

# CT based FE modeling of the acoustic effects of nasality for vowels [a:] and [i:] in female voice

Tomas Vampola<sup>1</sup>, Jaromír Horáček<sup>2</sup>, \*Anne-Maria Laukkanen<sup>3</sup>

<sup>1</sup>CTU in Prague, Dept. of Mechanics, Biomechanics and Mechatronics, Prague, Czech Republic

<sup>2</sup>Institute of Thermomechanics of the Czech Academy of Sciences, Prague, Czech Republic

<sup>3</sup>Speech and Voice Research Laboratory, Faculty of Social Sciences, Tampere University, Tampere, Finland

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## Introduction and aims

Classical singers use nasal consonants as 'resonance exercises', and aim at vibratory sensations at the nose and facial structures at all pitches sung. According to [1], a male singer used slight velopharyngeal opening for [a:] but not for [i:]. This was explained as a means to increase the prominence of the singer's formant during [a:] by decreasing the acoustic energy at F1 region. The nasal cavity may also serve as a narrowing for the main vocal tract, which might increase reactance over a wide range, thus supporting vocal fold vibration. This study investigates the effects of nasality on *fo* range.

## Method

A novel, computerized tomography based model of the vocal tract and the nose from the same female volunteer was used. She sustained the vowels in speech range.

## Results

Figure 1 shows reactance calculated over the frequency range 0-1.5 kHz for vowels [a:] and [i:] without and with nasality. With nasality, the lowest resonance frequencies R1-R2 increased and the reactance decreased throughout the range compared to non-nasalized phonation. Table 1 summarizes the lowest resonance frequencies for these two cases.

## Discussion

The findings for R1 are in line with those observed for male speaker based on MRI [2] but differ for other resonances. Nasality seems to lower acoustic energy in general for the female. The only potentially beneficial effect of nasality in this participant might be that due to higher resonances, the vocal tract seems to be inertive at passaggio regions 300 Hz and 500 Hz and also at ca 1000 Hz which is near the high c

for sopranos. Also [3] reported that tenors in their study used velopharyngeal opening at passaggio.

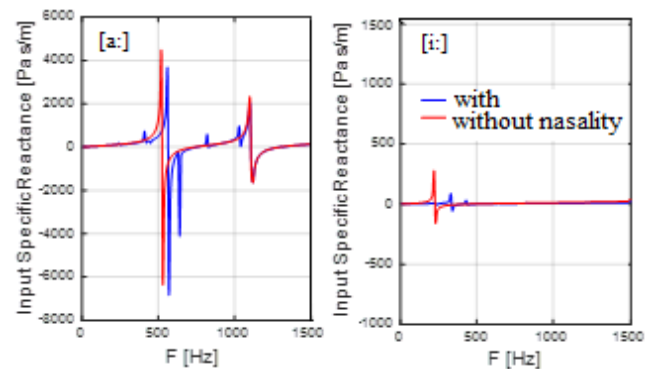


Figure 1: Reactance with and without nasality for vowel [a:] and [i:] in a female amateur singer.

[a:]	R1	R2	[i:]	R1	R2
without	599	1260	without	231	2209
with nasality	625	1265	with nasality	339	2233

Table 1: Lowest resonances for vowel [a:] and [i:] without and with nasality

## Conclusions

Nasality may offer some assistance for phonation at passaggio. This requires further investigation.

## Acknowledgements

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## References

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