

Perception and Production of Spanish /f/: the role of the listener

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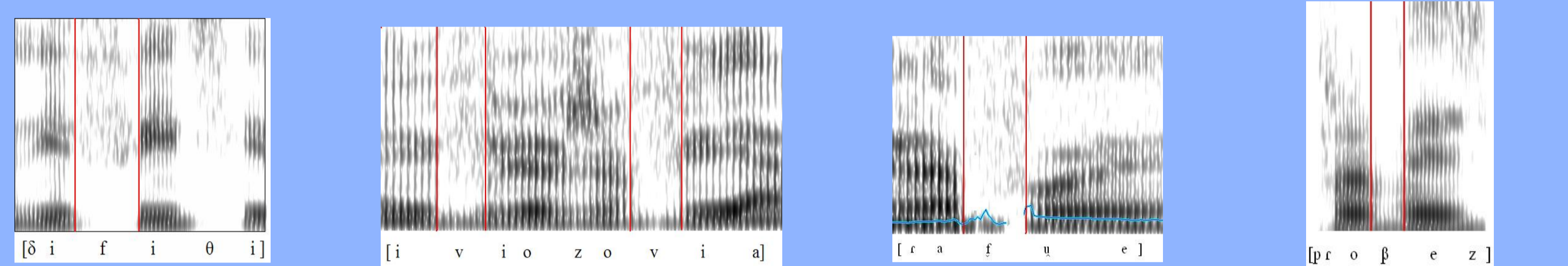
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1. FIRST STEP

This research focuses on the perceptual effects of acoustic variation of the voiceless labiodental fricative /f/ in spontaneous speech in Spanish. The starting point of this study are the results from a first analysis of the acoustic nature of this sound (Blecua & Rost, 2011).

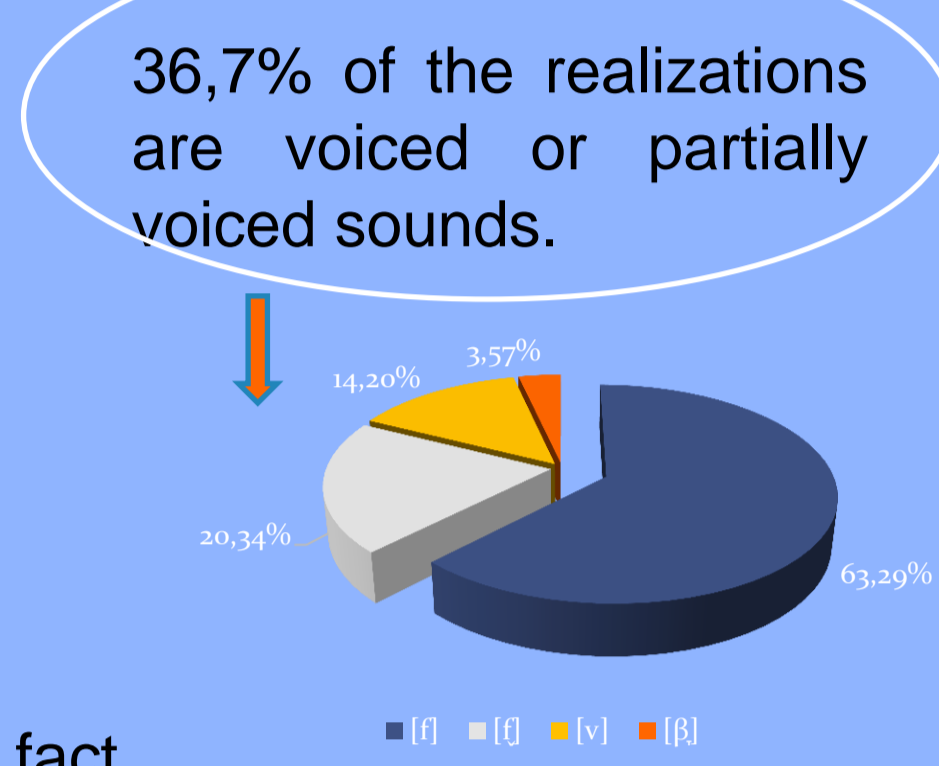
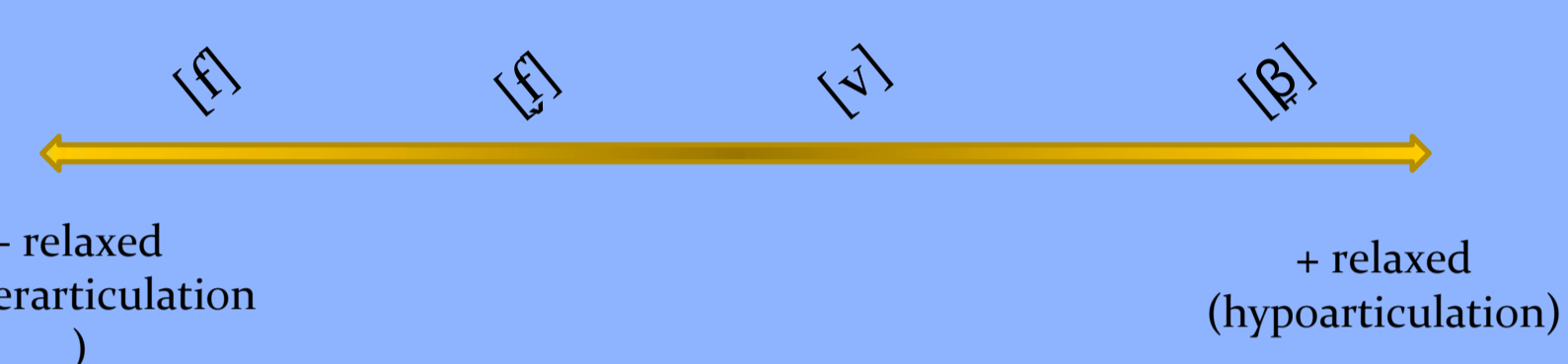
For that analysis, 6 male subjects were interviewed and recorded. 421 labiodental fricative consonants were extracted from this sample of spontaneous speech. The variables taken into account were context and stress. Segments were analysed using Praat and then classified into four categories, regarding presence or absence of voicing and formants. Duration was also measured.

The results obtained prove that /f/ has indeed four possible allophones: a labiodental voiceless fricative [f] (as expected), a labiodental voiced fricative [v], a labiodental partially voiced fricative [ɸ] and an approximant one (which we transcribe as [β]). Notice that three of them are voiced solutions.



Labiodental voiceless fricative, Labiodental voiced fricative, Labiodental partially voiced fricative, Labial approximant

Variation is organized following a gradual scale of reduction, from hyper to hypoarticulated forms.



Duration tends to decrease as weakening degree increases. In fact, spontaneous speech brings about higher speaking rate and higher degree of coarticulation, which favours the appearance of more relaxed sounds. This kind of sounds entail less articulatory effort.

2. GOALS

- To check if listeners perceive differences among the aforementioned acoustic realizations of /f/ by means of perception tests.
- To test if the listener classifies any realization of /f/ as an allophone of a different phoneme, and therefore variation would have consequences at a phonological level.
- To investigate if speakers of a Romance language with a phonological system containing both /f/ and /v/ classify the realizations in the same way as Spanish listeners do.

3. HYPOTHESES

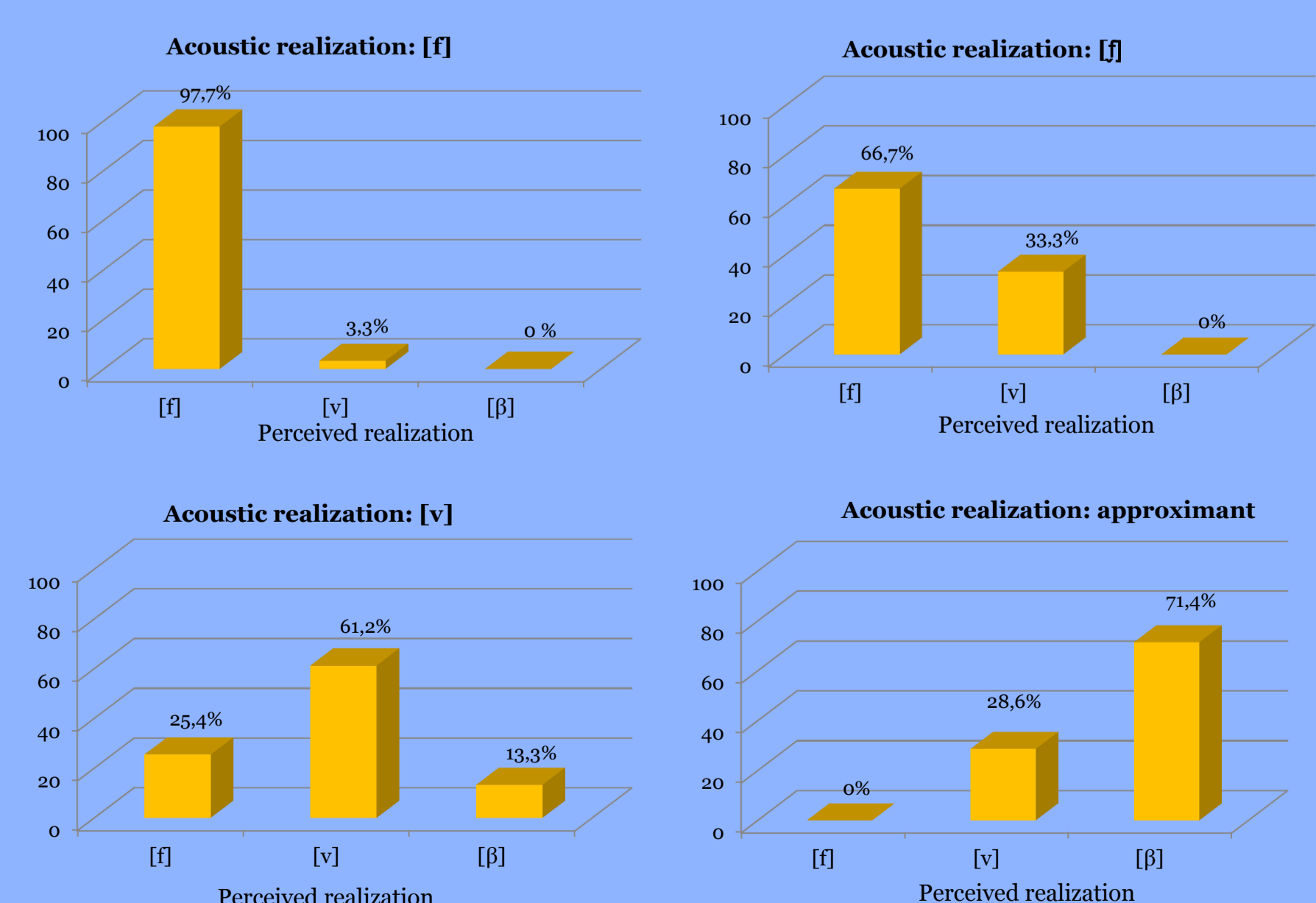
- Perceptually, phonetic variation can entail certain confusion when interpreting the realizations.
- The most relaxed allophones (voiced fricatives and approximants) could be identified as a voiced phoneme other than /f/.
- Voiced labiodental fricative realization is identified as the expected allophone for /v/ in those systems that have such phoneme.

4. EXPERIMENTAL DESIGN

Perception test design:	
25 stimuli extracted from the spontaneous sample used for the acoustic analysis.	
(C)V_V nonsense sequences, including instances of the 4 realizations of /f/: [f], [v], [ɸ] y [β], and two examples of /b/: [β].	
Praat (v.5.3.0.)	
Listeners heard 3 repetitions of each stimulus in a row.	
Test 1 Identification task: 3 possible categories /f/-/v/-/b/ E.g. stimulus [ivo] a) ifo b) ivo c) ibo	Test 2 Identification task: 2 possible categories /f/- /b/ E.g. stimulus [ivo] a) ifo b) ibo
1a) 30 subjects, Spanish speakers.	30 subjects, Spanish speakers.
Number of answers: 750	Number of answers: 750
1b) 30 subjects, Balearic Catalan speakers	
Number of answers: 750	TOTAL ANSWERS: 2.250

5. RESULTS

5.1 Perception test 1



There is no voiced labiodental fricative phoneme in Spanish, but the test was performed by speakers with some knowledge of phonetics, so they could understand which sound we referred to.

Acoustic category	Perceived category		
	[f]	[v]	[β]
[f]	145	5	0
[v]	40	202	44
[β]	0	60	150

Analysis of listener's categorization show that voiced realizations of /f/ are not mostly identified with a voiceless labiodental fricative, but rather with either a voiced fricative or an approximant. Thus, acoustic variation has a clear effect on the perception of these sounds. These results reveal confusion across categories, because the approximant is an allophone of /b/ in Spanish. We have to check if stimuli classified as [v] are interpreted as allophones of /f/ or of /b/, but it has already been confirmed that listeners perceive something different from [f] stimuli.

Balearic Catalan speakers

30 Balearic Catalan speakers were asked to perform the same test. Balearic is a variant of Catalan with a phonological system including two labiodental phonemes: /f/ and /v/. The purpose is to figure out if they classify the stimuli just in the same way as Spanish subjects did.

Labiodental voiceless or partially voiced instances were clearly recognized as allophones of the phoneme /f/, whereas labiodental voiced fricative stimuli were mainly identified with /v/. Although there is a significant percentage of /f/ responses, the fact that more than half of these realizations were perceived as /v/ means that they must be quite similar to the expected allophone of this phoneme in Balearic Catalan.

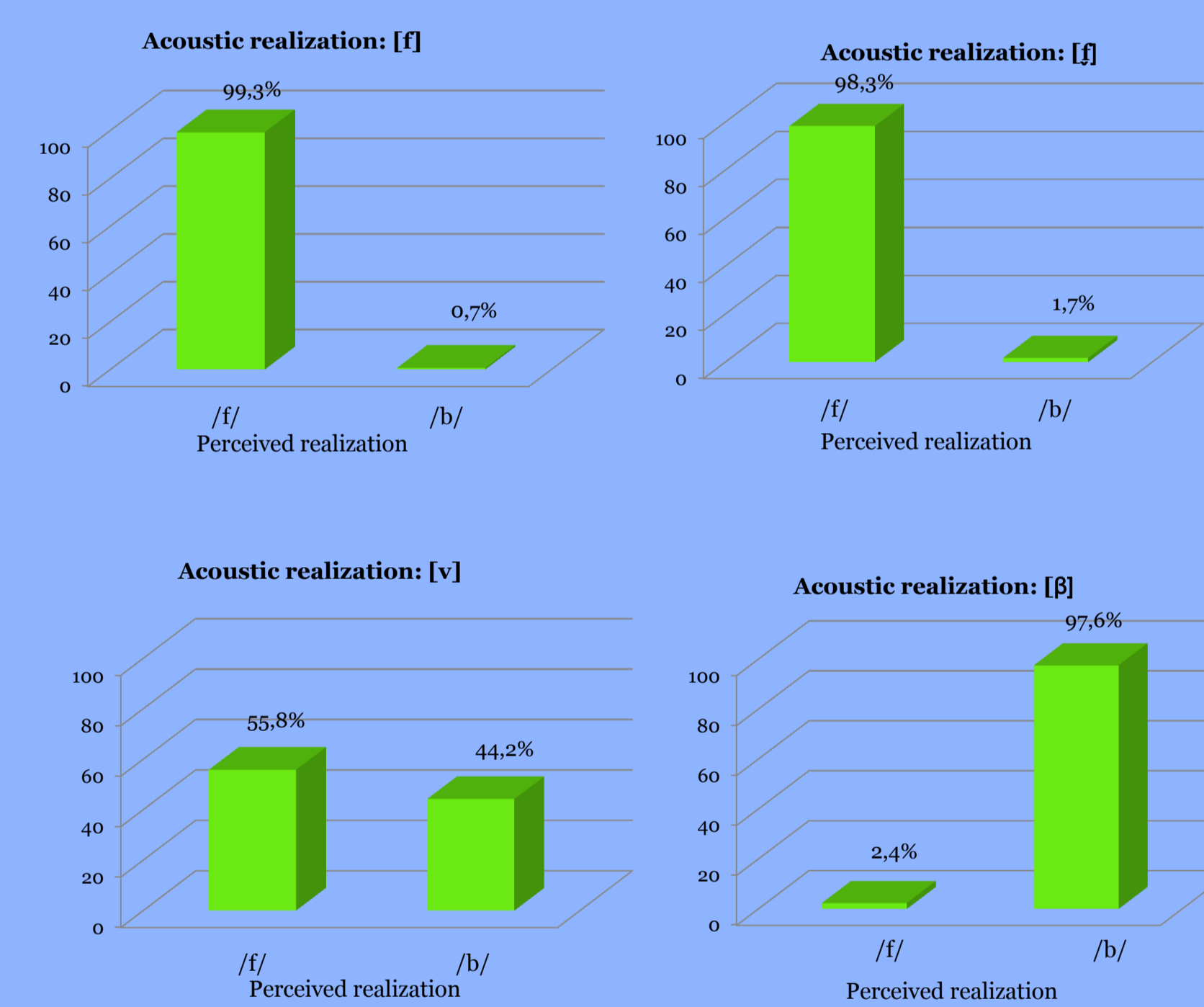


Approximant stimuli were also mainly identified with /v/, what clearly differs from the results obtained from Spanish speakers' classification, where most of these realizations were labelled as /b/. This could be due to the properties of the Balearic system: [b] is the expected allophone for /b/ in intervocalic position, instead of [β], as it is in Spanish (cf. Recasens 1991). Therefore, a non continuant sound is not likely to be identified with /b/, but rather with the fricative phoneme.

Acoustic category	Perceived category		
	[f]	[v]	[β]
[f]	147	3	---
[v]	52	8	---
[ɸ]	123	179	25
[β]	1	121	88

5.2 Perception test 2

The main purpose of this test is to check with which phoneme are [v] stimuli identified; since there is no voiced labiodental phoneme, listeners had to choose between /f/ and /b/.



Acoustic category	Perceived category	
	[f]	[β]
[f]	149	1
[v]	59	1
[ɸ]	184	146
[β]	5	205

Results of this test are certainly conclusive for [f], [ɸ] and [β] acoustic realizations. The first two were always identified with /f/, as expected. The approximant was interpreted as /b/, although the speaker produced this sound meaning /f/.

When referring to the voiced labiodental realization, confusion arises: it can be categorized either as /f/ or /b/, and it shows high perceptual variation. In fact, there is almost an evenness between the two possible options. Therefore, listeners can interpret this sound as a phoneme different from what the speaker meant.

6. CONCLUSIONS

- There is a systematic and significant variation of /f/ in Spanish, at least in spontaneous speech, which has important effects at a perceptual level: they give rise to perceptual variation.
- There is not a univocal correspondence between allophone and phoneme: one realization can correspond to different phonemes. An approximant realization, for instance, might be an allophone both of /b/, as expected, but also of /f/.
- The results of these tests show that relaxed realizations of /f/ are mainly associated to /b/ (97.6% of the approximant realizations and 44.2% of the [v] ones).
- Results in Balearic Catalan speakers' test allow us to support the existence of a voiced labiodental allophone in Spanish even in intervocalic position, since it has been clearly recognized as the phonetic realization of /v/.
- Acoustic variation entails the interlocutor's reanalysing the signal and relating it to a phonological category different from the speaker's. This would somehow explain the phonological change from Latin -F- to Spanish [β] ([RAPHANUM > rabano), with an intermediate stage /v/ (cf. Batllori et al, 2009). According to evolutionary phonology (Blevins 2004), that would be a case of *chance*.

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