

A contrastive acoustic analysis of dental and alveolar stops in Spanish and English

While both Spanish and English possess a contrast between *fortis* (/p t k/) and *lenis* stops (/b d g/), the phonetic implementation of the contrast differs for the two languages. According to one view, the phonological opposition in English depends on the feature [spread glottis], which is specified for the *fortis* stops but not for the *lenis* ones; on the other hand, the Spanish contrast depends on [voice], which is specified for the *lenis* stops but not for the *fortis* ones (Beckman et al., 2011).

The primary acoustic-phonetic correlate of the *fortis-lenis* contrast is Voice Onset Time (Lisker & Abramson, 1964). Voice Onset Time (VOT) is a correlate of both the features [spread glottis] and [voice], which makes this correlate able to capture the difference between Spanish and English stops in general. The differences between Spanish and English with respect to how they use VOT in stops are well known. However, it is also well known that English and Spanish stops do not merely differ on the use they make of VOT. There is one important difference in addition to VOT: Spanish /d/ and /t/ are described as “dental” and English /d/ and /t/ are described as “alveolar”. These descriptions are largely based on impressionistic observations. In addition to VOT, what other acoustic correlates may be exploited to distinguish between Spanish and English (coronal) stops? We are not aware of any phonetic study of this difference between Spanish and English—there is, however, one such study for French (Sundara, 2005). The main goal of the present study is to provide careful acoustic measurements of Spanish and English coronal stops that may be used in the future to investigate further questions regarding Spanish and English /d/ and /t/, including their use by bilingual populations.

Using professional equipment, 7 female native speakers of English were recorded in North America and 7 native speakers of Spanish were recorded in Spain. Speakers produced target words in utterance-initial position, in carrier phrases such as “__ es la palabra” and “__ is the word”. There were 12 words with word-initial /d/ and 12 with word-initial /t/ in each language. Word-initial syllables were manipulated for lexical stress, with equal number of words in two target categories: stressed first syllable, unstressed first syllable. Production data were collected with the delayed shadowing technique—six male “talkers” (3 Spanish, 3 English) recorded the materials while reading from a list and these “stimuli” were then played in random order to the speakers, who were asked to “listen and repeat the sentences”. Each speaker provided the dataset with 144 observations for a total of 2016 tokens recorded and examined. The data were submitted to acoustic scrutiny; in addition to VOT, we analyzed the statistics of the spectrum of the burst (30 ms Gaussian window left-aligned with the burst). The selected measurements were: center of gravity, skewness, kurtosis, standard deviation and central moment. This resulted in a dataset of 2016 (tokens) * 5 (metrics) = 10080 data observations.

The data, which have already been analyzed and are ready to be reported, indicated the following: standard deviation and central moment of the spectra contributed to the contrast between Spanish and English coronal stops, center of gravity, skewness and kurtosis did not. Of course, VOT was a strong predictor, capable of distinguishing even between Spanish /t/ and English /d/ (both of them short-lag VOT categories). This was established with separate factorial analyses for the 5 acoustic metrics. A follow-up analysis took a scalar logistic regression approach in which the acoustic metrics were used as predictors rather than as dependent variables. This analytical approach showed that standard deviation of the spectrum was the strongest acoustic correlate of dental vs. alveolar place (this predictor improved the model by 26%); the next best predictor was VOT (which contributed an additional 11.3% of the variance). Other predictors had either minimal or no predictive power.

The present study examined the acoustics of Spanish and English /d/ and /t/. In particular, it set out to find acoustic metrics that captured the possible place-of-articulation difference between Spanish and English coronal stops. The metrics that were identified may then be used to address further questions regarding these sounds and how they are used by different populations. Now that we know how to measure this from acoustic data, a remaining question among many follows: Do Spanish-English bilinguals produce Spanish and English coronal stops with different places of articulation?