Vocal expression of emotions in Unilateral Vocal Fold Paralysis

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Introduction

1. Emotional prosody

Basic emotions associated to systematic prosodic modulations [1,2], e.g., :

- Anger -> increase in the fundamental frequency (f0) mean, higher intensity, and harsh/tense voice compared to a neutral emotional state
- Sadness -> decrease in f0 and intensity, increase in breathiness

2. Unilateral Vocal Fold Paralysis (UVFP)

- Immobility of one of the vocal folds [3,4] -> instability in the vibratory pattern
- Dysphonia, weak voice, breathiness, roughness, diminished voice intensity, diplophonia, air loss [5, 6]
- Higher values of jitter and shimmer, lower values of the harmonic-to-noise ratio (HNR) and lower f0 range compared to heathy controls [6, 7; cf. also 8].
- UVFP patients complain of a mismatch between the emotion they intend to express and the emotion conveyed through their voice (Mattei, p.c.)

AIM: *Exploratory study on* the impact of UVFP in the vocal expression of emotions

Acoustic study

Materials:

- 8 short sentences with verbal neutral meaning
- Same syntactic structure, e.g., *Il v**a** rentrer chez lui* ("He is going back home")
- Three emotional states, elicited by three context types:

Neutral	Angry	Sad
You have just learned that Vincent is going back home and you say to a friend:	Vincent, your best friend, had promised to visit some flats with you. However, you receive a call from him : he is tired and is going back home. Angry, you call your partner and tell him/her:	You had a great week with your partner but now it is time to say goodbye because he/she has to go back home. Sad, you say to a friend:
He is going back home	**He is going back home**	**He is going back home**

Procedure [9]:

- Participants read contexts and target sentences silently, and produced the target sentences without reading
- Sentences presented in 3 different blocks of emotional states. The intended emotion was indicated at the beginning of each block, and each block was preceded by a familiarization and a training phase
- Within each block, sentences were presented in a random order

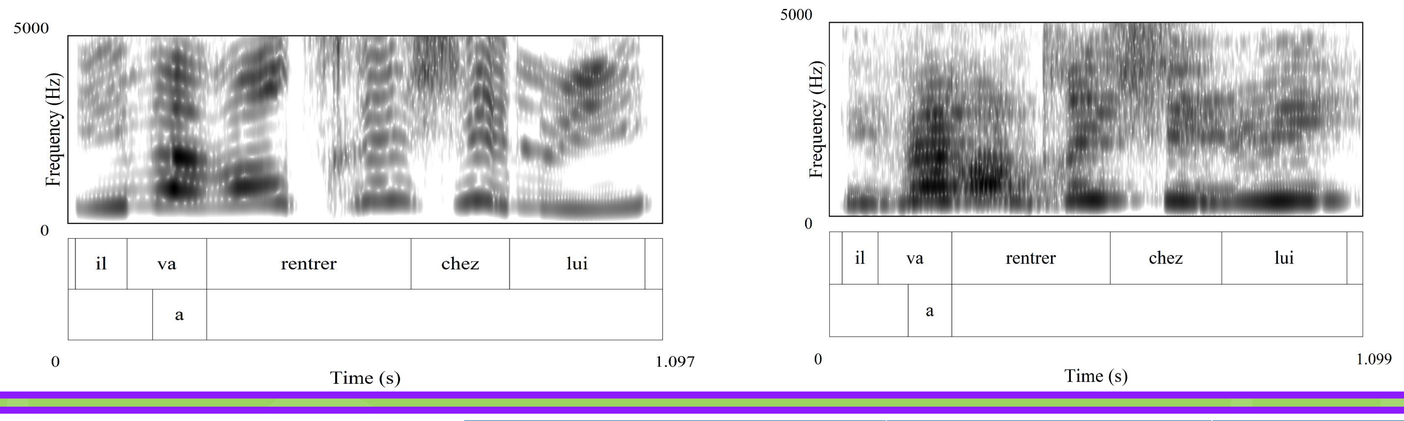
-> **480 utterances** (8 sentences X 3 emotions X 10 participants X 2 populations).

Measures: At the midpoint of vowel /a/ of the word v**a** ("going")

- Harmonic to noise ratio (HNR) over 1kHz
- f0 via FCN-f0 [10, 11]
- 0-5kHz spectrum computed on 20Hz bins; comparisons based on correlation coefficient
- Smoothed cepstral peak prominence (CPPS)

Statistics: Linear mixed models testing Group (HC/UVFP), Emotion (neutral/anger/sadness) and their interaction + post-hoc comparisons (p-values adjusted using Tukey's method)

Materials



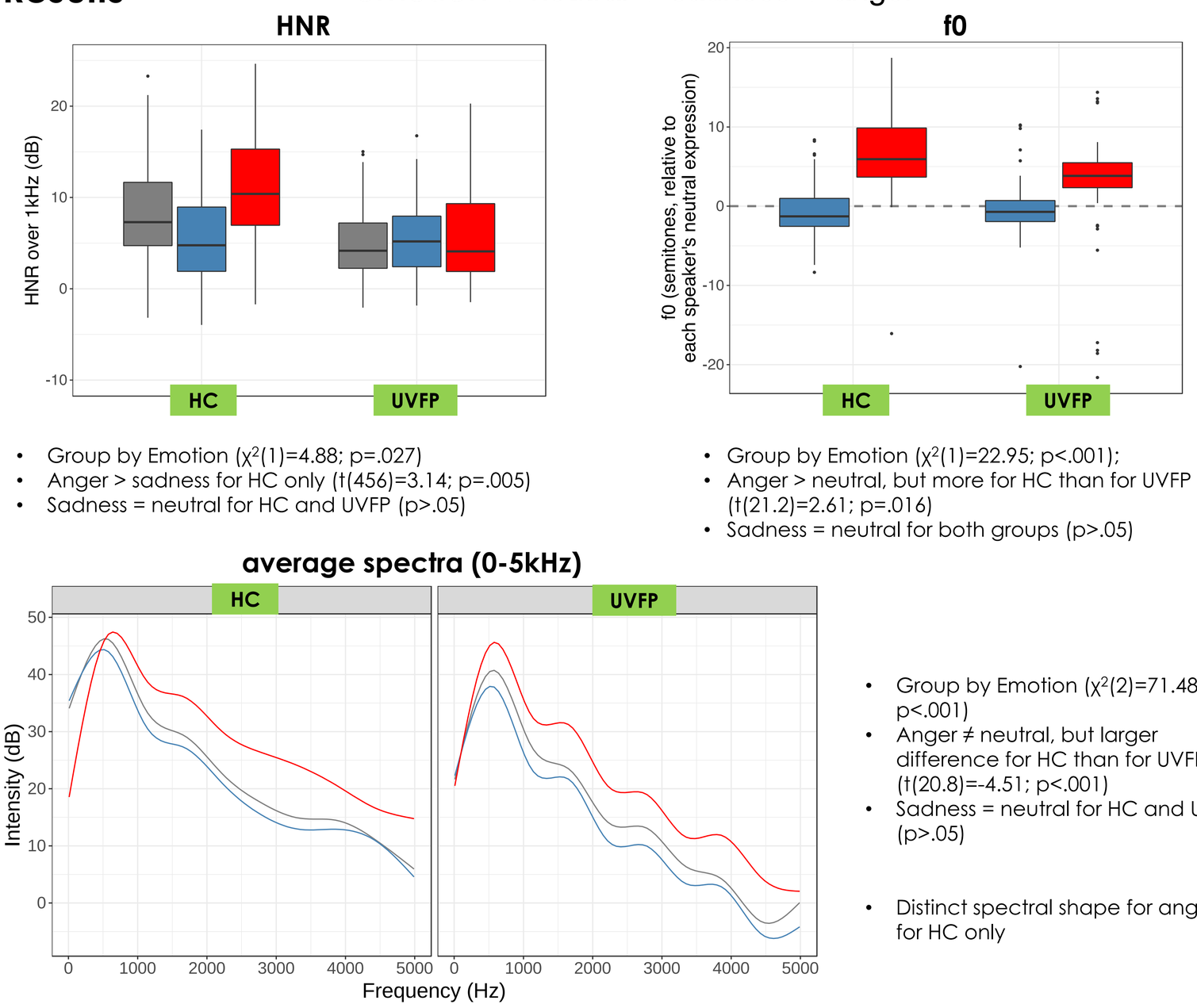
Participants

Demographics	UVFP n = 10	HC n = 10
Age	66 (7.8)	65.3 (7.3)
Gender	5 F + 5 M	5 F + 5 M
Disease Duration (months)	6.6 (9.7)	--
VHI-30	57.9 (21.5)	--
PHQ-9	3.7 (1.7)	--

Inclusion criteria for UVFP:
post-operative UVFP,
with no dysarthria, no neurological or psychiatric disorders.

- > Assessment of the impact of voice impairment (VHI-30, [4]) and depression (PHQ-9, [12])

Results



- Group by Emotion ($\chi^2(1)=4.88$; p=.027)
- Anger > sadness for HC only (t(456)=3.14; p=.005)
- Sadness = neutral for HC and UVFP (p>.05)

- Group by Emotion ($\chi^2(1)=22.95$; p<.001);
- Anger > neutral, but more for HC than for UVFP (t(21.2)=2.61; p=.016)
- Sadness = neutral for both groups (p>.05)

- Group by Emotion ($\chi^2(2)=71.48$; p<.001)
- Anger ≠ neutral, but larger difference for HC than for UVFP (t(20.8)=-4.51; p<.001)
- Sadness = neutral for HC and UVFP (p>.05)

- Distinct spectral shape for anger for HC only

- CPPS: UVFP<HC (UVFP more dysphonic, χ 2 (1)=21.74; p<.001); anger=neutral=sadness within each Group (p>.05)

Discussion

Reduced prosodic modulations for UVFP patients:

- Smaller range of f0 variations, less distinct spectral shape, poorer harmonic structure: linked to global decrease in f0 control and increase in breathiness and roughness
- Stronger impact on the expression of hot anger: crucial role of voice quality for expressing anger [1, 2]

-> **In line with patients' informal observations that UVFP has a negative impact on their ability to convey emotions**

Future perspectives: Perceptual evaluation of the corpus; acoustic analyses before and after vocal cord medialization

References

[1] Scherer, K. R. (2003). Vocal communication of emotion: A review of research paradigms. *Speech Communication, 40*(1–2), 227–256.
[2] Gobl, C., and Chasaide, A. N. (2003). The Role of Voice Quality in Communicating Emotion, Mood and Attitude. *Speech Communication*, 40, 189–212.
[3] Alwan, M., Paddle, P. M. (2021). Vocal Cord Paralysis: Pathophysiology, Etiologies, and Evaluation. *Int. J. Head Neck Surg.*, 12(4), 153–160
[4] Mattei, A., Desuter, G., Roux, M., Lee, B.-J., Louges, M.-A., Osipenkof, E. et al. (2018). International consensus (ICON) on basic voice assessment for unilateral vocal fold paralysis. *Eur. Ann. Otorhinolaryngol. Head Neck Dis*., 135, S11–S15.
[5] Manal E.-B., Gamal, Y. (2015). Early Voice Therapy in Patients with Unilateral Vocal Fold Paralysis. *Folia Phoniatr Logop* 1, 66 (6): 237–243.
[6] Jesus, L. M. T. , Martinez, J., Hall, A., Ferreira, A. (2015). Acoustic Correlates of Compensatory Adjustments to the Glottic and Supraglottic Structures in Patients with Unilateral Vocal Fold Paralysis. *Biomed. Res. Int.*, 704121.
[7] Hirano, M., Mori, K., Tanaka, S., Fujita, M. (1995). Vocal function in patients with unilateral vocal fold paralysis before and after silicone injection. *Acta Otolaryngol*, 115(4):553-9.
[8] Lotto, A. J., Holt, L. L., Kluender, K. R. (1997). Effect of Voice Quality on Perceived Height of English Vowels. *Phonetica*, 54(2):76–93.
[9] Enos, F. and Hirschberg, J. (2006). A Framework for Eliciting Emotional Speech: Capitalizing on the Actor's Process. *Proceedings of LREC Workshop on Emotional Speech*. https://doi.org/10.7916/D88S4ZCG. Retrieved from: https://academiccommons.columbia.edu/doi/10.7916/D88S4ZCG
[10] Ardaillon, L., Roebel, A. (2019) Fully-Convolutional Network for Pitch Estimation of Speech Signals. *Proc. Interspeech* 2019, 2005–2009.
[11] Vaysse, R., Astésano, C., & Farinas, J. (2022). Performance analysis of various fundamental frequency estimation algorithms in the context of pathological speech. *JASA*, *152*(5), 3091–3101.
[12] Arthurs E, Steele RJ, Hudson M, Baron M, Thombs BD, (CSRG) Canadian Scleroderma Research Group. Are scores on English and French versions of the PHQ–9 comparable? An assessment of differential item functioning. *PLoS One*. 2012;7(12):e52028.