First Results of an RT-MRI study on the influence of context in the synchronization of European Portuguese nasal vowels

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European Portuguese (EP)
- 5 phonic nasal vowels with three different tongue heights & two high vowels /i, ü, ò, õ/.
- The coordination of oral and nasal gestures is delayed in EP (Oliveira, 2009, Martins, 2012)
- Late alignment of the gestures in Brazilian Portuguese (Meireles et al, 2015)
- Influence of nasal context for the velum synchronization in unknown
- Barlaz et al. (2018) showed significant differences in tongue fronting, height, and shape between oral /a, e, u/ and their nasal counterparts /ã/, /ẽ/, and /ũ/ in this variety.
- Cunha et al. (2018, 2019) shows adjustments in tongue height, between nasal vowels and their nasal counterparts in EP.
- Quality differences between oral and nasal vowels not yet studied.

MAIN AIMS:
- a better description of the nasal system of EP
- influence of proceeding consonant (oral or nasal bilabial) on the synchronisation of the velum gesture with the lips

Predictions
- nasal gestures start late in EP nasal vowels
- nasal vowel starts earlier in nasal consonantal context

Methods

Articulatory study
- **Materials**: Diga | ouvi | leio | 'say' | 'heard' | 'read' TW baixinho | depois | 'gentle, after'
TW = pato panto manto manto
- **Speakers**: 25 speakers (acoustics)
- **RT-MRI**: 3 Tesla Siemens Prisma Fit MRI System equipped with a 64-channel head coil (Niebergall et al. 2013, Frahm et al. 2014).
- Low-flip angle gradient-echo sequence with radial encodings and a high degree of data undersampling
- Synchronous audio recorded by means of an optical microphone (Dual Channel-FOMRI, Optoacoustics).
- **Frame selection criteria**: Based on the audio annotations; *identification of target and consonantal context (pre and post target) image frames
- **Articulatory Variables**: Vocal tract contours for the selected data were processed to extract LIP APERTURE and VELOPHARYNGEAL PASSAGE width, over time
- **Time normalization**: Multiple repetitions for each sound and context are considered
- All repetitions for all contexts for a particular vowel are time aligned, with pre-target, target, and post-target treated independently
- The result is a set of repetitions with the same number of frames to represent context and target
- **Overall Plots**: The multiple repetitions for each context are considered to compute an average curve

Conclusion & Further Work

- Timing pattern between oral and nasal; convergence in the velum closing movement
- Greater lip aperture for oral than nasal vowels related with more peripheral oral vowels
- Coherent velar passage variation across vowels
- a good grasp of the articulatory behaviour regarding the considered variables.
- These need to be further developed with considerations regarding the oro-velar passage and a quantitative assessment of different velar movement stages

Acoustic data

Illustrative Articulatory Behaviour from RT-MRI data

1) /a/ and /ã/; all contexts
- Lip opening peak happens later for oral, and is higher
- Velar passage variations for /ma/ and /p/ coherent with expected
- Greater lip aperture for oral than nasal vowels related with more
- Less variability for /ma/ and /p/ across repetitions
- Smaller lip opening and earlier closing movement for /ã/ and /p/
- Similar velar passage variation pattern for both nasals

2) /a/, /ã/, /O/, /Õ/, in /p/ or /m/ context
- Similar lip variation patterns as for /p/ contexts
- Small lip opening and earlier closing movement for /ã/ and /p/
- Similar velar passage variation pattern for both nasals

3) Orals or nasals, all contexts
- Velar passage variation patterns similar across vowels
- Velar passage variation shown inflation, at end of nasal vowels, similar to all vowels/contexts

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