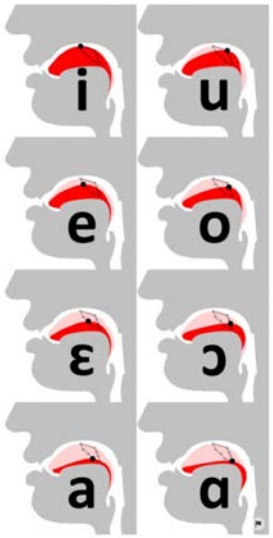


24.901/931, 2026
Introduction to Phonology

Lecture 6

This week and next

- **Problem set** 2 due at the end of this week, no later than 2-28.
- Read: *Hayes 2009 chapter 15 on tone

  Goldsmith 1975 Tone Melodies

  Leben 2019 Auto-segmental Phonology

- Next week: Quiz 1 on Thursday.

  10-15 mins, small problem, open book.

Midterm date moved

- Currently scheduled for Tuesday March 31, after spring break.
- We moved it to Thursday April 2.

Today: assimilation and length; then tone

Dissimilation review

- Sequences of similar sounds are dispreferred
- The more similar, the greater the dispreferrence:

  Latin: l…l r…r, changed; while l…r, l…n ok

  Arabic: t…d avoided; t…s also avoided, but less so

  ([±strident] count more than [±voice])
- The closer the similar sounds to each other, the more dispreferred.

  Latin: *f**l**o**r**a**r** worse than f**l**o**r**a**l**

  Arabic: ***b**V**p**Vk worse than **b**VkV**p**
- Phonological processes eliminate some of these dispreferred seq's

Obligatory Contour Principle (OCP)

- OCP: identical values for certain Fs are dispreferred in the same domain (same word, same morpheme).

  As a function of their degree of similarity and closeness
- Prediction: if a system prohibits a sequence of similar sounds, it will also prohibit a sequence of even more similar ones, all else being equal.
- E.g. if dʒ ..s is avoided, then tʃ…s, dʒ…z, and also z…z are avoided too.
- All this seems true.
- Except in one class of cases.

Recall the Sudanese possessed nouns

kitaab ‘book’	bit ‘daughter’	samak ‘fish’
kitaaf Faṫi	bit Faṫi	samak Faṫi
kitaap Samir	bis Samir	samak Samir
kitaap ʃariif	biʃ ʃariif	samak ʃariif
kitaap Xaalid	bit Xaalid	samax Xaalid
kitaap ħasan	bit ħasan	samak ħasan

A similarity-conditioned rule

bi**t** **F**aʈhi sama**k** **ʃ**ariif kitaa**p** **ʃ**ariif	Distinct active artic	bi**t** **s**amir →bis samir sama**k** **X**aalid→samax xaalid Kitaa**b** **F**aʈhi→ kitaaf Faʈhi	Same active artic

$C_{[\alpha \text{ articulator}]} \rightarrow C^{i} / \_\_ C^{i}_{[\alpha \text{ articulator}]}$

Was the sequence of similar Cs in UR replaced by a **less** similar sequence?

Length and its representation

Vs and Cs can contrast in length

- English Vs ([-low] is [αlong] iff [αtense])

  bin [bɪn] vs. *bean* [bi:n]

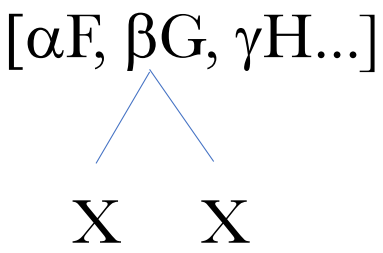
- Italian V's and Cs

  Vito (name) ['vi:to] vs. *vitto* 'food' ['vit:o]

- Latin, Greek, Sanskrit, Finnish, Swedish, Norwegian, Kannada, Tamil, …

Xs and the representation of length

- Segment duration represented by units of standardized duration:
  one **X** for every segment, or more than one X.
- Actual ms. duration of segments varies with features and context.
  But most stable contributor to duration diff's is number of Xs
- Long segments carry 2 Xs; rarely 3 (Estonian Vs, Cs; Mixe, Yavapai Vs).



One bundle of features: whole segment or part of it

association lines: indicate which Fs overlap in time with which X

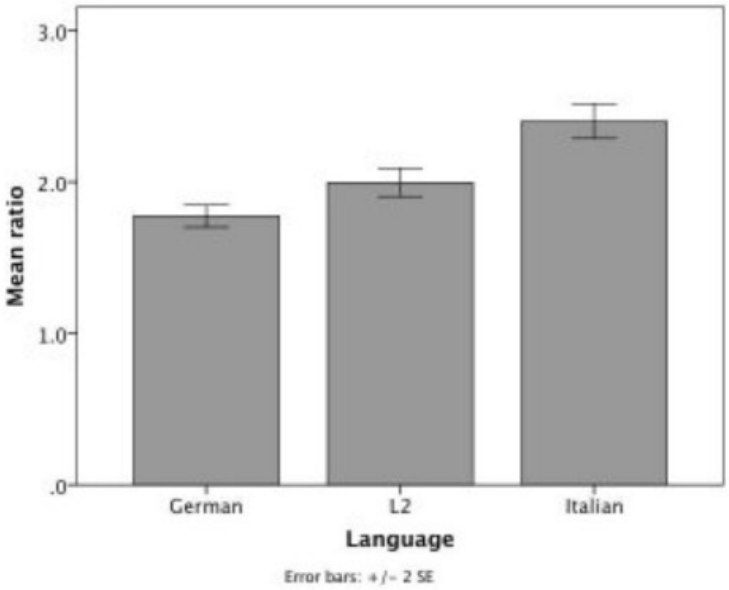
units of length: 1 for short, more for long

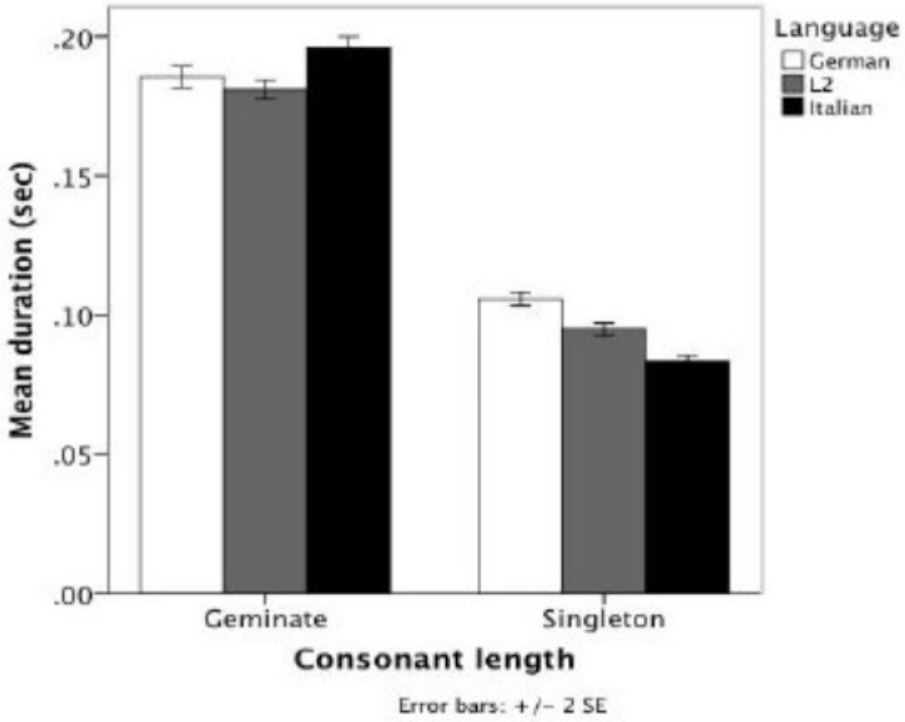
Segment	Unstressed/ Stressed	Stressed/ Unstressed	Differ- ence	Percent
/s/	149	112	37	33
/f/	126	101	26	25
/t/$_{burst}$	71	9	62	716
/p/$_{burst}$	61	18	43	238
/d/$_{burst}$	12	7	5	67
/b/$_{burst}$	9	8	1	12
/t/$_{closure}$	75	20	55	274
/p/$_{closure}$	90	68	22	33
/n/	63	39	24	62
/m/	75	62	14	22

Van Santen 1993, English data

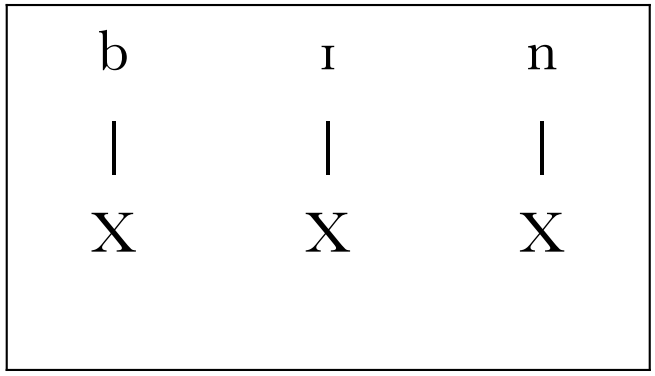
Table 1: Durations (in ms) of intervocalic consonants in two stress conditions: *unstressed/stressed* and *stressed/unstressed*.

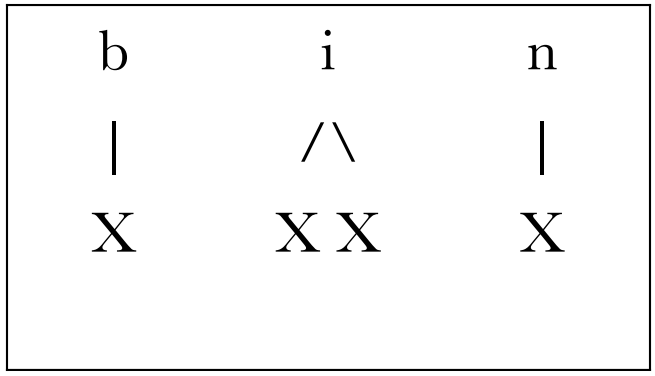
Durations of singleton and geminate p, t, k
in Italian, German + L2 Italian Kabak and Braun 2011





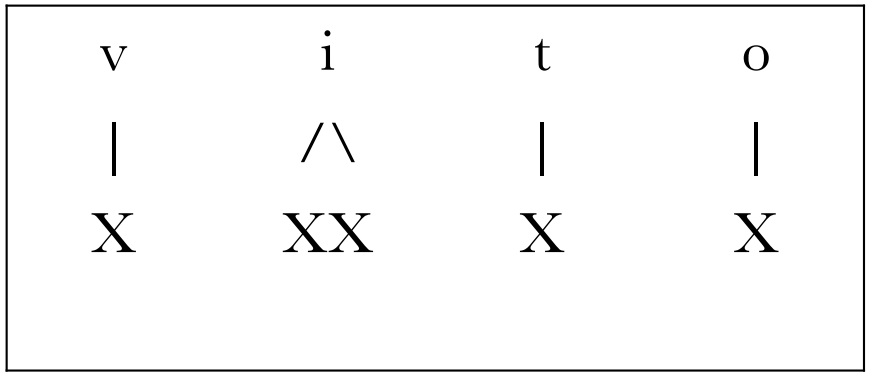
bin [bɪn] vs. *bean* [bi:n]

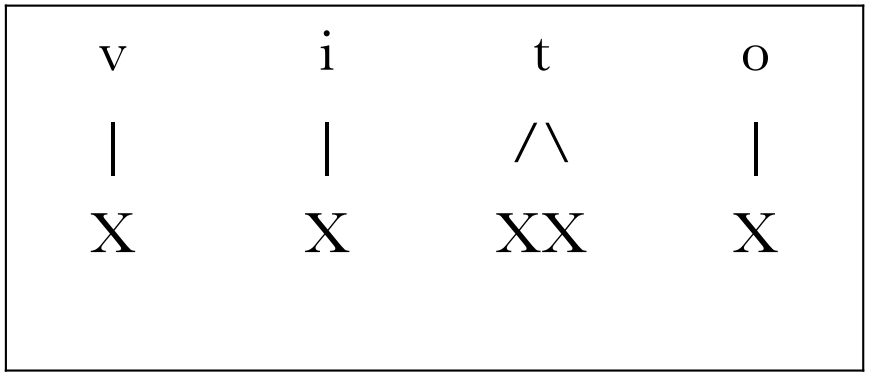




IPA symbols abbreviate bundles of features; each such bundle linked to at least 1 X

Italian *Vito* [vi:to] (name) vs. *vitto* [vitto] 'food'





Geminate means traditionally a long C.
By extension, among phonologists, any long segment is a geminate.

Work that led to this representation: McCarthy 1979 MIT diss, Marantz 1981 LI, Blevins 1985 MIT diss, others. The X notation is due to Blevins.

2 properties of geminates

- Each geminate, or [+long] segment, contains 2^{+} Xs + 1 feature bundle.
- Diagnostic for long segments vs. 2 identical copies:

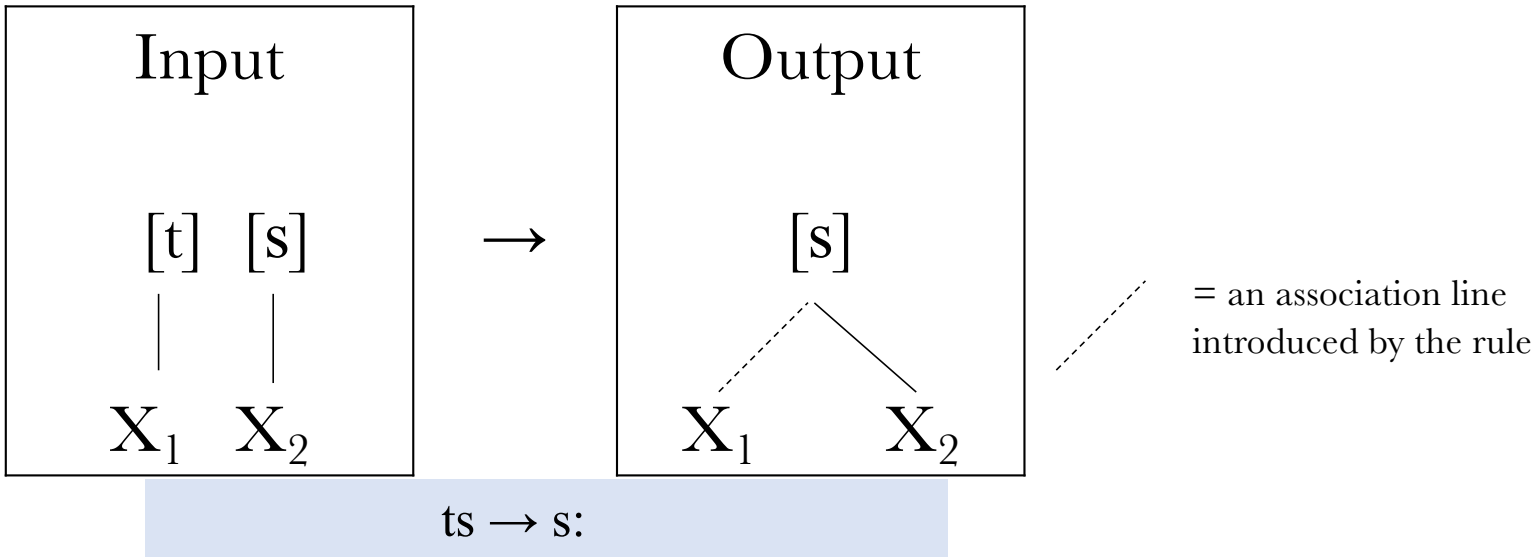
  long segments are uninterrupted.

  e.g. no stop release after the first half of a C:.

  cf. Arabic *kattab*, [kat:ab] vs. [*katbab*] w. released [t^{-}]

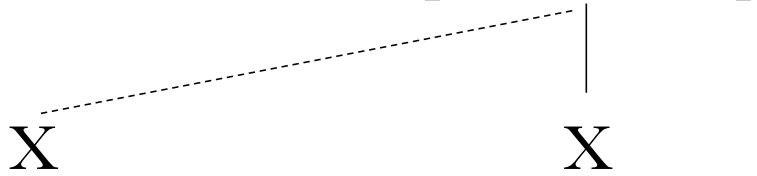
The X-solution to OCP problems

‘Copy’ rules *spread* a feature bundle to a different X



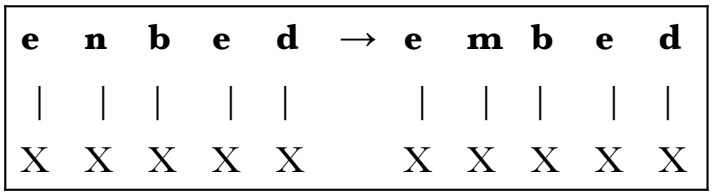
Like dissimilation, this rule eliminates a sequence of similar segments. It solves the OCP problem of the input: [+cor][+cor]→[+cor]:

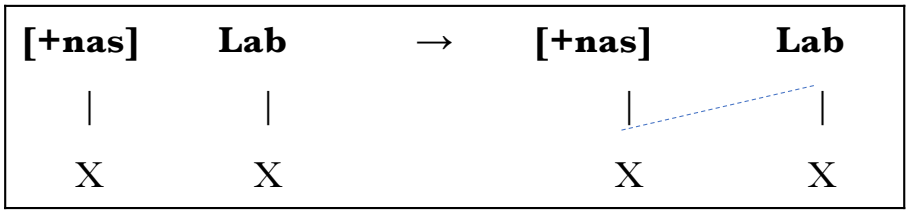
Derivation of t s→s: in /bit Samir/ → [bis:amir]

Input	
OCP effect Eliminate 1st C in sequence of similar Cs.	
Spread all features of remaining C to empty X	

Upshot: total assimilation rules *don't copy*

Extension: partial assimilation rules don't copy either.





More on length and geminates

Geminates and units of rhythm: Xs and Moras

- Long Cs/Vs have an extra unit of rhythm, in meter/song/stress.
- Haikus: Japanese poems of alternating lines of 5-7-5 units or 6-7-5

fu-ru-i-ke ya (5)	nu-su-**t-t**o ni (5) **[t:]**	fu-ji no ka-ze ya (6)
ka-wa-zu to-bi-ko-mu (7)	to-ri-no-ko-sa-re-shi(7)	**o-o**-gi ni no-se-te (7) **[o:]**
mi-zu-no o-to (5)	ma-do no tsu-ki (5)	e-do mi-ya-ge (5)

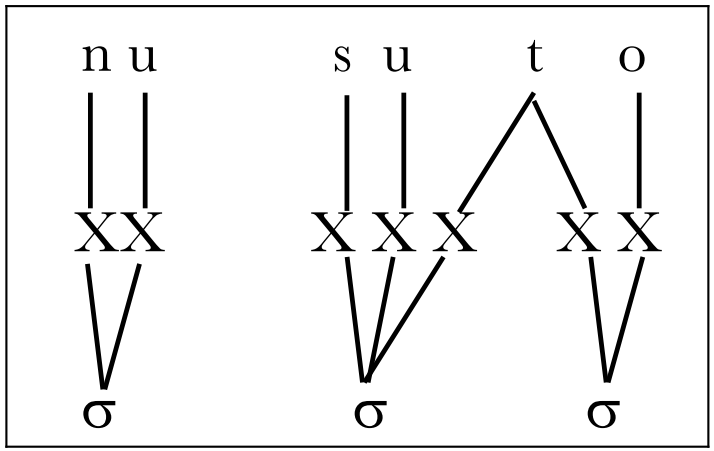
The units counted are called *moras*, abbrev. μ: 1μ or 2μ at most per syllable.
They relate to Xs: any geminate (2X) means an extra μ relative to the short sound.

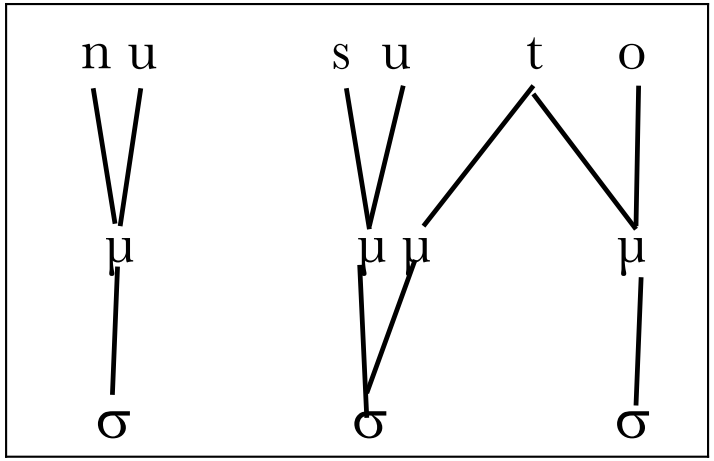
More at https://www.gendaihaiku.com/research/metrics/haikumet.html; https://en.wikipedia.org/wiki/Haiku

- Comparable patterns in all languages with *quantitative rhythm*:
  meter or stress is based on alternating long/short syllables: 1 vs. 2 μ (≈ X).
- Geminates always create long syllables: they add an extra unit of rhythm.

Moras (μ) vs. Xs

- Moras ≈ Xs: both contribute to the number of rhythmic beats
- Difference: at most 2 μ per syllable; but as many Xs as there are segments in the syllable, or more, if some segments are long.





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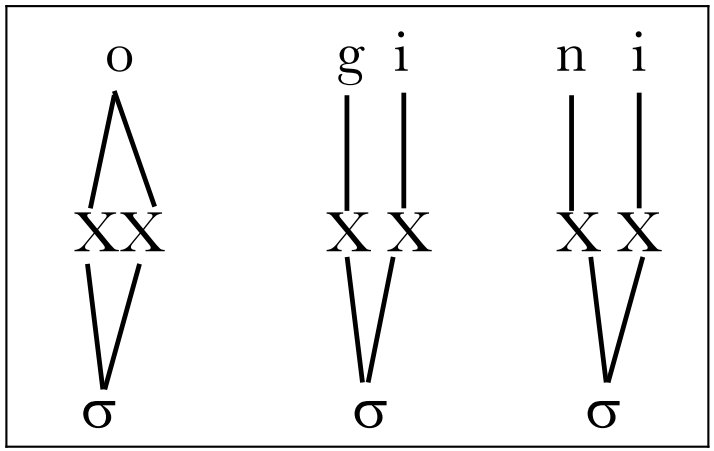

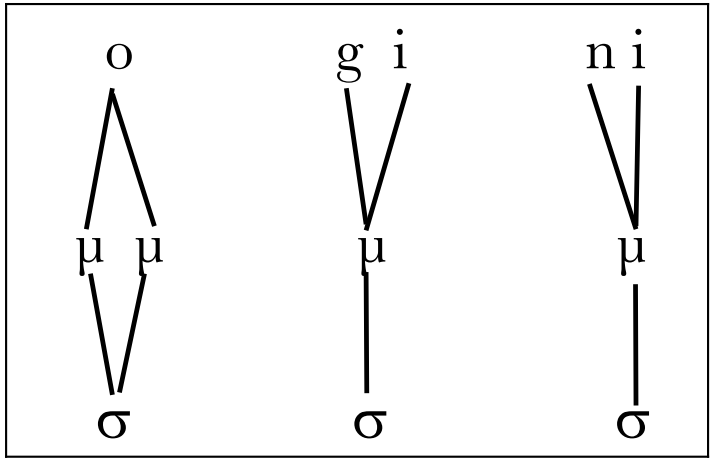

What the haikus show

- Japanese poets rely on the knowledge that every geminate C or V contains an extra countable unit compared to short Cs/Vs
- This counting fact suggests that the feature [±long] is insufficient to distinguish long from short Vs and Cs.

  No feature other than [+long] alters rhythmic count by adding a unit.
- By contrast, if geminates consist of an extra X (or extra μ), that fits the counting evidence.
- Then [+long] is just a reference to number of Xs/segment

Geminates: one segment, not 2 identical ones

- Long Vs in languages with diphthongs (Japanese, A. Greek, Latin)
- Basic vowel qualities {a, e, i, o, u} (/u/ = [y] in Greek, [ɯ] in Japanese)
- Diphthongs = 2Vs in the same syllable ([oɪ], [eɪ], [aʊ] as in *boy, bay, bow*)
- Diphthong constraint: V_1 must be [-high], V_2 must be [+high]
- So: *ua, *iu, *ui, *io, *ea, *oe
- Long Vs in the same languages: {a:, e:, i:, o:, u:}.
- If long Vs are distinct V_1V_2, i.e. [e:] = [ee], [i:] = [ii]...
- Then all 3 languages deviate identically from diphthong rule in ee, ii, aa...

  V_1 must be [-high], V_2 must be [+high], **except if V_1=V_2**

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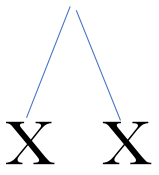
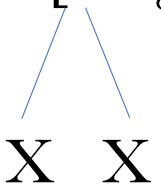
  V_1 must be [-high], V_2 must be [+high], **except if V_1=V_2**
- Alternatively, [e:] = [–high, -back] [i:] = [+high, -back]





Geminates: one segment, not 2 identical ones

- Geminate C:'s in Italian, Japanese
- All these languages allow [p:], [t:], [k:] [s:]
- Neither allows distinct stop-stop or distinct obstruent sequences
- *pt, *kp, *tk, *ps, *fk, *tf and *sp, *st, *sk (Japanese only), ...
- *$C_{[-sonorant]}$ $C_{[-sonorant]}$ or more general version
- But if [p:] = [pp], etc. then geminates are exceptions to this constraint
- No exceptions if [p:] = 2X one [p].

Back to Berber prefixes

reflexive				agentive			
m-xazar	scowl	n-fara	disentangle	am-las	shear	an-ɾˁmi	tire
m-saggal	look	n-ħaʃʃam	be shy	am-kɻz	plow	an-bur	celibate
m-ʃˁawar	ask	n-xalaf	place	am-agur	remain	an-ɖˁfur	follow
mmɻ-ʒla	lose	n-kaddab	liar	am-zug	hide	an-zˁum	fast
		n-fasˁal	arrange			an-dˁalab	beg
		n-bˁdan	separate			an-ɾzif	invite

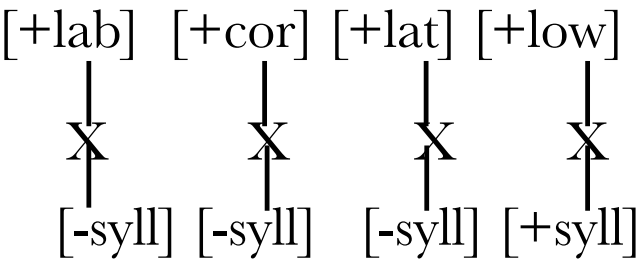
Why **mmɻ**? Why in just this form? Why lengthened and half-syllabic?

Reasoning about this

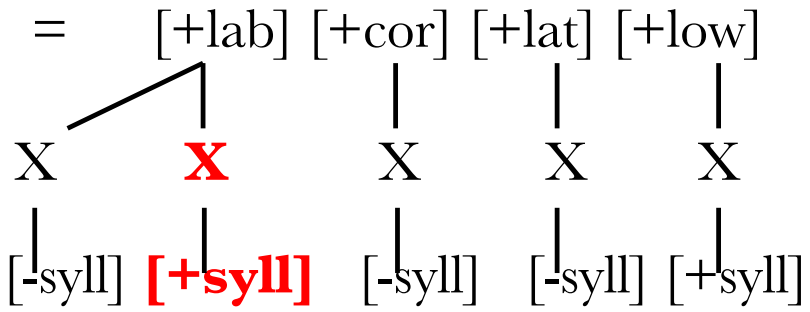
- CC clusters are ok in Berber but CCC clusters are not allowed
- m-ʒla is a potential CCC cluster
- To fix it, we need a vowel, or vowel-like thing to break the CCC cluster
- Any C can be syllabic in Berber
- So, m̩ʒla or mʒla or mʒl̩a (l̩) would be better. But it's none of them.
- *mʒla : sequences of VV or VC̩ or C̩V *(hiatus)* are avoided
- mʒla is worse than m̩ʒla: syllabic sonorants better than syllabic obstruents. Even in languages that tolerate both.
- But why mm̩ʒla? All syllables in Berber begin with a [-syllabic] sound.

Representing this with Xs and [±syllabic]

- UR m ʒ l a =



- SR mm̩ ʒ l a =



Compensatory Lengthening

UR X's can be preserved independently
of the segments that used to occupy them

Lithuanian prefixes, again

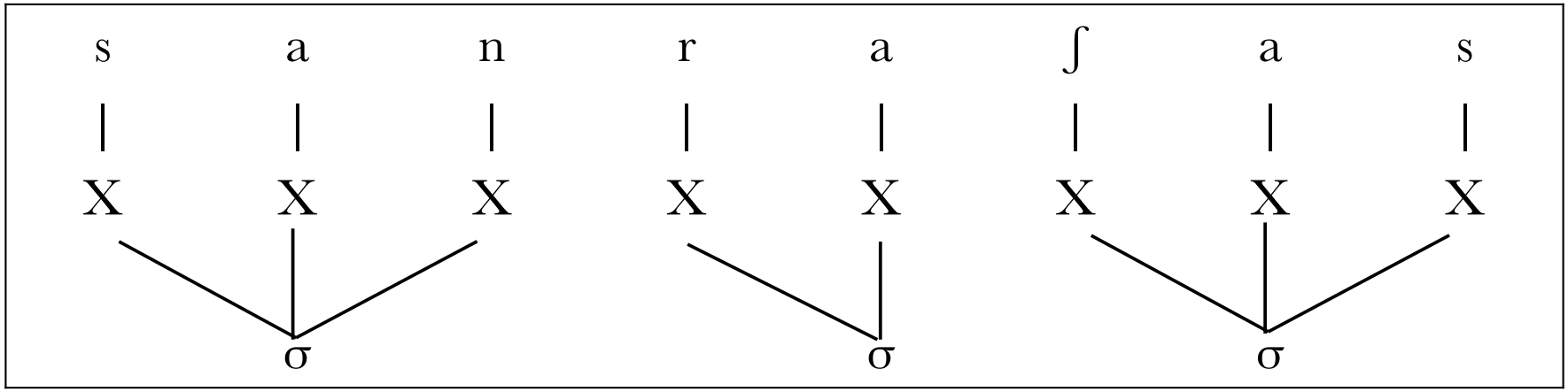
ienas	shaft	san-ienas	(?)
burɨs	‘crowd’	sam-burɨs	‘assembly’
pilnas	‘full’	sam-pilas	nasal surfaces in some form
dora	‘covenant’	san-dora	
kaba	‘hook’	saŋ-kaba	‘connection’
vok-ti	‘to understand’	sa:-voka	‘idea’
skamb-e-ti	‘to ring’	sa:-skambis	‘harmony’
juŋga-s	‘yoke’	sa:-juŋga	nasal does not surface
ʒino-ti	‘to know’	sa:-ʒine:	
raʃɨ-ti	‘to write’	sa:-raʃas	‘list, register’

Rule: [+nasal]→Ø/_[-syll, +cont]

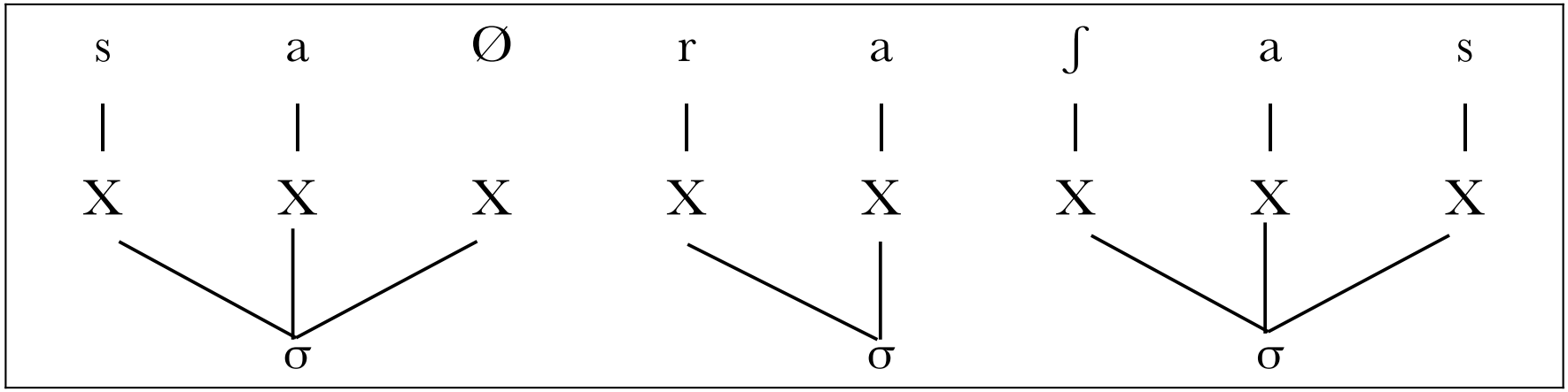
san-ienas	[+syll, +cont]
sam-buris	
sam-pilas	[-syll, -cont]
san-dora	
saŋ-kaba	
sa:-voka	
sa:-skambis	
sa:-juŋga	[-syll, +cont]
sa:-ʒine:	
sa:-raʃas	

Why does the vowel lengthen when the nasal disappears?

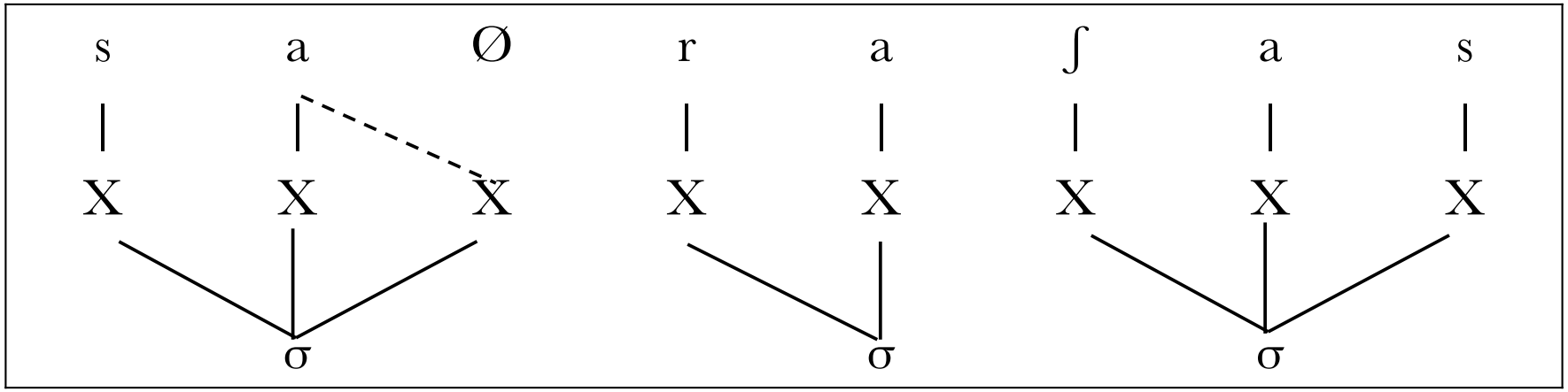
UR



[+nasal]→Ø/_[+continuant, -syllabic]



Compensatory Lengthening



Tone

- Tonal features
- Associations between tones and X
- Mutual independence of tones, Xs and other Fs

Tonal features

- Pitch (F0): frequency of vocal chord vibrations, in Hz: periods/second
- *Tonal* features identify regions in the pitch range (not absolute Hz values)

  e.g.: High (H); Mid (M); Low (L)

  or: High (H); Low (L)
- Tones are used in most languages as *intonation*: tonal morphemes providing information on speaker attitude about their utterance.
- Used in tone languages to differentiate Vs, or V-like units, or morphemes
- A tone = one such feature value. Always realized on some V-like bearer: a V, a syllabic sonorant, a sonorant after a V.

The focus now: independence between tones and their bearers

Hayes's 2009 tone features and others'

	H	M	L
hipitch	+	-	-
lopitch	-	-	+

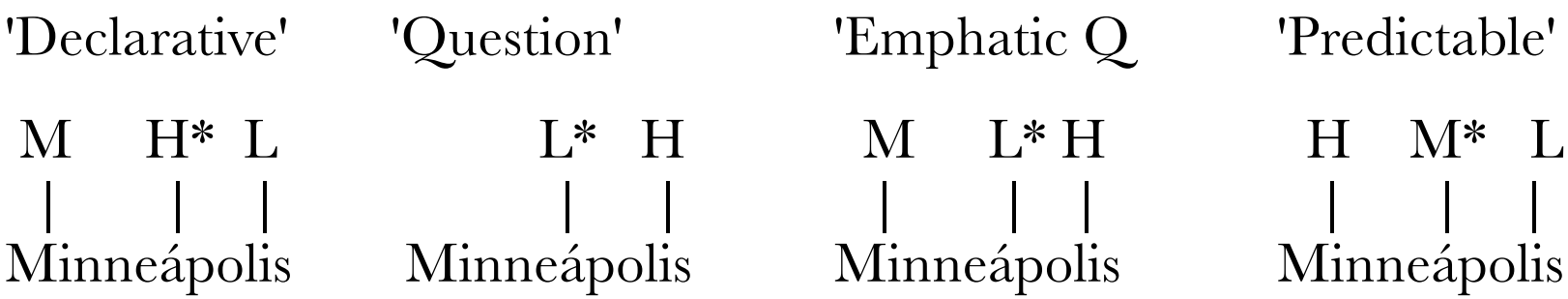
	H	M1	M2	L
High register	+	+	-	-
Low register	-	-	+	+
higher	+	-	+	-
lower	-	+	-	+

Intonational tunes

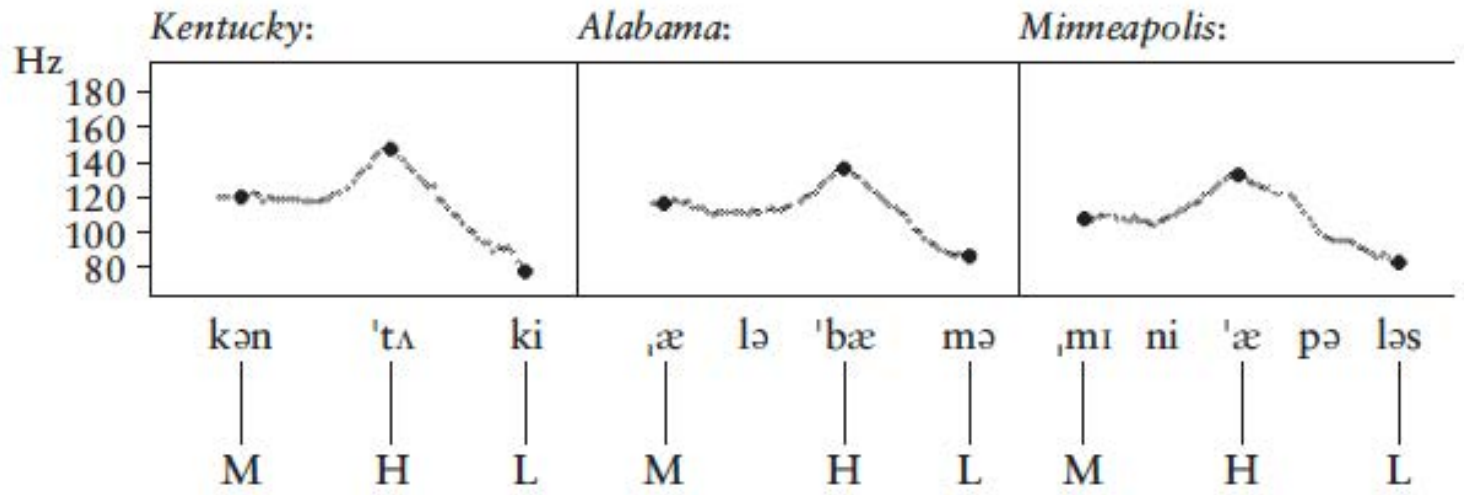
'Declarative'	'Question'	'Emphatic Q'	'Predictable'
M H* L	L* H	M L* H	H M*L
| | |	| |	| | |	| | |
Alabáma	Alabáma	Alabáma	Alabáma
Answer to, e.g. 'where do you live?'	Is it X?	Is it *really* X?	X, as expected.

Tones marked T* are *nuclear* (as in *nuclear stress*, main stress of utterance): they must be realized on the main stressed vowel

Same tunes different stress

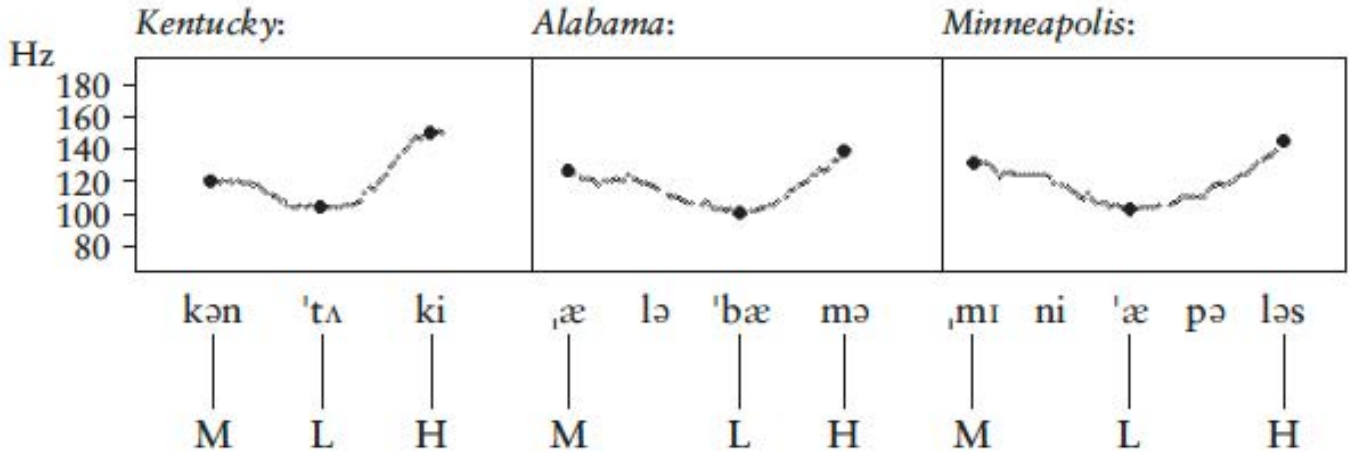


Pitch tracks (F0 trajectories): declarative tune, as in answer to a Q 'where?'



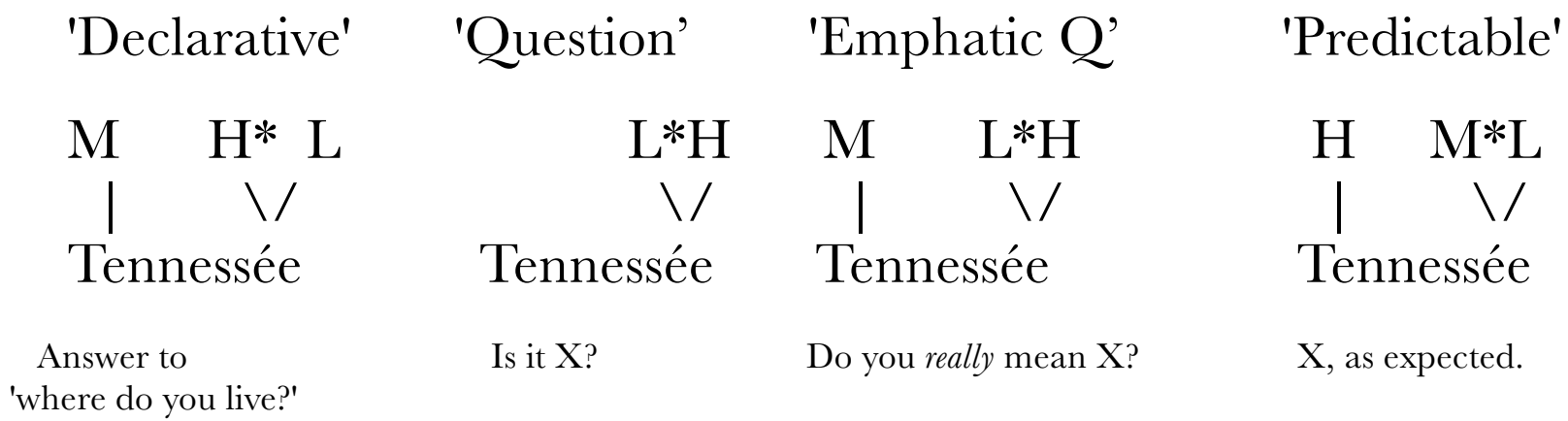
Hayes 2009:296

Pitch tracks: as in an emphatic question



Hayes 2009:297

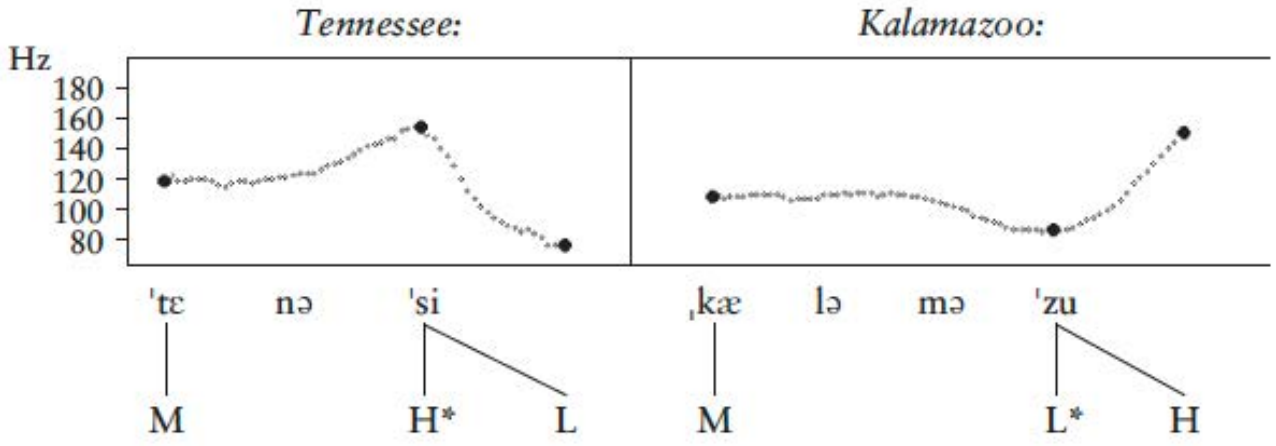
Tones can create *contours*: 2Tones on 1Vowel



Contrast *contours* with *level* tones: the V has a single tone, roughly constant F0

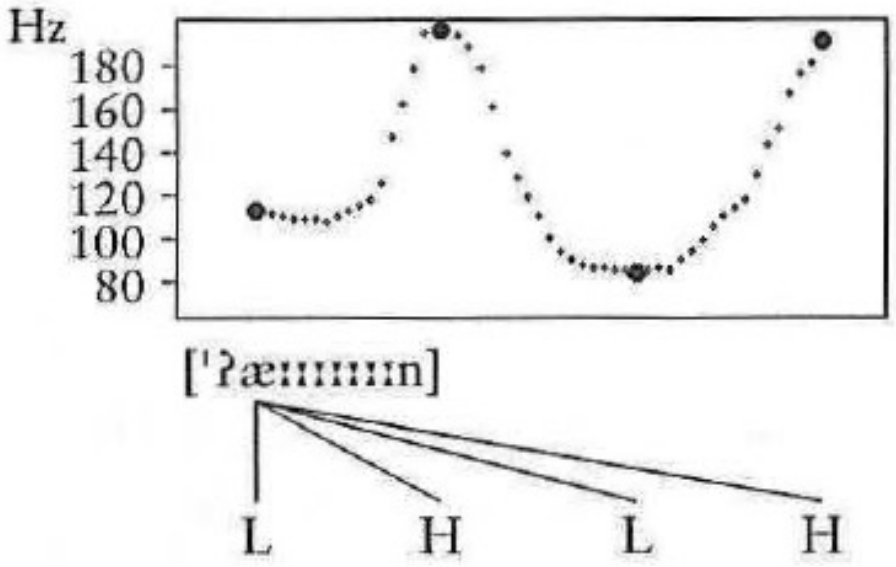
Terms: *Rising* (LH), *Falling* (HL), *Rising-Falling* (LHL), *Falling-Rising* (HLH)

Pitch tracks:
contours in declarative and question intonation



Hayes 2009: 301

Even on very short syllables



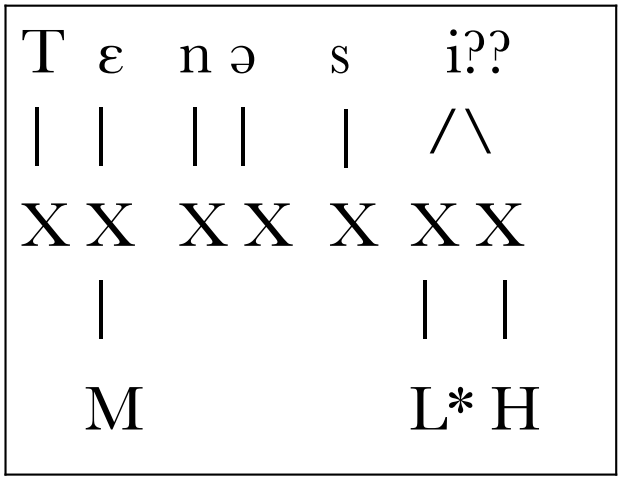
A four-tone contour on "Anne!!"

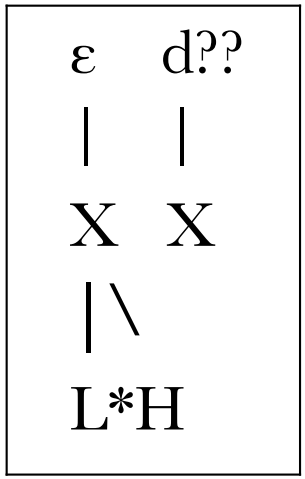
'Predictable'

HM*L
\ | /
Ed

Ed, as expected.

Tones link to the Xs of vowels





But how do we know that Ts don't link *to the V?*

In some lgs, a syllable can carry only *as many Ts as it has Xs linked to Vs*.
A long V or diphthong has 2 X (μ)s. Each X can carry 1T.
So, short Vs can carry only 1T, V:'s and dipthongs can carry a contour, 2Ts

A. Greek vowels and their tones

VV(C):	LH	Zdeús 'Zeus' Ζεύς
	HL	Zdéu 'Zeus!' Ζεῦ
	HL	bó:s 'ox'
	LH	pó:s 'foot'
	L	Oidípo:s 'Oedipus'
V(C):	H	strabós 'squinting' στραβός
	L	blábos 'harm' βλάβος
	no HL, LH here	

*[+syll]	✓[+syll]
|	/\
X	X X
/\	| |
T_1 T_2	T_1 T_2