

Creaky voice variation across language, gender and age in Canadian English-French bilingual speech



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BACKGROUND

Acoustics of creaky voice

A voice quality often characterized by a bundle of acoustic properties:

- Low pitch
- Irregular vocal pulses
- Decreased transglottal airflow

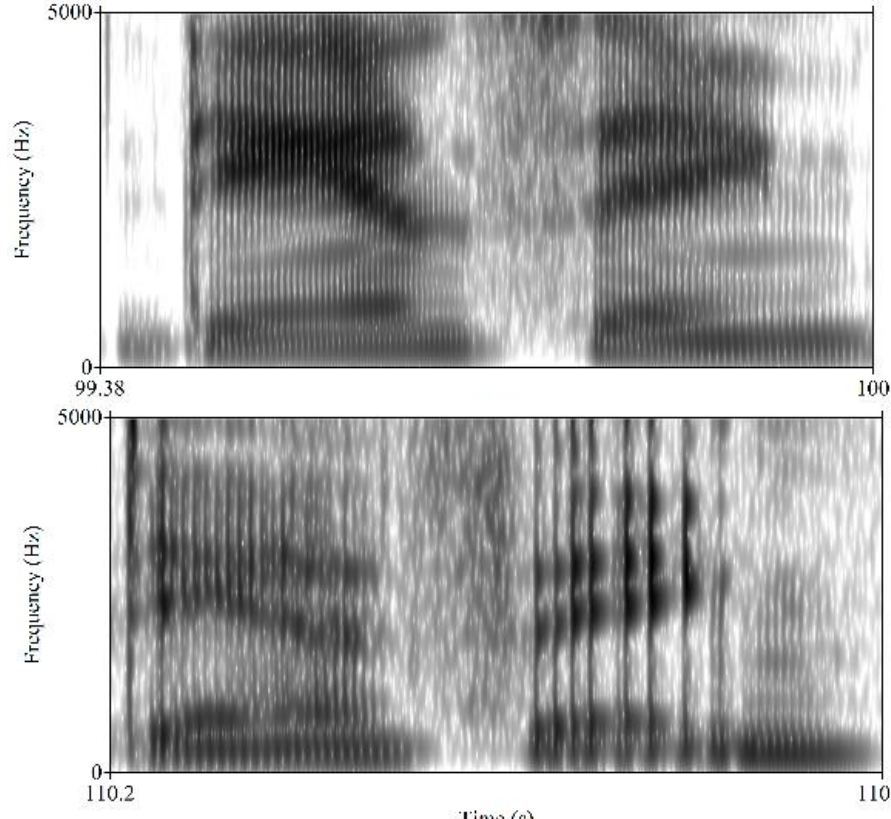


Figure 1: Spectrograms of modal voice (top) and creaky voice (bottom) productions of the word “dancing” from speaker F27.

Motivation: Why study creaky voice?

Insight into whether voice quality is a **language-dependent** [1,2] or **speaker-dependent** [3] parameter

No clear consensus on gender differences

- Some find more creak in men’s speech than in women’s [4,5,6]
- Some find more creak in women’s speech than men’s [7,8].
- Others find no clear gender differences [9,10].

... Nor on the effect of age/time.

- Broader community-level sound change [8,11]?
- Age-graded variation [12,13]?
- Vocal aging [14,15]?
- No mediation by age [16,17]?

RESEARCH QUESTIONS

Does the prevalence of creaky voice vary cross-linguistically?

How does creaky voice differ acoustically by gender?

Is there any empirical evidence for sound change?

METHOD

Data collection: Corpus

- 49 English-French bilinguals
- Born and raised in Ontario/Quebec
- Born between 1937 and 2000 (21-82 years)
- Recorded in the last decade
- ≈ 5-minute clips from publicly available audio
- 93k vowels
- Spontaneous speech from public figures

Statistical analysis: LMMs

Main effects

- Language
- Gender
- YOB

Control effects

- Utterance position
- Vowel height
- Phonological context
- Speech rate

Random effects

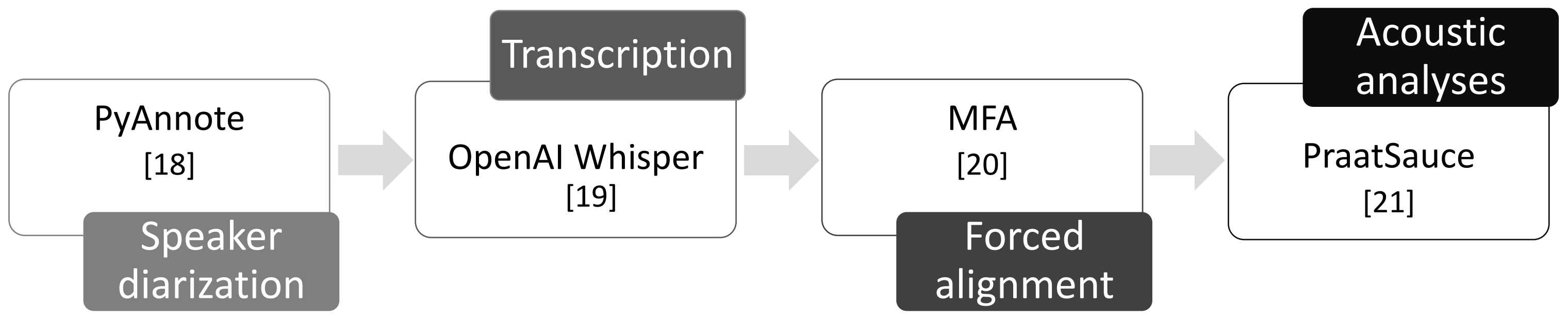
- By-speaker and by-word random intercepts and slopes

Acoustic correlates of creak

Type	Acoustic measure	Indicator of:	Values for more creak
Pitch track	f0	Pitch	Lower
	Prop. unrel. tracks	Irregular voicing	Higher
Spectral tilt	H1*-H2*	Glottal constriction	Lower
Harmonics-to-Noise Ratio	CPP	Noise (entire freq. range)	Lower
	HNR05	Noise (0-500Hz)	Lower
Disturbance index	Jitter	f0 variability	Higher
	Shimmer	Amplitude variability	Higher

Table 1: Acoustic correlates of creak

Automatic data treatment pipeline



RESULTS

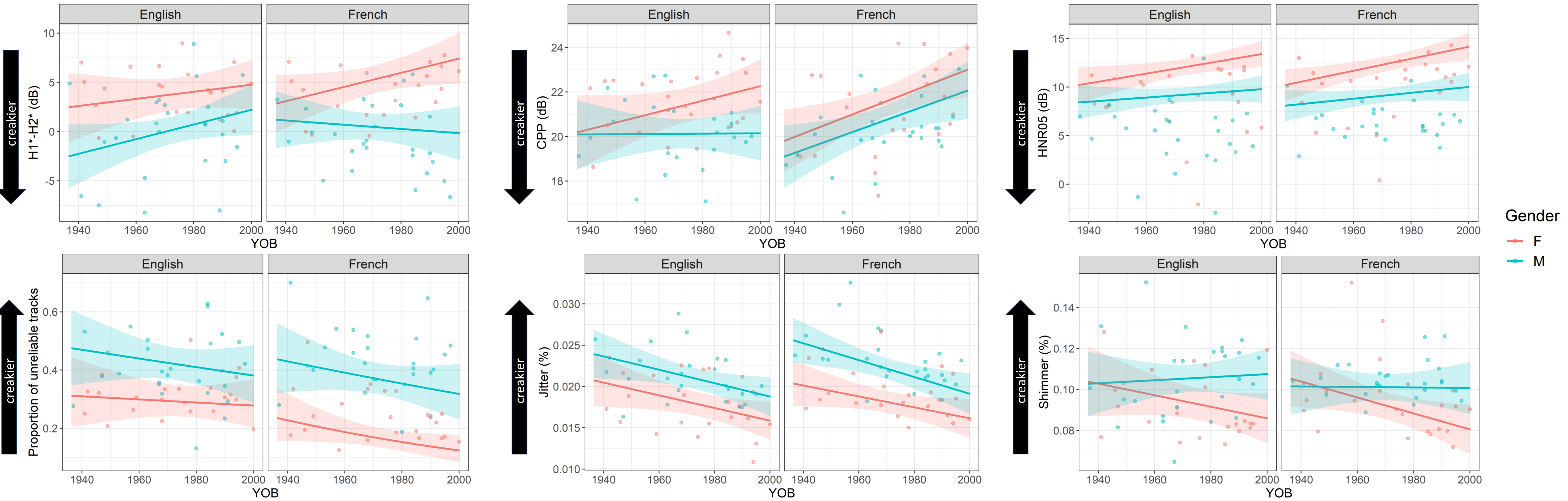


Figure 2: All model predictions and by-speaker empirical means for acoustic measures by language, gender and YOB.

Language

English speech shows:

- **more unreliable pitch tracks** (FR: $\beta = -0.46$, $z = -4.52$, $p < 0.0001$).
- **Language effects are limited.**

YOB

Older speakers show:

- **lower f0** ($\beta = 20.54$ Hz, $t = 3.47$, $p = 0.001$)
- **lower CPP** ($\beta = 1.20$ dB, $t = 2.81$, $p = 0.007$)
- **lower HNR05** ($\beta = 1.45$ dB, $t = 2.88$, $p = 0.006$)
- **more jitter** ($\beta = -0.0029$, $t = -3.50$, $p = 0.0009$).

If anything, older speakers are creakier than younger speakers.

Gender

Men show:

- **lower f0** (M: $\beta = -72.40$ Hz, $t = -12.72$, $p < 0.0001$)
- **higher proportions of unreliable f0 tracks** (M: $\beta = 0.84$, $z = 5.73$, $p < 0.0001$)
- **lower H1*-H2*** (M: $\beta = -4.36$ dB, $t = -5.66$, $p < 0.0001$)
- **lower CPP** (M: $\beta = -1.01$ dB, $t = -2.61$, $p = 0.01$)
- **lower HNR05** (M: $\beta = -3.05$ dB, $t = -6.49$, $p < 0.0001$)
- **more jitter** (M: $\beta = 0.0035$, $t = 4.58$, $p < 0.0001$)
- **more shimmer** (M: $\beta = 0.01$, $t = 3.16$, $p = 0.003$).

Men are clearly creakier than women.

Acoustic correlates of more creak	Language	Gender	YOB
Low f0	∅	M > F	O > Y
High prop. unrel. tracks	Eng > Fr	M > F	∅
Low H1*-H2*	∅	M > F	∅
Low CPP	∅	M > F	O > Y
Low HNR05	∅	M > F	O > Y
High jitter	∅	M > F	O > Y
High shimmer	∅	M > F	∅

Table 2: Summary of results for all acoustic correlates of increased creak by Language, Gender and YOB/Age. Gradient colours show p-values (darker shading indicates lower p-values).

DISCUSSION

Within-speaker **cross-linguistic differences are limited at best.**

Canadian English-French bilinguals’ speech argues for **similar voice qualities across languages** (aligning with [3]).

Acoustically, men’s vowels are unequivocally creakier.

The **acoustics** of creaky voice are distinct from its **perception**.

- Complex interactions between pitch, gender and creak [22,23].

None of the acoustic cues support increased creak for younger speakers/generations.

Vocal aging seems likely.

- Convergence on more creakiness with age [12,13,14,15].
- Consistent with pitch decreasing with age [24,25].

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