



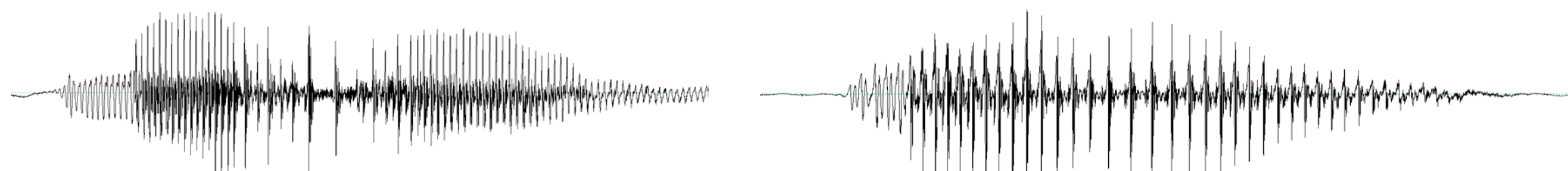
The covariation between phonation and pitch: creaky voice in Mandarin tones

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Creaky voice in Mandarin

- Tone 3 (214, or T3) is often realized with creaky voice (Hockett, 1947; Chao, 1956; Davison, 1991; Belotel-Grenié and Grenié, 1994)
- The presence of creaky voice can facilitate Tone 3 identification (Belotel-Grenié and Grenié 1997; Yang 2011)



Examples of creaky voice in Tone 3

Question: What mechanism leads to the presence of creaky voice in the Mandarin tonal contrast?

Hypotheses:

Creaky voice is tied to T3, vs. driven by low pitch targets

Presence of creak in tonal production

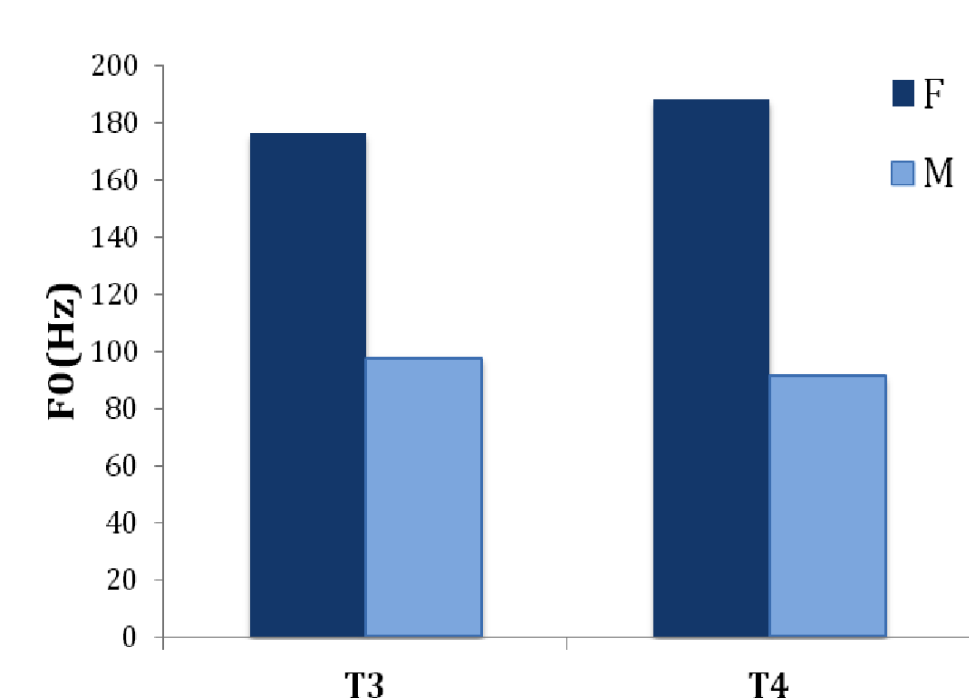
Is the presence of creak T3-specific, or for all low-F0 targets?

Data: Syllable “ma” produced in isolation form; 6M/6F native Mandarin speakers from Beijing; Tones with low targets: Tone 3 (214) and Tone 4 (51)

Presence of creak in previous and current studies

	Style	Speakers	Tone 1	Tone 2	Tone 3	Tone 4
Current study	Laboratory	6F/6M	--	--	60/60	39/60
Belotel-Grenié & Grenié 1997	Laboratory	4M/3F	0/53	8/44	40/51	18/56
Belotel-Grenié & Grenié 2004	Broadcast	1F	0/55	1/40	17/64	4/121

Creak happens at similar pitch values for T3 and T4



- Supports the hypothesis that only F0 values matter for the presence of creaky voice in Mandarin.
- Creak is the sign of lowest pitch; whenever speakers reach the bottom of their pitch ranges, they tend to creak, no matter with what tonal categories.

Acknowledgements

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The effect of pitch ranges on voice quality

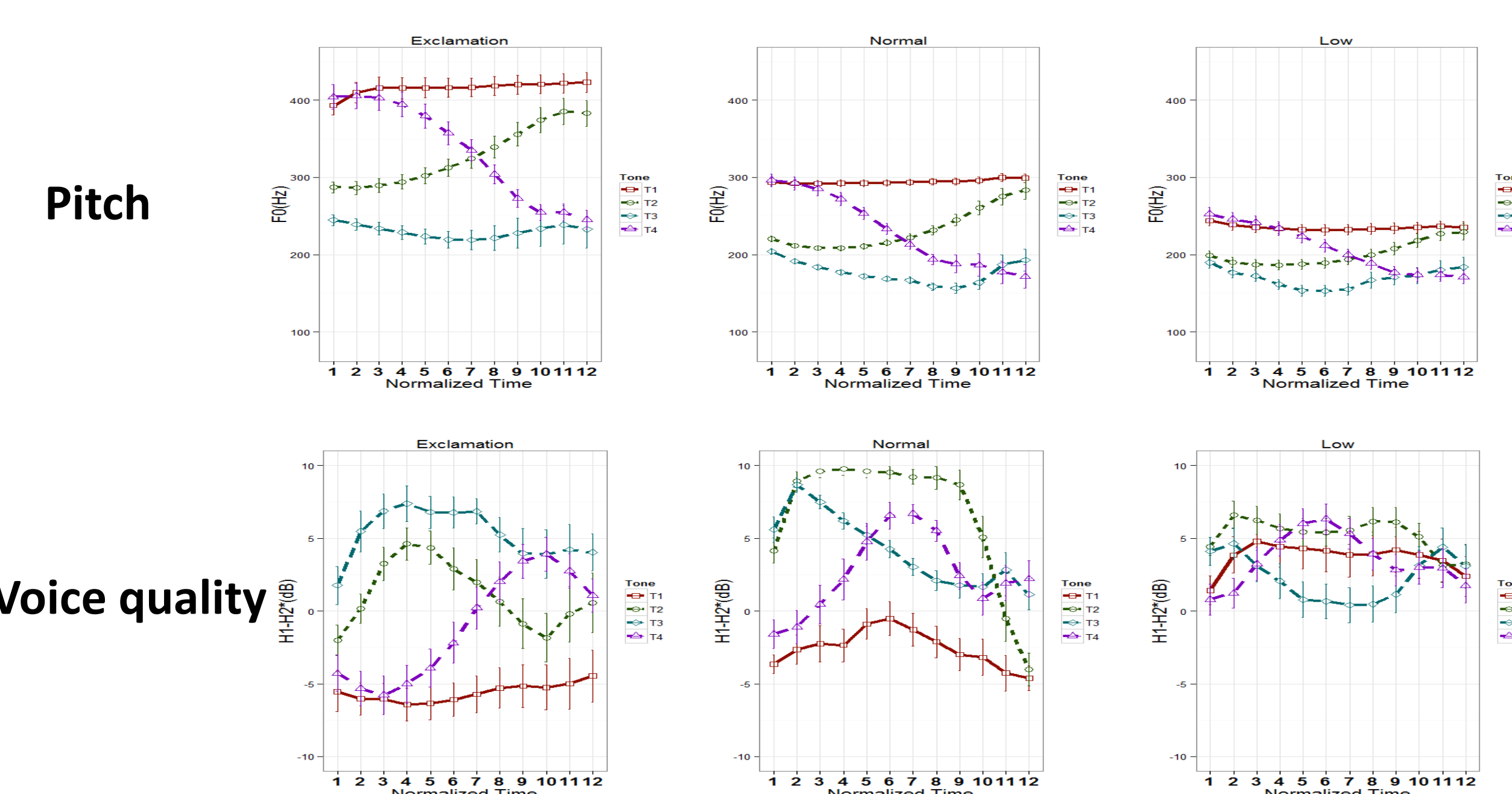
Can pitch ranges affect the voice quality of tonal production?

Data: 22 Mandarin speakers (11M/11F); lexical tones with the syllable “shi” (orthographic transcription of “师时使是”) in three different conditions:

- Exclamation: words are produced as if there is an exclamation mark after the word (e.g. shi!);
- Normal pitch: words are produced in speakers' most comfortable pitch ranges;
- Low pitch: words are produced in a lower pitch range.

Tone production in three conditions

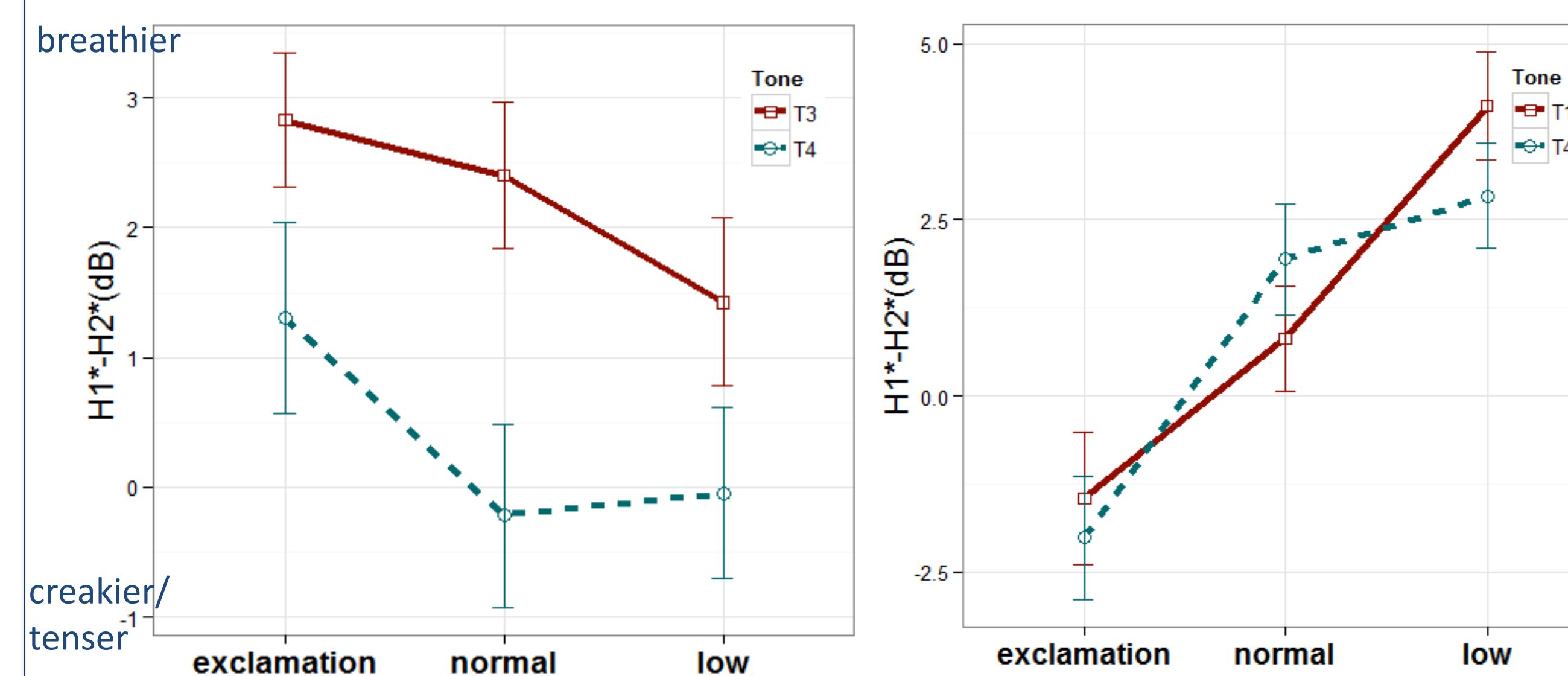
(showing female data)



Mean H1*-H2* by pitch targets

Low targets

High targets



Pitch ranges affect the voice quality in both low targets and high targets of Mandarin tones:

- low targets: breathier when pitch range is raised; creakier when pitch range is lowered
- high targets: tenser when pitch range is raised, breathier when pitch range is lowered.

Non-modal phonation in Mandarin is very sensitive to pitch range

The relationship between pitch height and voice quality

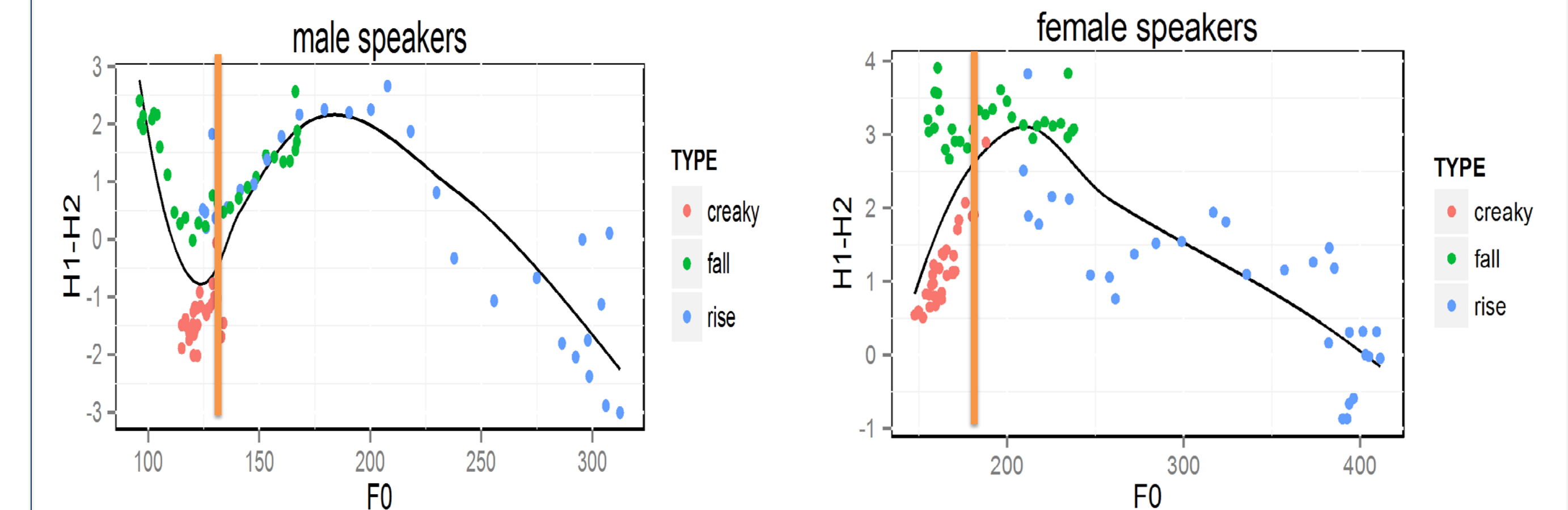
How does voice quality co-vary with the pitch scale?

Data: The same 22 Mandarin speakers produced

- Pitch rising
- Falling into breathy voice to avoid creak
- Naturally falling into creaky voice

All the pitch glides start from a comfortable F0

Relationship between F0 and H1*-H2*



- Voice quality co-varies with pitch height in a wedge-shaped way, with breathiest voice quality in the mid range, and creakier and tenser voice quality as pitch moves lower or higher.
- Non-modal phonation (either creaky or breathy) is likely to occur when F0 is lower than the break points shown by the vertical orange bars (~130 Hz for men, ~180 Hz for women)

Conclusions

- ❖ Creaky voice in Tone 3 is driven by low pitch targets
- ❖ Pitch range can affect the voice quality in producing Mandarin tones
- ❖ Voice quality co-varies with pitch in a wedge-shaped way
- ❖ Non-modal phonation is likely to occur when F0 falls below certain values

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