ESTUDIOS LINGÜÍSTICOS

VOT OF VOICELESS PLOSIVES BY WESTERN ANDALUSIAN SPANISH YOUNG SPEAKERS

VOT DE OCLUSIVAS SORDAS POR HABLANTES JÓVENES DE ANDALUZ OCCIDENTAL

Dario Barrera-Pardo
Universidad de Sevilla
dario@us.es
ORCID: 0000-0002-3439-4883

Enviado: 12-05-2022
Aceptado: 19-06-2022

Abstract

This study sought to investigate the voice onset time (VOT) of Western Andalusian Spanish voiceless plosives, a dialect whose phonetic characteristics have not been sufficiently researched empirically. Results indicated that both place of articulation and vowel height had an effect on VOT, especially the former. Two Spanish dialects, Castilian and Latin American, were compared with Western Andalusian in terms of VOT. Findings revealed only minor differences in VOT between Castilian and Latin American voiceless plosives, but sizeable differences between these two dialects and Western Andalusian VOT. A number of potential explanations for the detected contrasts are expounded.

Keywords: Voice onset time, voiceless plosives, Western Andalusian Spanish, Castilian Spanish, Latin American Spanish

resumen

Este estudio investigó el tiempo de inicio de la sonoridad (VOT) de las oclusivas sordas del español de Andalucía Occidental, un dialecto cuyas características fonéticas no han sido suficientemente investigadas empíricamente. Los resultados indicaron que tanto el lugar de articulación como la altura de la vocal tuvieron un efecto sobre el VOT, especialmente el primero. Se compararon dos dialectos españoles, el castellano y el latinoamericano, con el andaluz occidental en cuanto al VOT. Los hallazgos revelaron solo diferencias menores en el VOT entre las oclusivas sordas del castellano y del latinoamericano, pero diferencias considerables entre estos dos dialectos y el andaluz occidental. Se exponen posibles explicaciones para los contrastes detectados.

Palabras clave: Tiempo de inicio de la sonoridad (VOT), oclusivas sordas, español de Andalucía Occidental, español de Castilla, español latinoamericano

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

1. Introduction

Voice onset time (VOT) refers to the delay between the release of a plosive and the beginning of voicing. This acoustic feature has been shown to vary widely throughout the languages of the world, and is a well-studied phonetic event. In fact, Whalen, DiCanio, and Dockum (2022) documented that VOT is the most studied consonant feature in the phonetics literature they surveyed. For voiceless plosives, VOT can be relatively short or relatively long, depending on how each language partitions this acoustic dimension (e.g., Ladefoged & Johnson, 2015). The phonological and phonetic description of a language or speech variety is not complete until its VOT has been analyzed (Ladefoged, 2003). The current study is in line with the spirit of Ladefoged's call, and aims at investigating VOT in the speech variety known as Western Andalusian Spanish (WAS). The study focuses on the voiceless plosives articulated at the bilabial place of articulation (PoA), /p/, the denti-alveolar /t̪/[1], and the velar /k/. While VOT has been described for dialects such as Castilian and several Latin American (LA) accents, to date no data have been reported for WAS, and this study addresses this research gap.

1.2. Spanish VOT

1.2.1. Spanish VOT and PoA

The relationship between VOT and PoA in Spanish has been researched in a number of studies, the vast majority of which have firmly established that VOT varies as a function of PoA, such that voiceless bilabial plosives have a shorter VOT than both denti-alveolars and velars, and denti-alveolars have a shorter VOT than velars. That is, in terms of articulatory description, the further back in the oral cavity, the longer the VOT. This observation has been explained by Cho and Ladefoged (1999: 208) according to three sets of findings, to wit: (1) the further back the closure, the longer the VOT; (2) the more extended the contact area, the longer the VOT; and (3) the faster the movement of the articulator, the shorter the VOT. Thus, for example, velars tend to have a comparatively longer VOT because they are articulated back within the oral cavity; their active articulator, the tongue dorsum, rests on the velum with a sustained gesture; and, concomitantly, the active articulator takes longer to arrive at the release stage.

Asensi, Portolés, and del Río (1998) examined the VOT of Castilian Spanish voiceless plosives, finding that /p/ had a mean VOT of about 15 ms, /t̪/ had a mean VOT of 20 ms, and /k/ had a mean VOT of 35 ms. Rosner et al. (2000) however found for Castilian that there were statistically significant differences between the bilabials and denti-alveolars on the one hand, and the velars on the other, but no statistical

[1] This consonant has been usually described as dental but, in this study, it is referred to as denti-alveolar, following Martínez-Celdrán, Fernández-Planas, and Carrera-Sabaté (2003).

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

difference between bilabials and denti-alveolars. Castañeda Vicente (1986) for her part observed again that in Castilian the VOT pattern p < t < k was ratified. Poch (1984) reported similar data also for Castilian, as did Machuca Ayuso (1997) for the same variety. For Gran Canarian Spanish, Troya Déniz (2005) reported the same results, albeit with lower VOT values for the voiceless plosives than those found for Castilian in the studies mentioned. Recently, Martínez-Belda and Padilla (2021) investigated the VOT of Alicante Spanish plosives in emotional speech, and their results are in line with the durational pattern previously referred to. In LA dialects of Spanish, the VOT of voiceless plosives has been the focus of a number of studies.

Avelino (2018) reported for Mexican Spanish characteristically short values for the voiceless plosives, and PoA followed the sequence whereby velars had longer VOT values than bilabials and denti-alveolars, and denti-alveolars in turn were longer than bilabials. For Chilean Spanish, both Roldán and Soto-Barba (1997) and Soto-Barba and Valdivieso (1999) reported analogous results of the effect of PoA on VOT, that is, the sequence was p < t < k. Research on Ecuadorian Spanish by Stewart (2018) yielded slightly different results. This researcher examined both urban and more local rural speech varieties in the Ecuadorian context, and found that /p/ and /t̪/ did not differ in their VOTs (in fact, they had the same value), whereas /k/ contrasted with the bilabial and the denti-alveolar. Villamizar (2002) investigated the VOT of plosives in Venezuelan Spanish, and she reported the same PoA effect on VOT values. Finally, Williams (1977) examined voicing in three LA dialects, namely Venezuelan, Peruvian, and Guatemalan. Data from all three varieties supported the previous findings in the literature, such that the VOT values of the voiceless plosives were in agreement with the p < t < k sequence.

In sum, European and LA dialects of Spanish evidence a coherent and strong effect of PoA on the mean VOT values of voiceless plosives, whereby /p/ values are shorter than /t̪/ and /k/, and /t̪/ has shorter VOT than /k/.

1.2.2. Spanish VOT and vowel height

For a number of languages, VOT has been found to show substantial variation in duration depending on the height of the following vowel, such that VOT is longer before high vowels (e.g., /i/, /u/) than before lower vowels (e.g., /a/). However, as shown in what follows, this variability has not always been corroborated.

In English, Morris, McCrea, and Herring (2008) reported statistically significant shorter values for voiceless plosives in syllables with /a/ than in syllables with /i/ or /u/, with a large effect size, $\eta^2_p = 0.59$; this means that almost 60% of the variability in the VOT of the voiceless plosives can be attributed to the height of the following vowel (see Lakens 2013 for an introduction to this family of effect sizes). For Australian English, on the contrary, Clothier and Loakes (2018) found a vowel height effect only for /t/, whose VOT was longer in the presence of high vowels than when followed by low vowels. This effect was not found for /p/ and /k/. Significant effects

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

of vowel height on VOT duration were reported for Mandarin by Chen, Chao, and Peng (2007), showing that high vowels triggered statistically significant longer VOT values for the voiceless plosives. Bijankhan and Nourbakhsh (2009) examined plosive VOT duration as a function of vowel height in Persian, finding that VOT values for the plosives varied significantly according to the height of the following vowel, again with high vowels lengthening this acoustic characteristic of the plosives. Oh (2011) reported for Korean plosives that the effect of vowel context was statistically significant for the plosives of this language, such that, as in the previous studies, the presence of a following high vowel induced longer mean VOT values.

Turning now to Spanish, fewer analyses have been conducted to ascertain the role of vowel height on VOT. Rosner et al. (2000), studying Castilian plosives, found no effect of vowel height on VOT duration. The same dialect was investigated by Castañeda Vicente (1986), and this researcher's experiment yielded data that are in line with what has been reported for other languages: VOT values increase as the height of the vowel rises. For Gran Canarian Spanish, Troya Déniz (2005) reported the same pattern, especially noticeable for the high vowel /u/. It should be noted nonetheless that these data were not analyzed quantitatively.

To sum up, it seems that there is an overall tendency for vowel height to have an effect on VOT, whereby high vowels lengthen the VOT of voiceless plosives, and low vowels shorten it. This phenomenon may be explained by the narrower constriction in the gesture required for high vowels, which leads to a longer VOT. This is further explained by the greater resistance to the airstream caused by high vowels, which in turn delays the glottal pressure differential that generates voicing (Chang et al., 1999).

1.2.3. Spanish VOT and gender

Another factor that has been found to have an impact on VOT is speaker gender, although, as we will observe, the results for this relationship are partially inconclusive and not fully resolved. Clothier and Loakes (2018) reported that in Australian English women had, for voiceless plosives, longer VOTs than men, a finding that is congruent with data from other English varieties. Kaňok and Novotný (2019) examined the effect of gender on Czech VOT, and found statistically significant shorter values for men, but only for /p/ as well as /t/, and not for /k/. Research on Mandarin Chinese by Li (2013) yielded significant differences between women and men, but only for the voiced plosives. Li focused on speech rate in his analysis, because this temporal measure has previously proved differential when considering speaker gender, such that men tend to talk faster than women. Controlling for speech rate, then, Li did not find significant differences in the VOT of voiceless plosives by women and men. Noting the discrepancy between these results and the data reported for English, where women do show significantly longer VOTs, Li comments that such dissimilarity may be due to cultural or sociolinguistic causes, rather than anatomical factors (e.g., women having shorter

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

vocal tracts). In fact, while Munson and Babel (2019: 511) explain the shorter VOTs of men according to males' larger vocal tract volumes, they also acknowledge that these acoustic patterns may reflect language-specific learned language performance (see Oh 2011 for similar conclusions regarding Korean).

With respect to Spanish, it is generally claimed that the general tendency is for women to produce longer VOTs than men. Asensi, Portolés, and del Río (1998) confirmed for Castilian this tendency, although they did not quantify their results. To gather more objective data, therefore, the VOTs reported in this study were subjected to a series of chi-square tests, none of which were statistically significant (all $p > 0.05$) and the effect sizes were negligible. This means that, in reality, there was no effect of gender on VOT in that study. The same methodological reasoning can be applied to the data reported by Troya Déniz (2005) for Gran Canarian Spanish. This researcher found slightly higher VOTs for women than for men, but did not quantify this relationship. Again, chi-square tests showed that none of the differences by gender in the VOT of /p t̪ k/ were statistically significant, and that the effect sizes were trivial, meaning that there actually was no effect of gender on VOT. Also for Castilian, Rosner et al. (2000) reported for their part no statistical effect of gender on VOT.

To round up hence this review of the relationship between gender and VOT in Spanish, it can be concluded that to date there are no data that support a hypothesis whereby gender has an effect on the VOT of voiceless plosives.

1.3. WAS

The dialectal area of the provinces of Huelva, Seville, Cordoba, and Cadiz (and, depending on the authors, also Malaga) has been classified within WAS (Fernández de Molina & Hernández-Campoy, 2018; Herrero de Haro & Hajek, 2022; Villena Ponsoda, 2000). The other Andalusian dialectal area, Eastern Andalusian Spanish (EAS), has been the focus of more research than WAS. Many, perhaps most, studies of WAS have a sociolinguistic aim, such as investigations of *ceceo* (e.g., Regan in press), or inquiries into attitudes toward this speech variety (see Santana Marrero & Manjón-Cabeza Cruz, 2021).

Less research has been directed to the acoustic properties of WAS; Del Saz (2014, 2019) carried out experimental studies of this type. Coloma (2012) classified the worldwide dialects of Spanish after developing a linguistic innovation index that included ten phonetic features (such as *seseo*, aspiration of /s/, velarization of /n/, deaffrication of /tʃ/). He concluded that WAS can be classified as the most innovative accent (out of 28) according to this scheme. Fernández de Molina & Hernández-Campoy (2018: 501) as well refer to WAS as an innovative variety (as opposed to conservative varieties, for example Castilian or Andean Spanish). All this makes WAS an ideal target for further phonetic investigation, especially since there is a dearth of data on the acoustic features of this variety (see Hernández-Campoy & Villena-Ponsoda, 2009 for additional characterization of this accent).

1.4. Research questions

Give the literature review in the previous sections, the present study addressed the following research questions (RQs):

1. RQ1: What are the relative effects of PoA, vowel height, and gender on WAS VOT?
2. RQ2: To what extent are the WAS VOT values different from the Castilian and LA VOTs reported in the literature?

2. Method

2.1. Participants

The researcher advertised a call for participants through fliers and personal contacts in a large public university in the city of Seville. Course credit was offered to participants enrolled in two of his courses, and these efforts resulted in 21 participants, all of them university students. 12 were females and 9 males, with a mean age of 20.4 (SD = 1.16, range 19 – 23). 16 subjects were from the Seville area (Seville city and province), and 5 from the Cadiz area (all of them from the Cadiz province). 20 subjects resided in the city of Seville and 1 in the city of Cadiz at the time of the experiment. All reported normal hearing and knowledge of at least one second language (English, French).

2.2. Materials

The stimuli of the experiment consisted of a wordlist (see Table 1) featuring the three voiceless plosives followed by a high or low vowel in CVCV words, with the first syllable being stressed. This syllabic pattern is the most common in Spanish (Dauer 1983), and has been used customarily in other phonetic studies of this language (e.g., Lavoie 2001). Together with the 27 target words, the stimuli included another 21 distractor words with the same phonological pattern (e.g., 'fase', 'milla', 'nube'). There were thus 48 stimuli in total.

Table 1

Stimuli for the experiment

Context	/p/	/t̪/	/k/
High vowel	pito, pulla, pino, pura, piso	tito, tino, tuya, tuna, tiro	cuya, cuna, quito, quiso, kilo
Low vowel	pata, para, paso, pala	tala, tara, tasa, talo	cala, casa, calo, cara

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

2.3. Procedure

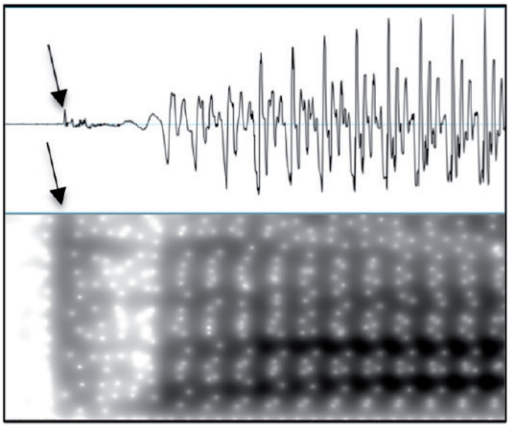
The experiment took place at the phonetics laboratory of the university, in a sound-treated booth. The recordings were done at a 44.1 kHz sampling rate using a Marantz professional PDM671 solid-state recorder and a Shure SM48 microphone. Participants were instructed to record each of the 48 words in the carrier sentence ‘Digo la palabra _____’ (‘I say the word _____’). They completed an anonymous background questionnaire after the recording session. This questionnaire collected age, place of birth, place of residence, gender, and educational level information from each speaker.

2.4. Analysis

The recording sessions yielded a total of 567 tokens (21 speakers x 27 words; the 21 distractors were left out of the analysis). VOT was measured both from the waveform (upper panel in Figure 1) and from the spectrogram (lower panel in Figure 1). As shown in Figure 1, on the waveform the transient corresponding to the burst of the consonant can be identified. On the spectrogram, a plosion bar clearly signals the presence of the plosive release.

Figure 1

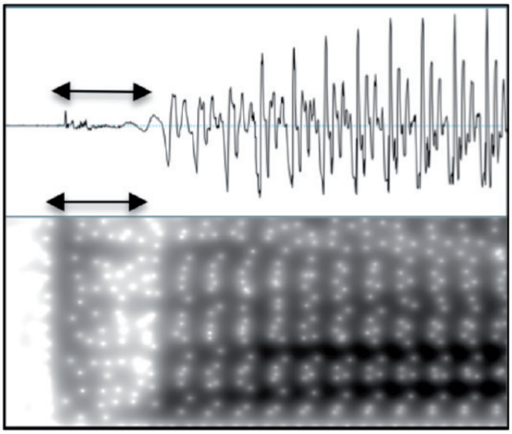
VOT of the first syllable of the token ‘tala’ [ˈt̪ala] by speaker 1, showing the transient on the waveform (upper arrow) and the plosion bar on the spectrogram (lower arrow)



As shown in Figure 2, VOT measurement can be done from the waveform or from the spectrogram. For the VOT analyses in this study the waveform measurement was preferred, but the spectrogram reading was resorted to in cases when the waveform did not provide an optimal measurement.

Figure 2

VOT measurement of the first syllable of the token 'tala' [ˈt̪ala] *by speaker 1, from the waveform and from the spectrogram*



While VOT measurement may seem a straightforward procedure, this is far from the truth (e.g., Thomas 2011). There were two complications encountered in this analysis. First, as shown in Figure 3, some plosives evidenced more than one burst and plosion bar. This is called a multiple burst (MB), and 25% of the plosives had more than one burst. Barrera-Pardo (2022) gave a comprehensive account of MBs in these data. Following Cho and Ladefoged (1999) and Thomas (2011), the decision was to take VOT measurements from the last burst for each consonant. It is an open question whether this methodological approach had an impact on the results of the current study (see section 3.2).

The second complication in the analysis was that some VOTs were not suitable for analysis, as shown in Figure 4. Here, the velar plosive seems to have three transients on the waveform, but the plosion bars on the spectrogram are less unequivocal. One plosion bar appears to be evident, but what follows is more obscure and not prone to further analysis. Such tokens were discarded in the analysis. Outliers, as identified in boxplots, were also removed from the data.

In sum, 117 tokens were eliminated in the final analysis, which left 451 VOT measurements (567 – 117 = 451).

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

Figure 3

First syllable of the token 'tira' [ˈt̪ira] by speaker 16, with two bursts (two transients, upper arrows; two plosion bars, lower arrows)

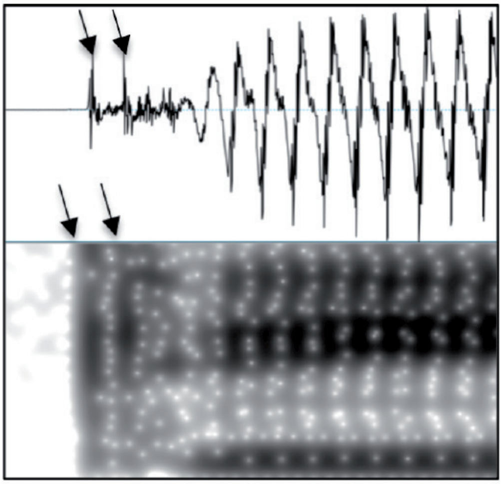
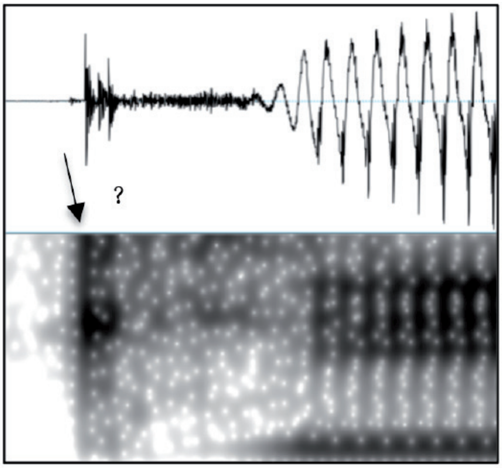


Figure 4

First syllable of the token 'quiso' [ˈkiso] by speaker 2, unanalyzable (see text)



Finally, to determine the reliability of the data measurements, a month after the initial analysis, the researcher reanalyzed 25% of the data, and a high correlation was observed, $r = 0.89$, $p < 0.001$) between both sets of measurements.

3. Results

To address the first research question, a three-way ANOVA was conducted on VOT as the dependent variable and PoA (bilabial, denti-alveolar, velar), vowel height (high, low), and gender (female, male) as factors. Addressing the second research question, to understand the differences in VOT values between WAS and two other Spanish varieties, Castilian and LA Spanish, a two-way ANOVA was run on VOT and PoA (bilabial, denti-alveolar, velar) and dialect (Castilian, LA, and WAS) as factors. The results are presented first as descriptive statistics and thereafter with inferential statistics (i.e., ANOVAs) for the two research questions of the current study.

3.1. Research question 1

Research question 1 asked about the relative effects of PoA, vowel height, and gender on WAS VOT. The answer is provided in the form of descriptive and inferential statistics. The latter are presented by means of ANOVAs, their significance tests and corresponding effect sizes. These effect sizes are reported as partial eta-square (η^2_p) indexes for the ANOVA tests, and Cohen's *d* indexes for the post-hoc tests. Briefly, the significance tests, indicated by the *p*-values, reveal whether there is an effect, and the effect sizes account for the magnitude of the effect. Researchers and consumers of research may be clearly more interested in effect sizes. The descriptive statistics for PoA, vowel height, and gender are displayed in Table 2. PoA follows the sequence p < t < k mentioned in the literature, albeit with noticeably shorter VOTs than in other studies (more on this in section 3.2 below). The variability in the data seems rather uniform and unproblematic, as evidenced by the relatively low standard deviations and minimum and maximum values.

Table 2

WAS VOT values by vowel and gender (in milliseconds)

Factors	/p/				/t̪/				/k/			
	M VOT	SD	Min	Max	M VOT	SD	Min	Max	M VOT	SD	Min	Max
PoA	10	3.15	2	18	12.6	3.12	6	21	16.1	4.34	7	25
High vowel	11.21	3.33	6	18	13.91	3.20	7	21	15.76	4,84	7	25
Low vowel	8.40	1.97	2	13	10.97	2.11	6	16	16.31	3.96	7	24
Female speaker	10.40	3.52	2	18	12.61	3.22	6	21	15.99	4.51	7	25
Male speaker	9.61	2.66	3	17	12.58	3.02	7	21	16.20	4.15	7	24

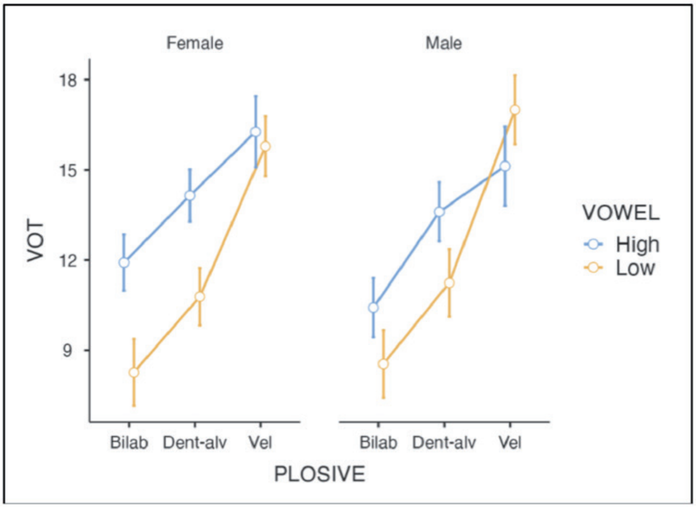
Figure 5 below illustrates in line graphs the relative effects of the three factors considered in the study. First, it can be observed that the VOT of each plosive differed substantially, increasing as the articulation goes from bilabial to velar. This

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

is evident for both genders, and for vowel height as well. Second, with reference to gender, females had seemingly higher (i.e., longer) VOT values than males, but only in the presence of high vowels, except for the velars, which behaved differently and showed a reversed pattern. And third, vowel height was also comparable, with the exception of the velars again.

Figure 5

Line graphs for the factors (PoA, vowel height, and gender) of the study



Turning now to the inferential statistics, the ANOVA test revealed a main effect for PoA ($F(2,451) = 123.99$, $p < 0.001$, $\eta^2_p = 0.35$), where post-hoc Tukey tests showed that the bilabial PoA (M = 10 ms) had a significantly and to a very large extent ($p_{tukey} < 0.001$, $d = 1.9$) shorter VOT than the velar PoA (M = 16.1 ms); the bilabial PoA also differed significantly and to a large extent ($p_{tukey} < 0.001$, $d = -0.8$) from the denti-alveolar (M = 12.6) PoA. The velar had a longer VOT, that was significantly different and this a large extent ($p_{tukey} < 0.001$, $d = 1.09$), from the denti-alveolar VOT.

There was also a main effect for the height of the vowel (high or low) following the plosive, ($F(1,451) = 27.45$, $p < 0.001$, $\eta^2_p = 0.06$), where the high vowels /i, u/ had a significantly higher VOT (M = 13.3 ms) than the low vowel /a/ (M = 12 ms) with a medium effect size ($d = 0.5$). There was also an interaction between PoA and vowel height ($F(2,451) = 9.13$, $p < 0.001$, $\eta^2_p = 0.05$), where Tukey post-hoc tests showed the following. The bilabial had a nonsignificant lower VOT (M = 15.76) when followed by a high vowel than when followed by a low vowel (*M* = 16.3), $p_{tukey} = 0.84$, $d = -0.21$ with a weak effect size. The denti-alveolar had a statistically significant longer VOT (*M* = 13.91) when followed by a high vowel than when followed by a low vowel (*M* = 10.97), $p_{tukey} < 0.001$, $d = 0.87$; the effect size is large. The velar followed by a high vowel (*M* = 15.76) did not differ significantly when followed by a low vowel (*M* = 16.31), $p_{tukey} = 0.84$, $d = -0.2$, and the corresponding effect size is weak.

There was a significant interaction between Vowel and Gender, $F(2,451) = 7.45$, $p = 0.007$, $\eta^2_p = 0.02$, but the effect size is small. Tukey post hoc tests revealed that females produced a longer VOT when the plosive was followed by a high vowel (*M* = 13.8) than when it was followed by a low vowel (*M* = 11.8), $p_{tukey} < 0.001$, $d = 0.76$, with a strong effect size. There was no significant difference for the males ($p_{tukey} = 0.46$, $d = -0.19$); its associated effect size is small.

3.2. Research question 2

Research question 2 asked about the extent to which WAS VOT differed from the VOTs of other Spanish dialects across PoA. The Castilian and LA VOT values were compiled in the following way. Table 3 shows the sources from which the VOTs for Castilian were obtained (5 studies), and the sources from which the LA VOTs were collected (11 studies; these included Mexican, Argentinian, Puerto Rican, Chilean, Ecuadorian, Venezuelan, Peruvian, and Guatemalan). ANOVA tests showed that the Castilian VOTs did not differ significantly ($F(4,10) = 0.505$, $p = 0.73$), and neither did the LA VOTs ($F(10,22) = 0.56$, $p = 0.82$). These studies thence are homogeneous in terms of their VOTs and may be grouped as two distinct dialects. Their values were averaged and then used for comparison with the WAS VOTs.

The descriptive statistics for the three dialects are presented in Table 4. Castilian and LA showed rather similar values for the three PoAs, and also a comparable variability in the data, as signified by the relatively uniform standard deviations across both dialects. However, the WAS VOTs were distinctly lower (i.e., shorter). This disparity is especially evident for the VOT of /k/, which in WAS was nearly half as long as in both Castilian and LA. These differences will be entertained below.

The barplots in Figure 6 clearly show, first, that the Castilian and LA VOTs were analogous, especially for the bilabial and the denti-alveolar, and identical for the velar. Secondly, WAS VOTs were notably shorter for the velar, as compared with both Castilian and LA.

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

Table 3

Sources of mean VOT values for Castilian and LA

Study	/p/	/t̪/	/k/	Dialect
Asensi, Portolés, and del Río (1998)	14.7	20.2	35.4	Castilian
Avelino (2018)	15	20	49	Mexican
Castañeda Vicente (1986)	6.5	10.4	25.7	Castilian
Borzone (1980)	10	15	25	Argentinian
Lisker and Abramson (1964)	4	9	29	Puerto Rican
Rosner et al (2000)	13.1	14	26.5	Castilian
Soto-Barba and Valdivieso (1999)	10.1	16.9	28.3	Chilean
Stewart (2018)	19	19	33	Ecuadorian
Stewart (2018)	21	21	40	Ecuadorian
Poch (1984)	18	17	32	Castilian
Roldán and Soto-Barba (1997)	13.2	16.4	30	Chilean
Villamizar (2002)	17.43	19.22	32.24	Venezuelan
Machuca Ayuso (1997)	12.5	18.25	27.5	Castilian
Williams (1977)	14	20.6	32.6	Venezuelan
Williams (1977)	15.2	16.2	29.7	Peruvian
Williams (1977)	9.8	10.3	25.7	Guatemalan

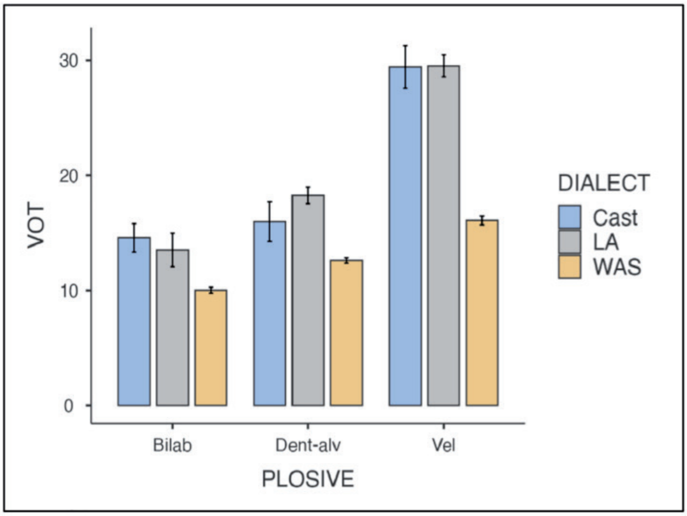
Table 4

VOT values by dialect (in milliseconds)

Dialect	/p/				/t̪/				/k/			
	M VOT	SD	Min	Max	M VOT	SD	Min	Max	M VOT	SD	Min	Max
Castilian	14.6	2.46	12.5	18	16	3.84	10.4	20.2	29.4	4.14	25.7	35.4
LA	13.5	4.84	4	21	18.3	2.17	15	21	29.5	2.87	25	33
WAS	10	3.51	2	18	12.6	3.12	6	21	16.1	4.34	7	25

Figure 6

Barplots for the VOT of the three dialects (Castilian, LA, and WAS) of the study

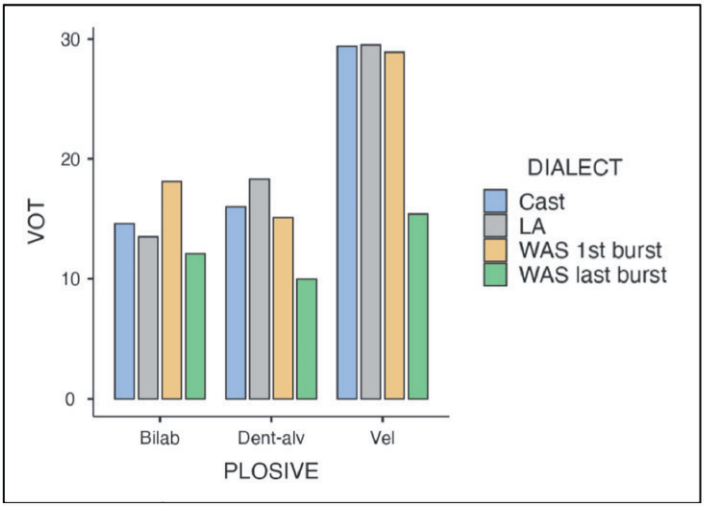


Before looking at the inferential statistic analyses of these differences, an important remark must be made with reference to the measurement methodology in the current study. Full details are given by Barrera-Pardo (2022). As noted previously in section 2.4, 25% of the data presented MBs; 9.5% of the bilabials had MBs, 15.22% of the denti-alveolars showed MBs, and 33.33% of the velars had more than one burst. Other researchers have noted as well, but only in passing, that MBs were observed in the data they collected. Thus, Asensi, Portolés, and del Río (1997) reported frequent MBs in Castilian for velars and also for the denti-alveolars; Torres and Iparraguirre (1996) made the same observation for velars, as did Lavoie (2001). However, only Lavoie offered quantitative data on the MBs found in her study. It is reasonable to infer that other researchers must have also found MBs in their data, but, notably, did not report or quantify them. In the present study, as explained in section 2.4, VOT measurements were routinely taken from the last burst in the presence of MBs (see Barrera-Pardo 2022 for further information on this analysis and the reason behind it). It could be the case that this methodological decision had some repercussion on the WAS VOT data reported in the current study and its comparison to the other dialects, but this is an open question that needs to be answered by means of a quantitative analysis (see below).

By way of comparison, Figure 7 displays the mean VOTs for WAS across PoA when the first burst was taken as the onset of VOT or when the last burst was taken as the onset of VOT. The Castilian and LA VOTs are also displayed for comparison. The differences seem evident and substantial. The bilabials showed a clear disparity between their mean VOT value as per the method employed, and so did the denti-alveolars; nonetheless it is the velars that showed the largest variation, with a VOT that was half the length when measurements were taken from the last burst. Note as well that, when the first burst was taken as the onset of VOT, the differences between WAS and the other two dialects are fundamentally neutralized, especially for the velars.

Figure 7

Barplots for the VOT of the three dialects of the study, with WAS measurement methods compared



To elucidate the quantitative significance of these differences, a series of chi-square tests wer run on the data. This resulted in the following. For the bilabial, the only differences worth considering were between Castilian and WAS when measured from the first burst; the difference was not statistically significant and the associated effect size very weak; the same result was observed for the difference between the bilabial LA and the bilabial WAS measured from the first burst. For the denti-alveolar, the difference between Castilian and WAS measured from the last burst almost reached significance and its associated effect size was medium. For this consonant, a statistically significant difference between LA and WAS measured from the last burst was found, with a moderate effect size. Lastly, the results for the velar were these. Castilian and WAS measured from the last burst differed significantly and to a moderate extent, as evidenced by the effect size. The same result for the velar was obtained for the difference between LA and WAS measured from the last burst.

These results therefore indicate that the measurement method actually had some impact (as expressed by the medium effect sizes observed) on the differences detected among the three dialects. This means that the differences among WAS, Castilian and LA reported below were to some extent an artifact of the methodology employed in measuring the WAS VOTs, specifically for the denti-alveolars and more notoriously for the velars. The results reported in what follows should be interpreted with this important caveat in mind.

To answer the second research question, we now consider the inferential statistics for the differences explored in the study. There was a statistically significant PoA effect ($F(2,497) = 91.7$, $p < 0.001$, $\eta^2_p = 0.27$), with a large effect size. There was also a significant effect due to Dialect ($F(2,497) = 85.8$, $p < 0.001$, $\eta^2_p = 0.26$), with a large effect size as well. Finally, the PoA by Dialect interaction was significant ($F(4,497) = 14.9$, $p < 0.001$, $\eta^2_p = 0.11$), and associated with a medium effect size. Post-hoc Tukey tests showed that the bilabial and the denti-alveolar mean difference of -2.9 ms was significant, t (497) = -3.04, $p_{tukey} = 0.007$, $d = -0.82$, and this to a very large extent, as indicated by the effect size; the bilabial and velar mean difference of 12.3 ms was significant, t (497) = 12.84, $p_{tukey} < 0.001$, $d = 3.49$, with a very large effect size; and the velar and denti-alveolar mean difference of 9.39 ms was significant, t (497) = 10.04, $p_{tukey} < 0.001$, $d = 2.66$, also to a great extent, as per the effect size observed.

For the Dialect main effect, post-hoc Tukey tests revealed that the mean difference of -0.44 ms between Castilian and LA was not significant, t (497) = -0.38, $p_{tukey} = 0.92$, $d = -0.12$, with a trivial effect size. Between Castilian and WAS there was a significant mean difference of 7.09 ms, t (497) = 7.38, $p_{tukey} < 0.001$, $d = 2.01$, and this to a very large degree; and between LA and WAS there was a significant mean difference of 7.59 ms, t (497) = 11.22, $p_{tukey} < 0.001$, $d = 2.13$, also to a great extent. The effect sizes, as noted, are very large.

For the interaction between PoA and Dialect, post-hoc Tukey tests revealed the following. There was a nonsignificant mean difference of 1.05 ms between the Castilian bilabial and the LA bilabial, t (497) = 0.51, $p_{tukey} = 1$, $d = 0.29$; the effect size was small. The mean difference of 4.55 ms between the Castilian bilabial and the WAS bilabial was not significant, t (497) = 2.55, $p_{tukey} = 0.208$, $d = 1.29$, but the effect size was very large. The mean difference of 3.5 ms between the LA bilabial and the WAS bilabial was significant, t (497) = 3.19, $p_{tukey} = 0.04$, $d = 0.99$, with a large effect size.

There was a nonsignificant mean difference of 2.28 ms between the Castilian denti-alveolar and the LA denti-alveolar, t (497) = -1.16, $p_{tukey} = 0.96$, $d = -0.65$; the effect size was medium. The mean difference of 3.37 ms between the Castilian denti-alveolar and the WAS denti-alveolar was nonsignificant, t (497) = 2.11, $p_{tukey} = 0.46$,

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

d = 0.95, but the difference yielded a large effect size. There was a significant mean difference of 5.65 ms between the LA denti-alveolar and the WAS denti-alveolar, t (497) = 4.70, p_{tukey} < 0.001, d = 1.6, with an associated effect size that was very large. There was a nonsignificant mean difference of -0.08 ms between the Castilian velar and the LA velar, t (497) = -0.04, p_{tukey} = 1, d = -0.02; the effect size was trivial. The mean difference of 13.34 ms between the Castilian velar and the WAS velar was significant, t (497) = 8.31, p_{tukey} < 0.001, d = 3.97, and this to a very great extent. There was a significant mean difference of 13.4 ms between the LA velar and the WAS velar, t (497) = 11.06, p_{tukey} < 0.001, d = 3.81, also to a very large degree. Again, these effect sizes are extremely large.

4. Discussion and conclusion

The ensuing discussion of the results reported will proceed mainly by an analysis of the effect sizes detected, rather than simply considering the significance tests and their associated p-values. In other social sciences, such as psychology, this is the recommended analytical approach when quantifying data from empirical studies (e.g., Stukas & Cumming 2014).

The first research question asked about the relative effects of three factors on WAS VOT: PoA, vowel height, and gender. PoA alone explained 35% of the variance of the VOT values, as indexed by the effect size obtained (η^2_p = 0.35). This is normally considered a very large effect size (Cohen 1988). Vowel height, on the other hand, explained 6% of the variance in VOT values, which is a medium effect size. Finally, gender by itself only explained 0.01% of the variability of VOT (its associated effect size was η^2_p = 0.001, a trivial index).

The post hoc tests for PoA showed that the bilabial differed to a very large extent from the velar, since the effect size for this comparison was d = 1.9, a very large effect size (Cohen 1988). In more lay and practical terms, this effect size indicates that 97.1% of the VOT values of the bilabial are below the average velar, which is a very extensive amount. This type of interpretation of Cohen's d effect sizes is a "common language explanation" (Magnusson 2022; this site was used also for calculating and interpreting the d effect sizes that follow), and will be used in the subsequent discussion.

The comparison between the bilabial and the denti-alveolar also proved sizable, with a d = -0.8 effect size (it does not matter that this index is negative), which again can be translated as 78.8% of the bilabials being below the average VOT for the denti-alveolars. Finally, the velar had a substantially longer VOT than the denti-alveolar, with a very large effect size d = 1.09, an index that can be construed as 97.1% of the denti-alveolars being below the average value for the velars.

Vowel height post hoc tests showed that high vowels had a longer VOT than low vowels, with a d = 0.5 effect size, which can be considered a medium effect size, once more translatable as 69.1% of the low vowels being below the average of the high vowels.

ISSN 1132-0265
https://dx.doi.org/10.12795/PH.2022.v36.i01.10

The interaction between the two effects PoA and vowel height yielded a statistically significant close to medium effect size, $\eta^2_p = 0.05$, which means that 5% of the variability in VOT values can be attributed to the effect of the following vowel.

Post hoc tests revealed that the bilabial followed by a high vowel had a shorter VOT than followed by a low vowel, with a small effect size $d = -0.21$; this translates as 58% of the bilabials followed by a high vowel being below the average of the low vowels. This result is slightly above the chance level (i.e., 50%). This result is in contradiction with the effect size for the denti-alveolar in this comparison, which was $d = 0.87$, a large effect size, meaning that about 80.8% of the consonants when followed by a low vowel were below the average VOT for high vowels. The velar plosive showed the same effect size as the bilabial, which can be interpreted again as a lack of substantial difference.

Finally, the interaction between vowel height and gender proved statistically significant but its associated effect size was small, $\eta^2_p = 0.02$, indicating that 2% of the variability in the VOT values can be ascribed to this effect. The follow-up tests showed a large effect size $d = 0.76$ when the plosives produced by females were followed by a high vowel than in a low vowel context. This can be stated as 77.6% of the VOTs in the low vowel context being below the average of the VOTs in the high vowel context, as produced by female speakers. For the male speakers, the effect size was small, $d = 0.19$, meaning that 57% of the VOTs in the low vowel context were below the average VOTs in the high vowel context, a result that is close to chance level (i.e., 50%).

To synthesize the answer to the first research question, then, the following pointers can be put forth. First, the effect of PoA on WAS was very strong, in line with what has been observed in other studies (e.g., Asensi, Portolés, & del Río 1998; Williams 1977), but differed from the results of Rosner et al. (2000), who found no significant difference between bilabials and denti-alveolars. No clear explanation can be offered for this discrepancy.

Second, the effect of vowel height seemed to ratify the results of the scant previous research carried out on this variable (e.g., Castañeda Vicente 1986; Troya Déniz 2005), but the effect found for this relationship is in disagreement with the data reported by Rosner et al. (2000). There seemed to be, in spite of this, a tendency for VOT to be longer in the high vowel context, although in WAS the current study has observed that for bilabials the effect is reversed, with low vowels triggering a longer VOT. However it must be acknowledged that the effect size for this relationship was close to chance level. All this makes the results for the association between PoA and vowel height rather inconclusive. Clearly, more research is needed to further elucidate the role of vowel height.

And third, to conclude commentary on the first research question, gender alone explained a negligible 0.01% of the variability of VOT, although for the combined effects of gender and vowel height for plosives produced by females there was a substantial interaction, such that high vowels by female speakers had a longer VOT than in the context of a low vowel.

The second research question asked about the comparison between WAS VOTs on the one hand and Castilian and LA VOTs on the other. For the sake of brevity, the findings will be synthesized as follows. The dialect of the speaker showed a very large effect size, since over a quarter of the variability in VOT values was explained by this factor alone.

The Castilian bilabial VOT was one ms longer than the LA bilabial, with a small effect size that was above chance level (61%). The Castilian denti-alveolar VOT was 2.28 ms shorter than the LA plosive, with a moderate effect size that was well above chance level (74.2%). The difference between Castilian and LA velars was negligible (less than 0.1 ms), with an effect size at chance level (50%). Hence only small to medium differences were found between Castilian and LA, and this in the bilabial and the denti-alveolar.

As for the comparison between Castilian and WAS, the data showed that for the bilabials, the Castilian VOT was 4.55 ms longer than the corresponding WAS VOT, with an effect size close to maximal probability (90.1%). The Castilian denti-alveolars had a 3.37 ms longer VOT than the WAS consonants, with an effect size close to maximal probability (83%). To end, the Castilian velars had a VOT that was 13.34 ms longer than the corresponding WAS VOT, whose effect size was at 100% probability. Thus, large to very large differences were found between Castilian and WAS, especially for the velar plosive.

The differences between LA and WAS were as follows. For the bilabials, LA VOT was 3.5 ms longer than for WAS, and the associated effect size is very likely, at 84%. For the denti-alveolars, LA VOT was 5.65 ms longer than the WAS VOT, with an effect size close to maximal probability (94.5%). Lastly, the velar LA had a VOT that was 5.65 ms longer than the velar WAS VOT, with maximal probability (100%). All this means that for the three plosives large to extremely large differences were observed between WAS and LA.

The reasons for this variability in VOTs among the three dialects that the current study has focused on can be explained in number of ways. Perhaps the variability can be attributed to idiosyncratic causes; WAS VOTs are characteristically shorter than the VOTs of other varieties. Hualde (2005: 140) in fact explains in this fashion the different VOTs reported for Castilian by Castañeda Vicente (1986) and those reported for LA by Williams (1977). Put simply, WAS evidences inherently shorter VOT values than other dialects. This conclusion is nevertheless tentative and should be taken with due caution, given the effect that the VOT measurement for WAS seemingly had in the study (see page 216). For the denti-alveolars and velars, the VOT measurement decision (measuring from the first or from the last burst), clearly had an impact on the VOT differences observed between WAS and the other two dialects.

A second factor that may have played a role in this variability is age; recall that the WAS speakers were all young, with a very restricted age range (19 – 23). A number of researchers have found that age has an effect on VOT. Bóna (2014) investigated the relationship between age and VOT in Hungarian, and reported that young speakers produced significantly shorter VOTs in bilabial and alveolar plosives than old speakers. However, Torre and Barlow (2009) found the reverse pattern, with older speakers showing shorter VOT values. Smith, Wasowicz, and Preston (1987) also reported overall shorter VOTs for young adults than for older speakers. Although the age of the subjects was not described in many of the studies for Castilian and LA used for comparison in the current study, those who did seemed to have investigated older cohorts than the WAS group recruited in the current study. Thus, for example, Castañeda Vicente (1986) reported having selected senior students and university professors (i.e., both younger and older subjects), and Soto-Barba and Valdivieso's (1999) report included speakers with an age range of 30 – 50. It could be the case that the globally shorter VOTs found in the present study are linked to the age factor.

Finally, the subjects of this study were all university students, and this sociological profile may also have had an effect on the data collected. Less educated and privileged speakers may have produced different VOTs.

To conclude this report, a few recommendations for future research and potential limitations of the study will be noted. First, the VOT measurement in the probable presence of MBs should be clearly explicated by researchers. Given the the likely effect that the two methods (measuring VOT from the first or last burst) seemingly had in the current study, future analyses of VOT should firstly quantify MBs and secondly state their VOT estimation method. Second, the results presented here need to be replicated by future studies of WAS; replication is an essential endeavor in advancing any scientific discipline (see Hendrik 1990). More speakers and with more diverse sociolinguistic profiles are needed to confirm or disprove the VOT values reported here. That is, bigger and more representative samples are crucially needed. Since age does play a role in VOT production, future studies also need to incorporate older speakers of WAS. As for the limitations of the study, it must be acknowledged that insufficient data for Castilian and LA was collected, input from only 5 studies for Castilian and 11 studies for LA, although it needs to be said that the efforts made in the literature search did not yield a bigger sample. It is hoped that future research of the type reported here will further advance knowledge in this area.

5. References

Asensi, L., Portolés, S. & del Río, A. (1998). Barra de explosión, VOT y frecuencia de las oclusivas sordas del castellano. *Estudios de Fonética Experimental*, *IX*, 221-242. https://www.ub.edu/journalofexperimentalphonetics/pdf-articles/EFE-IX-LlAsensi _SPortoles_AdelRio-Barra_explosion_VOT_frecuencia_oclusivas_sordas.pdf

Avelino, H. (2018). Mexico City Spanish. *Journal of the International Phonetic Association*, *48*(2), 223-230. https://doi.org/10.1017/S0025100316000232

Barrera-Pardo, D. (2022). Measurement of the VOT of voiceless plosives: Multiple bursts in Western Andalusian Spanish. *Estudios de Fonética Experimental, XXXI*, 81-95. https://www.ub.edu/journalofexperimentalphonetics/pdf-articles/XXXI-07-Barrera.pdf

Bijankhan, M. & Nourbakhsh, M. (2009). Voice onset time in Persian initial and intervocalic stop production. *Journal of the International Phonetic Association*, *39*(3), 335-364. https://doi.org/10.1017/S0025100309990168

Bóna, J. (2014). Voice onset time and speakers' age: Data from Hungarian. *Clinical Linguistics & Phonetics*, *28*(5), 366-372. https://doi.org/10.3109/02699206.2013.875593

Borzone, A. M. (1980). *Manual de fonética acústica*. Hachette.

Castañeda Vicente, M. L. (1986). El V.O.T. de las oclusivas sordas y sonoras españolas. *Estudios de Fonética Experimental*, *II*, 92-110. https://www.ub.edu/journalofexperimental phonetics/ pdf-articles/EFE-II-MLCasta%C2%A7eda-VOT_oclusivas.pdf

Chen, L. M., Chao, K. Y., & Peng, J. F. (2007). VOT productions of word-initial stops in Mandarin and English: A cross-language study. *ROCLING 2007 Poster Papers*, 303-317. https://aclanthology.org/O07-2004/

Chang, S. S., Ohala, J. J., Hansson, G., James, B., Lewis, J., Liaw, L. & Van Bik, K. (1999). Vowel-dependent VOT variation: An experimental study. *The Journal of the Acoustical Society of America*, *105*(2), 1400. https://doi.org/10.1121/1.426611

Cho, C. & Ladefoged, P. (1999). Variation and universals in VOT: Evidence from 18 languages. *Journal of Phonetics*, *27*, 207-229. https://doi.org/10.1006/jpho.1999.0094

Clothier, J. & Loakes, D. (2018). Coronal stop VOT in Australian English: Lebanese Australians and Mainstream Australian English. In J. Epps, J. Wolfe, J. Smith, & C. Jones (Eds.), *Proceedings of the 17th Australasian International Conference on Speech Science and Technology* (pp. 13-16). Australasian Speech Science and Technology Australia (ASSTA). https://rest.neptuneprod.its.unimelb.edu.au/server/api/core/bitstreams/a4160cc6-d45f-467-a6d1-3d988b71f953/content

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum.

Coloma, G. (2012). The importance of ten phonetic characteristics to define dialect areas in Spanish. *Dialectologia*, *9*, 1-26. http://www.publicacions.ub.edu/revistes/ dialectologia9/documentos/742.pdf

Dauer, R. M. (1983). Stress-timing and syllable-timing reanalyzed. *Journal of Phonetics*, *11*(1), 51-62. https://doi.org/10.1016/S0095-4470(19)30776-4

Del Saz, M. (2014). *The perception of Western Andalusian Spanish aspirated stops by General American English listeners*. Paper presented at the International Workshop on Cross-Language Speech Perception (CEHUM 2014), Braga, Portugal, January 30-31, 2014. https://www.researchgate.net/publication/259375412_The_perception_of_Western_Andalusian_Spanish_aspirated_stops_by_General_American_English_listeners

— (2019). Native and nonnative perception of Western Andalusian Spanish /s/ aspiration in quiet and noise. *Studies in Second Language Acquisition*, *41*, 673-694. https://doi.org/10.1017/S0272263119000056

Fernández de Molina, E. & Hernández-Campoy, J.M. (2018). Geographic varieties of Spanish.

In K. Geslin (Ed.), *The Cambridge handbook of Hispanic Linguistics* (pp. 496-528). Cambridge University Press. https://doi.org/10.1017/9781316779194.024

Hendrik, C. (1990). Replications, strict replications, and conceptual replications: Are they important? *Journal of Social Behavior and Personality*, *5*(4), 41-49. https://www.proquest.com/scholarly-journals/replications-strict-conceptual-are-they-important/docview/1292299202/se-2?accountid=14744

Hernández-Campoy, J. M. & Villena-Ponsoda, J. A. (2009). Standardness and nonstandardness in Spain: Dialect attrition and revitalization of regional dialects of Spanish. *International Journal of the Sociology of Language*, *196-197*, 181-214. https://doi.org/10.1515/IJSL.2009.021

Herrero de Haro, A. & Hajek, J. (2022). Eastern Andalusian Spanish. *Journal of the International Phonetic Association*, *52*(1), 135-156. https://doi.org/10.1017/S0025100320000146

Hualde, J. I. (2005). *The sounds of Spanish*. Cambridge: Cambridge University Press.

Kaňok, M. & Novotný, M. (2019). Effect of age and gender on articulation of voiced and voiceless stop consonants in Czech. *Lekar a technika – Clinician and Technology*, *49*(3), 97–101. https://doi.org/10.14311/CTJ.2019.3.05

Ladefoged, P. (2003). *Phonetic data analysis: An introduction to fieldwork and instrumental techniques*. Oxford: Blackwell.

Ladefoged, P. & Johnson, K. (2015). *A course in phonetics*. 7th ed. Stamford, CT: Cengage Learning.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for *t*-tests and ANOVAs. *Frontiers in Psychology*, *4*, 863. https://doi.org/10.3389/ f psyg.2013.00863

Lavoie, L. M. (2001). *Consonant strength: Phonological patterns and phonetic manifestations*. Routledge.

Li, F. (2013). The effect of speakers' sex on voice onset time in Mandarin stops. *The Journal of the Acoustical Society of America*, *133*, EL142. https://doi.org/10.1121/1.4778281

Lisker, L. & Abramson, A. S. (1964). A cross-language study of voicing in initial stops: Acoustical measurements. *Word*, *20*(3), 384-422. https://doi.org/10.1080/00437956.1964.11659830

Machuca Ayuso, M. J. (1997). Las obstruyentes no continuas del español: Relación entre las categorías fonéticas y fonológicas en habla espontánea (Doctoral dissertation). Universitat Autònoma de Barcelona. https://ddd.uab.cat/record/37091?ln=es

Magnusson, K. (15 April 2022). *Interpreting Cohen's d effect size: An interactive visualization* (Version 2.5.2). https://rpsychologist.com/cohend/

Martínez-Belda, J. C. & Padilla, X. A. (2021). El VOT de las oclusivas del español en habla emocional simulada. *Estudios de Fonética Experimental/Journal of Experimental Phonetics*, *XXX*, 35-57. https://www.ub.edu/journalofexperimentalphonetics/pdf-articles/XXX-03-Martinez-Belda.pdf

Martínez-Celdrán, E., Fernández-Planas, A. M. & Carrera-Sabaté, J. (2003). Castilian Spanish. *Journal of the International Phonetic Association*, *33*(2), 255-259. https://doi.org/10.1017/S0025100303001373

Morris, R. J., McCrea, C. R. & Herring, K. D. (2008). Voice onset time differences between adult males and females: Isolated syllables. *Journal of Phonetics*, *36*, 308–317. https://doi.org/10.1016/j.wocn.2007.06.003

Munson, B. & Babel, M. (2019). The phonetics of sex and gender. In W. F. Katz & P. F. Assmann (Eds.), *The Routledge handbook of phonetics* (pp. 499-525). Abingdon: Routledge. https://www.routledgehandbooks.com/doi/10.4324/9780429056253-19

Oh, E. (2011). Effects of speaker gender on voice onset time in Korean stops. *Journal of Phonetics*, *39*, 59–67. https://doi.org/10.1016/j.wocn.2010.11.002

Poch, M. D. (1984). Datos acústicos para la caracterización de las oclusivas sordas del español. *Folia Phonetica*, *1*, 89-106.

Regan, B. (in press). The social meaning of a merger: The evaluation of an Andalusian Spanish consonant merger (ceceo). *Language in Society*. https://doi.org/10.1017/S0047404521000543

Roldán, Y. & Soto-Barba, J. (1997). El VOT de /ptk/ y /bdg/ en el español de Valdivia: Un análisis acústico. *Estudios Filológicos*, *32*, 27-33. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0071-17131997003200003

Rosner, B. S., López Bascuas, L. E., García-Albea, J. E. & Fahey, R. P. (2000). Voice-onset times for Castilian Spanish initial stops. *Journal of Phonetics*, *28*, 217-224. https://doi.org/10.1006/jpho.2000.0113

Santana Marrero, J. & Manjón-Cabeza Cruz, A. (2021). Percepción del andaluz: Creencias y actitudes de jóvenes hispanohablantes y estudiantes de ELE. *Philologia Hispalensis*, *35*(*1*), 15-28. https://doi.org/10.12795/PH.2021.v35.i01.01

Smith, B. L., Wasowicz, J. & Preston, J. (1987). Temporal characteristics of the speech of normal elderly adults. *Journal of Speech and Hearing Research*, *30*, 522-529. https://doi.org/10.1044/jshr.3004.522.

Soto-Barba, J. & Valdivieso, H. (1999). Caracterización fonético-acústica de la serie de consonantes /p-t-k/ vs. /b-d-g/. *Onomázein*, *4*, 125-133. http://onomazein.letras.uc.cl/Articulos/4/6_SotoBarba.pdf

Stewart, J. (2018). Voice onset time production in Ecuadorian Spanish, Quichua, and Media Lengua. *Journal of the International Phonetic Association*, *48*(2), 173-197. https://doi.org/10.1017/S002510031700024X

Stukas, A. A. & Cumming, G. (2014). Interpreting effect sizes: Toward a quantitative cumulative social psychology. *European Journal of Social Psychology*, *44*, 711-722. https://doi.org/10.1002/ejsp.2019

Thomas, E. R. (2011). *Sociophonetics: An introduction*. Palgrave Macmillan.

Torre, P. & Barlow, J. A. (2009). Age-related changes in acoustic characteristics of adult speech. *Journal of Communication Disorders*, *42*, 324-333. https://doi.org/10.1016/j.jcomdis.2009.03.001.

Torres, M. I. & Iparraguirre, P. (1996). Acoustic parameters for place of articulation identification and classification of Spanish unvoiced stops. *Speech Communication*, *18*, 369-379. https://doi.org/10.1016/0167-6393(96)00025-8

Troya Déniz, M. (2005). El VOT de las oclusivas sordas en la norma culta de Las Palmas de Gran Canaria. *Boletín de Lingüística*, *24*, 92-107. http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0798-97092005000200005

Villamizar, T. (2002). Caracterización acústica de las consonantes oclusivas en el español de Venezuela: El parámetro duración (silencio-barra de explosión-VOT). *Lengua y Habla*, *7*(*1*), 140-157. http://erevistas.saber.ula.ve/index.php/lenguayhabla/article/view/3605

Villena Ponsoda, J. A. (2000). Identidad y variación lingüística: Prestigio nacional y lealtad vernacular en el español hablado en Andalucía. In G. Bossong & F. Báez de Aguilar González (Eds.), *Identidades lingüísticas en la España autonómica,* (pp. 107–150). Iberoamericana Vervuert. https://doi.org/10.31819/9783865278456-007

Whalen, D. H., DiCanio, C. & Dockum, R. (2022). Phonetic documentation in three collections: Topics and evolution. *Journal of the Phonetic International Association*, *52*(1), 95-121. https://doi.org/10.1017/S0025100320000079

Williams, L. (1977). The voicing contrast in Spanish. *Journal of Phonetics*, *5*, 169-184. https://doi.org/10.1016/S0095-4470(19)31127-1