Temporal and Devoicing Analysis of European Portuguese Fricatives

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Temporal and devoicing properties of fricatives in English have been studied:

- Duration:
  - unvoiced vs. voiced differences
  - effect of stress
  - effect of vowel context
- Devoicing of voiced fricatives.

No comparable studies of Portuguese exist, so we focus on such analysis here.

Method

A speech corpus has been designed for European Portuguese, with the fricatives /f, v, s, z, ʃ, ʒ/ in the following contexts:

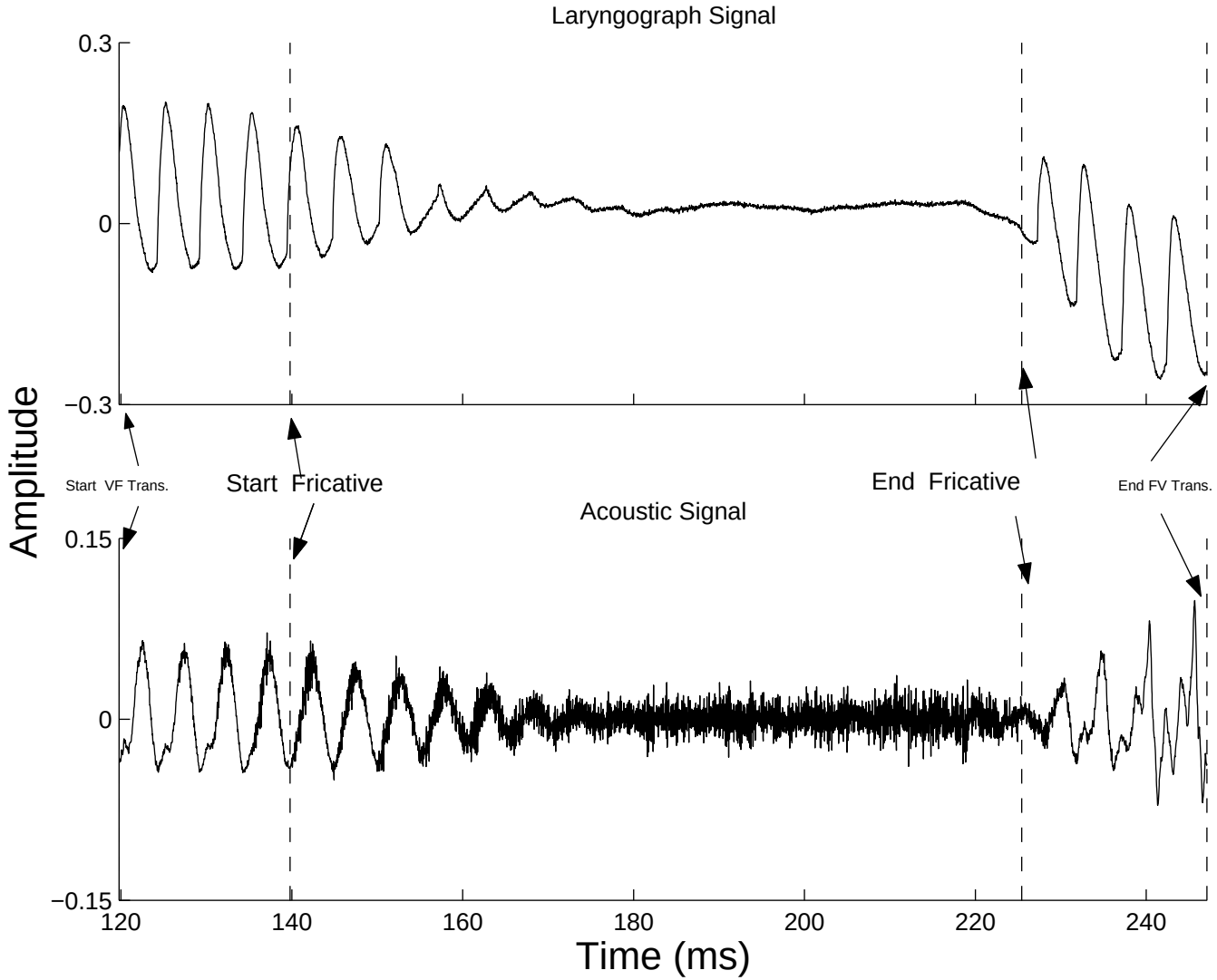
- sustained (Corpus 1),
- repeated nonsense words (Corpus 2),
- words containing fricatives in frame sentences (Corpus 3), and
- the same set of words in sentences (Corpus 4).

Method

Four subjects, two male (LMTJ and CFGA) and two female (ACC and ISSS), were recorded reading the corpora.

Recordings of acoustic and laryngograph (Lx) signals were made in a sound treated room, and digitally transferred to a computer for post-processing.

/z/ in *azar* /ɐˈzaɾ/, Corpus 3 (ISSS)



Manual Criterion for Devoicing

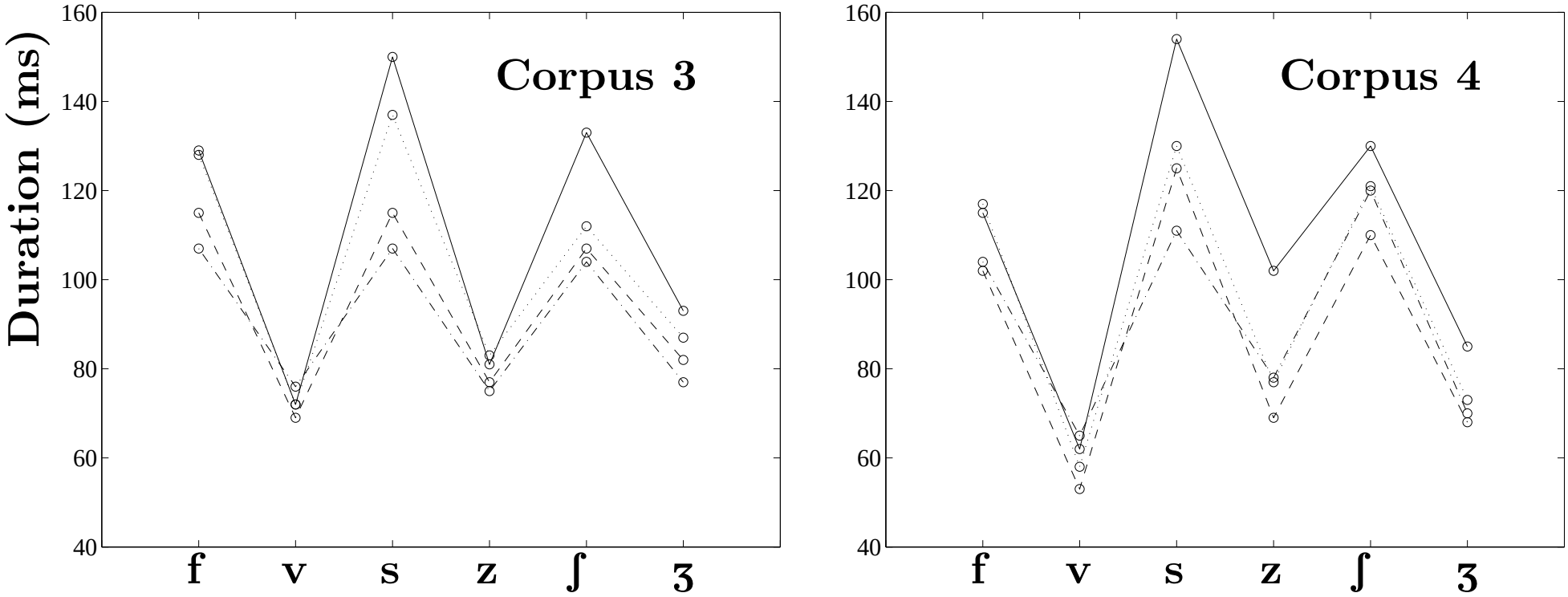
Voicing is often maintained over only part of the fricative.

When acoustic or Lx signal has periodic structure for:

- **$< 1/3$ of frication interval $\rightarrow$ devoiced**
- **between $1/3$ and $1/2$ $\rightarrow$ partially devoiced**
- **$> 1/2$ $\rightarrow$ voiced**

Temporal Analysis (Corpus 3 and 4)

Mean duration of fricatives



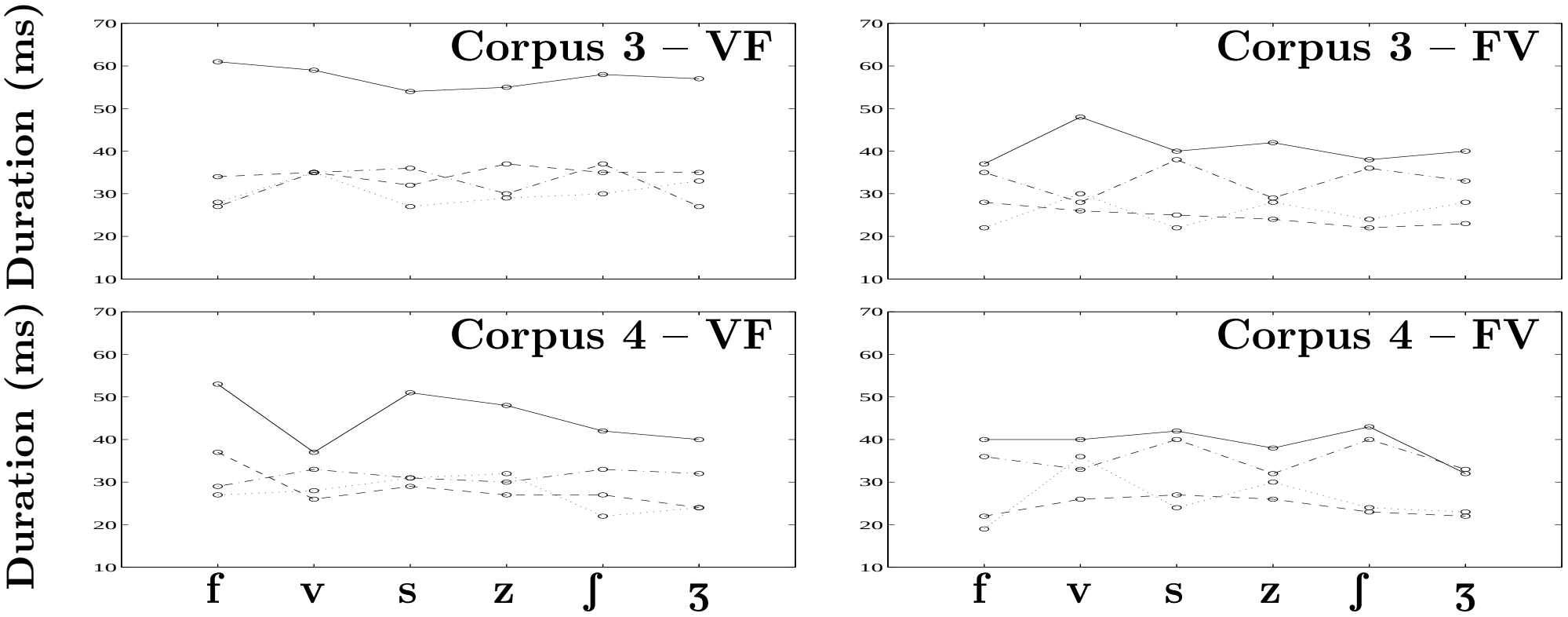
– Speaker LMTJ

- - Speaker ACC

-.- Speaker CFGA

... Speaker ISSS

Mean duration of VF and FV transitions



– Speaker LMTJ

-.- Speaker CFGA

- - Speaker ACC

... Speaker ISSS

Analysis of Variance of Duration

One-way ANOVA was used to study the effects of the independent variables

- speaker (LMTJ, CFGA, ACC and ISSS),
- place of articulation (labiodental, alveolar and postalveolar) and
- position in word (word-initial, word-medial and word-final)

on the dependent variable

- duration of fricatives in Corpus 3 and 4.

Analysis of Variance of Duration

Two groups

voiceless fricatives /f, s, ʃ/ and

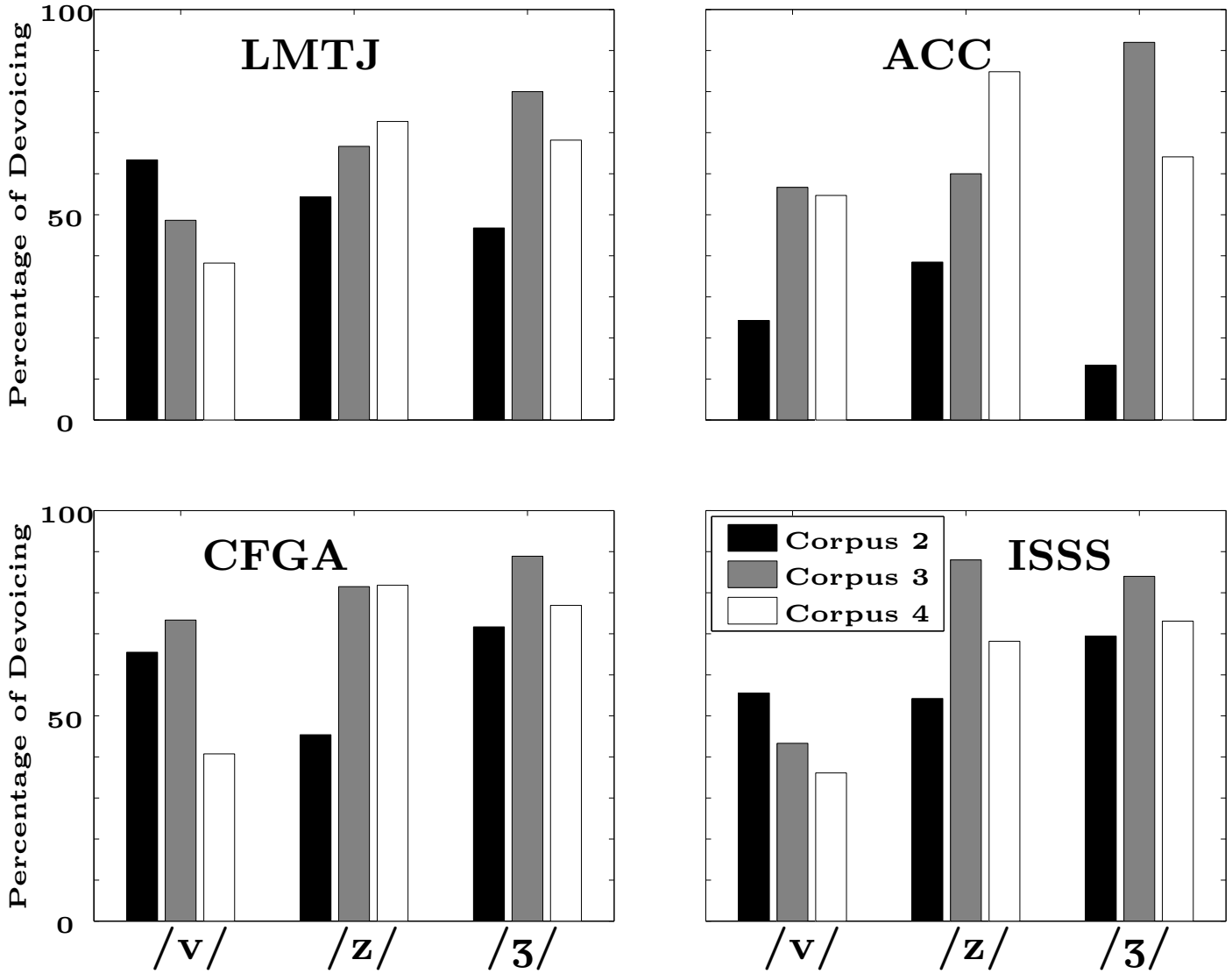
voiced fricatives /v, z, ʒ/,

were analysed because the duration of voiceless fricatives was always significantly greater than their voiced counterparts.

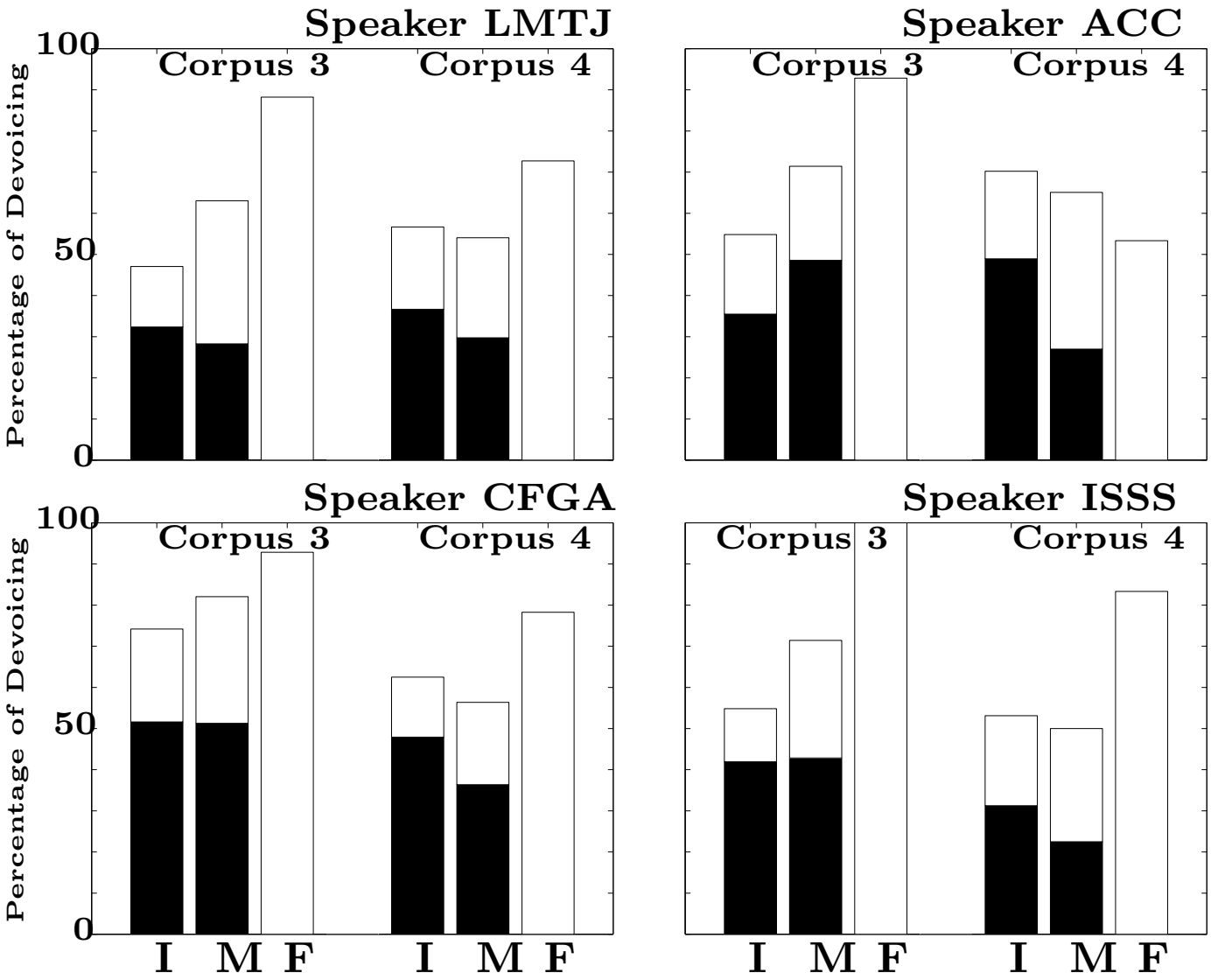
Analysis of Variance of Duration

Factor	Corpus	Duration	
		/f, s, ʃ/	/v, z, ʒ/
Speaker	3	$p < .001$	N. S.
	4	$p < .001$	$p < .001$
Place	3	$p = .005$	$p < .001$
	4	$p < .001$	$p < .001$
Position in Word	3	$p < .001$	$p < .001$
	4	$p < .001$	$p = .005$

Devoicing Analysis – Percentage of total devoicing



Percentage of total devoicing by position in word



Analysis of Variance of Devoicing

One-way ANOVA was used to study the effects of the independent variables

- speaker,
- place of articulation and
- position in word

on the dependent variable

- amount of devoicing of fricatives in Corpus 3 and 4.

Analysis of Variance of Duration and Devoicing

Factor	Corpus	Duration		Devoicing
		/f, s, ʃ/	/v, z, ʒ/	/v, z, ʒ/
Speaker	3	$p < .001$	N. S.	$p = .025$
	4	$p < .001$	$p < .001$	N. S.
Place	3	$p = .005$	$p < .001$	$p < .001$
	4	$p < .001$	$p < .001$	$p < .001$
Position in Word	3	$p < .001$	$p < .001$	$p < .001$
	4	$p < .001$	$p = .005$	N. S.

Conclusions

Have studied temporal and devoicing properties of European Portuguese.

Study of temporal and devoicing properties of European Portuguese reveals:

- **Mean duration of voiceless is greater than voiced fricatives.**
- **Steady - state: 100 - 150 ms (voiceless) vs. 50 - 90 ms (voiced)**

Conclusions

Transitions: 20 - 60 ms, no significant difference voiced vs. voiceless

These characteristics are not particular of Portuguese, as similar results have been previously reported for English.

Devoicing rate is very high (overall 65%), more so than in English and French.

Acknowledgements

This work was partially supported by Fundação para a Ciência e a Tecnologia, Portugal.