

A phonetic-acoustic study of inter- and intra-speaker variation in Catalan-Spanish bilingual speakers

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The existing sociolinguistic context in Catalonia, and the fact that the two languages are predominant in this region, puts forward the need to consider the possibility of using speech samples in Catalan and Spanish in a forensic speech comparison context. According to the data from a survey on the linguistic uses of the population carried out in 2013 (DGPL & Institut d'estadística de Catalunya, 2013), more than 80% of the population has a suitable command of both Catalan and Spanish so as to be able to communicate naturally. Therefore, there exists the possibility that the forensic phonetician is involved in a case where the disputed and undisputed sample(s) have been produced in these two different languages.

The objective of the present research is to determine whether the analysis of the phonetic-acoustic parameters that are most commonly used in forensic speech comparison in one language can also be applied to the comparison of samples in different languages, in this case Catalan and Spanish. The corpus of study contains data on read-aloud speech by 22 adult male experienced professional speakers, of which 11 are balanced bilingual speakers and 11 are Catalan dominant bilingual speakers. The texts that were read were the Catalan and the Spanish versions of the same news article published

in the newspaper *El Periódico*. The participants were asked to read each article twice in the order they chose, with the aim of having two repetitions by each speaker and thus being able to analyse intra-speaker variation. Consequently, each speaker produced four readings (two in each language) and all of them chose to read the Spanish text first and then the Catalan text.

The variables that were analysed can be grouped into six main categories. Firstly, the parameters related to F0 were the mean, the median, the standard deviation, the skewness and the kurtosis of a total of 4646 tone units. Secondly, the first four formants of 1848 instances of the central low vowel [a] in stressed position and followed and preceded by a plosive or an approximant. Thirdly, the first four formants of 1320 instances of [l] in unstressed and intervocalic position. Fourthly, the duration of the VOT of 1144 instances of [k] in unstressed and intervocalic position. Fifthly, the centre of gravity, the standard deviation, the kurtosis, the skewness and the intensity of 792 instances of [s] in unstressed and intervocalic position. Finally, the articulation rate of the bilingual Catalan-Spanish speakers was also analysed. Therefore, the total number of phonetic-acoustic variables that was analysed in the present PhD thesis was 20. The selection of these variables was based on the grounds that they are most frequently analysed by forensic phoneticians, according to Gold and French (2011), and due to their frequency of appearance in comparable phonetic contexts in the corpus of analysis.

The statistical analysis of the data was carried out by means of the *Generalised linear mixed model* method, since it considers the possibility that there are correlated observations linked to the presence of fixed and random effects. This method has allowed the estimation of the impact of the independent variables, namely language, speaker and repetition, over the 20 dependent variables.

In light of the results obtained, it is possible to conclude that the majority of the phonetic-acoustic parameters usually analysed in forensic speech comparison for a single language are equally valid when comparing speech samples in Catalan and Spanish. However, the results obtained for five of the parameters in this investigation do not confirm the initial hypothesis completely, due to several reasons.

First, the values of the second formant of stressed [a] followed and preceded by a plosive or an approximant shows high inter-speaker variation and low intra-speaker variation, both in Catalan and Spanish. However, these values show an inter-language variation that is statistically significant in 41% of the speakers analysed. Therefore, it is concluded that the analysis of this parameter should not be carried out in the comparison of samples in two different languages.

Secondly, the values of the second formant of intervocalic unstressed [l] show low inter- as well as intra-speaker variation, both in Catalan and Spanish. Nevertheless, the F2 values of this segment indicate an inter-language variation that is statistically significant in 68% of the speakers analysed and, consequently, this parameter should not be taken into consideration in the comparison of samples in different languages.

Finally, the values of the third formant of stressed [a] preceded and followed by a plosive or an approximant, the intensity of unstressed intervocalic [s] and speech rate all show statistically significant intra-speaker and inter-language variation in a very low percentage of speakers. However, in the context of this research, these parameters show statistically significant inter-speaker variation in approximately half of the speak-

ers analysed. Therefore, they cannot be considered as reliable parameters in forensic speech comparison, not only in the comparison of samples in different languages, but also in the comparison of samples in the same language, either Catalan or Spanish.

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