

Question

What is the purpose of hyper-articulation when shouting ?

Hyp1 - Preserving vowel intelligibility

Maintaining the distance $(F1-f_0)$ barks a phonetic cue to vowel height

Hyp2 - Resonance tuning

Optimization of voice efficiency by tuning a vocal tract resonance to a voice harmonic

Hyp3 - Lip radiation

Optimization of sound transmission

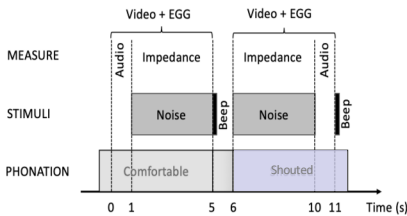
Material and method

8 speakers of Australian English (4 M, 4 F)

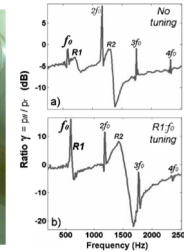
6 vowels : [a], [ɛ], [y], [u], [o] and [œ]

3 sessions:

- S1: Normal increase of vocal effort
- S2: Increase of vocal effort with maintained pitch
- S3: Increase of vocal effort with maintained pitch and lip articulation

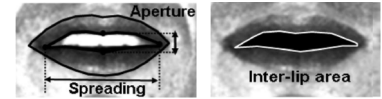


- Audio signal (B&K microphone + Nexus amplifier)
 - Clean second of phonation
 - Intensity (calibrated)
 - Four seconds of broadband noise
 - f_{R1}, f_{R2} (freq. of the first two resonances)



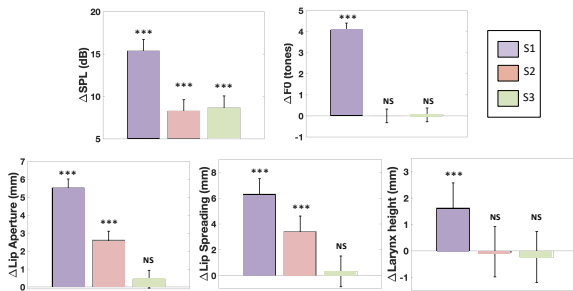
- EGG signal + Larynx Tracking signal (EG2 Glottal Enterprise)
 - f_0
 - Amp_{EGG} (degree of glottal contact)
 - OQ_{EGG} (Open quotient)
 - Qcs (Contact speed quotient)
 - LH (Larynx height)

- Front pictures of the lips (25 images / s)
 - LA (Lip Aperture)
 - LS (Lip Spreading)
 - ILA (Interlip Area)

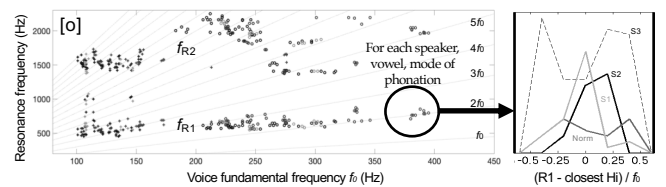


Results

Task achievement

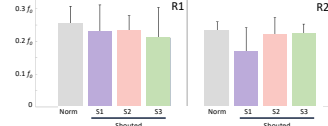


Resonance tuning (Hyp2)



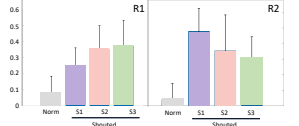
- Tuning : Reduced average distance btw resonances and voice harmonics ?
- Tuning : Resonances more frequently found close to a voice harmonic ?

Relative distance to the closest voice harmonic



R1: in shouted S1, S2 and S3, R2: in shouted S1 only

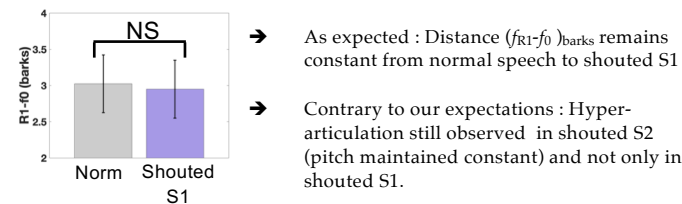
Probability for a vowel to be produced with a resonance close to a voice harmonic (relative dist < 0.1 f0) more than half of the time



R1: in shouted S1, S2 and S3, R2: in shouted S1, S2 and S3

- As expected : Greater resonance tuning in shouted S1 and S2 (free articulation), compared to normal speech
- Contrary to our expectations : Greater resonance tuning also observed in shouted S3 (constrained lip articulation)

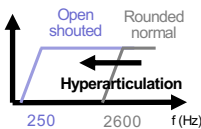
Preserving vowel intelligibility (Hyp1)



Lip radiation (Hyp3)

- Horn radiation models

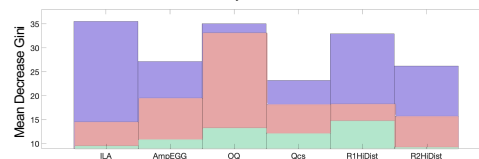
High-pass filter with cutoff frequency $f_c = c / (2\pi r)$



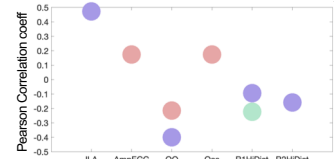
→ Lip radiation contributes very significantly to variations in intensity in S1, but no longer in S2 and S3, where glottal parameters are the most decisive

- Relative importance of glottal and articulatory parameters to explain variations in voice intensity

Random forest analysis from zscored data



Correlation analysis from zscored data



Conclusions

- In « natural » shouting (S1), hyperarticulation contributes at the same time
 - at preserving the R1-f0 cue (Hyp1)
 - at tuning (more frequently, an closer) R1 and R2 to voice harmonics (Hyp2)
 - at increasing voice intensity through enhanced lip radiation (Hyp3)
- When pitch is constrained (S2), speakers keep on hyper-articulating when shouting → excludes Hyp1 only
- When lip articulation is constrained (S3), speakers still demonstrate closer and more frequent tunings of R1 and R2 compared to conversational speech → Alternative articulatory strategies to achieve these tunings
- Lip hyper-articulation contributes significantly to the increase of voice intensity in S1 only, but no longer in S2 → excludes Hyp 3 only