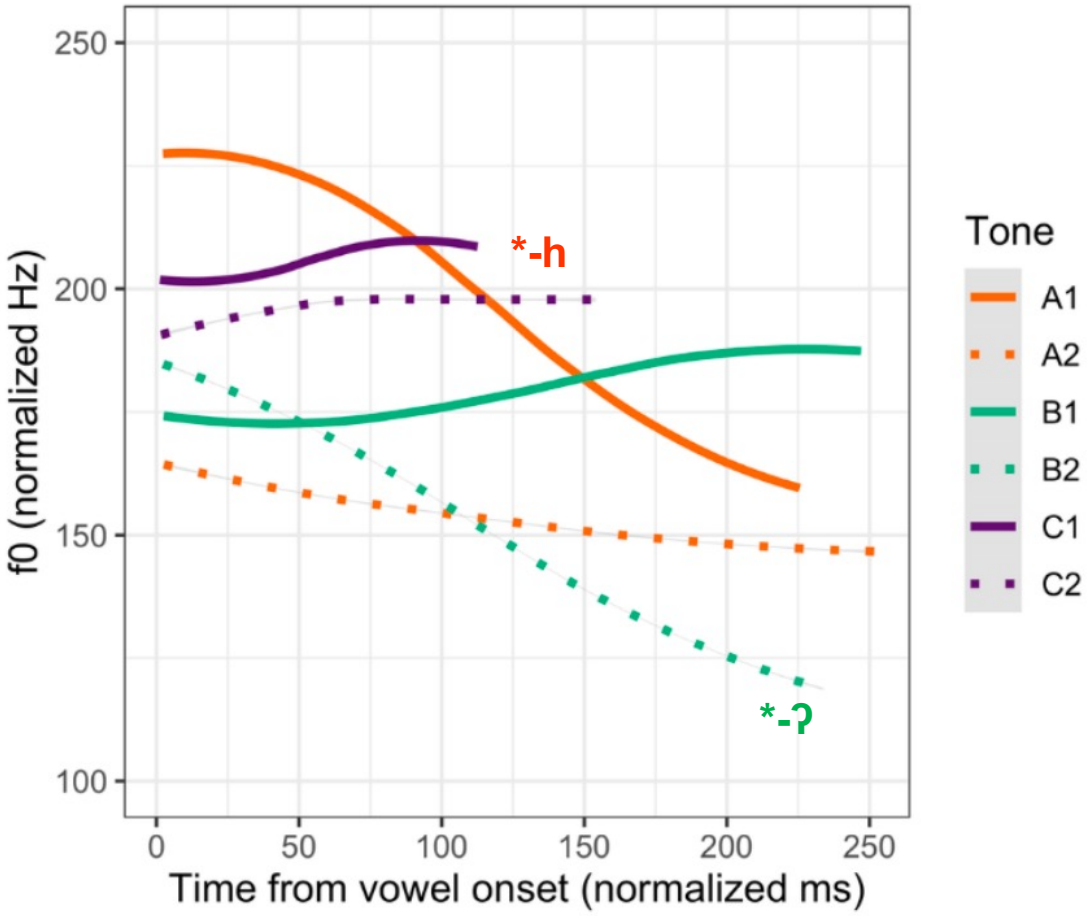
   (effect of coda is modulated by the onset)

Kirby et al. 2024

It’s not just Khmu

- In Rục (Vietic), -h conditions a high pitch on the preceding vowel, while -ʔ is preceded by a mid-rising contour in the high register and a low-rising contour in the low register.

- Similar effects are observed in other Vietic languages



Tạ, 2023; Brunelle & Kirby, in press

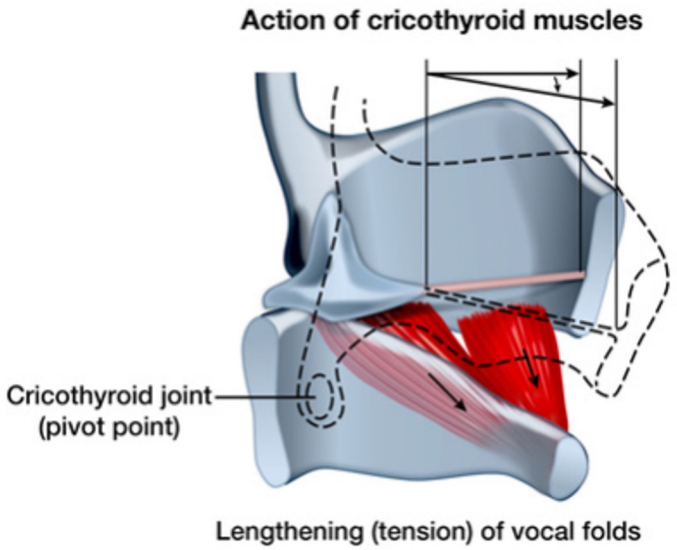
Sources of variability

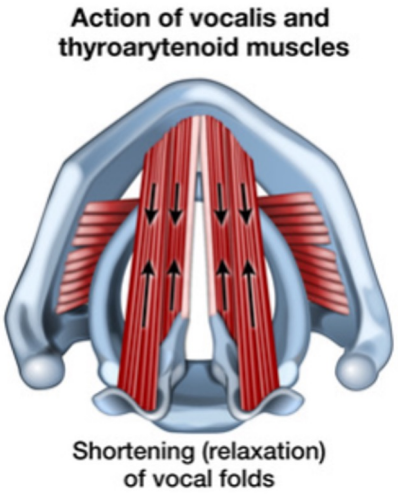
- Effect on pitch (raising vs. lowering) may depend on the details of how the glottal stop is articulated
  - A clear and sharp glottal stop is often preceded by a stiffening of the vocal folds, resulting in an F_0 **rise**
  - A sluggish creakiness seems to hinder regular vocal fold vibrations, resulting in an F_0 **drop**

Kingston, 2005

Sources of variability

- The *cricothyroid* (the ‘stretching muscle’ and the *thyroarytenoid* (the ‘heavy muscle’) are **antagonistic**
- However, they are separately **innervated**, meaning they can be controlled separately
- Thus the vocal folds can be adducted by activating either, with different effects on pitch.





Implications

- Both magnitude and temporal extent of codas effects seem sufficient to serve as phonetic precursors for tonogenesis.
- **But**: direction of coda effects are not universally predictable and may be **modulated** by onset voicing
- Haudricourt's model probably too restrictive: onsets can 'go first', and/or processes may be interleaved (cf. Gerhman, 2022; Tạ, 2023)

Tone from other sources

Vowel-intrinsic F_0 (IF_0)

		i	*ɛ*	*æ*	*a*	*ɔ*	*u*
Peterson & Barney 1952	men	136	130	127	124	129	141
	women	235	223	210	212	216	231
	children	272	260	251	256	263	274
Lehiste & Peterson 1961	(1)	129	127	125	120	116	134
	(2)	183	166	162	163	165	182
House & Fairbanks 1953		127.9		119.8	118		129.9
Mohr 1971		128.8			124.2		129.9

Hombert et al., 1979; Whalen & Leavitt, 1995; Ting et al., in press

Tone from vowel height

- Magnitude and temporal extent of vocalic IF_0 about the same as for post-consonantal CF_0
- So why do we hardly ever see vowel height differences becoming tones?
- Hombert (1977): **perceived** difference in pitch between high and low vowels smaller than acoustic F_0 difference would suggest

Summary

Summary

- H79 largely validates the phonetic basis for Haudricourt's model
- But: phonetic reality doesn't always line up neatly with historical record
- Lots of work still to be done!

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