TONAL ALIGNMENT IN SHANGHAI CHINESE

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1. INTRODUCTION

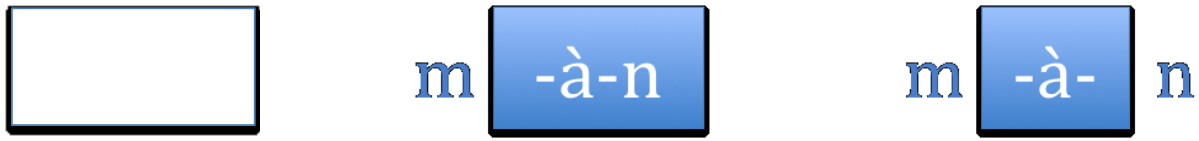
Recent research has greatly increased our knowledge of the F0 alignment with segmental units in tone languages, especially in Standard Chinese (SC).

(Shin, 1988; House, 1999; Xu, 1997, 1998)

However, there are still two questions under debate.

1. What is the tone-bearing unit?

- the whole syllable (Xu 1998, 1999)
- the rhyme (Howie 1974)
- the nuclear vowel (Lin 1995)



2. How are contour tones aligned with segments?

- Simple pitch targets [H/L], "anchored" to onset or offset of segments (Pike 1948, Wang 1967)
- dynamic targets [R/F], continually approached until the end of the syllable (Xu 2001)

Tonal alignment of SC

Xu (1998) compared the F0 alignment patterns in SC syllables with and without a final nasal /n/ or / ŋ / at three speaking rates

- the F0 contours of four lexical tones maintain a consistent alignment to the syllables that carry them;
- The F0 peak associated with the [R] tone always occurs near the offset of the syllable; the onset of F0 rise stays at the center of the syllable

Tonal system of SHC

Shanghai Chinese is a Wu dialect with 5 citation tones:

- F0 contour: falling vs rising
- Register: high vs low
- Duration: long (CV) vs short (CV?)

Table 1: Citation tones of SHC [2, 16]

		Duration		
		Long		Short
Register	High	T1（52）	T2（34）	T4（5）
	Low		T3（23）	T5（12）
		Fall	Rise	
		Contour		

Research questions:

In order to investigate the F0 alignment patterns in different syllable structures (CV & CVʔ) and with different F0 contours (rising & falling), we examined syllables starting with nasal consonant /m/ of T1(52), T3(23) & T5(12).

- Is lexical tone aligned with the whole syllable?
- Does glottal coda influence the F0 alignment pattern?

2. METHODOLOGY

- Stimuli

9 Shanghai monosyllabic words, taken from "The Dictionary of Shanghai Dialect"

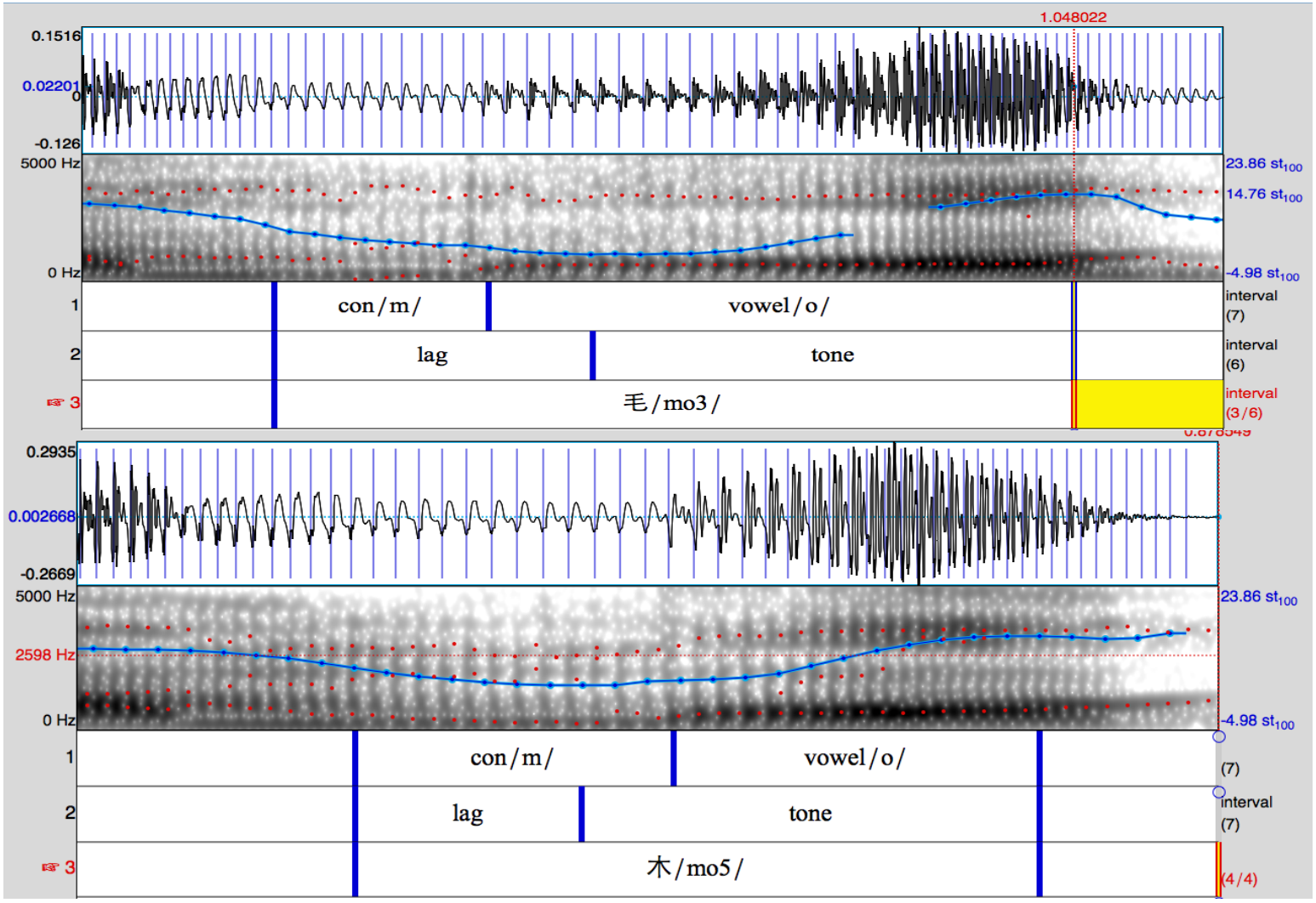
Table 2. Stimuli of monosyllabic words

Tone	/a/	/o/	/i/
T1	妈（mother）	猫 (cat)	眯 (to squint)
T3	买 (to buy)	毛 (hair)	米 (rice)
T5	麦 (wheat)	木 (wood)	蜜 (honey)
Carrier: 我讲X这个字。(I say X this word.)			

- Subjects

2 males and 2 females, between 25 to 35 years old

Acoustic analysis



Acoustic measurements

Duration measurements:

- D_{con} & D_{vow}
- D_{lag} & D_{tone}
- $R[C/V]=D_{Con}/D_{Vow}$
- $R[L/T] =D_{Lag}/D_{tone}$

F0 measurements:

- F_{max} & F_{min}
- $F_{range}=F_{max}- F_{min}$
- $F_{slope}=F_{range}/D_{tone}$

3. RESULTS

3.1 Graphical comparison of the F0 contours

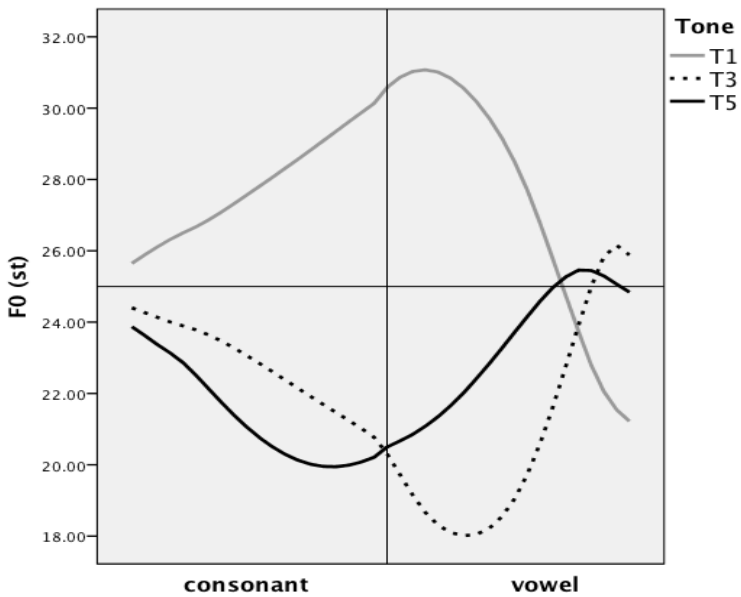


Fig. 2. F0 contours of T1, T3 & T5 (averaged across four speakers)

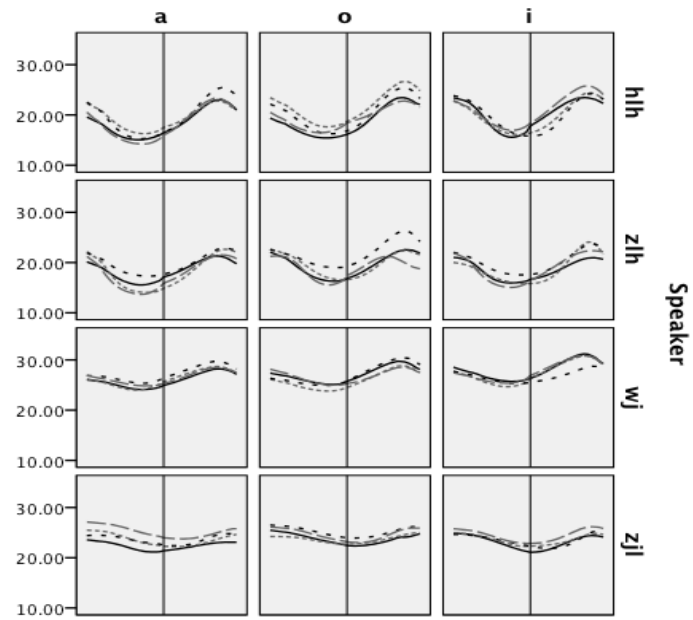


Fig.3 F0 contours of T5

3.2. Quantitative analyses

3.2.1 Duration of consonant and vowel

D_{Vow}: **T3(206ms) > T1(172ms) > T5(93ms)**;

D_{Con}: **T5 (151ms) >** T3(116ms) > T1(112ms);

R[C/V]: **T5(1.76)>**T1(0.65)>T3(0.57).

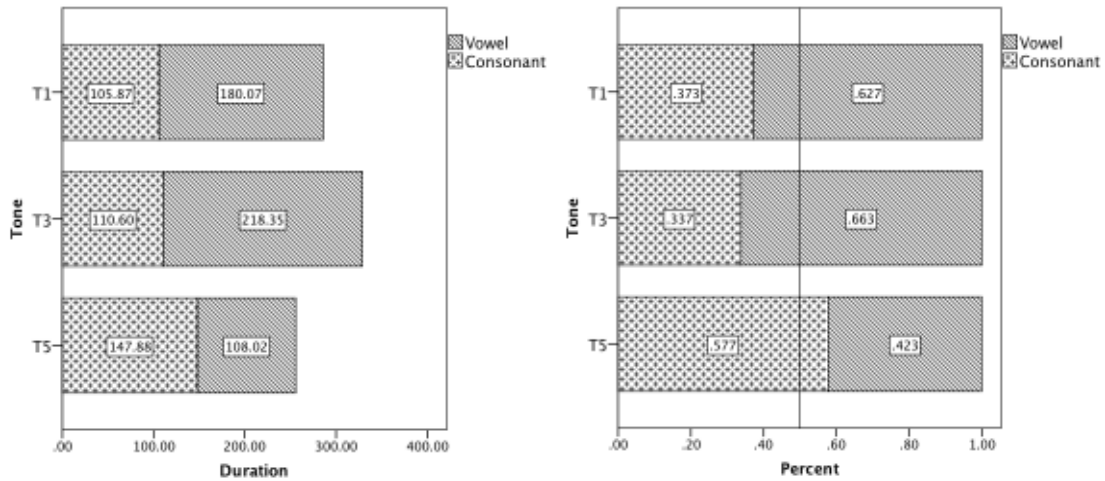


Fig. 4 duration of consonant and vowel (left: absolute duration; right: proportional duration)

3.2.2 Duration of lag and tone

D_{lag}: **T3(196ms)>**T1(144ms) >T5(139ms);
D_{Tone}: **T1(158ms)>T3(144ms)>T5(112ms);**
R[L/T]: T3(1.37)>T5(1.31)**>T1(0.93)**.

*R[L/T]: **T3(1.31)**>T5(1.01)>T1(0.90).

Table. 4: Duration of lag and tone

	T1			T3			T5		
(ms)	Lag	Tone	R[L/T]	Lag	Tone	R[L/T]	Lag	Tone	R[L/T]
M1(hlh)	134.26	143.30	0.94	195.39	161.60	1.22	123.53	121.52	1.03
M2(zlh)	134.89	167.53	0.81	183.59	138.83	1.33	128.18	122.21	1.06
F1(wj)	136.12	148.57	0.95	155.34	113.93	1.38	102.19	108.56	0.95
M ean	**135.09**	**153.13**	**0.90**	**178.10**	**138.12**	**1.31**	**117.97**	**117.43**	**1.01**
F2(zjl)	172.76	172.65	1.02	250.09	165.49	1.56	203.41	96.06	2.18

Fig. 5 duration of lag and tone (left: absolute duration, right: proportional duration)

3.2.3 F0 measurements

F_{max}: **T1(18.25st) >** T3 (13.68st) /T5 (13.38st).

F_{min}: **T3 (5.96st) <T5 (7.81st) <T1(9.46st).**

F_{range}: **T1(8.79st)>T3(7.72st)>T5(5.56st)**.

F_{slope}: T1(0.062)>T3(0.058)**>T5(0.050)**.

Table 5: minF0, maxF0, F0 range and F0 slope

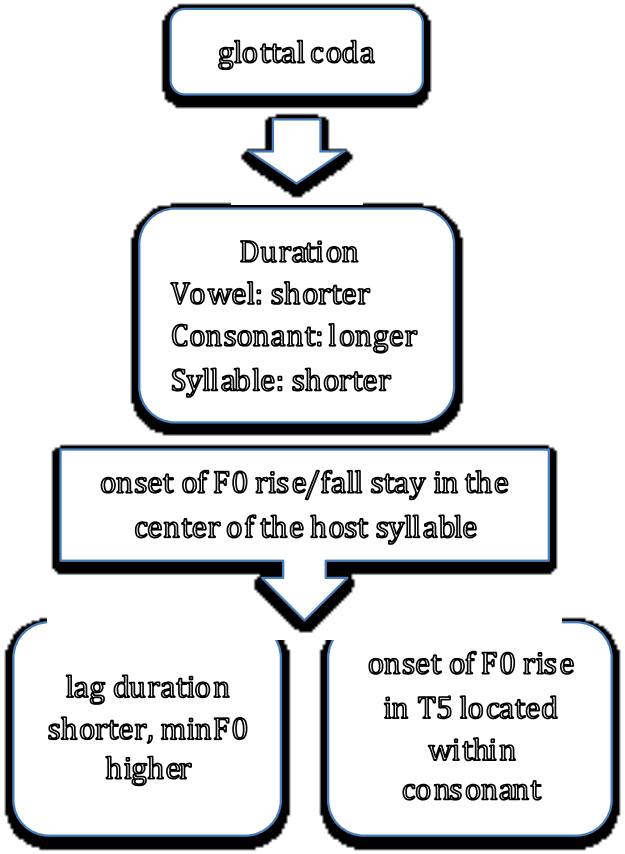
	T1				T3				T5			
(st)	F_{min}	F_{max}	F_{range}	F_{slope}	F_{min}	F_{max}	F_{range}	F_{slope}	F_{min}	F_{max}	F_{range}	F_{slope}
M1(hlh)	4.88	11.62	16.50	81	1.30	12.83	11.53	73	3.92	12.23	8.31	70
M2(zlh)	7.94	8.94	16.88	53	2.49	11.70	9.21	65	4.03	10.67	6.64	54
F1(wj)	13.94	9.43	23.37	64	10.76	16.77	6.01	54	12.85	17.53	4.68	45
F2(zjl)	11.10	5.18	16.28	47	9.31	13.46	4.14	42	10.47	13.11	2.64	35
M ean	**12.52**	**8.79**	**19.82**	**61**	**10.03**	**15.11**	**7.72**	**59**	**11.66**	**15.32**	**5.57**	**51**

Summary

1. The glottal coda (T5) made D_{vow} shortened , while D_{con} lengthened for compensation.
2. The D_{lag} was shorter than T1 & T3, but the R[L/T] of T5 was similar to T1 (close to 1:1).
3. T3 and T5 had the same maxF0 while the minF0 of T3 was significantly lower than that of T5.

Tone	Underlying form	Surface form
T3	LH	LH
T5	LH	LM

4. DISCUSSION



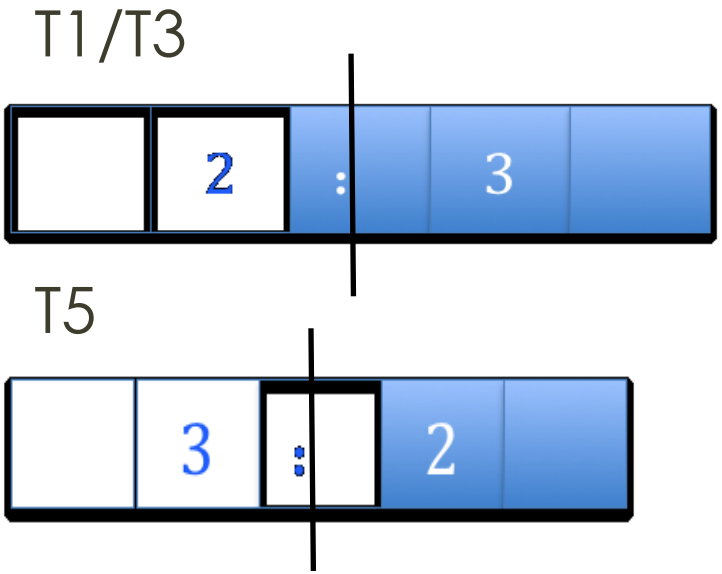


Fig.6 the mechanism of the influence of glottal coda

5. Conclusion & Future work

In this paper, we investigated how F0 contour was aligned with segmental units in Shanghai Chinese. Furthermore, we compared that in open syllable (CV) to those in closed syllable (CVʔ).

However, there is more work to be done. We should investigate the syllables starting with voiceless stops, especially with T4, another checked tone inSHC.

Thank you!