



# Effect of tone sandhi on singing in Chaozhou dialect

Xi Zhang & Ian Cross

Centre for Music and Science, Faculty of Music, University of Cambridge

## Introduction

- Chaozhou dialect, a branch of Southern Min Chinese, is a tone language with eight tones and a wealth of tone sandhi (see Table 1 on the right). The tone sandhi patterns are final-prominent, the syllable in the final position of a tone sandhi group keeping the value of its citation tone while others in the non-final position undergo sandhi.
- With songs that are sung in the Chaozhou dialect the question arises of whether there is a tone-sandhi effect on melodic construction and tonal realisation. This paper aims to present empirical results from a corpus analysis of Chaozhou songs and an observational study on Chaozhou singers' realisation of tones.

## Corpus analysis

- Hypothesis.** Tones undergo sandhi in Chaozhou songs.
- Materials.** 10 folk songs and 10 contemporary songs were included in the corpus of Chaozhou songs.
- Method.** We looked at the relationship between consecutive tones and consecutive notes in Chaozhou songs using two datasets: one of them was coded based on the values of citation tones (Citation dataset) and another was coded based on the values of tones when they are realised in the context with sandhi (Sandhi dataset). We conducted Pearson correlation coefficient test to assess the correlation between the pitch transitions of tones and of notes in two datasets. We also calculated the rate of matches and mismatches between two consecutive tones and two consecutive notes, taking the form of similar motion, oblique motion or contrary motion (Ladd & Kirby, 2020).
- Result.** Pearson's  $r$  shows that tones and notes in Chaozhou songs were strongly correlated in Sandhi dataset, while the correlation between the two variables in Citation dataset was weak (see Table 2). There is a strikingly higher rate of similar motions in Sandhi dataset than that in Citation dataset (see Table 3).
- Discussion.** These outcomes show that there is a clear effect of tone sandhi on the tone-melody correspondence in Chaozhou songs.

Genre of songs	Dataset	Pearson's $r$
Folk songs (n=1432)	Sandhi	0.87
	Citation	0.22
Contemporary songs (n=815)	Sandhi	0.79
	Citation	0.18

Table 2. The outcomes of Pearson's correlation coefficient test between tones and notes in two genres of Chaozhou songs in Sandhi dataset and Citation dataset.

Genre of songs	Motion	Sandhi dataset	Citation dataset
Folk songs	Similar	<b>1271 (89%)</b>	621 (43%)
	Oblique	147 (10%)	626 (44%)
	Contrary	14 (1%)	185 (13%)
Contemporary songs	Similar	<b>637 (78%)</b>	381 (47%)
	Oblique	150 (19%)	370 (45%)
	Contrary	28 (3%)	65 (8%)

Table 2. Different degrees of tone-melody correspondence in two genres of Chaozhou songs in Sandhi dataset and Cation dataset, measured by the number of matches and mismatches. These matches are called similar motions; the mismatches, on the other hand, are divided into oblique motions and contrary motions. In similar motion, the line of tones and the line of notes; in oblique motion, one line goes up or down while the other stays at the same pitch; in contrary motion, two lines go in opposite directions.

Surface Tone	Form of tone	N	Median	Iqr
tone/35/	Citation	136	2.82	1.68
	Sandhi	102	2.97	1.54
tone/53/	Citation	68	-4.00	4.3
	Sandhi	68	-1.99	2.33
tone/213/	Citation	34	2.00	2.22
	Sandhi	136	1.18	3.32
tone/21/	Citation	102	-0.90	2.84
	Sandhi	68	0.97	3.11

Table 4. Samples, Medians and Interquartile range of four surface tones /35/, /53/, /213/ and /21/ in citation form and sandhi form.

Tone	Traditional Names of tones	Value (citation)	Value (sandhi)	Example
1a	Yin Ping 阴平	33	23	si – 诗poet
1b	Yang Ping 阳平	55	213	si – 死death
2a	Yin Shang 阴上	53/21	24/35	si – 四four
2b	Yang Shang 阳上	35	21	si – 薛surname 'si'?
3a	Yin Qu 阴去	213	42/53	si – 时time
3b	Yang Qu 阳去	11	12	si – 是yes
4a	Yin Ru 阴入	<u>21</u>	<u>33/54</u>	si – 逝disappeared
4b	Yang Ru 阳入	<u>54</u>	<u>21</u>	si – 蚀erosion

Table 1. The citation tones and tone sandhi in Chaozhou dialect, labelled by using the numerical representation of Chao's tone system. The variety presented here is from the area of Chaozhou City. The underlined '21', '33' and '54' are called Chinese entering tones or checked tones, being shorter in duration than the other tones. .

## Observational study

- Hypothesis.** Tones that can be expressed in citation form and in sandhi form are realized differently when they are sung.
- Material.** We used a Chaozhou song 'O $\eta$  a o $\eta$ ' (拥啊拥, 'I am tucking you in, my little baby') based on a traditional Chaozhou nursery rhyme. Four tones /35/, /53/, /213/ and /21/ that have the two underlying sources were included in the observational study (see Table 1 for the tones in citation form and in sandhi form, such as tone /35/, with citation 2b and sandhi 2a).
- Participants.** 34 Participants who are native Chaozhou speakers were invited to sing the song 'O $\eta$  a o $\eta$ '.
- Method.** We textgrided syllables with tones /35/, /53/, /213/ and /21/ in 34 song recordings, normalised the duration of sung syllables and extracted the values of  $f0$  at 10 equal-time points (Xu, 2015). We then calculated the data point that reflected the pitch change by  $\Delta F0 = f_{max} - f_{min}$ , where the  $f_{max}$  was the maximum value of the 10 time points from  $f1$  to  $f10$  and the  $f_{min}$  the minimum. When the  $f_{max}$  occurred before the  $f_{min}$ , the direction of pitch change was counted as fall and marked with a minus sign '-'; conversely, it was counted as rising in the opposite case. 714 data points were then measured in semitones and divided into two groups, citation and sandhi (see Table 4 on the bottom of the left).
- Results.** There were highly significant differences between two underlying forms in relation to the tones /53/ ( $p < 0.001$ ) and /21/ ( $p < 0.0001$ ). However, tones /35/ and /213/ were performed similarly in the two forms (see Figure 1 below).
- Discussion.** The significant differences may be related to the position of the syllable in a phrase that serves as a tone sandhi group. Results suggest that falling citation tones that were in the final position of a phrase tended to exhibit a larger falling contour. However, the pitch change of sandhi tones that are in non-final position may be more affected by the pitches of tones that precede or follow them. Although no significant difference was found between citation /213/ and sandhi /213/, the median pitch changes of the two forms suggested citation tones in the final position tended to be freer of expressiveness, while sandhi tones were relatively less flexible (see Table 4). Overall, the result implies a sandhi effect on the tonal realisation when tones are sung.

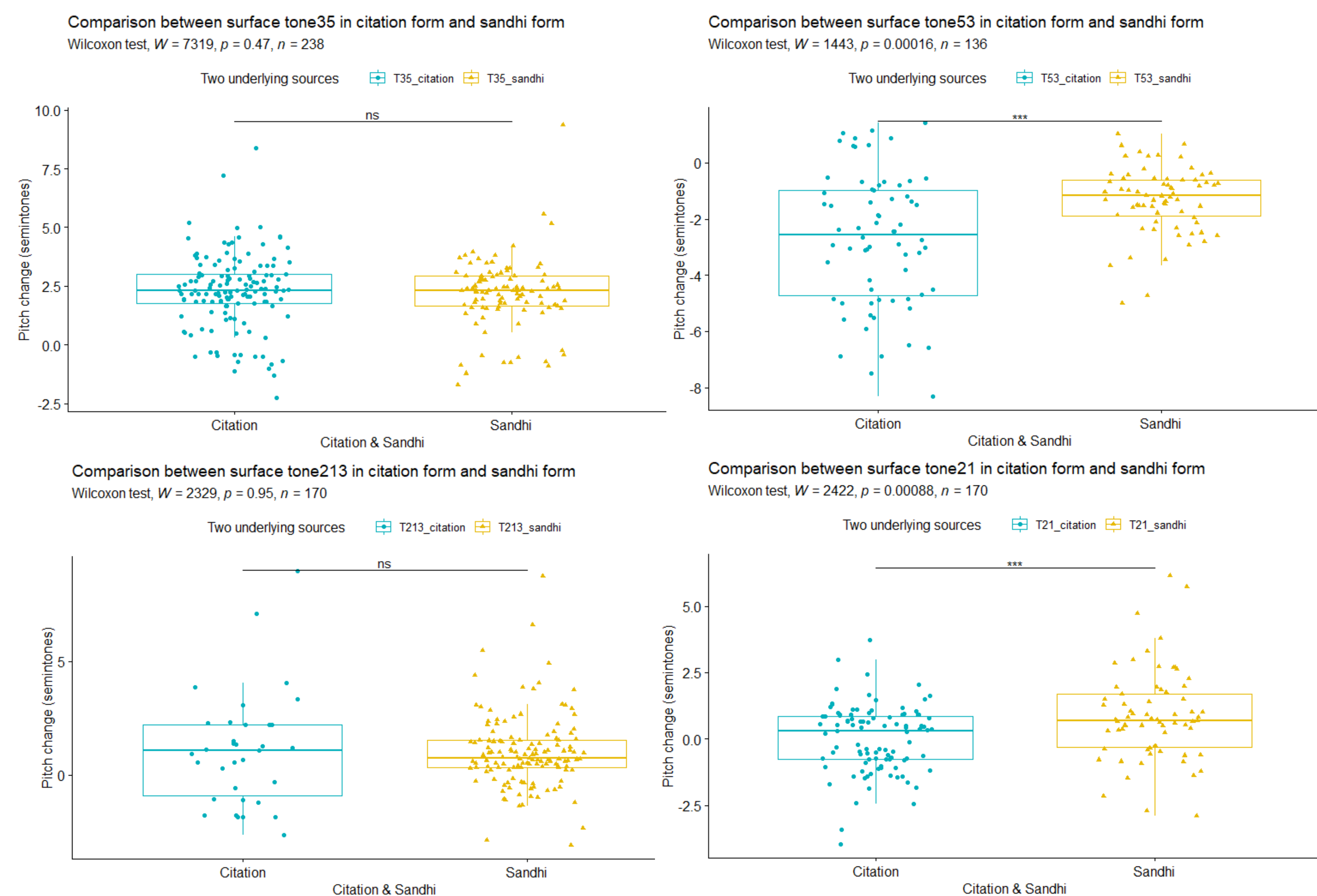


Figure 1. Differences between surface tones /35/, /53/, /213/ and /21/ in citation form and in sandhi form.

## Acknowledgements

The authors wish to acknowledge Sarah Hawkins and Bob Ladd for their suggestions on data analysis and to thank Hai Hua Huang for her enormous help with recruiting participants in Chaozhou.

Contact: Xi Zhang  
xz349@cam.ac.uk

## Bibliography

- Ladd, D. R., & Kirby, J. P. (2020). Tone-melody Matching in Tone Language Singing. In C. Gussenhoven & A. Chen (Eds.), Oxford Handbook of Linguistic Prosody (pp. 676–687).
- Xu, Y. (2013). ProsodyPro — A Tool for Large-scale Systematic Prosody Analysis. In Proceedings of Tools and Resources for the Analysis of Speech Prosody (TRASP 2013), Aix-en-Provence, France. 7-10.