1. general features

- richer inventory of levels and shapes
- Chao notation: 5 denotes top of pitch space and 1 the bottom
- impoverished morphology; but tonal changes (sandhi) when lexical items combine to form compounds and grammatical phrases
- autosegmental behavior in which contour tones decompose into L and H components

Cantonese (Yip 2003)

si:	55	'poetry'
si:	44	'try, taste'
si:	33	'affair'
si:	22	'time'
si:	35	'make'
si:	24	'market'
si:	53	'silk'

Mandarin

ma	55	'mother'
ma	35	'hemp'
ma	214	'horse'
ma	51	'scold'

/fei55 +le/ ->	55 + L	'fly' asp
/lai35 +le/	35 + L	'come' asp
/mai214 +le/	21 + H	'buy' asp
/lei51+le/	53 + L	'tire' asp

Contextual tonal variations

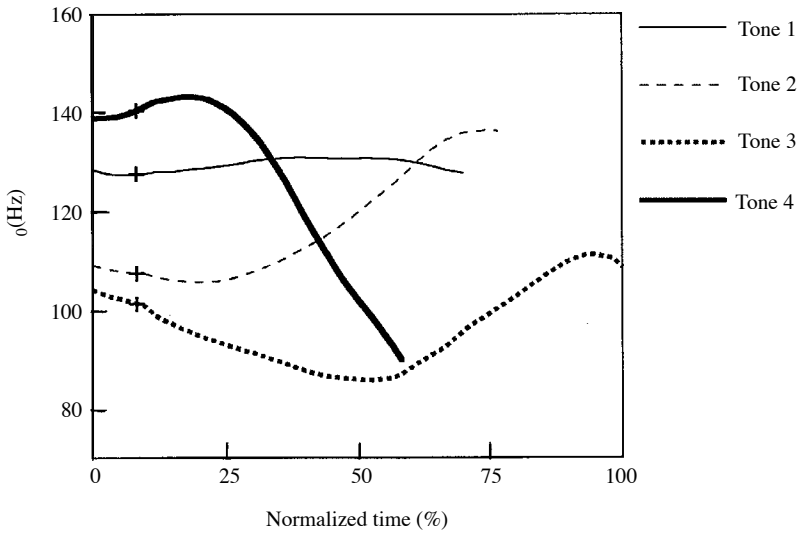


Figure 2. Mean f_0 contours (averaged over speakers and tokens; $n = 48$) of four Mandarin tones in the monosyllable /ma/ produced in isolation. The time is normalized, with all tones plotted with their average duration proportional to the average duration of Tone 3.

Xu, Yi. 1997. Contextual tonal variations in Mandarin. J of Phonetics 25, 61-83.

2. Shanghai compounds (Duanmu '97):

HL LH LH	LH LH LH	input
H L L	L H L	output
ɕi ve ti	lo ve ti	
new meal store	old meal store	
'new restaurant'	'old restaurant'	

- initial syllable is stressed; tones of noninitial syllable are deleted
- contour tone of initial morpheme is reparsed over the entire phrase
- recall Kagoshima Japanese

2. Tonogenesis (Haudricourt 1954, Matisoff 1973)

Fo is lower after voiced obstruents: voicing contrast lost and F0 difference is phonologized.

- Punjabi tones (Bhatia 1975)
- low tone following former voiced aspirates and high tone preceding them

Hindhi	Punjabi	
ghor-a	kòra	'horse'
dhol	tòl	'drum'
labh	lab	'profit'

- tone attracted to stressed syllable

(70)

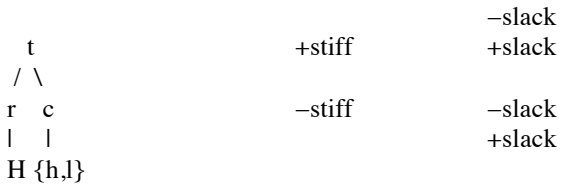
High tone		Low tone	
/páɽ/	'study' (verb)	/bàn/	'tie' (verb)
ˈpáɽ.na:	'to study'	ˈbàn.na:	'to tie'
ˈpá.ɽɪ.a:	'studied' (masc.sg.)	ˈbàn.ni:	'tied' (fem.sg.)
pə.ˈɽáː.iː	'studies' (noun)	bə.ˈnàː.ɔː	'help tie'
pə.ˈɽáː.ɔː	'cause to study'		

3. Chinese: register

Songjiang (Shanghai):	53	44	35	5	yin register
	31	22	13	3	yang register

- fall, level, and rising tones in upper and lower regions of pitch space
- checked syllables with ʔ coda bar contour tones
- yang register not found after voiceless consonants
- yin register not found after voiced obstruents
- contrast after sonorants

4. Bao's (1990, 1999) representation



- [±stiff vocal folds] splits pitch space into two broad regions; [±slack vocal folds] lowers or raises pitch within each register
- predicts four tone levels (mid is ambiguous in three tone system)
- contour tones as units but with internal parts: F = [l h], R = [h l]; evidence from
    - register changes and contour changes independent
    - contour decomposition
    - terminal assimilation
    - contour shift and spread

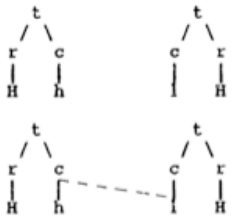
4. Gao'an (Mandarin) (Bao: 1990 110)

a. 55: ka "add"; siu "repair"
A. 24: siu "rest"
b. 42: hou "beg"
c. 33: p'i "match"; su "four"
C. 11: p'ei "double"; t'i "earth"
d. 3: tsok "table"
D. 1: hok "study"; ɕiak "stone"

in sandhi 55 b-> 53 / ____ 33,11,3,1

sam su	'three-four'	ka p'Ei 'double'	sang t'iet 'pig iron'	tciang yot 'first month'
55-33	-> 53-33	55-11 > 53-11	55-3 > 53-3	55-1 > 53-1

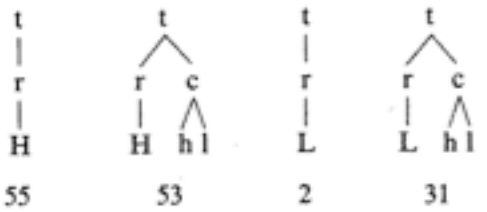
- original register maintained; just addition of l component; hence 55 > 53, not 51 which would be crossing a register boundary



typo: second tone is in L register; hence r ---L

5. Tibetan compounds (Meredith 1989): WS metrical structure; T_1 deletes r node, T_2 changes r to H

- isolation: 55, 24 (from /22/), 52, 31: a level and fall in the upper and lower registers



- compounds

input			compound	
first syllable	second syllable	⇒	first syllable	second syllable
H-level	H-level		H-level	H-level
H-fall	H-level		H-level	H-level
L-level	H-level		L-level	H-level
L-fall	H-level		L-level	H-level
H-level	H-fall		H-level	H-fall
H-fall	H-fall		H-level	H-fall
L-level	H-fall		L-level	H-fall
L-fall	H-fall		L-level	H-fall
H-level	L-level		H-level	H-level
H-fall	L-level		H-level	H-level
L-level	L-level		L-level	H-level
L-fall	L-level		L-level	H-level
H-level	L-fall		H-level	H-fall
H-fall	L-fall		H-level	H-fall
L-level	L-fall		L-level	H-fall
L-fall	L-fall		L-level	H-fall

- examples

phöö 2 'Tibet'
mi 2 'person'
phöö-mi 2-5 'Tibetan'

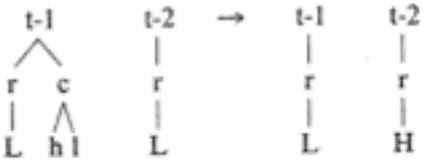
thuu 52 'banner'
caa 52 'iron'
thuu-caa 5-52 'iron banner fixture'

ree 31 'cotton'
see 2 'robe'
ree-see 2-5 'cotton robe'

yum 2 'mother'
chëë 5 'great'
yum - chëë 2-5 'mother' (honorific)

see 52 'knowledge'
yöö 2 'possessor'
see yöö 5-5 'intellectual'

- analysis: WS metrical structure; T_1 deletes c node, T_2 changes r to H



6. dissimilation by shape and register: (Bao 1999) Yantai (Mandarin, Shandong province)

- inventory

a. 31	fu	'man'	L, hl
b. 214	fa	'method'	L, lh
c. 55	t'u	'picture'	H, h

- sandhi:

a. 31-31	->	35-31	san p'o	'hill slope'
b. 214-214		55-214	y sui	'rain water'
c. 55-55		31-55	cy p'i	'tree bark'

	31	214	55
31	**35-31**	31-214	31-55
214	**35-31**	**55-214**	214-55
55	55-31	55-214	**31-55**

H, lh - L, hl		L, hl - L, lh	L, hl - H, h
H, lh	**L,hl**	**H, h - L, lh**	L, lh - H, h
H, h	H, hl	H, h - L, lh	**L, hl - H, h**

- observations
  - first tone changes: Ident-tone in stressed syll >> Ident-tone
  - 31-31 -> 35-31: dissimilation for register and contour
  - 214-31 -> 35-31: dissimilation for register
  - 214-214 -> 55-214: dissimilation for register; structure preservation: upper register lacks a rising tone
  - 55-55 -> 31-55: dissimilation for register and contour; *R >> *F

- analysis: Ident-Tone-Stressed syll >> Ident-Tone
  OCP-contour >> Linearity
  OCP-register >> Ident-register
  *[H, hl] >> *[L,l] : blocks creation of a high fall (53) as repair for 214-214; is 55-214 closer to input than 53-214?

7. Pinyao (Bao 1999; data from Hou 1980)

13	ti	'paw'	L, lh
35	ti	'field'	H, lh
53	ti	'top'	H, hl

	13	35	53
13	13-13	31-35	35-423
35	13-13	31-35	35-423
53	53-13	53-35	35-423

35-> 13 / __ 13 spread of L register
13 -> 31 / __ 35 dissimilation of contour (novel tone)
35 -> 31 / __35 dissimilation of contour and register
13 -> 35 / ___ 53 spread of H register

53 -> 35 / __ 53 dissimilation of contour

- the upper register rise 35 and fall 53 trigger contour dissimilation

  OCP on c node if T2 is H

- a rising tone assimilates the register of the second tone

  * @T1 @T2 where T1 is rising (i.e. c = lh)

- a fall [hl] adds a h before pause (blocked on rise or h by OCP)

8. While rise and fall can be unrestricted in distribution, convex and concave tones with two inflection points are typically derived: recall Mandarin T3 plus toneless syllable: suggests fall+high. Suzhou (Yip 1989): decomposition of convex and concave tones; full form is phrase-final where syllable is typically lengthened

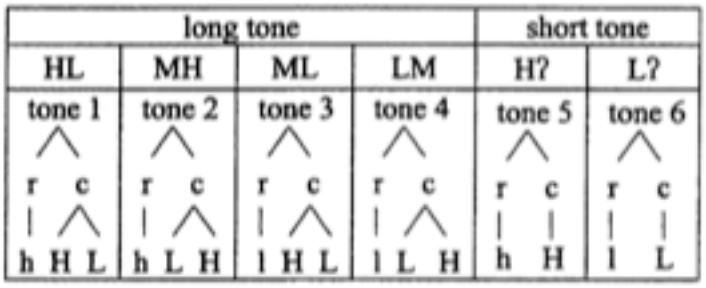
keu 523 i 523 -> keu 52 i 44 third tone realized on second syllable: HLH HLH >
mo 242 ko 523 -> mo 23 ko 11 HLH 0 > HL H

9. gross typology

- tone sandhi often dissmilatory; changes first of two similar/identical tones
- tone deletion: noninitial (Shanghai) left-edge stress; nonfinal (Xiamen) right-edge stress
- tone shift: preserve initial tone but realize on right edge (Zhenhai); preserve final tone but realize on initial (Wenzhou)

10. Zhenhai (Northern Wu) (Rose 1990, Li 2003)
inventory and representation

		tone	example	tone value	notation	gloss
long tone	high register	1	tɕi	441	HL	"to fill"
		2	tɕi?	323	MH	"chicken"
	low register	3	tɕi	231	ML	"to ride"
		4	tɕi?	213	LM	"he/she/it"
short tone	high register	5	tɕɪ?	5	H?	"knot"
	low register	6	tɕɛ?	23	L?	"straight"



- contour tones have CVV(?), CVN syllable durations of (250-350 ms); checked CV? (100 ms.)

- upper register have voiceless onset, lower register voiceless breathy onset that becomes voiced non-initially
- sandhi in compounds (disyllabic or longer)
- two metrical patterns: WS and SW partially predictable:
    - if σ_1 in H register (tone 2,5) then SW; if σ_1 in L register (tone 3,6) then WS
    - if σ_1 is Tone 1 or 4 then WS/SW is synchronically unpredictable
- V1 is longer (94 to 154 ms) than V2 regardless of metrical pattern; thus two prominences: duration for σ_1 and stress for WS/SW;
- no duration increase on checked syllables

tone sandhi changes in W-S (p. 121)

W-S disyllabic patterns

σ_1	σ_2					
	T1:441	T2:323	T3:231	T4:213	T5:5	T6:23
A T1:441	33-441				33-4	
B T3:231	11-441				11-4	
C T4:213	11-334		11-24		11-4	
D T6:23	1-441	1-35	1-242	1-114	1-4	1-25

A. "spring"	"western calendar"	
tshʏŋ thī	ɕi lı?	
441-441	441-23	citation tone
33-441	33-4	sandhi tone
B. "coal mine"	"hair"	
mei khwɑ̃	tœy fa?	
231-231	231-5	citation tone
11-441	11-4	sandhi tone
C. "place"	"yesterday"	
ti fɑ̃	sɑ̃ ȵı?	
213-441	213-23	citation tone
11-334	11-4	sandhi tone
D. "tongue"	"special"	
ɕɛ tœy	ta pɛ?	
23-231	23-5	citation tone
1-242	1-25	sandhi tone

- in A and B σ_2 has a falling contour while in C it is rising; corresponds to underlying contour of σ_1
- the register of σ_2 is H regardless of input; the register of σ_1 is H for A and L for B and C. this reflects the register of the input tone.

- so in WS the contour node of σ_1 is attracted to the stressed syllable. the stressed syllable is in the upper register (recall Tibetan); the register of the first syllable is determined by the underlying tone of that syllable.
- when σ_1 is short T6 then σ_2 preserves its contour specification but changes to the H register

Summary:

- stressed syllable is tonally prominent: H register and contour tone
- when both σ_1 and σ_2 are contour, the tone of σ_1 is preserved (it is longer in input) but realized on stressed syllable
- register specification is stable on initial syllable
- positional faithfulness for σ_1
- positional markedness for contour node: realized on stressed syllable

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24.961 Introduction to Phonology
Fall 2014