

Tone in Languages

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LIGN 101

What we will talk about today

- What is tone? Why do we care?
- Tone systems
- Tone symbols in IPA
- Lexical vs. grammatical use of tone
- Tone sandhi
- Production of tone
- Tone coarticulation
- Perception of tone
- Extra: Intonation

What is tone (linguistics)?

- A. emotion, opinions, attitudes of articles
- B. quality of brightness or shade of a color
- C. music or vocal sound
- D. contrastive pitch patterns to make semantic distinctions
- E. contrastive pitch patterns to add functional meaning

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- **D. contrastive pitch patterns to make semantic distinctions**
- **E. contrastive pitch patterns to add functional meaning (intonation)**

Are these tones?

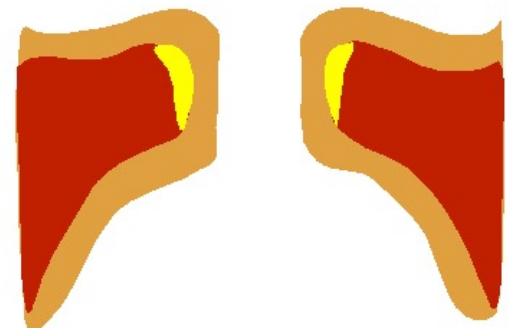


What about these?



What is linguistic tone?

- Contrastive pitch patterns to distinguish meaning
- Pitch is the *percept* of fundamental frequency (F0)
- F0 is the lowest repeating frequency – how frequently the vocal folds vibrate
 - *Percept* is how we perceive real world objects from mind
 - Pitch: **Psychological** vs. F0: **physical**
 - High pitch: vocal folds vibrate quickly
 - Low pitch: vocal folds vibrate slowly



Why should we care about tone?

- Compare with [b] vs. [p] in bat [**b**æt] vs. pat [**p**^hæt]

→ change in segment

- Rising vs. falling tones in 拔 [pa **1**] ‘pull’ vs. 爸 [pa **↓**] ‘dad’

→ change in **suprasegment** (e.g., tone, duration, stress, etc.)

- High vs. low Ibibio tones in [ákpá] ‘ocean expanse’ vs. [**à**kpá] ‘first’
Ibibio, *Nigeria, Niger-Congo* vs. [àkp**à**] ‘small ant’

- Very common: ~50% of languages of the world

[hide legend]



Tone systems

- Level tones



- Single pitch target (the target value aimed at)
- Tone values are not fixed, and change depending on the speaker
- All within speaker's normal f0 range
→ relative frequency

TONES AND WORD ACCENTS –	
Level	
◌̊ or ˊ	Extra high
◌́	High
◌̄	Mid
◌̀	Low
◌̋	Extra low
↓	Downstep
↑	Upstep

Level tones

- Two level tones together:

á (high) + à (low)

= â (falling)

- Lexical usage:

when tone change
distinguishes *word-level*
meaning

Mende /'mɛndi/, Sierra Leone, Mande

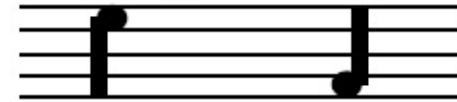
Mende

English

Melody on vowels

mbû

owl



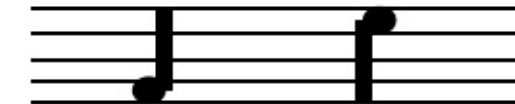
háwámá

waistline



mbă

companion



ndàvúlá

sling



kó

war



ɲàhâ

woman



Level tones

- Grammatical usage:

when the tone change signals different *grammatical* categories

Edo /'ɛdɔʊ/ (Bini), *Nigeria, Niger-Congo*

TABLE 10.1 The use of tone in part of the tense system of Edo.

Tense	Monosyllabic Verbs		Disyllabic Verbs	
Timeless	ì mà	'I show'	ì hrùlè	'I run'
Continuous	í mà	'I am showing'	í hrùlé	'I am running'
Past	ì má	'I showed'	ì hrúlè	'I ran'

Contour tones

- More significant pitch movement, still relative to speakers' range
- Different starting & end pitch targets
- Combination of high & low tones if levels are simple, but less precise
- 👉 Chao numerals and letters representing sequences of pitch heights

TONES AND WORD ACCENTS –	
	Contour
◌̎ or ◌̍	Rising
◌̎	Falling
◌̎̎	High rising
◌̎̍	Low rising
◌̎̎̎	Rising-falling
↗	Global rise
↘	Global fall

Contour tones

- Chao numerals: 1 = lowest pitch; 5 = highest pitch
- Tone letter →

TABLE 10.2 The tones of Mandarin Chinese.					
Tone Number	Description	Tone Letter	Pitch	Example	Gloss
1	high level	˥	55	ma ⁵⁵	‘mother’
2	high rising	˨˨˥	35	ma ³⁵	‘hemp’
3	low falling-rising	˨˨˥˨	214	ma ²¹⁴	‘horse’
4	high falling	˥˨	51	ma ⁵¹	‘scold’

- Tone is attached to a syllable, rather than a single segment
- So, we write /ma 55/ or /ma ˥/, putting tone after the entire syllable

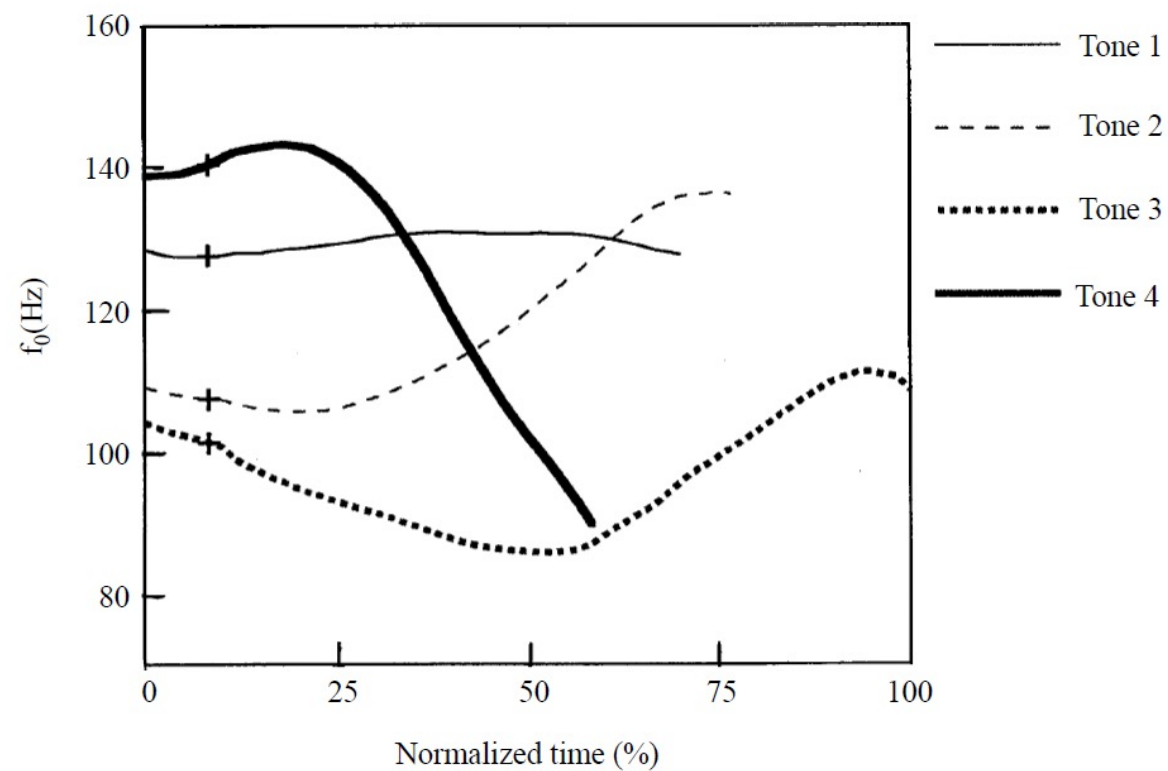
Which is incorrect?

- A. Tone systems have level and contour tones
- B. Tone can be used lexically and grammatically
- C. Tone is attached to a syllable
- D. Tone values are absolute

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Mandarin tones



Xu (1997)

Mandarin tones

Mandarin	Chao “letters”	Chao numerals
媽 /妈 ‘mother’	ma 1	ma ⁵⁵
麻 ‘hemp’	ma 1 (1 + 1)	ma ³⁵
馬 /马 ‘horse’	ma 1 (1 + 1 + 1)	ma ²¹⁴
罵 /骂 ‘scold’	ma 1 (1 + 1)	ma ⁵¹

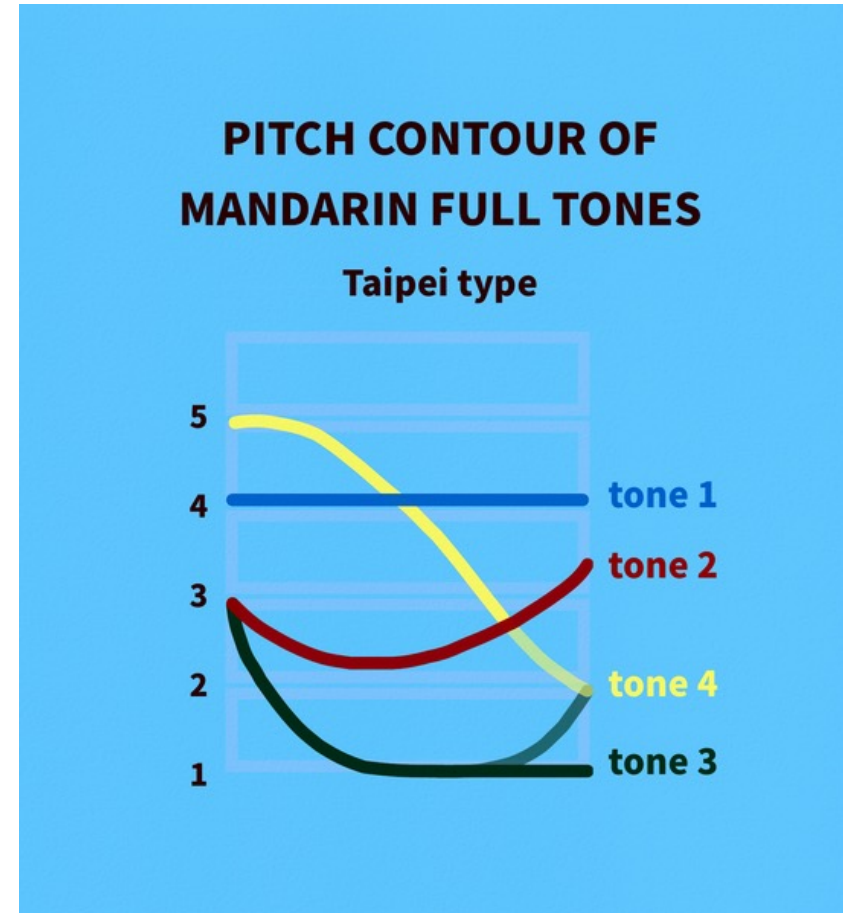
Compare accents vs. Chao system to indicate tone in the IPA:

- à (low) vs. á (high) vs. ā (mid)
 - â (fall) vs. ǎ (rise)
- Not to be confused with Pinyin accents!

Mandarin tones

- The neutral tone
- 东西 /tɔŋ 1 ɕi 1/ ‘east and west’ vs. 东西 /tɔŋ 1 ɕi0/ ‘things’
 - 妈妈 /ma 1 ma0/ ‘mom’
 - 头发 /tʰou 1 fa0/ ‘hair’
- Other examples:
 - 子 /tsi0/ as in 桌子 /tɕuo 1 tsi0/ “desk” (diminutive)
 - 的 /tɿ0/ as in 我的 /wo 1 tɿ0/ “my” (nominalizer or possessive)

Mandarin tones



Shi & Deng (2006)

Grammatical tone

- Mandarin
- “rain” 雨 [y ㄩˇ] low-dipping [y ㄩ˨˥] falling
- 风雨 “wind and **rain**” vs. 天雨雪 “the snow **falls** from the sky”
(antient Chinese)
- The tone changes the part of speech of the word: noun vs. verb

Grammatical tone

- Rere, *Sudan, Niger-Congo*

	REMOTE	RECENT	
a.	kwù-m-bèrtà	kwù-m-bèrté	's/he has wiped'
b.	kwù-m-mètɕè	kwù-m-métɕí	's/he has helped'
c.	kwù-m-lègǝìǝà	kwù-m-légǝà	's/he has closed'

- Recent past tense: lexical tone retained
 - Remote past tense: low-toned

Which is not a falling tone?

- A. e 51
- B. e 43
- C. e ↓
- D. è

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- A. e 51
- B. e 43
- C. e ↓
- **D. è**

Tone sandhi in Mandarin

- 4 lexical tones:

Tone 1 (55), Tone 2 (35), **Tone 3 (214)**, Tone 4 (51)

- *Tone sandhi*: tone always change to a different tone when they're next to one another

- Tone 3 Sandhi: T3 + T3 → T2 + T3

- 214 + 214 → 35 + 214

老虎 'tiger' /lau **214** xu 214/ → [lau **35** xu 214]

- Tone 3 + other tones: 214 → 21

- 狗吠 'bark' /kou **214** fei 51/ → [kou **21** fei 51]

Tone sandhi in Mandarin

- 4 lexical tones:

Tone 1 (55), Tone 2 (35), Tone 3 (214), **Tone 4 (51)**

- Some lexical items which follow their own rules:
- 不 /pu 51/ 'no' and 一 /i 55/ 'one' become a rising Tone 2 (35) before a high falling Tone 4
 - 不要 'no' /pu 51 jau 51/ → [pu **35** jau 51]
 - 一个 'one' /i 55 kɿ 51/ → [i **35** kɿ 51]

Production of tone

- *Laryngeal height* correlated with pitch
- *Laryngeal height* is the vertical movement of our larynx (try raising/lowering your larynx while producing the vowel 'ah'?)
- Falling tone more prevalent than rising tone, with a greater pitch range
 - *Downdrift, F0 declination* is very common

Downdrift, declination

- Most (all?) languages exhibit a gradual fall in pitch from the beginning to the end of an utterance (Ohala, 1978)
- Successive tones become phonetically lower and lower in pitch until, at the end of the phrase, some H (ending) < L (beginning)

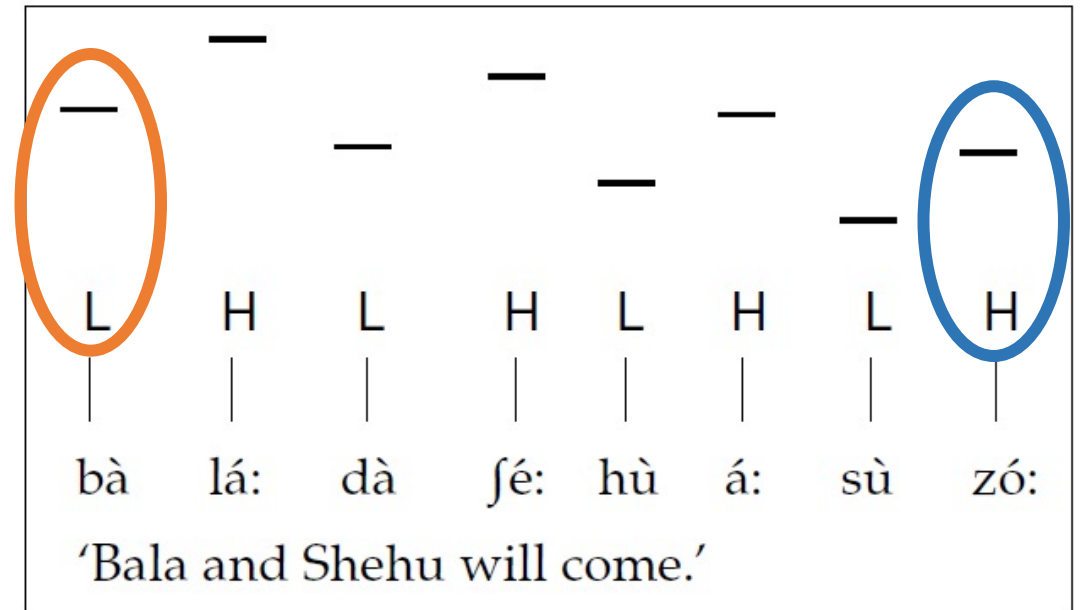


Figure 14.17 Downdrift in Hausa

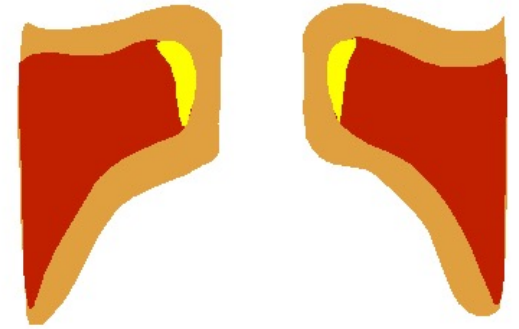
Hausa /'hausə/, Nigeria, Afro-Asiatic

Tone is multidimensional

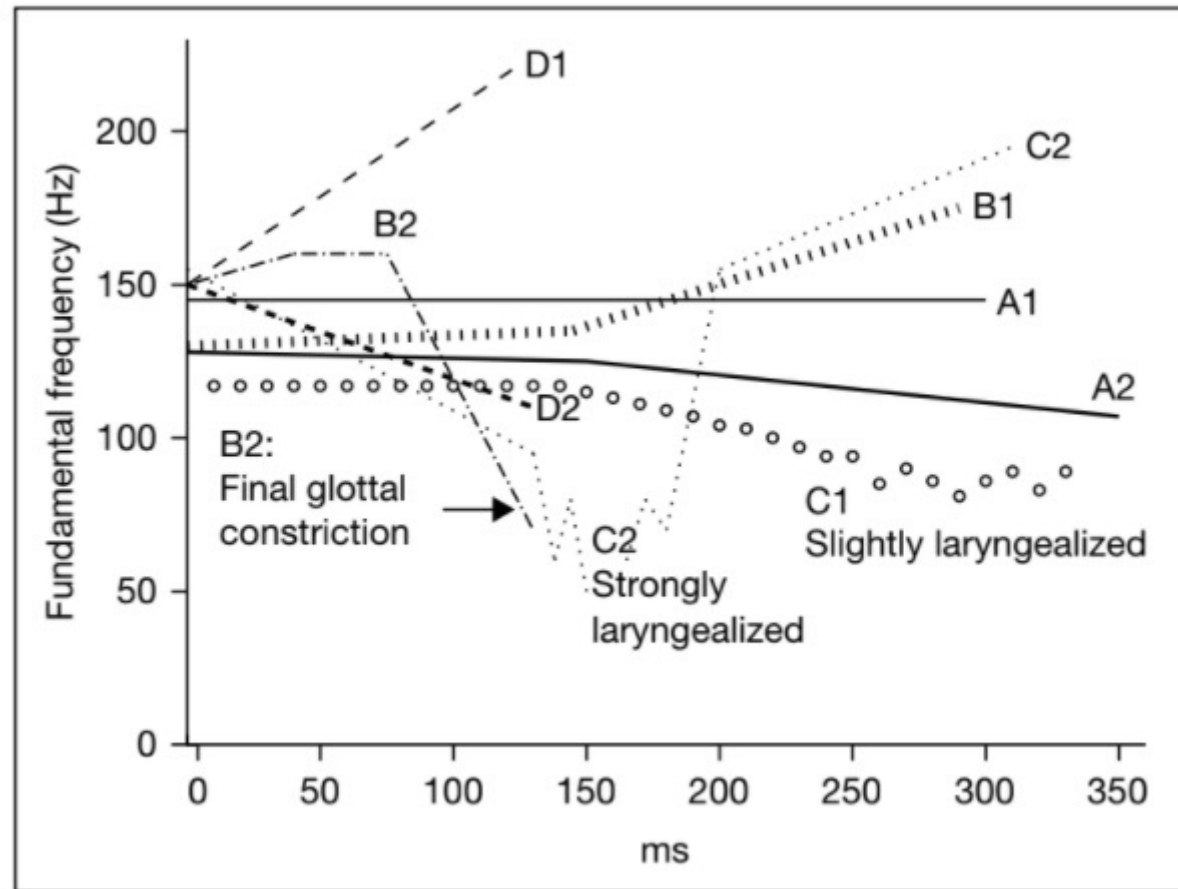
- Pitch: primary correlate
- Type of *phonation*: secondary feature
- *Phonation* is the pattern of voicing depended on the state of glottis

Phonation types

- Modal voice
 - Voiceless, whispery
 - Aspirated
 - Breathy voice (e.g., Marilyn Monroe)
 - Creaky voice (e.g., vocal fry)
- A lot more... slack voice, stiff voice, harsh voice, falsetto
 - Arbitrary categories!



Hanoi Vietnamese (Austroasiatic)



Michaud (2004)

Hanoi Vietnamese tones

<i>ngang</i>	A1	˥ (level)	ma˥	<i>ma</i>	‘ghost’
<i>huyền</i>	A2	˧ (mid falling)	ma˧	<i>mà</i>	‘but, yet’
<i>sắc</i>	B1	˨˨˦ (rising)	ma˨˨˦	<i>má</i>	‘cheek’
	D1	˨˨˦˥ (rising checked)	ma˨˨˦˥	<i>mát</i>	‘cool’
<i>nặng</i>	B2	˩˩˦ (low glottalized)	ma˩˩˦	<i>mạ</i>	‘rice seedling’
	D2	˩˩˦˥ (low checked)	ma˩˩˦˥	<i>mật</i>	‘louse, bug’
<i>hỏi</i>	C1	˧˨˦ (low falling)	ma˧˨˦	<i>mả</i>	‘tomb’
<i>ngã</i>	C2	˧˨˦˥ (broken)	ma˧˨˦˥	<i>mã</i>	‘code’

Pitch + phonation + (syllable structure):

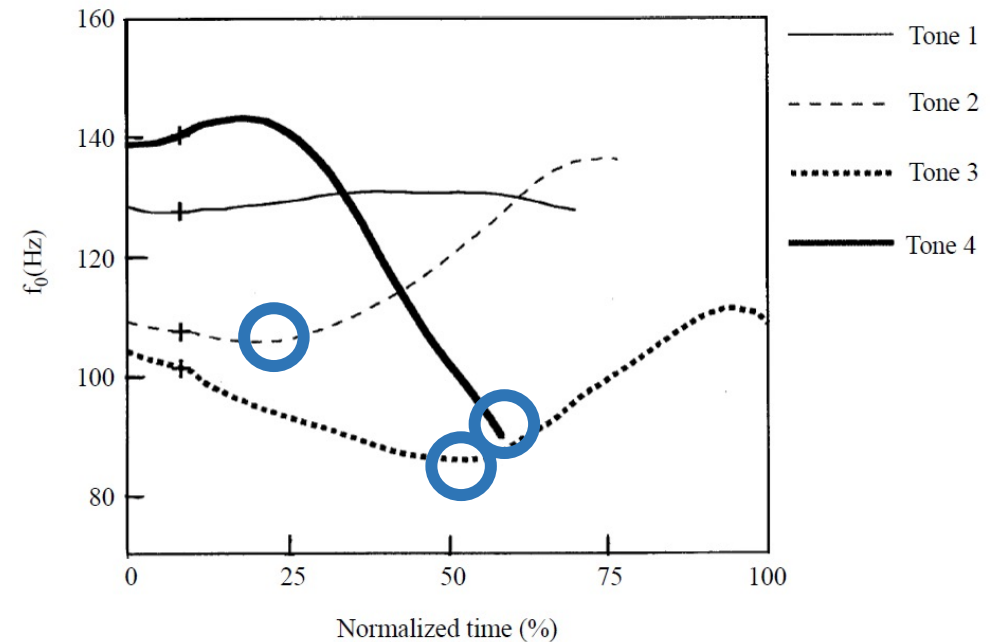
Glottalized: final glottal constriction (=creaky)

Broken: strongly laryngealized (=creaky)

Checked: a coda in the syllable

Creaky voice in Mandarin tones

- Creaky voice is mostly produced in the lowest Tone 3, and can occur on other tones (Belotel-Grenié and Grenié 1994, 2004)
- Creaky voice in Mandarin is associated with a **low F0** (Kuang 2017)



Mandarin tones in isolation; Xu (1997)

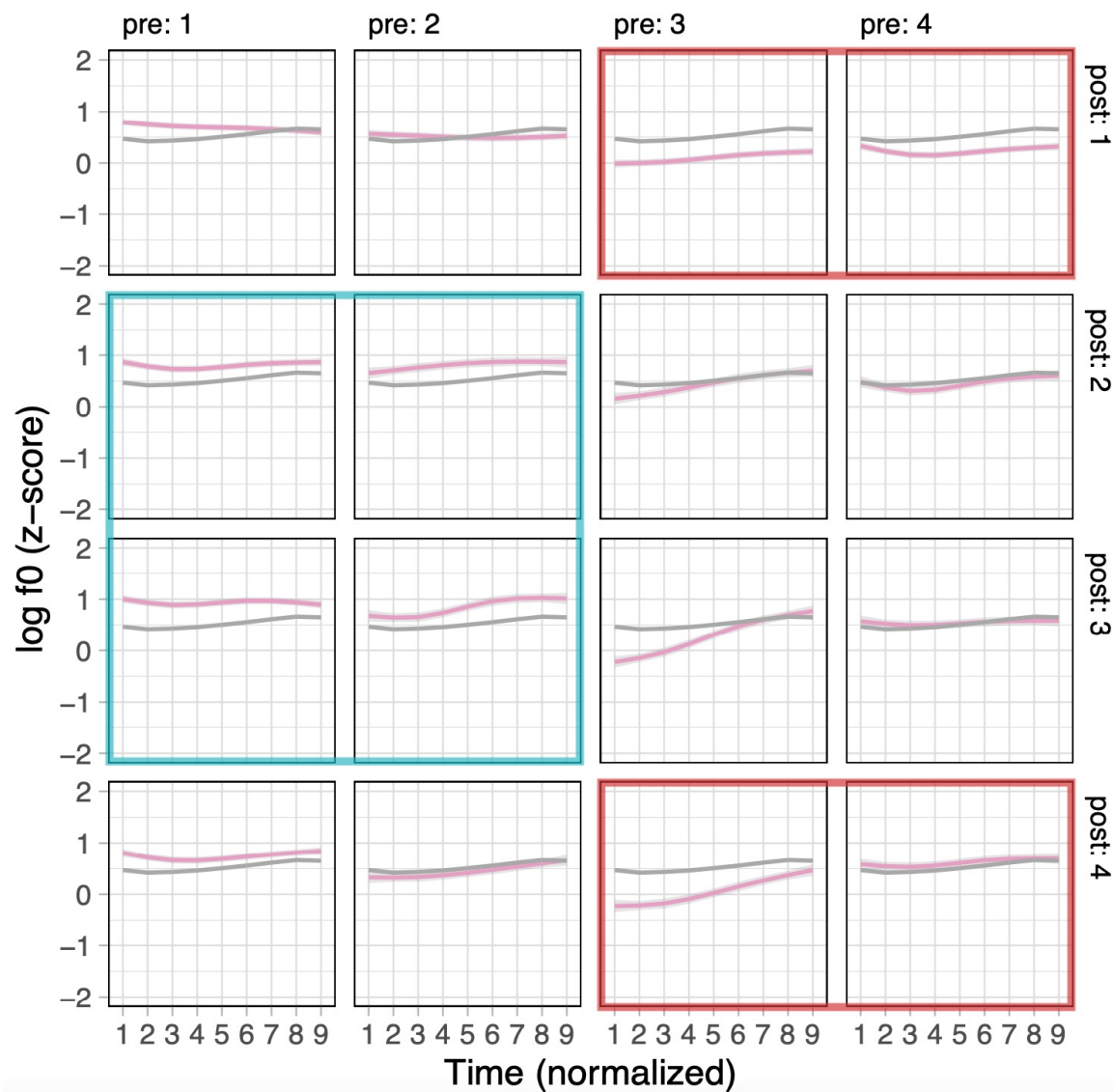
Tone coarticulation

- Citation form of tone – when in isolation
- Contextual variation in the realization of tone
 - != tone sandhi: phonetic variation vs. phonological change
 - It doesn't turn a tone into a different tone like sandhi does
- Put tones in a sequence of tones and measure them!
 - Tone – **Target tone** – Tone

Coarticulated Mandarin **Tone 1 (55)**

- Gray: average contour
- Flat, high f0
- Tone in 16 tonal sequences

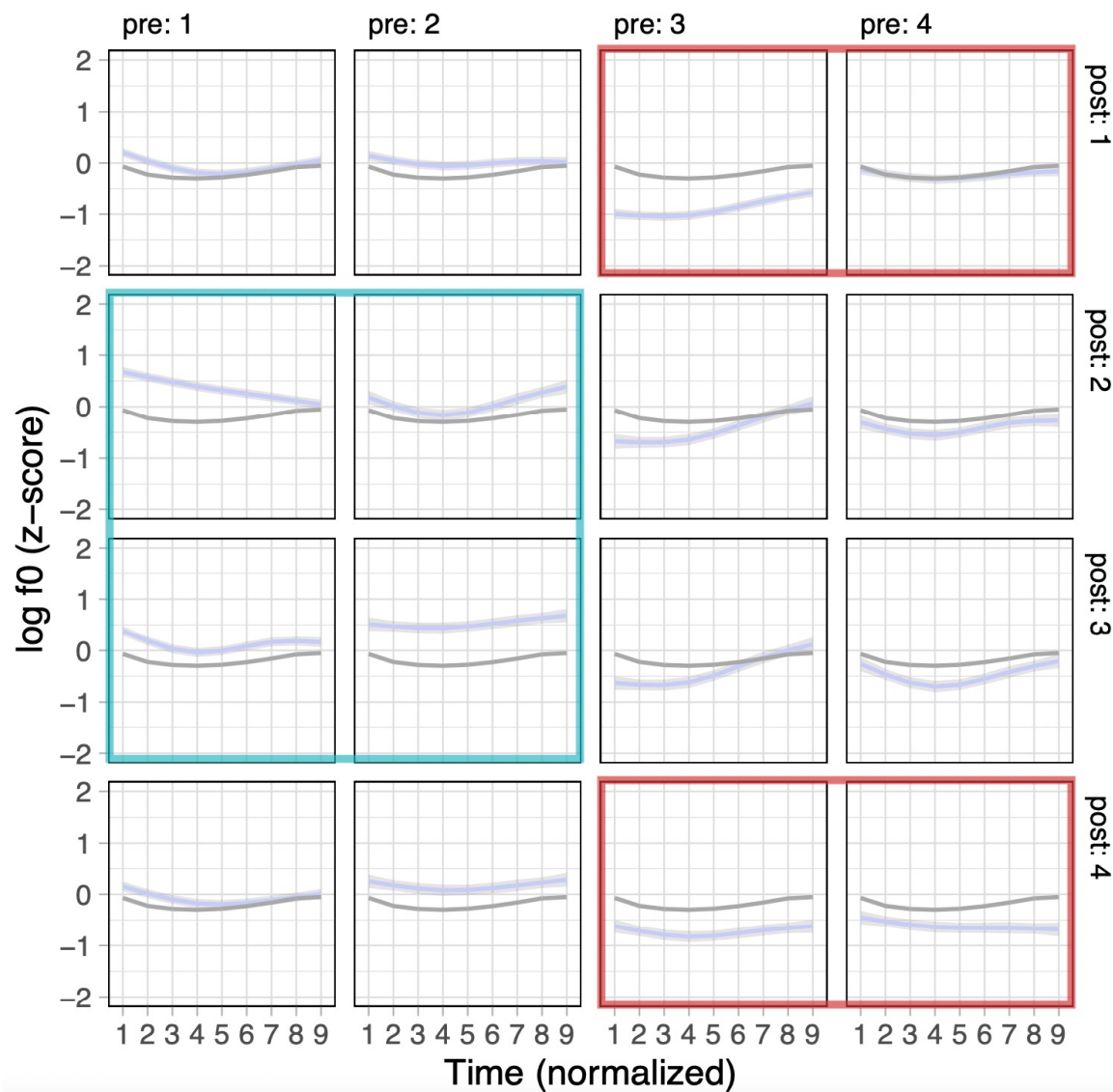
Huang (u.r.)



Coarticulated Mandarin **Tone 2 (35)**

- Gray: average contour
- Less flat, some rising
- Tone in 16 tonal sequences

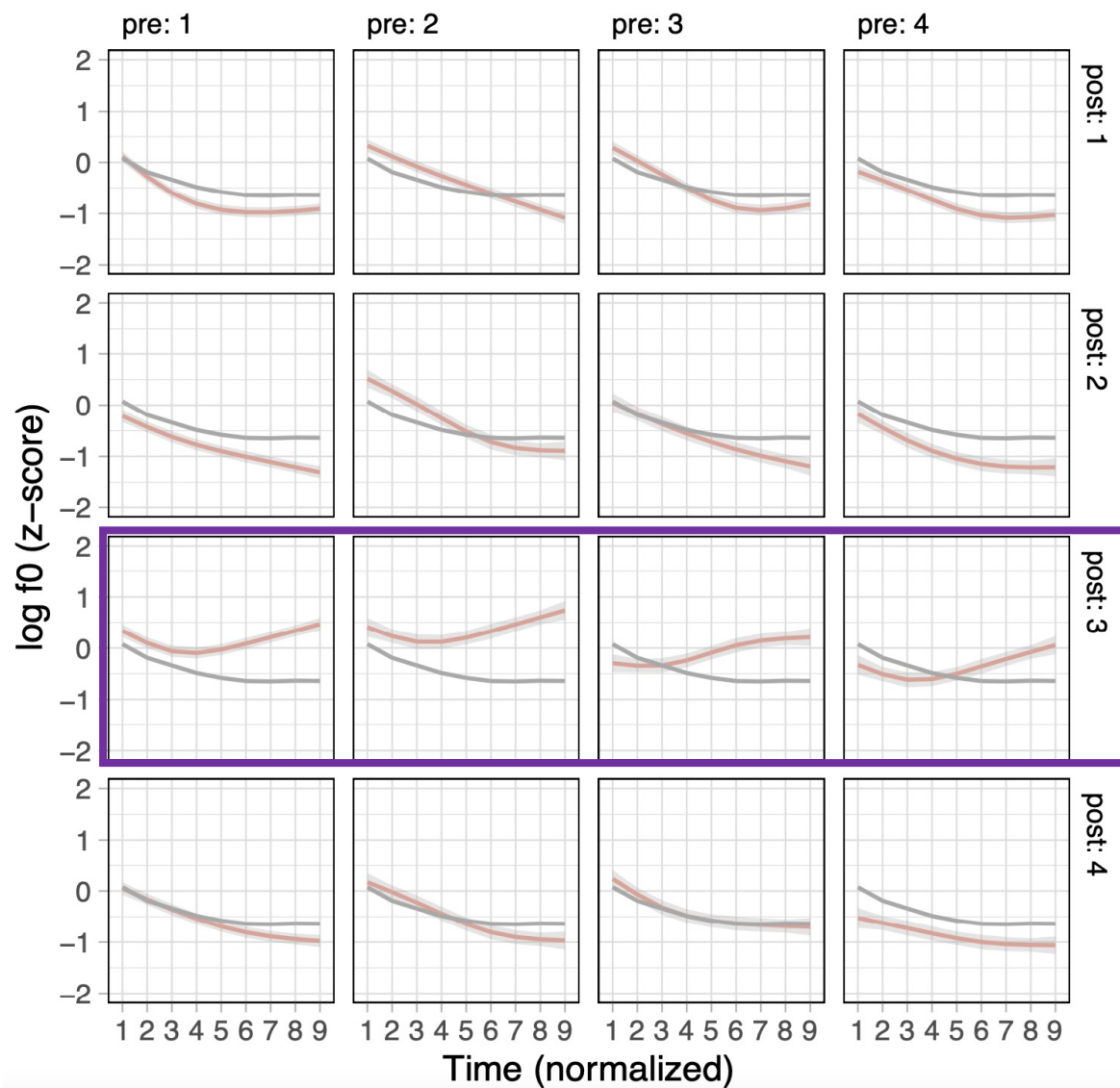
Huang (u.r.)



Coarticulated Mandarin **Tone 3** (214)

- Gray: average contour
- More like a 21, not 214
- Tone in 16 tonal sequences
- Note the *tone sandhi* when followed by another T3!

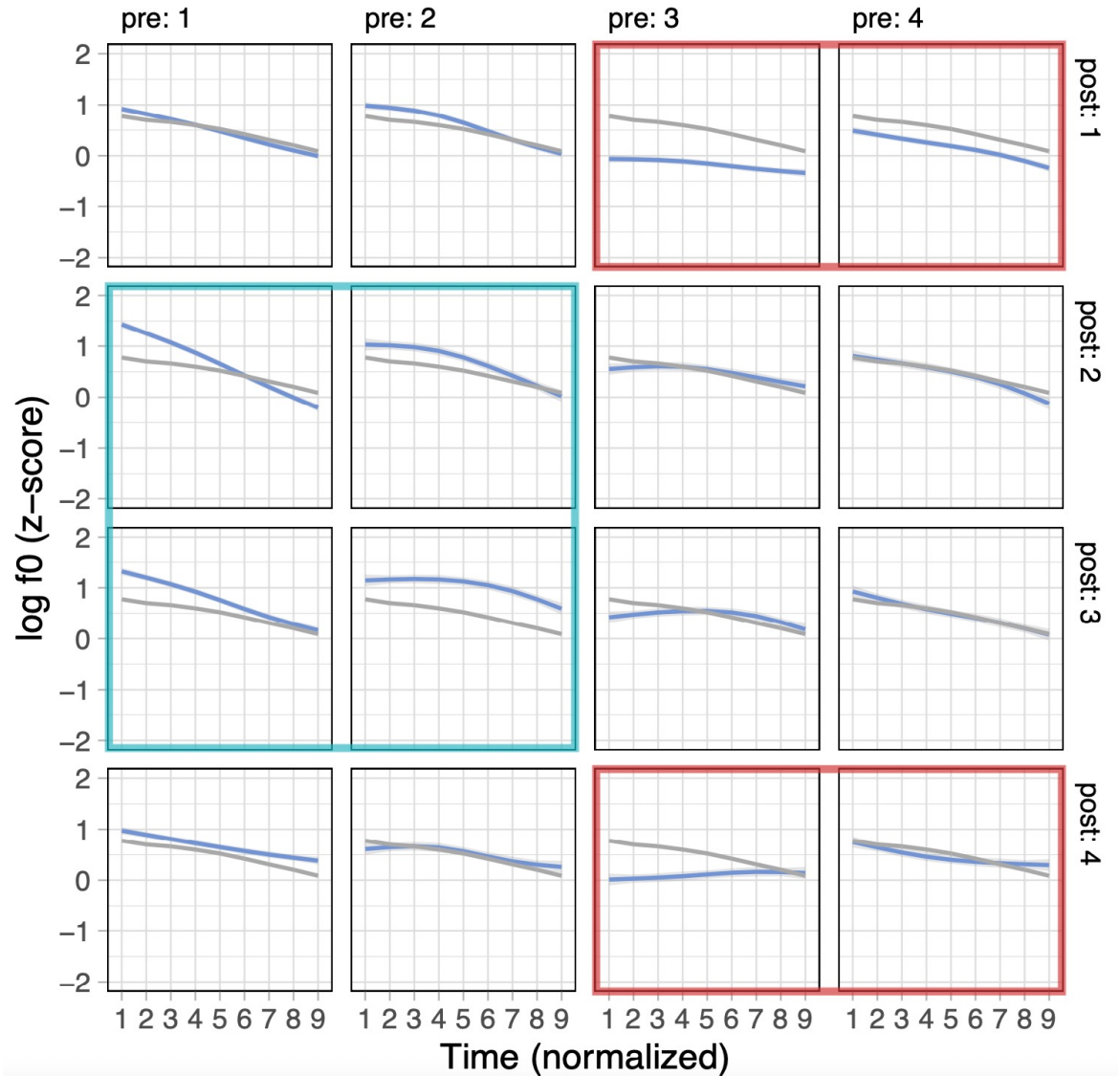
Huang (u.r.)



Coarticulated Mandarin **Tone 4 (51)**

- Gray: average contour
- High falling, but not too much
- Tone in 16 tonal sequences

Huang (u.r.)



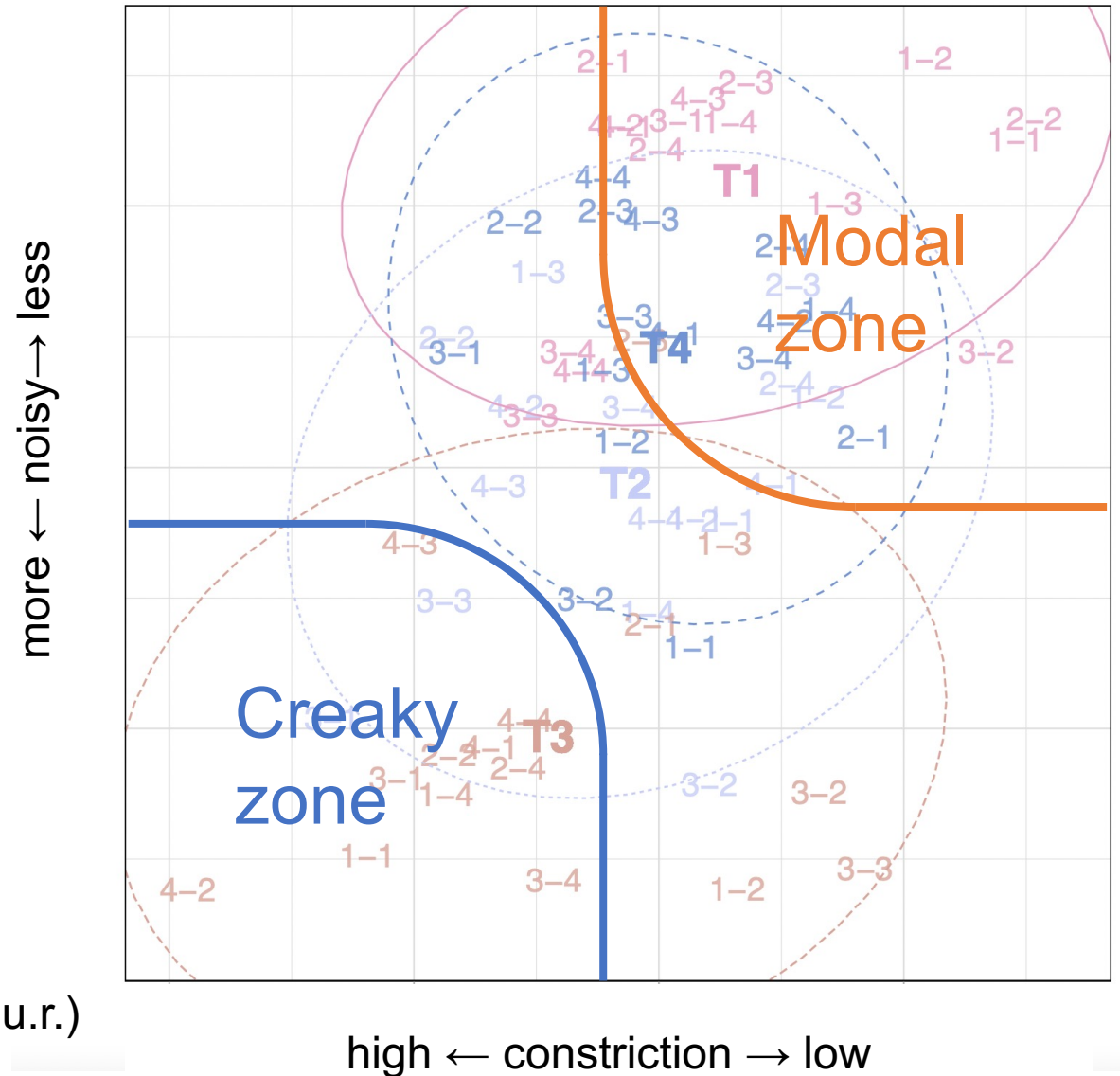
A phonation space of tone

- We can capture the tonal space by phonation type besides pitch:

More noisy, high constriction = more creaky

Less noisy, low constriction = more modal

- Tone 3 = creaky
- Tone 1 = modal



Huang (u.r.)

Perception of tone

- Factors: average pitch, direction, extreme endpoint, slope (Gandour, 1978)
 - ← depends on language experience
- Categorical perception, left hemisphere processing (~speech)
 - Prosody, right hemisphere (non-tonal language)
- Chinese listeners can easily identify the tones. Most errors confused Tone 2 and Tone 3;
- Nearly twice as many errors resulted from misidentifying Tone 3 as Tone 2, as from misidentifying Tone 2 as Tone 3 (Chuang et al., 1972)
- Chinese listeners do not correctly identify *sandhied* Tone 3 and Tone 2!
(骑马 [tɕʰhi 35 ma 214] 'ride horse' vs 起码 [tɕʰhi 35 ma 214] 'at least') →
phonological distinction is neutralized (Wang & Li, 1967)

A Mandarin tone perception experiment

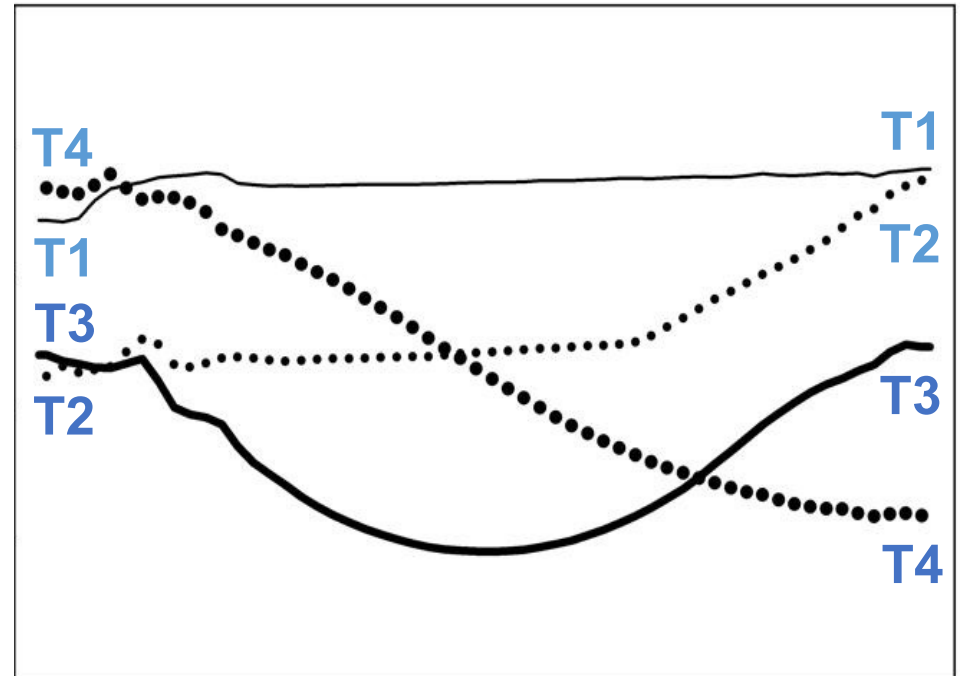
- Given that tone is a multidimensional category captured by pitch and phonation. What are your expectations?
 - A. Pitch is still the most important thing!
 - B. Phonation should matter as well!

A Mandarin tone perception experiment

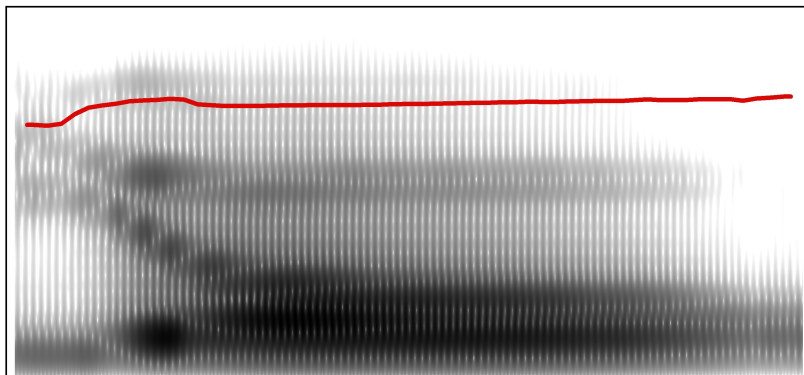
- Resynthesized words with pitch & phonation manipulation
- Forced-choice tasks: listeners choose which tones they heard



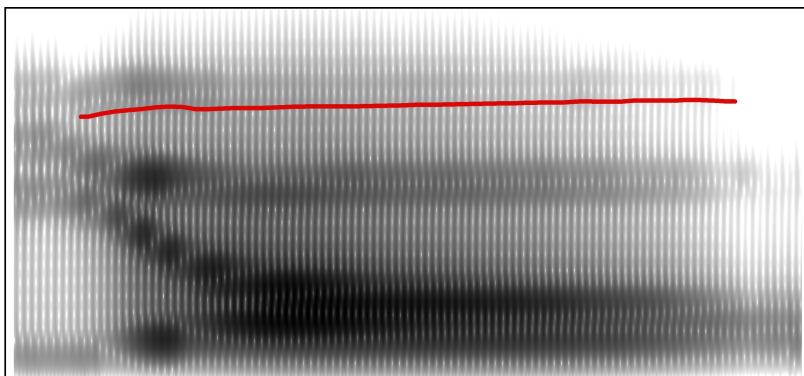
Huang (2020)



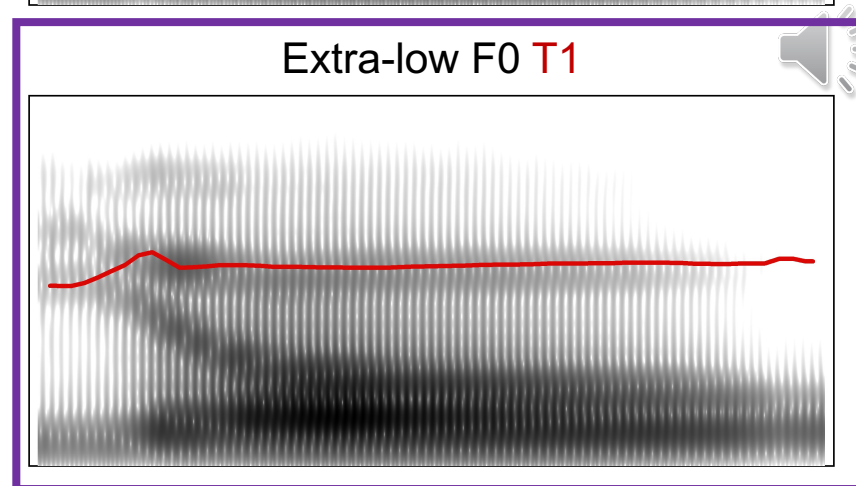
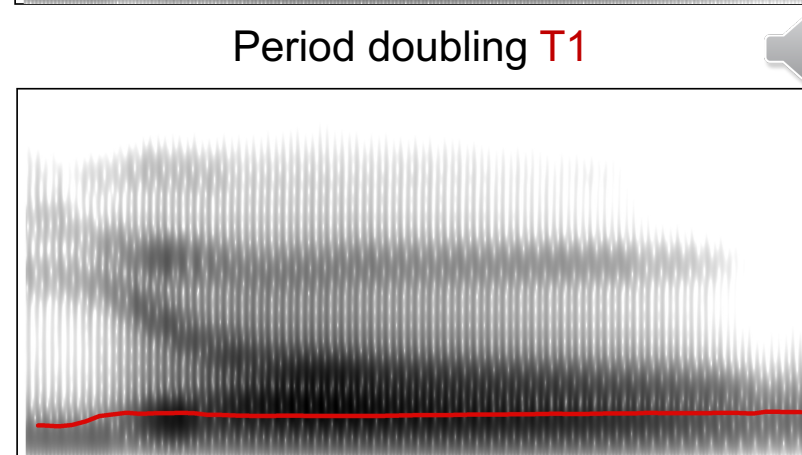
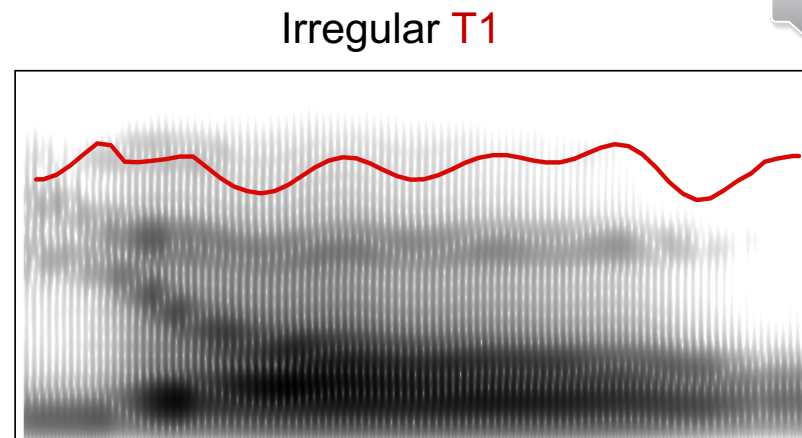
Phonation manipulations



Modal T1

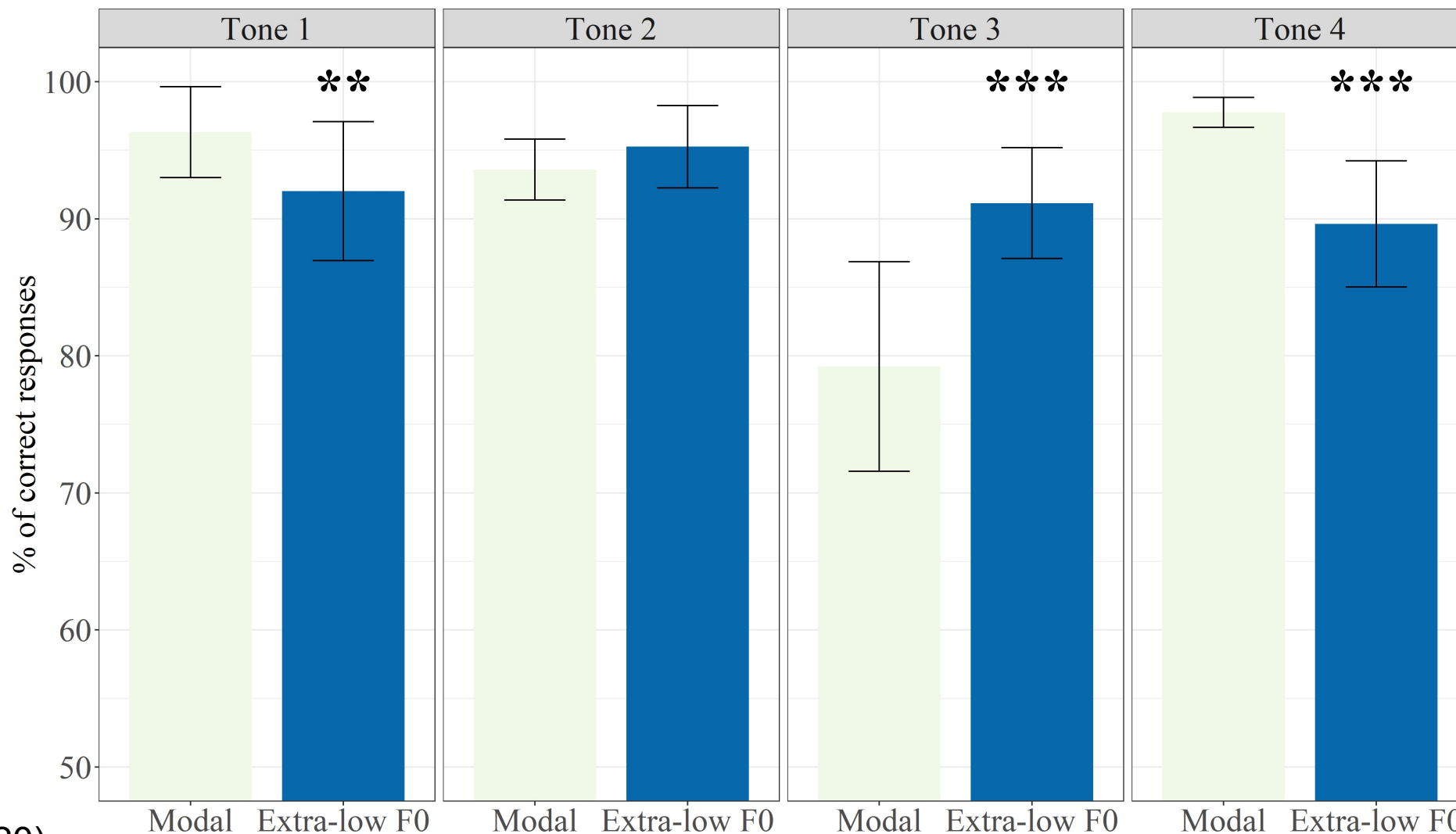


Low spectral tilt T1



Results: accuracy

T1, **T4**: extra-low F0 **lowered** accuracy
T3: extra-low F0 **improved** accuracy



So, what?

Extra-low F0 emerged as the most salient and consistent cue in Mandarin tone identification



- A **mapping from production to perception** that creaky voice in Mandarin is caused by a low F0, which in turn is used for tone identification
- Creaky voice **integrate perceptually with low F0** to cue tonal contrasts in Mandarin

Acquisition of tone

- Mandarin children acquire **tone first, then vowel, then consonant** (Hua & Dodd, 2000)
 - Design: Picture-naming and picture-description tasks
- Tone errors were rare, but some children uses citation tones when tone sandhi should apply
- Explanation: tone is the **most salient** because it is **compulsory, contrastive, and have only 4 options**. Other syllable components are less salient
- Children do not master neutral tone productions until around 4–6. The most common error that children make is to replace a neutral tone with a full lexical tone, i.e., using /tsi 214/ for /tsi0/ (Li & Thompson, 1977; Zhu & Dodd, 2000)


What is intonation?


- Tone vs. intonation
- Tone: contrastive pitch patterns to make *semantic* distinctions
- Intonation: contrastive pitch patterns to add *functional* meaning
 - Both contrastive, but apply to different units

Intonation


- All spoken languages have intonation
 - Regardless of whether they have stress, tone, or none of these
- Intonation is the use of pitch distinctively over a *phrase*
 - Statements vs. questions
 - Pragmatics: doubt, politeness, boredom


Examples


(17) *Laura* 


(18) *Laura* 


(19) *Laura* 

(20) *A'melia*. a simple statement, equivalent to *Her name is Amelia*. 

(21) *A'melia?* the question, equivalent to *Did you say Amelia?*. 

(22) *A'melia*. the form with the continuation rise, which might be used when addressing Amelia, indicating that it is her turn to speak. 

(23) *A'melia?* a question expressing surprise, equivalent to *Was it really Amelia who did that?*. 

(24) *A'melia*. the form for a strong reaction, reprimanding Amelia. 

Which of the following sound matches the following meaning?

- 1. please continue
- 2. did you really say “yes”?



- 3. please go on
- 4. do you really want me to go on?



What we talked about today

- What is tone? Why do we care?
- Tone systems
- Tone symbols in IPA
- Lexical vs. grammatical use of tone
- Tone sandhi
- Production of tone
- Tone coarticulation
- Perception of tone
- Intonation

Thank you!

How to apply Tone 3 Sandhi?

- The domain problem, more readings: Shih (1997)
- Disyllabic word: 老虎 ‘tiger’ /lau **214** xu 214/ → /lau **35** xu 214/
- Compound: 纸老虎 ‘paper tiger’ /tɕɿ 214 lau **214** xu 214/ → [tɕɿ 214 lau **35** xu 214]
- Is [tɕɿ **35** lau **35** xu 214] possible?
- Idiom: 有板有眼 ‘orderly’ /jou 214 pan 214 jou 214 jan 214/ → /jou 35 pan 214 jou 35 jan 214/
- Phrase: 我买酒 ‘I buy wine’ /wo 214 mai **214** tɕou 214/ → /wo 214 mai **35** tɕou 214/
- Sentence: 请你指点我。 ‘Please teach me.’
/tɕʰiŋ **214** ni 214 tɕɿ **214** tjan **214** wo 214/ → /tɕʰiŋ **35** ni 214 tɕɿ **35** tjan **35** wo 214/, right?
- 请你把手表保管好。 ‘Please take good care of the watch.’
/tɕʰiŋ 214 ni 214 pa 214 ɕou 214 pjau 214 pau 214 kwan 214 xau 214/, variations?