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Characterizing Vocal-Fold Dynamics in Singing Vocal Modes from Complete Vocal Technique (CVT) using High-Speed Laryngeal Imaging and Electroglottographic Analysis

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Background

- Complete Vocal Technique (CVT) pedagogy classifies voices in four vocal modes: Neutral, Curbing, Overdrive and Edge.¹
- Recent laryngostroboscopic imaging studies have demonstrated visibly different laryngeal gestures between Curbing, Overdrive and Edge.^{2,3}
- Previous study has reported EGG-derived contact quotient (CQ_{EGG}) mean values: Curbing 50.95%, Overdrive 53.10% and Edge 53.09%.³
- Overdrive has been associated with stronger vocal-fold adduction than in falsetto.⁴

Objectives

1. Examine vocal-fold dynamics in CVT four vocal modes by means of high-speed laryngeal imaging techniques (Optical Flow Glottovibrogram (OFGVG) and Glottal Area Waveform (GAW))⁵ and electroglottographic (EGG) analyses.
2. Test the feasibility of the methods to assess vocal modes.

Materials and Methods

Database

Participants

Five non-classical singers (3 F mean age 38 yo; 2 M mean age 41 yo) with 7-10 years of experience in using CVT method.

Vocal tasks

Sustained vowels at same pitch (Bb4 - 466 Hz for female singers, F4 - 349 Hz for male singers) in CVT four vocal modes

Vowels and loudness for the vocal mode samples were selected according to recommendations by CVT¹ and the subjects' sensation of comfort (Table 1).

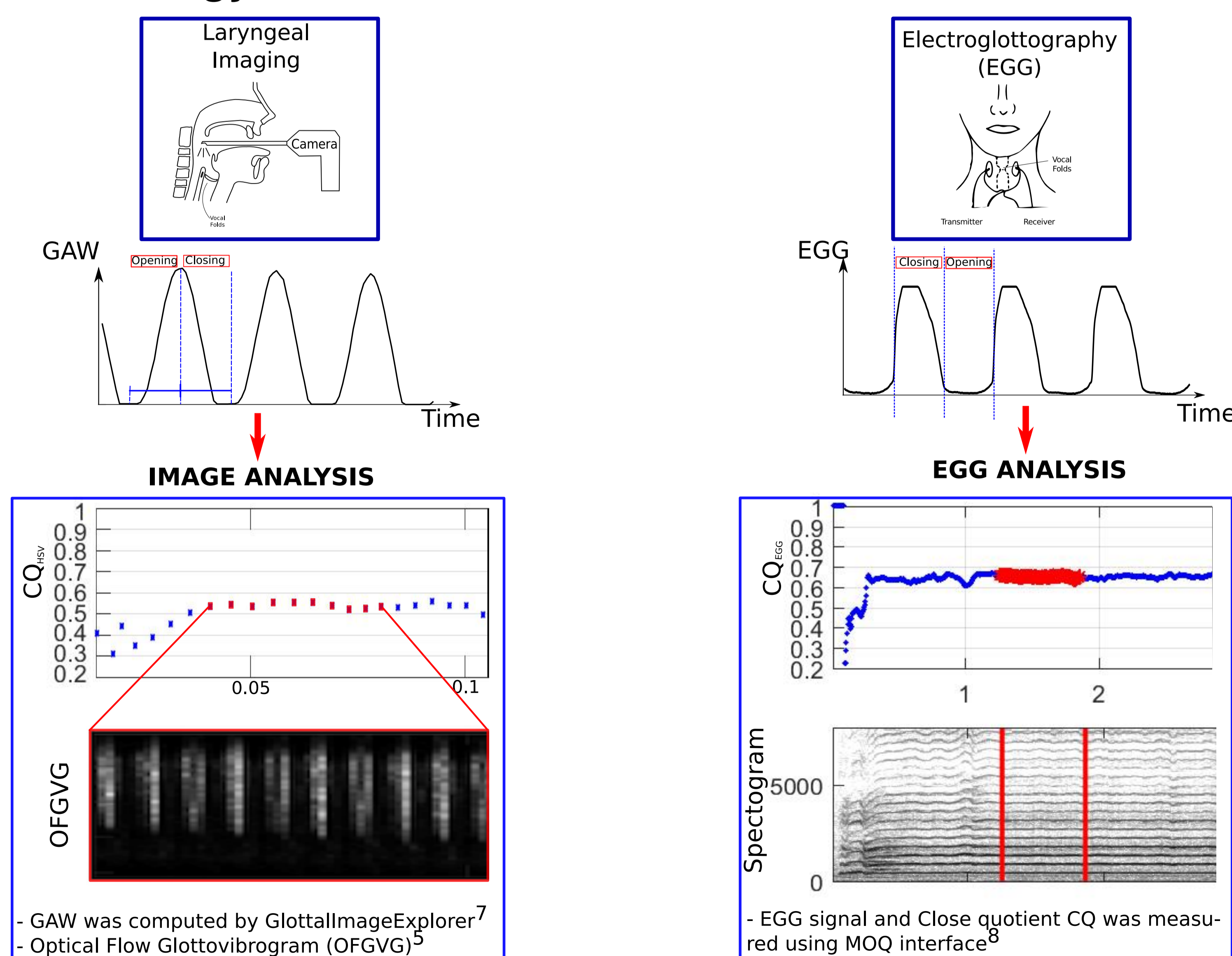
Vocal Mode	Vowel	Phonetics IPA	Loudness
Neutral	'Ee' as in 'see'	close front vowel [i:]	from very quiet to medium quiet
Curbing	'Uh' as in 'Hungry'	open-mid back vowel [ʌ:]	from medium quiet to medium loud
Overdrive	'Eh' as in 'stay'	open-mid front vowel [ɛ:]	from medium loud to very loud
Edge	'Eh' as in 'stay'	open-mid front vowel [ɛ:]	from medium loud to very loud

Table 1: Requested vowels according to CVT description¹, International Phonetic Alphabet (IPA) correlates⁶, and loudness according to CVT description¹.

Recordings:

- KayPENTAX High-Speed Video System (Model 9700); 70° rigid endoscope, and 300-W constant Xenon light source (KayPENTAX Model 7152).
- 2000 frames per second (fps), sample duration 4 seconds.
- Dual-channel EGG (Glottal Enterprises, EG-2), audio interface (Roland Quad-Capture) recording with Praat (44.1. kHz, 16-bit).

Methodology



Results

- EGG-derived contact quotient (CQ_{EGG}) was found to range between 44-72% of glottal-cycle duration for the three vocal modes Curbing, Overdrive, and Edge.
- Lowest values and greater variability was found in Neutral mode, with contact quotient ranging between 12-57% of glottal-cycle duration.
- Vibratory behaviors reflected on high-speed kymograms and optical-flow play-backs

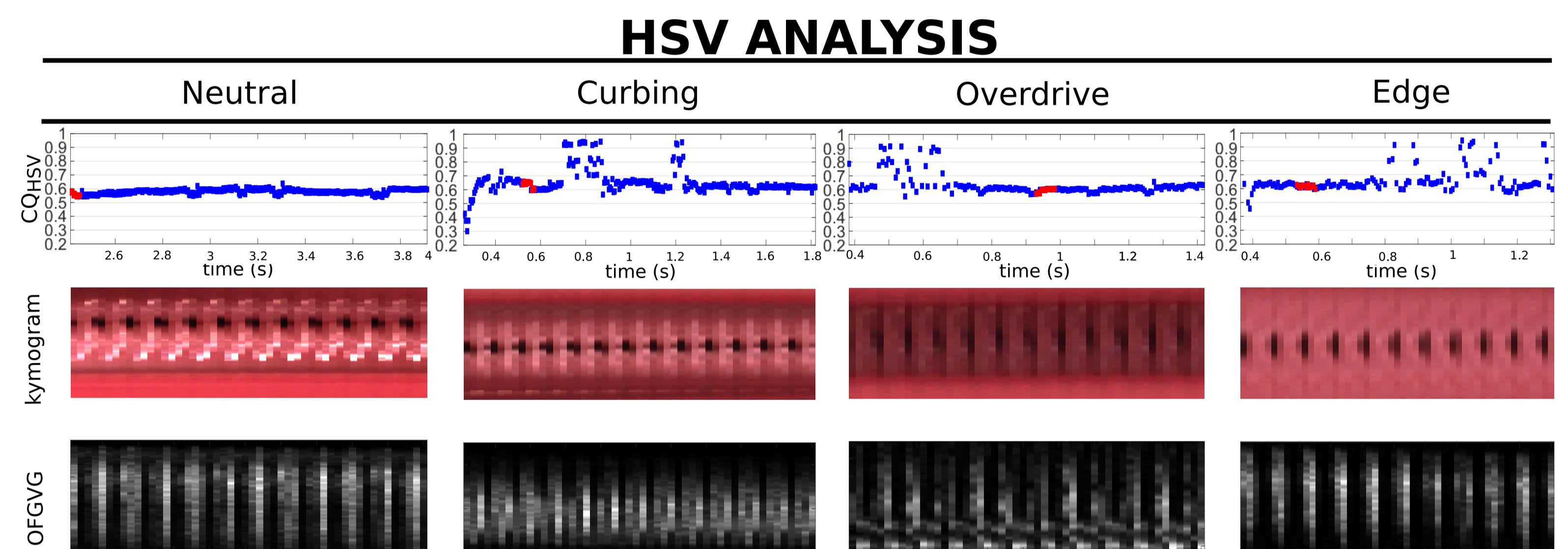


Figure 1: Image analysis results of a female using the CVT four vocal modes. First row: CQ plots. Second row: Kymograms taken from the medial axis. Third row: OFGVG play-backs.

EGG ANALYSIS

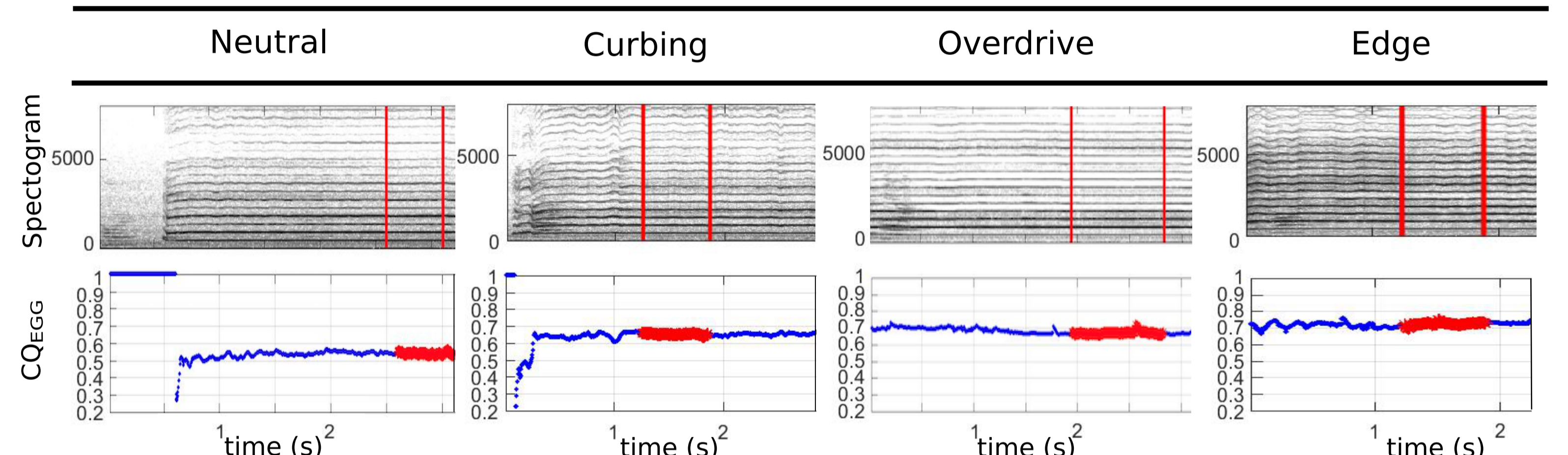


Figure 2: EGG analysis results of a female using the CVT four vocal modes. First row: Spectrograms. Second row: CQ plots.

Conclusions

- Curbing, Overdrive and Edge, as louder and metallic vocal modes, were produced with more vocal-fold adduction resulting in higher contact time, relative to quieter and non-metallic Neutral mode.
 - Curbing, Overdrive and Edge could not be distinguished as separate categories on the basis of EGG analyses.
- This could be related to the feasibility of highspeed endoscopy for vocal-mode assessment. The rigid endoscopy interferes with the singer's lingual and labial articulatory behavior modifying the resulting vowel and the expected sound for a given vocal mode.

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