Glottal adduction and spectral envelope variation at singing diatonic scales with different dynamic shapings

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Background
In classical voice training one of the main goals is the timbral consistency (Miller 1996). Voice quality depends (1) on the vibrational characteristics of the vocal folds, and (2) on the shape and size of the vocal tract (Fant 1960).

Closed quotient (CQ) shows the proportion of the closed time of the glottis in a vibrational cycle. 

CQ < 0.3 — breathy
CQ > 0.6 — pressed phonation (Titze 1994)

CQ between about 0.4–0.5 — “flow phonation” allows producing maximum sound power (Titze & Sundberg 1992).

Vocally untrained persons tend to increase glottal adduction with pitch and loudness, but professional singers tend to avoid such automatism (Björkner et al. 2006). In the case of steady sounds, the voice timbre is determined primarily by variable spectral envelope (Heller 2012).

Aims
(1) Does the assumption of Björkner et al. hold, when classically trained male singers sing ascending scales with various dynamic shapings?
(2) whether and how the dynamic changes are expressed in the voice spectrum?

Method
Ten professional male singers and voice students were asked to sing the ascending D-major scales on vowel /a/ three times:

(1) p — with most habitual dynamics without intentional dynamic changes,
(2) f — idiosyncratic variability in the case of high tones (in the piano task).

The recordings were done in a studio with low reverberation (T30 = 0.2 s).

We measured the following parameters for each sung note:

(1) CQ (from the inverse filtered sound with the Soprano 1.0.15 software)
(2) SPL (sound pressure level, 30 cm from the mouth)

Results

1. Similarly with vocally untrained persons, also in the case of classically trained vocalists, their glottal adduction tends to increase with loudness. However, big idiosyncratic differences are frequent at singing high pitches in piano.
2. There is no clear correlation between CQ and pitch.
3. In the average, the glottal adduction of classically trained singers tends to stay close to the values at which maximum sound energy is generated.

4. Similarly with vocally untrained persons the voice timbre of classically trained voices tends to depend on the dynamics — the fundamental tends to be stronger, and the singer’s formant tends to be weaker in singing piano.

5. The strength of the glottal adduction is mainly mirrored in the level of the fundamental component of the voice spectrum and less on the level of the singer’s formant.

Conclusions

1. Similarly with vocally untrained persons, also in the case of classically trained vocalists, their glottal adduction tends to increase with loudness. However, big idiosyncratic differences are frequent at singing high pitches in piano.
2. There is no clear correlation between CQ and pitch.

References


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