

The neutralization of Xiapu Min tones in disyllabic tone sandhi forms

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Introduction

- Tone sandhi results can result in neutralization.
 - In production, **tone neutralization** can be either **complete** (e.g. Taiwanese Min sandhi circle: Chien & Jongman, 2018; Myers & Tsay, 2008) or **incomplete** (e.g. Mandarin T3-T2 neutralization: Chen & Yuan, 2007; Peng, 2000).
- The **degree of neutralization** can be predicted by the degree of **productivity of sandhi** in nonce words. Productive sandhi usually results in incomplete neutralization; unproductive sandhi results in complete neutralization (Chien & Jongman, 2018).
- Xiapu Min: spoken in Xiapu County, Eastern Fujian, China (Wen, 2015)
- Seven-tone system: Smooth tones: T44, 11, 23, 35, 42; Checked tones (short and ending in glottalization): T5, 2
- Tone sandhi system in Xiapu Min:

	Citation	Sandhi	Transcription	Gloss
Left-Edge	2	44/___X	[xu44 tsɔŋ44]	服装 “clothes”
	23		[xu44 kain44]	护工 “caretaker”
	44		[xu44 tɕin42]	肤浅 “superficial”
Right-Edge	5	55/___X	[i55 tiaŋ23]	一定 “certain”
	35		[i55 ŋuai23]	意外 “accident”
	42		[i55 xeu23]	以后 “later”
Right-Edge	11	42/{44,42}__	[kin44 ŋy42]	金鱼 “goldfish”
	42		[iŋ44 ŋy42]	英语 “English”
Right-Edge	2	5/{44,42}__	[peu55 pa5]	表白 “confess”
	5		[paŋ55 pa5]	半百 “half-hundred”

- Left-edge** sandhi is **more productive** than **right-edge** in Xiapu Min.

Research questions

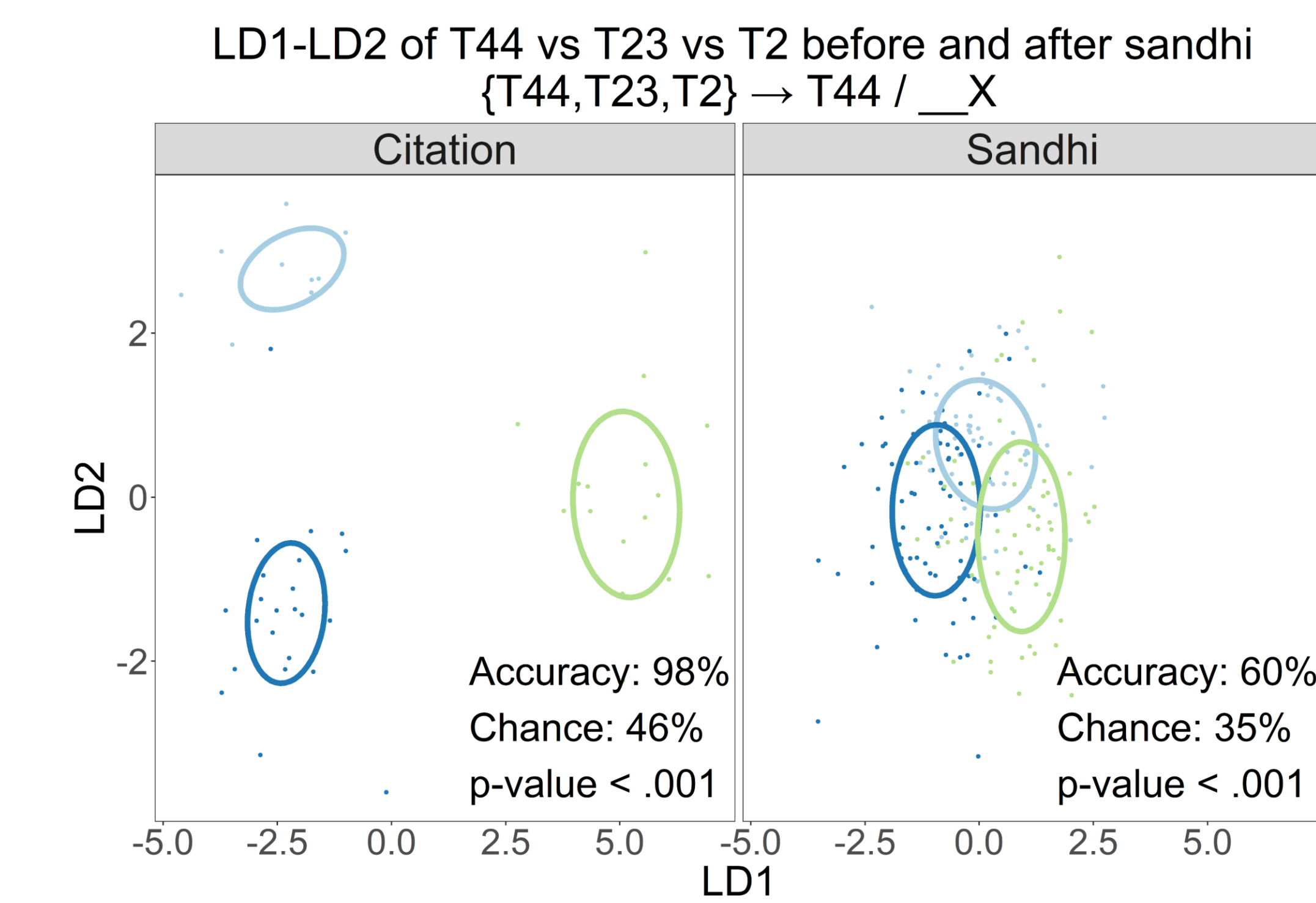
- Degree of neutralization:** Does tone sandhi in Xiapu Min result in complete neutralization in production in Xiapu Min, in terms of F0, voice quality, and duration?
- Productivity and neutralization:** Is **right-edge** neutralization more complete than **left-edge**?

Method

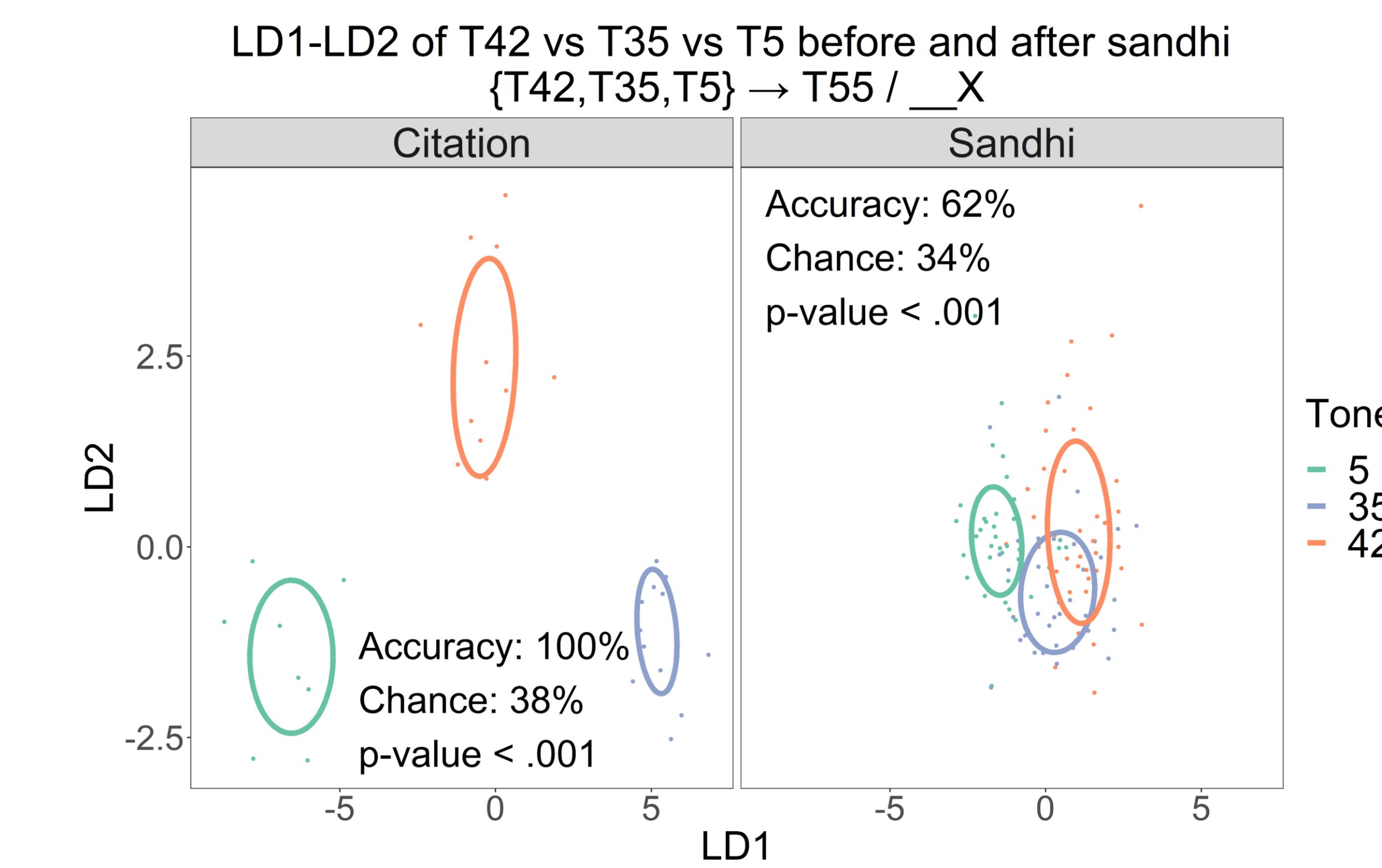
- Subjects:** Four speakers of Xiapu Min
- Stimuli:** Disyllabic compounds: Neutralized targets are minimal pairs; Tone of the environment segment is controlled; 101 tokens * 2 reps

Sandhi neutralization results

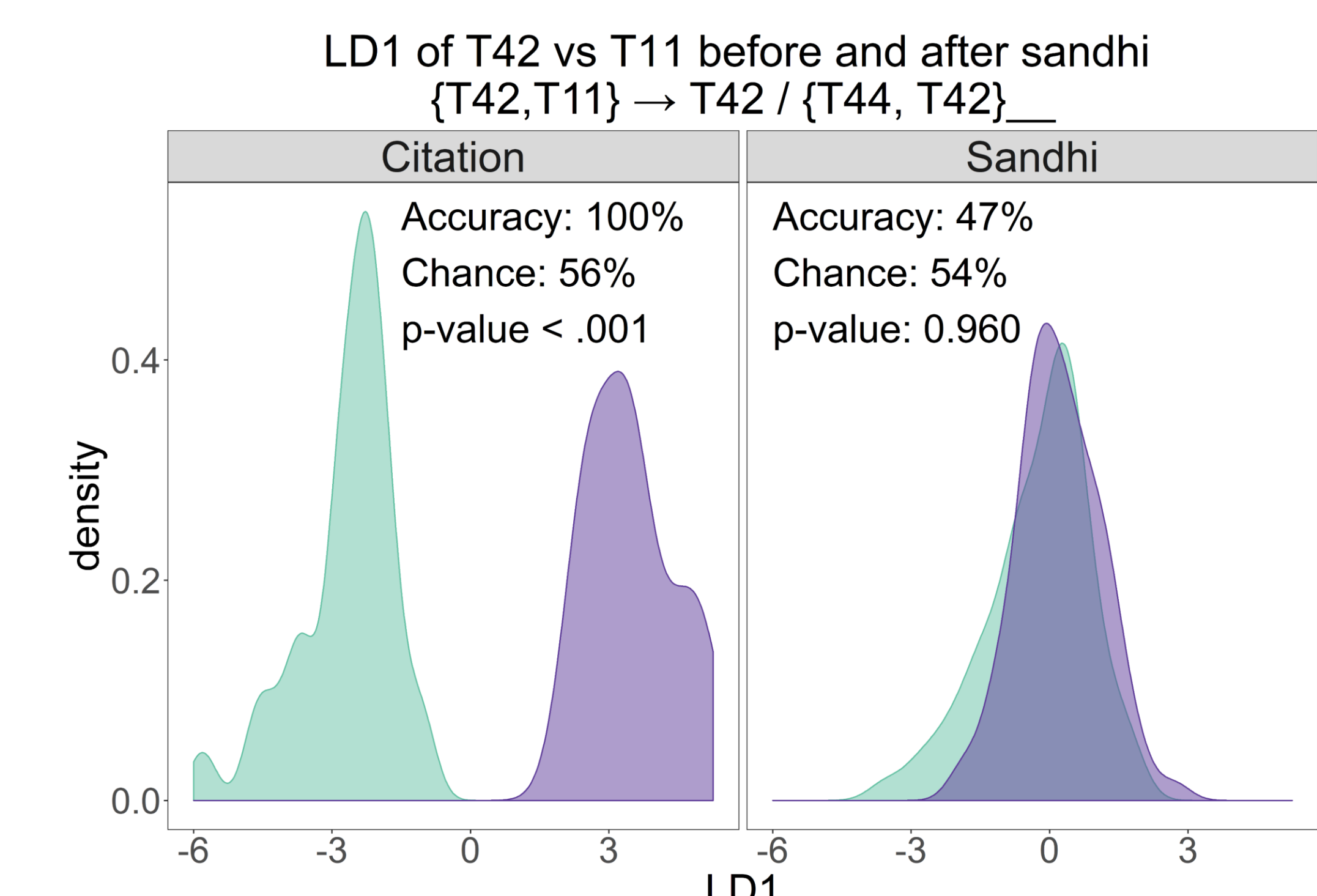
- Parameters:** F0_onset, mid, offset; H1*_onset, mid, offset (vocal fold constriction; see Chai & Garellek, 2019 for the calculation of H1*); HNR_onset, mid, offset (noise); Duration (all z-scored by subject)
- Models:** Linear discriminant analysis: $lda(\text{Underlying tone} \sim \text{Parameters})$



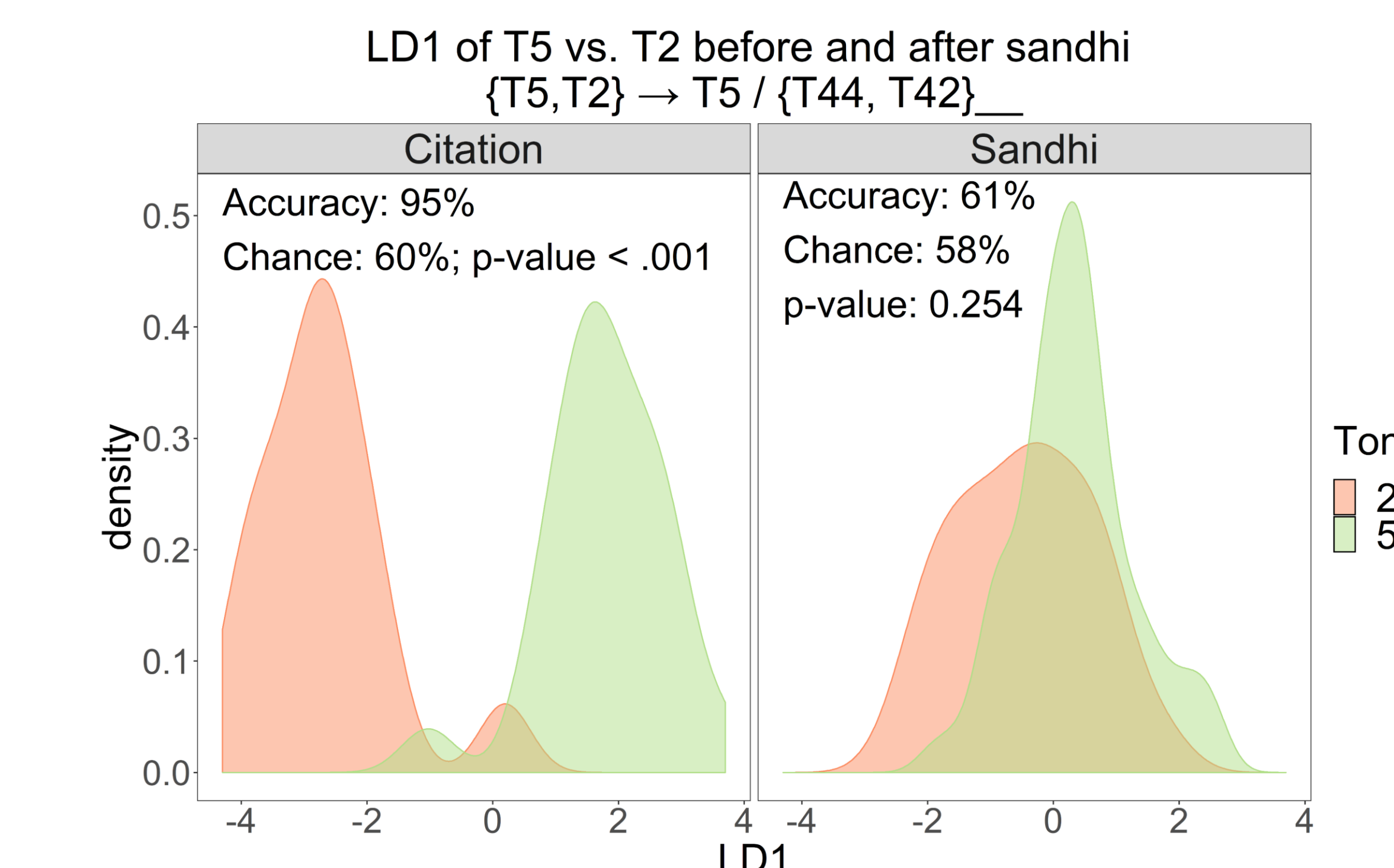
- | | CITATION | SANDHI |
|-----|--|--|
| LD1 | <ul style="list-style-type: none"> Separates T2 from T23 & T44; Most associated with onset F0 and final H1*. | <ul style="list-style-type: none"> Separates T44 from T2; Most associated with onset F0 and duration |
| LD2 | <ul style="list-style-type: none"> Separates T23 from T44; Most associated with mid F0. | <ul style="list-style-type: none"> Separates T23 from T44 & T2; Most associated with onset and mid F0 |



- | | CITATION | SANDHI |
|-----|---|--|
| LD1 | <ul style="list-style-type: none"> Separates three tones; Most associated with onset F0 | <ul style="list-style-type: none"> Separates T5 from T35 & T42; Most associated with duration |
| LD2 | <ul style="list-style-type: none"> Separates T42 from T35 & T5; Most associated with offset H1*. | <ul style="list-style-type: none"> Separates T5 from T35; Most associated with mid F0 |



- CITATION & SANDHI
- LD1 most strongly associated with **F0 in middle third**, followed by the **offset F0** and the **onset F0**



- CITATION SANDHI
- LD1
- Most associated with **mid F0**
 - Most associated with **onset F0**

Result summary

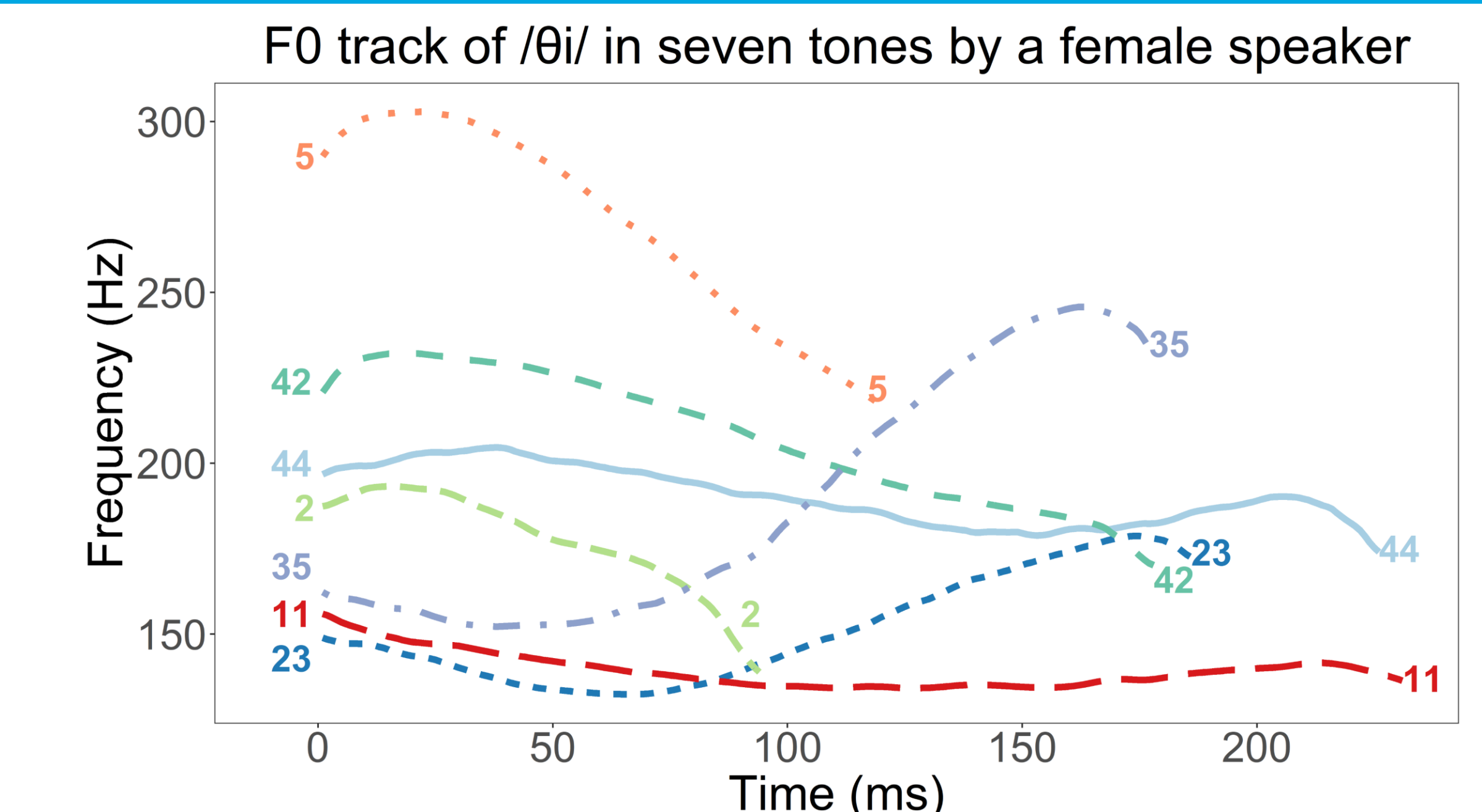
	CITATION accuracy	SANDHI accuracy (chance level)
T44 vs 23 vs 2	98%	59% (34%)
T42 vs 35 vs 5	97%	61% (34%)
T42 vs 11	100%	46% (53%)
T5 vs 2	100%	61% (58%)

- The classification of **left-edge** sandhi tones was **above chance** and the LDA models were significant.
- The classification of **right-edge** sandhi tones was **below or near chance** and the LDA models were **NOT** significant.
- The **phonation differences** between checked and unchecked tones are **largely neutralized** in sandhi.
 - Citation** tones are differentiated by **F0** and **H1*** (lower particularly for checked tones)
 - Sandhi** tones are differentiated by **F0** and **duration**

Conclusions

- Sandhi in Xiapu Min results in tonal neutralization in production. The differences in **F0** and **duration** are **preserved** in sandhi forms but the **phonation difference** is **lost**.
- The neutralization at **right-edge** is **more complete** than at **left-edge**, confirming that **less productive** sandhi results in **more complete** neutralization in production.

Appendix: Seven tones in Xiapu Min



References

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