Evaluating a new measure of fricative source intensity

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LabPhon 15 – Dynamics and Representation of Turbulent Sounds

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Introduction

SFDI (**Sonorant/Fricative Discriminant Index**, Anantapadmanabha et al. 2014) - a proposed method for measuring fricative source amplitude separately from properties of radiated sound.

Derived from LPC coefficients:

$$A(z) = 1 + a_1 z^{-1} + a_2 z^{-2} + a_3 z^{-3} + \ldots + + a_M z^{-M}$$

$$SFDI = \tan^{-1}[A(1)] = \tan^{-1}[\sum_{i=1}^{M} a_i]$$

RATIONALE:

"The filter gain itself is determined by two factors, namely, the frequency response and the filter gain at *f = 0*. Conventionally, a standard method of representing a filter is to set the filter gain at *f = 0* to be unity. Hence, we deduce that the filter gain at *f = 0* must be influencing the source intensity. This led us to investigate *A(1)* as an acoustic feature for distinguishing sonorants from fricatives." (A. et al., 2014)

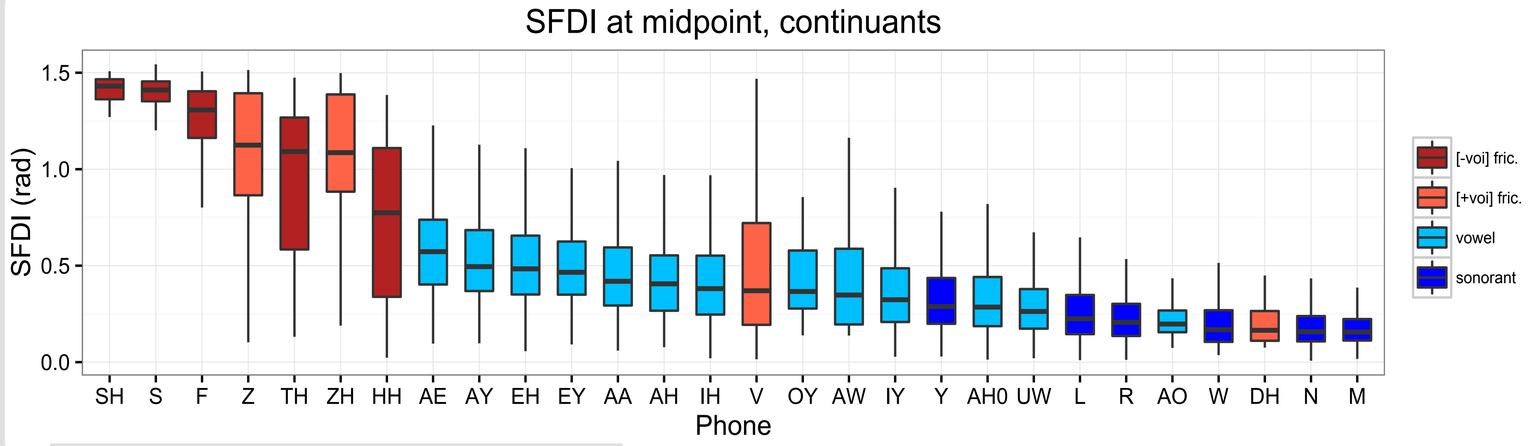
OBJECTIVE: testing the method

How useful might SFDI be? Does SFDI respond selectively to changes in fricative noise source?

Test 1: Natural speech

SFDI calculated for all continuant segments in isolated word readings in a laboratory environment (38 M speakers, 13,486 phone tokens)

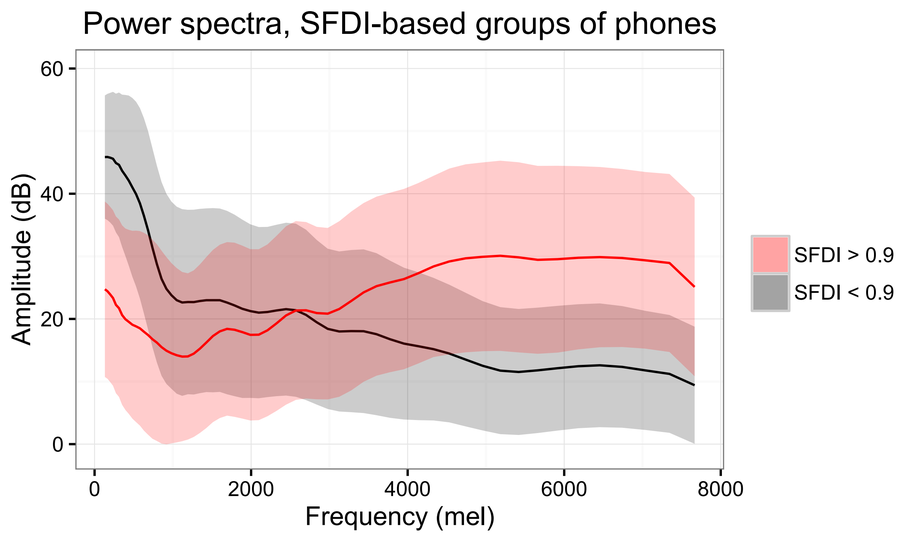
High SFDI values correspond to strong fricative noise sources, especially stridents. A **threshold of about SFDI = 0.9** captures fricatives except /v/, /ð/; some /h/; and some low vowel tokens.



Voicing modulates SFDI. Why?

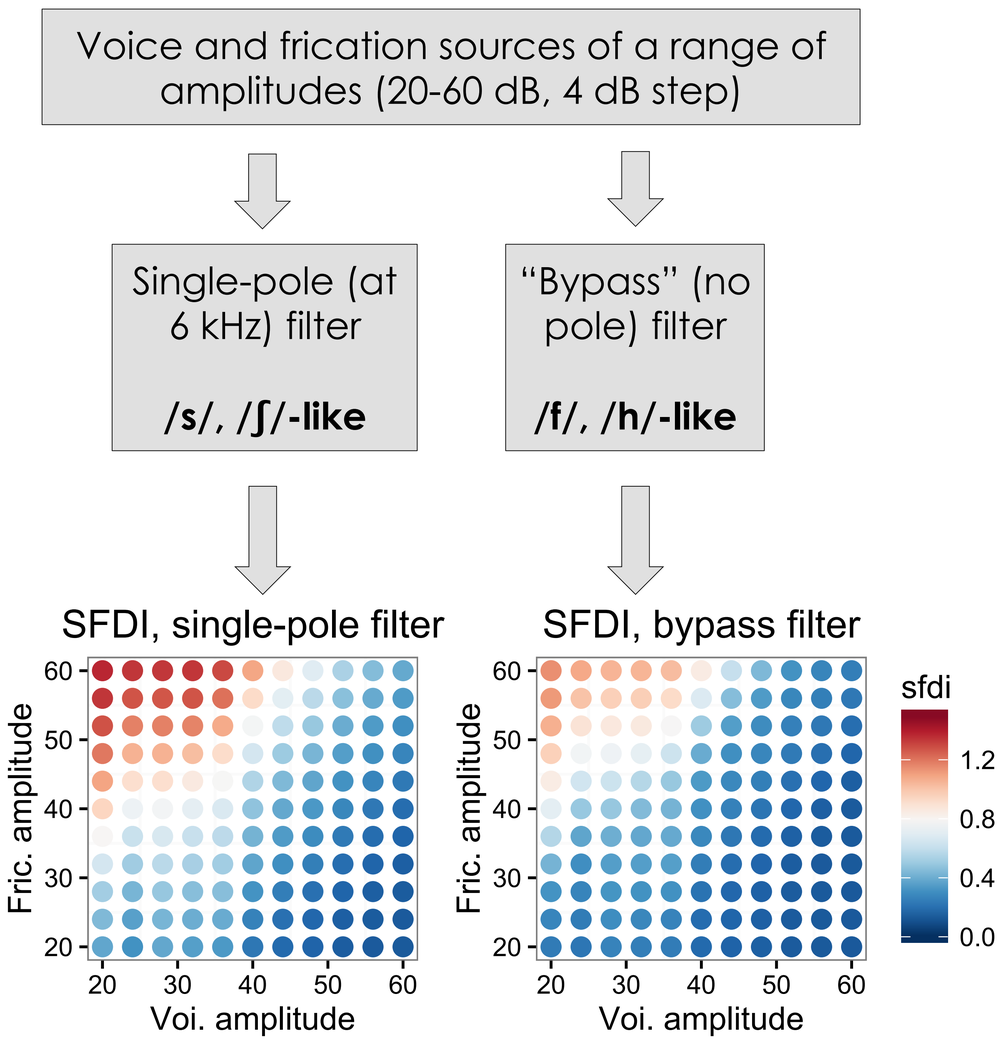
Aerodynamics? Frication noise source less intense under aerodynamic conditions of voicing; SFDI may accurately reflect this.

The measure itself? Addition of periodic energy might reduces fricative noise that can be accounted for by SFDI.



Test 2: Synthesized speech

SFDI applied to synthesized phones with **fixed amplitudes of voicing and fricative noise**. Using the synthesizer described in Klatt & Klatt (1990):



Predictions

If SFDI reflects fricative source amplitude, we should get **the same results** for a given fricative source amplitude level, regardless of added voicing, and **the same results** for both filters.

Results

SFDI is lower for sounds with high-amplitude voicing source. Compared to the single-pole filter, **SFDI is lower** for the flat "bypass" filter for all given intensities of voicing and frication

Conclusions

SFDI responds to fricative source amplitude in a continuous manner.

However: **SFDI value is also impacted** by voicing and by vocal tract filter shape.

SFDI is **potentially a useful tool** for detecting/segmenting voiceless fricative landmarks, but may be less reliable with voiced fricatives or with [grave] fricatives.

Acknowledgements

We would like to thank the members of the UC Berkeley PhonLab for their feedback and constructive criticism. Any remaining errors are our own.

References

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Klatt, D.H. and Klatt, L.C. (1990). Analysis, synthesis, and peception of voice quality variations among female and male talkers. *J. Acoust. Soc. Am.* 87(2), 820-858.