

1. Introduction

- (1) A description of the tonal system of Du'an Zhuang based on phonetic measurement is presented.
 - Of 55 minority languages in China, Zhuang (Tai-Kadai family) has the largest number of speakers.
 - The variety spoken in Wuming is considered the standard variety (Wei & Qin, 1980).
 - However there is a vast degree of dialectal difference within Zhuang (mutual unintelligibility)
- (2) Recent research on understudied languages has similarly focused on phonetic measurements.
 - Elias-Ulloa (2010) on Shipibo (Panoan), Hargus (2007) on Witsuwit'en (Athabaskan) and DiCanio (2008) on Trique
- (3) We aim to describe tonal differences between Du'an Zhuang and Wuming Zhuang via phonetic measurement.
 - There is a **4-way pitch contrast** and a **2-way phonation contrast** in Du'an Zhuang

2. Tone in Chinese and Southeast Asian languages

- (4) Tonal systems in Southeast Asian languages
 - Monosyllabicity; a greater contrastive burden is placed on tone as well as laryngeal contrasts.
 - A larger number of contrastive tones: Burmese has 3 contrastive tones, Thai has 5 tones, Vietnamese has 6 tones.
- (5) Modern descriptions use Chao Tone Letters (Chao, 1930).
 - Tone is represented using the numbers 1 (lowest pitch) through 5 (highest pitch).
 - Syllables are marked with a number representing the starting pitch and another representing the ending pitch.
 - I.e. **53** means the syllable starts with high pitch and falls to a mid-level pitch.

- (6) Wei & Qin (1980) summarize the tonal system of Zhuang as shown below.

Tone	1	3	5	7 short	7 long
Chao	24	55	35	55	35
Example	[na]	[na]	[na]	[nap]	[na:p]
Gloss	'thick'	'face'	'arrow'	'to put into'	'to be stuck'

Tone	2	4	6	8 short	8 long
Chao	31	42	33	33	33
Example	[na]	[na]	[na]	[nap]	[na:p]
Gloss	'field'	'aunt'	'meat'	'to bind'	'to turn in tax'

- (7) Wei & Qin's chart allows for as many as 10 contrastive tones.
 - Tone 3 and 7 short are both **55**; Tone 7 long and tone 5 are both **35**; Tones 6, 8 short, and 8 long are all **33**.
 - Tones 7 & 8 only with obstruent codas (*stopped/checked syllables*); tones 1 to 6 only in open syllables or with sonorant codas (*unstopped/unchecked syllables*). → **6 contrastive tones in Wei & Qin's system (to be revised).**
- (8) Wei & Qin also assume a tonal register split:
 - This split originates from the traditional descriptions of Chinese tone (4 tones split into two).
 - Tones 2, 4, 6, and 8 are lower register, with tones 1, 3, 5, and 7 as the respective upper register equivalents.

3. Tone in Du'an Zhuang: an acoustic analysis

- (9) Consultant: 1 male speaker of Du'an Zhuang (mid 20's) recorded in a sound-proof booth at Rutgers U. in 2007-2008.

- (10) Procedure
 - Zhuang words elicited from Chinese characters, pronounced in isolation to exclude possible tone sandhi effects.
 - The tones for these words in Wuming Zhuang are known, facilitating comparison between the two dialects.

- (11) Data: The number of tokens for each tone

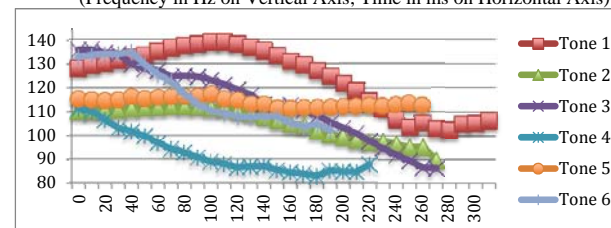
Tone	1	3	5	7 short	7 long
N =	148	33	59	44	18
Tone	2	4	6	8 short	8 long
N =	112	39	31	36	9

- Onset type and coda type is balanced over the tokens.
- If the syllable shapes show a discrepancy, the data is excluded from consideration.

- (12) Analysis using Praat (Boersma 2001)
 - Vowel boundaries are determined by looking for voiced portions with constant intensity (to distinguish nasals).
 - Pitch track data was automatically extracted at 10 ms intervals; duration of the vowels was measured as well.
 - Mean F0's were computed at each interval for each tone. Means were plotted over time as long as there were at least 5 tokens with F0 measurements at a given time.
 - Phonation: H1-A1 spectral tilt values are calculated from average spectra of the second third of the vowel.

3.1 Tones 1 to 6 (Unchecked syllables)

- (13) Mean Pitch Tracks in Du'an Zhuang (Tones 1 to 6, unchecked syllables)
(Frequency in Hz on Vertical Axis; Time in ms on Horizontal Axis)



- (14) **Tones 3 & 6** have identical F0 tracks; a phonation contrast exists: tone 3 is creaky and tone 6 is modal.
 - In Du'an Zhuang, spectral tilt is significantly lower ($p < 0.05$) in Tone 3 (0.53 dB) than in Tone 6 (14.91 dB), indicating tone 3 is creaky and tone 6 is modal.
 - Both are 51, with durations nearly equivalent.
 - Tone 3 mean: 0.175 ms, SD = 0.091
 - Tone 6 mean: 0.177 ms, SD = 0.068
 - These tones are level tones in Wuming, but falling in Du'an:
 - Tone 3 is upper register, with tone 6 as lower register in Wuming.
- (15) **Tones 2 & 4** are falling tones in both Wuming and Du'an Zhuang.
 - In Du'an Zhuang, both fall from 110 Hz to 90 Hz, indicating that there is no register split.
 - Instead, tone 2 falls towards the end and tone 4 falls early.
 - Additionally, tone 4 has lower spectral tilt (4.61 dB - creaky) than tone 2 (7.98 dB - modal) ($p < 0.05$).
- (16) **Tones 1 & 5**: phonetically rising in Wuming; in Du'an Zhuang, tone 1 is rising-falling (**453**) & tone 5 is level (**33**).
 - Spectral tilt measurements for tone 5 (5.14 dB) are lower than tone 1 (9.59 dB), but this difference is less meaningful.

- (17) Comparison of Chao Tones for Wuming & Proposed Chao Tones for Du'an Zhuang

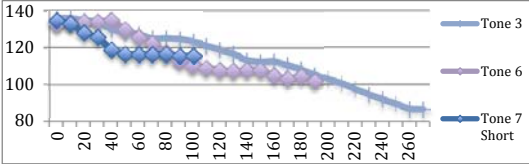
Tone	Wuming Zhuang	Du'an Zhuang	Du'an Zhuang Description	
	<i>Wei & Qin (1980)</i>	<i>Our proposal</i>	<i>pitch</i>	<i>phonation</i>
1	24	453	rising falling	modal
2	31	31 modal	lower falling	modal
3	55	51 creaky	falling	creaky
4	42	31 creaky	lower falling	creaky
5	35	33	mid level	creaky
6	33	51 modal	falling	modal

→ **There is no evidence of a split register tonal system in Du'an Zhuang.**

3.2 Tones 7 and 8 (Checked syllables)

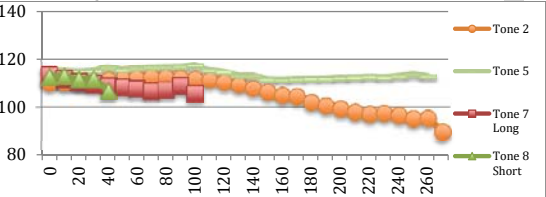
- (18) Vowels with tones 7 & 8 (with obstruent codas) are significantly shorter in duration than the unchecked syllables, but the phonetic evidence presented here suggests that they are allotones of tones 1 to 6.
 - Vowel length is predictably shorter in syllables with obstruent codas (Hubbard 1995 among others).
 - Tones 7 & 8 Short do appear to be significantly shorter than the long versions, however, suggesting a vowel length contrast exists in checked syllables only.
- (19) Tone 7 Short starts high, but unlike Wuming Zhuang where it is a level tone, it is a falling tone in Du'an Zhuang.
 - Tone 7 Short is equivalent to a shortened allotone of Tone 3/Tone 6 (**51**)
 - The presence of a coda accounts for the shorter duration.

(20) Mean Pitch Tracks of Tone 7 Short and Tones 3 and 6 in Du'an



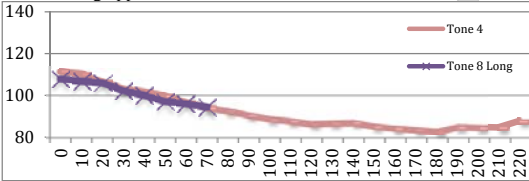
(21) Mean Pitch Tracks of Tone 7 Long, Tone 8 Short and Tones 2 and 5 in Du'an

- Tone 7 Long is rising in Wuming Zhuang, but is level mid tone in Du'an Zhuang, just like Tone 8 Short.
- Tone 7 Long & 8 Short are shortened allotones of either tone 5 (33) or tone 2 (31).



(22) Mean Pitch Tracks of Tone 8 Long and Tone 4 in Du'an

- Tone 8 Long is falling in Du'an Zhuang, unlike Wuming Zhuang, where it is mid-level tone.
- Tone 8 Long appears to be a shortened allotone of tone 4 (31).



(23) Comparison of Chao Tones for Wuming & Du'an Zhuang in Checked Syllables (tone 7 and tone 8)

Word	Wuming Zhuang Wei & Qin (1980)	Du'an Zhuang Our proposal	Du'an Zhuang Description
7 Short	55	53	upper falling
7 Long	35	31	lower falling
8 Short	33	31	lower falling
8 Long	33	31	lower falling

4. Discussion

(24) Tone 2 – Tone 4 Contrast in Du'an Zhuang

- The difference between tone 2 and tone 4 lies in the phonation and the timing of the falling.
- Tone 2 has modal phonation and has a late phonetic fall; it corresponds to [31] in Wuming Zhuang.
- Tone 4 has creaky phonation and has an early phonetic fall; it corresponds to [42] in Wuming Zhuang.
- Cf. Rose (1990) found that creaky phonation manifests with an early fall in pitch.

(25) Level tones in Wuming correspond to the 51 tone in Du'an

- Du'an Zhuang has creaky phonation for Wuming Zhuang tone 3; modal phonation for tone 6.
- Register contrast in Wuming Zhuang corresponds to a phonation contrast in Du'an Zhuang.

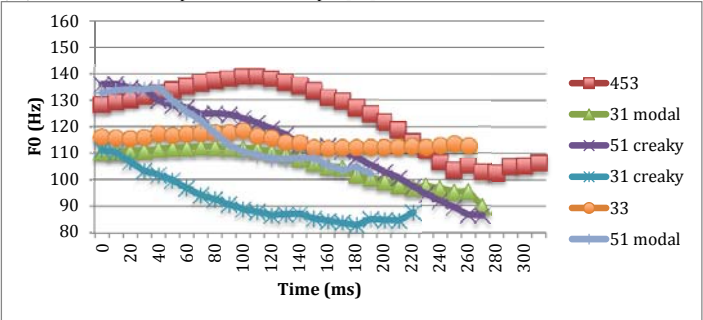
(26) Phonation vs. Tone Contrasts

- Tones 3 & 6 have identical F0 profiles but distinct phonations.
- Tones 2 & 4 have F0 profiles that differ in fall timing; phonation is somewhat distinct.
- Tones 1 & 5 have distinct F0 profiles but fairly similar phonations.
- Hypothesis: In Du'an Zhuang, a phonation contrast is in the process of replacing the register contrast.

(27) Tones in unchecked syllables and checked syllables

Tone 7 and 8 (in checked syllables) are most likely to be allotones of unchecked syllables. We observed three distinctive allotones in checked syllables.

(28) Near Minimal pairs with the shape, [na]



5. Concluding Remarks

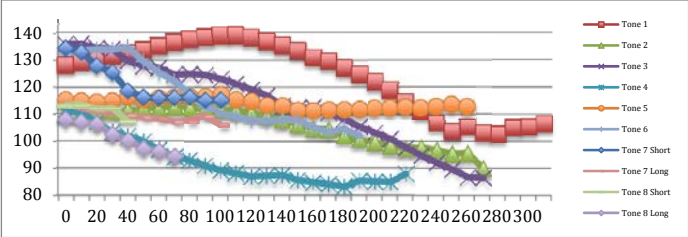
(29) Recommended Tonal Description for Du'an Zhuang based on pitch and phonation

- a 4-way pitch contrast, a 2-way phonation contrast

Our tonal Description		Description	Cf. Traditional Tone		Cf. Traditional Tone in Chao letters	
453	Modal	upper fall	Tone 1		24	
			Tone 2		31	
31	Creaky	lower fall	Tone 4		42	
			Tone 6		33	
51	Modal	fall	Tone 3		55	
			Tone 5		35	
33	Creaky	mid level	7 Long		35	
			8 Short		33	

(30) The traditional Chinese tonal description solely based on pitch can be complemented using acoustic analysis of phonation to adequately describe the tonal system in Du'an Zhuang.

Summary of All Du'an Zhuang Tones



References

Boersma, Paul 2001. Praat, a system for doing phonetics by computer. *Glott International* 5/9/10, 341-345
Chao, Yuen-Ren. 1930. A system of tone letters. *Le Maître Phonétique* 45, 24-27.
DiCanio, C. T. (2008) *The Phonetics and Phonology of San Martín Itunyoso Trique*. PhD dissertation, UC Berkeley.
Fon, Janice and Chiang, Wen-Yu. 1999. What does Chao have to say about tones? *Journal of Chinese Linguistics* 27.1.
Elías-Ulloa, José A. 2010. *An Acoustic Phonetics of Shipibo-Conio (Pano), an Endangered Amazonian Language*. The Mellen Press.
Hargus, Sharon. 2007. *Witsuwit'en grammar: phonetics, phonology, morphology*. Vancouver and Toronto: UBC Press.
Hubbard, Kathleen. 1995. *Duration in Moraic Theory*. PhD dissertation, UCB.
Wei, Qingwen, and Qin, Guosheng. 1980. *Zhuang yu jian zhi*. Beijing: Min zu chu ban she : Xin hua shu dian fa xing.
Yip, Moira. 2002. *Tone*. Cambridge University Press.

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