Accuracy of Acoustic Voice Quality Index and its isolated Acoustic Measures to Discriminate the Severity of Voice Disorders

Marina Englert, Leonardo Lopes, Vinicius Vieira, Mara Behlau
marinaenglert@gmail.com

INTRODUCTION

- Acoustic analysis with multiparametric approaches
  - World tendency[1-8]
  - Higher reliability with the perceptual auditory analysis[1-3]

- **AVQI** – Acoustic Voice Quality Index

  - Provides one score for the overall voice quality
  - Good reliability among different languages[3-8]
  - AVQI isolated acoustic measurements diagnostic accuracy among the different degree of vocal deviation is still unknown

Objective

- To evaluate the AVQI total score and its isolated acoustic measures accuracy in discriminating voices with different degrees of vocal deviation

METHODS

- Database – 258 individuals
  - 160 dysphonic and 98 non-dysphonic
  - Analysis of AVQI isolated acoustic measures, AVQI total score and G score
    - Smoothed cepstral peak prominence - CPPs
    - Harmonic-to-noise ratio - HNR
    - Shimmer local - Shim & Shimmer local dB -ShdB
    - General slope of the spectrum - Slope
    - Tilt of the regression line through the spectrum
- Perceptual auditory analysis
  - Median G score, previously rated by 5 voice specialist
  - Cohen Kappa > 0.605 ; Fleiss Kappa = 0.370

Statistical Analysis

Quadratic discriminant analysis and accuracy, sensitivity and specificity of performance measures were used to investigate discriminatory power of these measures, as well as cross-validation of random signals' combination with and without disturbance

RESULTS AND DISCUSSION

No deviation Vs With Deviation

- AVQI = 73.9%
- CPPs = 73.2%

AVQI & CPPs are reliable acoustic measures[1,2,5-14]

Combined measures

- CPPs, HNR = 73.2%
- CPPs, HNR, Slope = 75.07%
- CPPS, HNR, Shim dB, Tilt = 73.9%
- **CPPS, HNR, Shim dB, Slope, Tilt = 75.5%**

The combination of **5 acoustic measures** had the highest accuracy to differentiate between normal and deviated voice quality

- Weighing the acoustic measures in a multiparametric approach is essencial[1]

Degrees of Deviation

Acoustic Measures	Accuracy %
No deviation and Mild	
CPPs, ShdB	72.86 ± 3.26
Simmer dB, LTAS slope, LTAS tilt	70.99 ±3.70
CPPs, HNR, LTAS tilt	70.55 ± 5.47
CPPs, HNR, ShdB, LTAS tilt	74.29 ± 2.77
CPPs, HNR, LTAS slope, LTAS tilt	70.71 ± 3.90
CPPs, HNR, ShdB, LTAS slope, LTAS tilt	72.31± 2.80

Combined acoustic measures were better to discriminate among the degrees of deviation when compared to the AVQI total score

Acoustic Measures	Accuracy %
Mild and Moderate	
ShdB, LTAS slope	71.53 ± 5.70
Shim, ShdB, LTAS tilt	74.17 ± 4.64
HNR, LTAS slope, LTAS tilt	75.69 ± 2.73
Shim, ShdB, LTAS slope, LTAS tilt	76.11 ± 4.57
HNR, Shim, ShdB, LTAS slope, LTAS tilt	73.75 ± 4.90

Acoustic Measures	Accuracy %
Moderate and Severe	
Shim, LTAS tilt	93.00 ± 3.59
HNR, Shim, Ltas tilt	95.50 ± 3.02
Shim, ShdB, LTAS slope, LTAS tilt	93.50 ± 4.48
HNR, Shim, ShdB, LTAS slope, LTAS tilt	93.00 ± 3.59
All	86.00 ± 6.14

AVQI total score accuracy

No deviation Vs Mild
70.79

Mild Vs Moderate
71.39

Moderate Vs Severe
87.5

No isolated acoustic measurement was consistent to differentiate the voice quality among all degrees of deviation

Superiority of the AVQI and multiparametric measures[1-8]

CONCLUSION

- AVQI is a robust tool to discriminate among different degrees of deviation
  - More accurate between voices with moderate and severe deviations
- Isolated acoustic measures are more accurate to discriminate voices with more deviation
- AVQI acoustic measures with the same weight are more accurate to discriminate voices with different deviations

REFERENCES

1 -Maryn Y, Corthals P, Van Cauwenberge P, Roy N, De Bodt M. Toward improved ecological validity in the acoustic measurement of overall voice quality: combining continuous speech and sustained vowels. J Voice. 2010a;24(5):540-55.
2- Maryn Y, De Bodt M, Roy N. The Acoustic Voice Quality Index: toward improved treatment outcomes assessment in voice disorders. J Commun Disord. 2010b;43(3):161-74. doi: 10.1016/j.jcomdis.2009.12.004. Epub 2009 Dec 23.
3- Barsties V Latoszek B, Maryn Y, Gerrits E, De Bodt M. The Acoustic Breathiness Index (ABI): A Multivariate Acoustic Model for Breathiness. J Voice. 2017 Jul;31(4):511.e11-511.e27. doi: 10.1016/j.jvoice.2016.11.017.
4- Barsties B, Maryn Y. External Validation of the Acoustic Voice Quality Index Version 03.01 With Extended Representativity. Ann Otol Rhinol Laryngol. 2016 Jul;125(7):571-83. doi: 10.1177/0003489416636131.
5- Hosokawa K, Barsties V Latoszek B, Iwahashi T, Iwahashi M, Iwaki S, Kato C, Yoshida M, Sasai H, Miyauchi A, Matsushiro N, Inohara H, Ogawa M, Maryn Y. The Acoustic Voice Quality Index Version 03.01 for the Japanese-speaking Population. J Voice. 2019 Jan;33(1):125.e1-125.e12.10.1016/j.jvoice.2017.10.003
6 - Delgado Hernández J, León Gómez NM, Jiménez A, Izquierdo LM, Barsties V Latoszek B. Validation of the Acoustic Voice Quality Index Version 03.01 and the Acoustic Breathiness Index in the Spanish language. Ann OtolRhinolLaryngol. 2018;127(5):317-326.10.1177/0003489418761096
7 - Barsties V Latoszek B, Lehnert B, Janotte B. Validation of the Acoustic Voice Quality Index Version 03.01 and Acoustic Breathiness Index in German. J Voice. 2018bSep(18)30231-5. 10.1016/j.jvoice.2018.07.026
8 - Pommée T, Maryn Y, Finck C, Morsomme D. Validation of the Acoustic Voice Quality Index, Version 03.01, in French. J Voice. 2018a(18)30517-4. [Epub ahead of print]10.1016/j.jvoice.2018.12.008
9 - Awan SN, Roy N. Toward the development of an objective index of dysphonia severity: a four-factor acoustic model. Clin Linguist Phon. 2006 Jan-Feb;20(1):35-49.
10- Awan SN, Roy N, Dromey C. Estimating dysphonia severity in continuous speech: application of a multi-parameter spectral/cepstral model. Clin Linguist Phon. 2009 Nov;23(11):825-41
11- Awan SN, Roy N, Jetté ME, Meltzner GS, Hillman RE. Quantifying dysphonia severity using a spectral/cepstral-based acoustic index: Comparisons with auditory-perceptual judgements from the CAPE-V. Clin Linguist Phon. 2010 Sep;24(9):742-58
12- Lopes L, Sousa E, Silva A, Silva I, Paiva M, Vieira V, Almeida A. Cepstral measures in evaluating the severity of voice disorder. CoDAS 2019;31(X): e2018017
13- Patel RR, Awan SN, Barkmeier-Kraemer J, Courey M, Deliyski D, Eadie T, Paul D, Švec JG, Hillman R. Recommended Protocols for Instrumental Assessment of Voice: American Speech-Language-Hearing Association Expert Panel to Develop a Protocol for Instrumental Assessment of Vocal Function. Am J Speech Lang Pathol. 2018 Aug 6;27(3):887-905. doi: 10.1044/2018_AJSLP-17-0009.
14-Roy N, Barkmeier-Kraemer J, Eadie T, Sivasankar MP, Mehta D, Paul D, Hillman R. Evidence-based clinical voice assessment: a systematic review. Am J Speech Lang Pathol. 2013;22:212-26.