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Sibilant Merger in the Variety of Basque Spoken in Amorebieta-Etxano

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Abstract: Basque has an apico-alveolar /s̻/, a lamino-alveolar /s̺/, and a prepalatal sibilant /ʃ/ that are represented by the letters <s>, <z>, and <x>, respectively. The apico-alveolar and the lamino-alveolar sibilants have merged in some areas of Biscay, Guipuzcoa, and the Basque-speaking territories of Alava (e.g., Hualde 2010), and Spanish has been hypothesized as a factor driving this merger (Jurado Noriega 2011). On the other hand, complex sibilant systems like the traditional Basque one tend to be neutralized independently of language contact (Bukmaier et al. 2014). In order to add to this debate and shed new light on the merger, this study explored Biscayan Basque, a variety at an advanced state of the merger (Hualde 2010). More precisely, the study tested how the degree of bilingualism affects the production of the sibilants under study and the resulting neutralization by performing an acoustic analysis of the data. The results show that Basque- and Spanish-dominant speakers behave differently with regard to the sibilant merger, and that they have different places of articulation for their sibilants. Only Basque-dominant speakers maintain a significant distinction in the place of articulation of <z> and <x> overall, whereas Spanish-dominant speakers do not make a distinction among sibilants. Furthermore, the resulting merged sibilant is less fronted for Spanish-dominant speakers than the sibilants of Basque-dominant speakers.

Keywords: Basque; sibilants; merger; bilingualism; language dominance

1. Introduction

Basque has an apico-alveolar /s̻/, a lamino-alveolar /s̺/ and a prepalatal /ʃ/ sibilant that are represented by the letters <s> as in *hasi* 'begin', <z> as in *hazi* 'to grow up' and <x> as in *xake* 'chess', respectively. The difference between these sibilants is that they have three different places of articulation, and the Academy of the Basque Language recommends speakers to distinguish them [1]. Nevertheless, there are speakers of Basque who do not keep the distinction between the three sibilants and merge them to some extent. According to Hualde [2], the three sibilants are maintained in some varieties of Basque, such as the Basque spoken in Goizueta, Navarre, but the apico-alveolar and the lamino-alveolar sibilants have merged in Biscay, some areas of Guipuzcoa, and the Basque-speaking territories of Alava. This merger of the apico-alveolar and lamino-alveolar sibilants is not a new phenomenon, as Michelena Elissalt claims that it was already present centuries ago in Biscay and it was in fact completed by 1961 in Biscay (with the exception of Markina and Bolibar), and in some urban areas of Guipuzcoa [3]. Michelena Elissalt argues that the merger originated in Bilbao and that, from there, it spread to different territories [3]. However, Ulibarri Orueta finds that the sibilant merger was present in texts from Vitoria, a city in the southern Basque Country, in the 16th century and gives evidence for a possible southern origin of the merger [4].

This study aimed to present an acoustic analysis of the sibilants in a Biscayan variety of Basque and to analyze the characteristics of the merger, its current expansion and the factors that may condition

it including the language dominance, either Basque or Spanish, of the speakers. More specifically, the study analyzed the merger between the apico-alveolar and the lamino-alveolar sibilants in detail and investigated whether the prepalatal sibilant resists the merger or not. In order to analyze the production of the three sibilants, the study presents results from an acoustic analysis including the center of gravity (COG) of the sibilants. The center of gravity correlates with the different articulatory configurations among fricatives, which result in distinct places of articulation [5], and the analysis of this acoustic cue allows us to determine whether the sibilants are merged or not. The COG also allows us to establish the place of articulation of the fricative resulting from the merger, i.e., whether it is a more lamino-alveolar, apico-alveolar or prepatal sound.

The geographical focus of the present study was Amorebieta-Etxano, a village in Biscay. The study of the merger in Amorebieta-Etxano is of interest because it can provide information about the expansion of the phenomenon given its location close to the city of Bilbao and the town of Gernika, where the merger seems to be common only among younger speakers [2]. The present study analyzed the production of the sibilants by ten speakers aged between 20–33 years from Amorebieta-Etxano. The language dominance of these speakers was measured through the Bilingual Language Profile (BLP) Questionnaire [6], a tool that allows us to measure language dominance in a standardized manner.

Overall, the results of the present study show that the sibilant merger occurs in Basque, as expected, and that, at least among younger speakers, this merger depends on the speakers' degree of dominance in Basque or Spanish. More precisely, Basque-dominant participants merge two of the three sibilants and Spanish-dominant ones merge the three sibilants into a single one. This is the first acoustic study that explores the effect of language dominance quantitatively on the sibilant merger in Biscay, and it is a novel approach to the question of how the degree of bilingualism affects the merger in Basque. Moreover, it provides a description of the three sibilants with different places of articulation, which may be useful to analyze and describe the phonemic inventories of other languages with rich sibilant inventories.

1.1. Bilingualism and Bilingual Language Profile

Gutiérrez-Clellen defines the term bilingualism as the "knowledge of two languages" [7] (p. 291). Valdés and Figueroa, on the other hand, define it as "a condition that makes it possible for an individual to function, at some level, in more than one language" [8] (p. 8). With regard to Basque–Spanish bilingualism, the Basque Institute of Statistics, also known as Eustat, classifies speakers in the Basque Autonomous Community as follows [9] (p. 32):

- Bilingual speakers: People who speak and understand Basque well or reasonably well.
- Passive bilingual speakers: people who are able to understand Basque although they cannot speak it or they speak it with difficulty.
- Monolingual speakers of Spanish: people who cannot understand or speak any Basque.

It should be noted here that Eustat does not list monolingual speakers of Basque, due to their "virtually complete disappearance" [10] (p. 11). According to the census data of the year 2011, there were 2,056,136 inhabitants in the Basque Autonomous Community (henceforth BAC) and 749,182 of them were bilingual speakers. That is, they were able to communicate in both Basque and Spanish. Furthermore, 910,032 were monolingual speakers of Spanish, whereas 396,922 were passive bilingual speakers [9]. The Basque Institute of Statistics also provides reports on the degree of bilingualism in different towns and cities in each province of the BAC. In the last report of 2011, the town of Amorebieta-Etxano, the location of the present study, had a population of 17,581 inhabitants and the majority of them were bilingual (9308), whereas there were 3995 passive bilingual speakers and 4278 monolingual speakers of Spanish [9].

These census data report information on the overall linguistic competence in the BAC, and in its provinces and villages. Nevertheless, the classification of bilingual speakers provided by the census data has its limitations. Most notably, it does not reflect the gradient nature of the language dominance

among bilingual speakers, i.e., the fact that speakers might be more or less dominant in one or the other language. Birdsong et al. consider that it can be difficult to assess language dominance among bilingual speakers and they claim that, for that reason, researchers have relied on interviews, speakers' language choice, proficiency tests, psycholinguistic tasks and experiential and psychosocial criteria to classify speakers as dominant in one language or the other [6]. However, Gertken et al. claim that there are some "reliable" and "widely accessible" self-report tools now that enable researchers to measure language dominance in a more gradient, non-binary manner [11] (p. 213). Some of the newest questionnaires are the Language Experience and Proficiency Questionnaire (LEAP-Q), the Bilingual Dominance Scale (BDS), and the Self-Report Classification Tool (SRCT) [11]. The LEAP-Q, BDS and SRCT are all self-report questionnaires with questions about language experience, proficiency and in the case of the LEAP-Q, linguistic attitudes. The advantages of these questionnaires are that they allow researchers to collect data on bilingualism quickly (5–25 min) and they provide a description of speakers' bilingual profile (LEAP-Questionnaire), speakers' continuous dominance scores (BDS Questionnaire) or "discrete dominance groups" (SRCT Questionnaire) [11]. Nevertheless, there are some limitations when using these questionnaires [11]. Firstly, Gertken et al. claim that the LEAP-Q has many items, and that some of them are long and complex. Secondly, the BDS questionnaire has items that are not equally weighted. Finally, the SRCT questionnaire was designed to fit Mandarin–English bilingual speakers living in Singapore and it is difficult to apply to other bilingual speakers. Beyond the previously mentioned disadvantages, the questionnaires contain some ambiguous questions or free response questions, which result in a wide variety of responses that are difficult to measure or quantify [11].

Birdsong et al. [6] and Gertken et al. [11] propose the Bilingual Language Profile or BLP Questionnaire as an alternative tool to overcome the limitations of previous research methodologies. This BLP Questionnaire was created based on the LEAP-Q, BDS and SRCT. The main advantages of the BLP Questionnaire are that it is self-scored, items are equally weighted, it avoids free response questions, and it takes less than 10 min to complete. Furthermore, the BLP Questionnaire shows the gradient nature of language dominance in a systematic manner. Gertken et al. claim that measuring the gradient nature of dominance is essential because "a person is not simply dominant in a given language, but is dominant in that language to a certain measurable degree" [11] (p. 208).

The BLP Questionnaire has 19 multiple-choice questions and measures the following factors: (I) language history, (II) use, (III) proficiency and (IV) attitudes. Section 2.1 summarizes the results of these four factors for all the participants in the study. The BLP provides numeric scores of dominance from −218 to +218 that allow researchers to measure dominance in a standardized way and place speakers within that continuum. Positive scores indicate dominance towards one language, whereas negative scores indicate dominance towards the other language. It should be noted here that any of the two languages can be placed at any of the extremes: −218 or +218. That is, Basque can be placed at the −218 extreme or at the +218 extreme, and the same could be done with Spanish. These numeric scores are a system to measure dominance systematically and to allow researchers to compare the BLP scores to the ones in other studies. Furthermore, these scores are based on the detailed evaluation of the four factors mentioned above and they capture the linguistic reality of speakers better than other approaches based on only one or two factors, as they do not rely only on speakers' linguistic proficiency or language use. Several studies have successfully used the BLP to measure language dominance among bilinguals of Spanish and another language, including Baird [12], Coetzee et al. [13], and Amengual and Chamorro [14].

In the present study, the ten participants received a dominance score based on their BLP Questionnaire responses, which makes it possible to analyze the effects of language dominance on the production of Basque sibilants. This is the first time that this methodology has been used in a study of Basque sibilants to quantify the degree of bilingualism among bilingual speakers of Basque and Spanish, as previous studies on sibilants have relied on speakers' origin, and the experimenters' criteria in order to classify speakers as dominant in one language or the other [15]. The advantage of

using the BLP Questionnaire in this study is that it allows for measuring informants' language history, use, proficiency and attitudes in a more standardized manner, which makes this study replicable.

1.2. Basque Sibilants

According to Ladefoged and Maddieson, fricative sounds are those in which speakers produce a turbulent air stream [16]. The turbulence of the air stream is determined by two factors: the size of the channel and the volume velocity of the air stream [17]. More precisely, turbulence is more likely to arise when the constriction of the vocal tract is narrow and when the air velocity is high. Ladefoged and Maddieson classify fricatives depending on whether the turbulence is generated in the constriction or when the airstream is directed against an obstruction like the edge of the teeth. They define sibilants, the sounds that are analyzed in the present study, as fricatives that are generated when the airstream is directed against an obstruction [16]. Some varieties of Basque, such as Goizueta Basque, have three sibilants. These three sibilants are voiceless, although they undergo regressive voicing assimilation when followed by a voiced consonant, as in the word *esne* 'milk', which is pronounced as [ˈez.ne] [18] (p. 24). These sounds have been widely described, but there is no consensus on the terms and International Phonetic Alphabet (IPA) symbols used to describe them. Jurado Noriega describes the sibilants as "alveolopalatal" or "palatalized postalveolar" /ɕ/ (letter <x>),"apico-postalveolar" /ʂ/ (letter <s>), and "predorso-dentoalveolar" /s̻/ (letter <z>) [15]. Hualde classifies the Basque sibilants as being "dorsum-prepalatal" (<x>), "apico-alveolar or alveolar" (<s>), and "lamino-alveolar" (<z>) [2] (p. 90). In general, most authors use the feature of apical/ laminal to characterize the distinction between the two front sibilants (<z> vs. <s>) [15]. This feature is used to describe which part of the tongue—the tip of the tongue or the blade—is used in the production of the sibilants. Following this approach, Basque sibilants are classified as apical if the tip of the tongue is elevated and as laminal if it is not elevated [15]. Hualde uses this feature and describes the sibilants as being "prepalatal" (<x>), "apico-alveolar" (or "apico-postalveolar") (<s>), and "lamino-alveolar" (<z>) [18]. The IPA symbols that Hualde uses to represent the sibilants are the following ones respectively: /ʃ, s̺, s̻/ [18] (p. 22). Likewise, Egurtzegi also uses this apical/ laminal feature to describe the Basque sibilants in a more recent study [19]. The present study uses the same laminal/ apical description for the Basque sibilants as Hualde [18] and Egurtzegi [19], as can be seen in Table 1.[1]

Table 1. Sound, letter, and place of articulation of the three sibilants in Basque (following [18]).

Sound	Letter	Place of Articulation
s̻	<z>	Lamino-alveolar
s̺	<s>	Apico-alveolar
ʃ	<x>	Prepalatal

According to Jurado Noriega, the apico-alveolar sibilant is produced when the tip of the tongue is elevated towards the alveolar ridge and the blade of the tongue is also elevated [15]. Based on Alonso [21], Jurado Noriega claims that the lamino-alveolar sibilants, on the other hand, are produced when the tip of the tongue and the internal surface of the lower incisors are in contact, and the blade of the tongue is elevated towards the alveolar ridge [15]. With regard to the prepalatal sibilants, the tip of the tongue touches the gums and the base of the lower teeth, and the form of the tongue is convex [15].

[1] Basque sibilants have three affricate correlate consonants: the prepalatal /tʃ/ (represented by the letters <tx>), the apico alveolar /ts̺/ (letters <ts>), and the lamino-alveolar /ts̻/ (letters <tz>) [18] (p. 16). These three affricates are also voiceless and have the same place of articulation as the sibilants [20]. According to Hualde [2], the three affricates have also merged in Biscayan Basque but the merger process has been different from the sibilant merger. According to Hualde, the resulting merged sibilant is /ts̻/, and not /ts̺/ [2]. According to Iglesias Chaves et al., the resulting merged sibilant can be either /ts̻/ or /tʃ/ [20]. For further details on the affricate merger, please see [20,21].

According to Hualde, the most conservative varieties of Basque maintain the three-way distinction among the sibilants [2]. In Goizueta Basque, for instance, many speakers keep the three sibilants distinct in terms of their spectral peak, COG, and skewness. Hualde finds a correlation between the spectral peak and the articulation of the sibilant so that a higher spectral peak corresponds with a more fronted articulation [2]. Therefore, in the conservative varieties of Basque, the lamino-alveolar sibilant has the highest spectral peak of all the sibilants and the prepalatal sibilant has the lowest spectral peak. As for the spectral peak of the apico-alveolar sibilant, it falls between that for the lamino-alveolar and the prepalatal sibilants. Hualde's results show that the lamino-alveolar sibilant has the highest COG of the three sibilants (6645 Hz) and that the prepalatal sibilant has the lowest COG (3531 Hz) [2]. The COG values of the apico-alveolar sibilant (4173 Hz) fall between those for the lamino-alveolar and the prepalatal sibilants. It should be noted here that the apico-alveolar and the prepalatal sibilants are more similar in acoustic terms than the lamino-alveolar and the prepalatal sibilants. Even though Hualde's analysis only shows the results for a single speaker from Goizueta [2], his results are in agreement with what we would expect based on other studies. Jurado Noriega analyzes the Basque sibilants in the Guipuzcoan territories of Donostialdea and Bidasoa, where the sibilants have been kept distinct, and shows that the COG is higher for the lamino-alveolar sibilant (<z>) than for the apico-alveolar sibilant (<s>) [15]. Likewise, Iglesias et al. analyze the Basque sibilants as pronounced by a speaker from Beizama, Guipuzcoa [20], and report similar results to Hualde [2] for the COG values. Iglesias et al. analyze the production of the nonce-words *aza*, *axa*, *asa* from a reading task and they find that the lamino-alveolar sibilant has the highest COG of the three sibilants (14,452 Hz) and the prepalatal sibilant has the lowest COG (5966 Hz) [20]. As in Hualde [2], the COG values of the apico-alveolar sibilant (8081 Hz) fall between those for the lamino-alveolar and the prepalatal sibilants.

Results from Basque studies are in agreement with cross-linguistic work on fricative differences and COG values. Jongman et al. analyze English fricatives and they claim that the prepalatal sibilant /ʃ/ has lower COG values than the alveolar sibilant /s/ [23]. Likewise, Gordon et al. analyze the COG values of several fricatives in languages such as Chickasaw (a Muskogean language spoken in Oklahoma), Western Apache (spoken in Arizona), Scottish Gaelic (spoken in Scotland), Hupa (spoken in California), Montana Salish (spoken in Montana), and Toda (spoken in India) and report similar results [24]. More precisely, they find that the prepalatal sibilant /ʃ/ in Chickasaw, Western Apache, Gaelic, Montana Salish, and Hupa has lower COG values than the alveolar sibilant /s/. The authors also observe that the COG values of the lamino-alveolar sibilant /s̻/ in Toda has significantly higher COG values than the apico-alveolar /s̺/ and the prepalatal sibilants /ʃ/ [24], which is in agreement with the COG values in Hualde [2].

1.3. Basque Sibilant Merger

Many varieties of Basque have lost the distinction among the three Basque sibilants and they present only a two-way distinction among these fricatives. In those varieties of Basque, the lamino-alveolar sibilant is merged with the apico-alveolar sibilant and realized as an apico-alveolar sibilant, while the distinction between the apico-alveolar and the prepalatal sibilant is still maintained. This type of merger process between the apico-alveolar and the lamino-alveolar sibilants is widely spread and seems to have concluded in some areas of Biscay and the Basque-speaking areas of Alava [2]. In other territories, the sibilant merger is adopting a different tendency. In the Guipuzcoan towns of Azpeitia and Azkoitia, for instance, the tendency is to also merge the apico-alveolar and the lamino-alveolar sibilant, but the resulting production is a lamino-alveolar sibilant, and not an apico-alveolar sibilant [2]. As one can see, the merger of the lamino-alveolar and the apico-alveolar sibilants seems to be spreading in different manners through the Basque territories. Moreover, Hualde claims that, although the prepalatal sibilant (<x>) is kept distinct from the lamino-alveolar and the apico-alveolar sibilants in many territories, younger generations of speakers in certain areas merge the three Basque sibilants into a single one [2]. Hualde claims that speakers from Gernika, for instance, tend to merge the three sibilants to an apico-alveolar sibilant if they were born after 1980 [2].

When analyzing the sibilant merger, it is important to take into account that Basque is in contact with the Castilian variety of Spanish, which has four voiceless fricative phonemes: /f θ s x/ [25] (p. 147). That is, Castilian Spanish has an apico-alveolar sibilant that is represented by the letter <s> [25].[2] This Castilian sibilant has been acoustically measured in several studies. Medina del Moral and Romera, for instance, analyze the Spanish sibilant as pronounced by 44 informants from Navarre and claim that its mean COG value is 3525 Hz [26] (p. 43). One may think that the sibilant-merger is taking place because speakers are transferring their Spanish sibilant inventory to Basque and they are reducing the historical three-way contrast in Basque to a single sibilant. It should be noted here that before the interdental fricative /θ/ became part of the system, Spanish used to have a three-sibilant inventory that was very similar to the sibilant inventory found nowadays in some varieties of Basque, such as the variety of Basque spoken in Navarre [2]. Nevertheless, Hualde (2010) claims that it is difficult to determine whether the sibilant merger started in a variety of Basque first and was then transferred to Spanish, or if the merger started in a variety of Spanish and was then transferred to Basque [2]. Moreover, another possibility could be that the Basque sibilant system neutralized independently of language contact, as it happens with other complex sibilant systems [27].

Jurado Noriega analyzes the sibilants in both Basque and Spanish in Donostialdea, a region in Guipuzcoa, and Bidasoa [15]. The author measures the intensity, the second formant, the COG, the'frequency cut-off, and the spectral peaks of the sibilants in production data from 24 participants, who fall in three groups: (G1) monolingual speakers of Spanish from outside the Basque Country (n = 8), (G2) bilingual speakers whose first language (L1) is Basque (n = 8), and (G3) bilingual speakers whose L1 is Spanish (n = 8). Jurado Noriega offers an acoustic analysis of the apico-alveolar (<s>) and the lamino-alveolar (<z>) sibilants in Basque as produced by the bilingual groups G2 and G3, and an acoustic analysis of the Spanish sibilant as produced by all groups (G1–G3) [15]. Regarding the COG, Jurado Noriega finds that the apico-alveolar sibilant in Basque has the lowest COG values, whereas the lamino-alveolar sibilant in Basque has the highest COG values of the Basque sibilants. Regarding the Spanish sibilant, Jurado Noriega finds that the COG values among informants from G2 (5566 Hz), i.e., bilingual informants whose L1 is Basque, fall between those for the Basque apico-alveolar (5362 Hz) and the lamino-alveolar sibilants (9602 Hz) [15]. Informants from G3, on the other hand, i.e., bilingual informants whose L1 is Spanish, have very similar COG values for the Spanish sibilant (3945 Hz) and for the Basque apico-alveolar sibilant (4098 Hz). However, Jurado Noriega does not show whether the differences between the COG values of the sibilants are significant, as she does not present a statistical analysis [15].

Regarding the effect of surrounding vowels on Basque sibilant production, Jurado Noriega finds that the vowel that follows the sibilant (front vowel/back vowel) and the position of the sibilant in the word (word initial/intervocalic) have an effect on the production of the sibilants [15]. More specifically, the COG values are higher overall when the sibilant is followed by a front vowel than when it is followed by a back vowel, and the COG values are also higher among bilingual speakers when the sibilant is in intervocalic position than when it is in word initial position.

Ensunza Aldamizetxebarria explores whether the sibilant is palatalized after the high front vowel /i/ in the variety of Basque spoken in Gernika [28]. More specifically, the author analyzes the sibilants produced by 63 speakers in six words that have the letter <z> preceded by the front high vowel /i/ (such as *haize* 'wind'). Ensunza Aldamizetxebarria classifies the sibilants categorically as apico-alveolar or prepalatal and finds that younger speakers pronounce an apico-alveolar sibilant [s̻] more often (86% of the time) than the prepalatal sibilant [ʃ] (14%), whereas older speakers produce the prepalatal sibilant (86%) more frequently than the apico-alveolar (14%) sibilant. The results also show that overall, female speakers produce the apico-alveolar sibilant more often (74%) than the prepalatal sibilant (26%).

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[2] Hualde claims that the Spanish sibilant from central Spain and some parts of northern Spain is pronounced in a fronter region of the alveolar ridge than the Spanish sibilant from the Basque Country and the surrounding areas [25].

Likewise, male speakers use the apico-alveolar more frequently (57%) than the prepalatal sibilant (43%) . Ensunza Aldamizetxebarria finds that there are no differences overall in the production of the two sibilants after a front high vowel based on the school where the participants studied or the origin/linguistic background of their parents [28].[3]

Despite the contribution of previous studies on Basque sibilants, most of them do not present inferential statistics in order to evaluate whether the reported differences are significant. Only Hualde [2] and Iglesias Chaves et al. [20] present inferential statistics, although they only analyze the production data of a single participant. The present study aimed to offer the first quantitative analysis of the COG of speakers between the ages of 20–33 years in their production of the three Basque sibilants in the village of Amorebieta-Etxano, a Biscayan town close to Gernika. More precisely, the present study aimed to analyze the merger of sibilants and to examine whether there is a relationship between the speakers' language dominance and the merger. The present study also analyzed if the stress, i.e., whether the syllable that contains the sibilant is stressed or unstressed, and the sibilant position in the syllable and in the word have an effect on the production of the sibilant. The study answered the following research questions:

1. Are the apico-alveolar, the lamino-alveolar and the prepalatal sibilants merged in Amorebieta-Etxano? If they are, what is/are the resulting sibilant or sibilants?
2. Which factors condition the possible merger among the Basque sibilants in this community? More precisely, does the sibilant position in the syllable and in the word or the stress of the syllable containing the sibilant condition the merger? Does the language dominance of participants, either Basque or Spanish as determined by the BLP Questionnaire, affect the merger?

2. Materials and Methods

2.1. Participants

In order to answer the research questions, the production data of ten participants from Amorebieta-Etxano were recorded and acoustically analyzed. The research was approved by the Institutional Review Board at the Ohio State University (IRB Protocol number: 2008B0168). Participants were informed about the study and provided their informed consent. They filled out a paper-and-pencil version of the BLP Questionnaire in Basque [6], which allowed the participants' language dominance to be measured in a standardized manner, as explained in Section 1.1. The BLP Questionnaire was scored manually and every participant received a BLP score that shows a greater or smaller dominance in Basque or Spanish. Negative scores indicate that speakers are more Spanish dominant, whereas positive scores indicate that speakers are more Basque dominant.

The scores for each section of the BLP (language attitudes, proficiency, use, and history) can also be analyzed individually. Firstly, the scores for the linguistic attitudes showed that all the speakers in this study had more positive linguistic attitudes towards Basque than Spanish. Secondly, all the speakers reported being more proficient in Basque than in Spanish, or being equally proficient in both languages. None of the speakers reported being more proficient in Spanish than in Basque. However, only four of the informants reported speaking Basque more frequently than Spanish in their everyday lives. As for the language history, eight speakers reported having more experience learning and speaking Basque than Spanish, whereas only two speakers reported having more experience learning and speaking Spanish. Based on their BLP scores, speakers were grouped in two groups: Basque-dominant speakers (six speakers) and Spanish-dominant speakers (four speakers).

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[3] Ensunza Aldamizetxebarria includes the school at which the informants studied as a variable in her study because schools in the Basque Autonomous Community offer different models of education in which languages are taught differently. The two public schools and three private schools in Gernika offer classes in the "Model D" of education, where Spanish is taught as a subject and Basque is used as a medium for teaching classes [28]. However, only public schools have students in the "Model A" of education, where Spanish is used as a medium for teaching and Basque is taught as a subject [28].

Table 2 summarizes demographic and educational information, as well as the BLP score, pertaining to the ten participants. As Table 2 shows, all the participants were aged 20–33 years, and had been educated to secondary school level, received vocational training or completed at least two years of their BA Degree.

Table 2. Age, gender, studies, language of education, and Bilingual Language Profile (BLP) scores of the participants in the current study.

Speaker	Age	Gender	Studies	Language of Education	BLP Score
1	20	Female	A part of BA Degree	18 years of Basque	−3.272
2	21	Male	Vocational training	17 years of Basque and Spanish	47.134
3	21	Male	A part of BA Degree	16 years of Basque and Spanish	56.48
4	22	Female	A part of BA Degree	20 years of Basque	20.66
5	22	Female	BA Degree	20 years of Basque and Spanish	−17.628
6	22	Male	Secondary Education	5 years of Basque and 10 years of Spanish.	118.416
7	23	Female	A part of BA Degree	More than 20 years of Basque	13.98
8	26	Female	BA Degree	More than 20 years of Basque (12 of them taking a class in Spanish)	65.562
9	31	Male	Secondary Education	19 years of Basque	−0.918
10	33	Male	Vocational training	15 years of Basque and 2 years of Spanish	−26.708

BA Degree: Bachelor's Degree.

2.2. Experimental Materials

In addition to the paper-and-pencil version of the BLP Questionnaire in Basque [6], participants completed a sentence reading task and a picture description task. Participants completed a task in which they read 86 target words that contained the letters <s>, <z>, and <x> and their repetition. The stimuli in the present study had the sibilants in word initial or word medial position, in onset or coda position, and in stressed or unstressed syllables to analyze the effects of those factors on the sibilant production. Moreover, the stimuli had one to five syllables. There were 38 words with the sibilant in onset initial position, 31 words with the sibilant in onset medial position, and 17 words with the sibilant in coda position. Moreover, there were 43 words with the sibilant in a stressed syllable, and 43 words with the sibilant in an unstressed syllable. Some of the examples used as stimuli can be seen in examples (1–3) below.

1. Position of the sibilant in the word
   a. **Word initial**
      sari 'award'
      zahar 'old'
      xede 'objective'
   b. **Word medial**
      hasi 'to begin'
      pozik 'happy'
      goxo 'tasty'

2. Position of the sibilant in the syllable and in the word
   a. **Onset initial**
      soineko 'dress'
      zabalik 'open'
      xede 'objective'
   b. **Onset medial**
      oso 'very'
      ozen 'loud'
      kaxa 'box'

c. **Coda**

irakasle	'teacher/professor'
gaztelu	'castle'
pixka	'a little bit'

As I explain in Section 2.3, the factors of 'position of the sibilant in the word' and 'position of the sibilant in the syllable' were collapsed in a single factor because all the sibilants that were in the onset of the syllable were also in word-initial or word-medial position. The collapsed factor is called 'Word/syllable position' and the sibilant can be in onset initial position (*soineko* 'dress'), in onset medial position (*kaxa* 'box'), or in coda position (*irakasle* 'teacher/professor').

3. Stress (the stressed syllable is underlined)

a. **Stressed**

eseri	'sit down'
izotza	'ice'
baxua	'short'

b. **Unstressed**

sailkatu	'classify'
zaborra	'trash'
xaboi	'soap'

The target words were inserted in the middle of carrier sentences and had six to eight syllables before and after them, as can be seen in examples (4–6) below. The target words are underlined in the following examples:

4.

Bilboko	*idazlev*	*horri*	*sari*	*bat*	*eman*	*diote*	*gaur*
Bilbao-FROM	writer	that-to	prize	one	given-PRF	AUX	Today

'Today they gave an award to the writer from Bilbao.'

5.

Sukaldeko	*lapiko*	*zahar*	*hori*	*bota*	*egin*	*dut*
Kitchen-	pot	old	that	thrown-	do-PRF	AUX

'I threw away that old pot from the kitchen.'

6.

Erosi	*dugun*	*salda*	*goxo*	*dagoela*	*uste*	*dugu*
Buy-PRF	AUX-that	soup	tasty	is-that	think-PRF	AUX

'We think that the soup that we bought is tasty.'

It should be noted that all the experimental materials were presented to participants in standard Basque. This standard variety of Basque, also known as *euskara batua* ('unified Basque'), differs to some extent from the local variety spoken in Amorebieta-Etxano and is nowadays used in official and administrative documents, education, literature, and mass media in the Basque Autonomous Community [30]. The ten participants in this study have been exposed to the standard variety as they have studied between 5 and 20 years in Basque (see Section 2.1), and therefore, they have experience reading materials in standard Basque.

2.3. Recording Procedure and Data Analysis

Participants read the stimuli from Microsoft PowerPoint slides (Microsoft Corporation, Redmond, WA, USA, Version 14.5.1,) from a laptop. Avoiding any type of friction noise was important when recording sibilants, and, consequently, a clicker was used in order to avoid participants touching the computer to see the next slide. The recordings were made using the program GarageBand (Apple Inc., Cupertino, CA, USA Version 14.5.1) and an external microphone connected to the laptop through a USB.

For the present study, a total of 1658 tokens, i.e., occurrences of the three sounds under study, were analyzed. The PRAAT program (Amsterdam, the Netherlands, Version 6.0.22) was used in order to measure the COG of each token [31]. Firstly, sounds of interest were segmented in PRAAT. The beginning of the sibilant was marked when the high intensity frication noise begins, and the end of the sibilant was marked when this frication noise starts to decrease. Figure 1 below shows the segmentation of the production of <z> in the word *pozik* 'happy'. The same steps were followed in order to segment the productions of <s> and <x>. Figure 2 shows the segmentation of the sibilant in the word *hasi* 'begin'. Figure 3 shows the prepalatal sibilant in the word *goxo* 'tasty'.

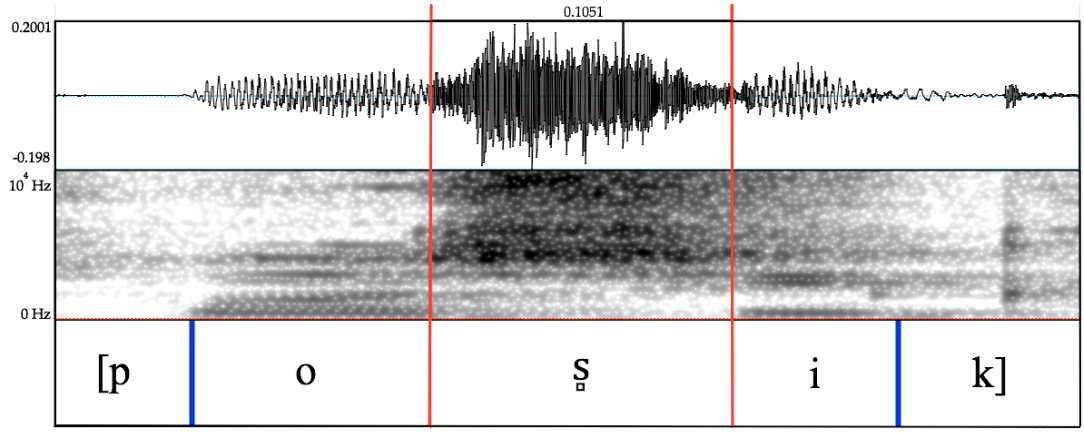

Figure 1. Waveform and spectrogram of the sibilant in the word *pozik* 'happy'.

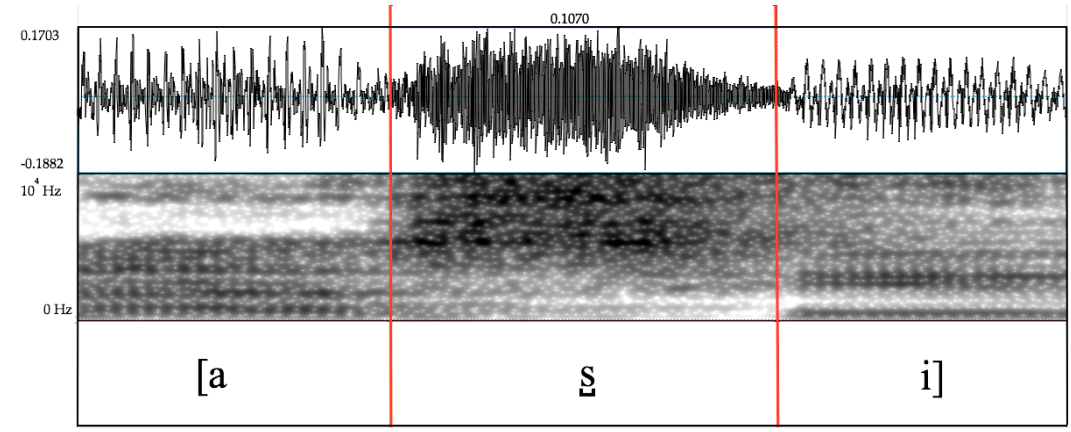

Figure 2. Waveform and spectrogram of the sibilant in the word *hasi* 'begin'.

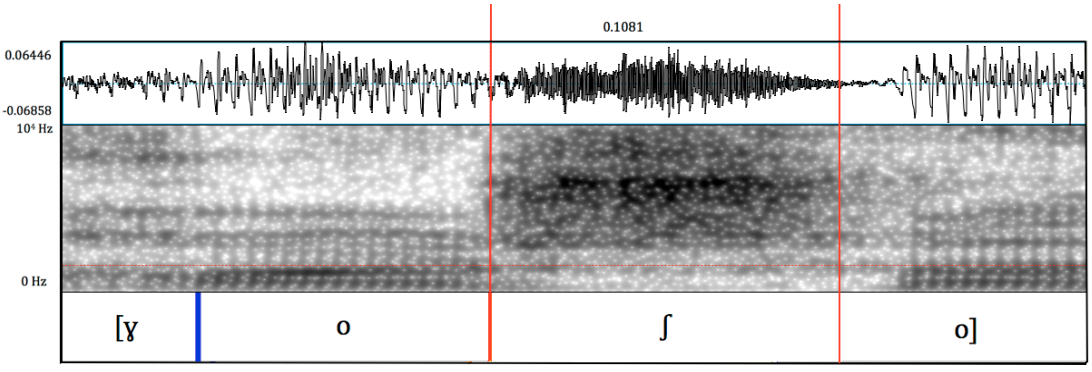

Figure 3. Waveform and spectrogram of the sibilant in the word *goxo* 'tasty'.

After segmenting the sibilants manually, a script was created in order to extract the values of COG automatically. The COG was extracted from the temporal midpoint of the sibilant. A 300 Hz high-pass filter was used in order to avoid interference in the COG value from any possible voicing during the sibilant following File-Muriel and Brown [32]. The present study explores the effect of the following independent variables on sibilant production:

- Participants' language dominance;
- Word/syllable position of the sibilant;
- Stress.

Following Amengual and Chamorro [14], participants were classified as Basque dominant or Spanish dominant depending on their BLP scores. More precisely, those participants that had a negative score were coded as Spanish dominant, and those that had a positive score were coded as Basque dominant. With regard to the second variable, the word/syllable position of sibilants can be onset initial as in *zaila* 'difficult', onset medial as in *pozik* 'happy', or coda as in *koxka* 'cause'. Moreover, all the sibilants that were in coda position in the present study were also in word internal position.

Based on Hualde [2] and Michelena Elissalt [3], I hypothesize that speakers from Amorebieta-Etxano will have the same or very similar COG values for the sibilants that correspond to orthographic <s> and <z>. That is, they will merge at least the apico-alveolar and the lamino-alveolar sibilants, as they are speakers of a Biscayan variety of Basque. The prepalatal sibilant, however, will be kept distinct and based on Hualde [2], Jongman et al. [23], and Gordon et al. [24], it will have lower COG values than the other sibilant. As for the factors that condition the merger, the hypothesis is that informants' language dominance will have an effect on the COG values of the sibilants, as in Jurado Noriega [15]. More specifically, speakers whose dominant language is Spanish will have more similar COG values for their three sibilants than speakers whose dominant language is Basque. In other words, Spanish-dominant speakers will tend to merge their sibilants more than Basque-dominant speakers. Moreover, based on Jurado Noriega [15], we hypothesize that the resulting merged sibilants for Spanish-dominant speakers will resemble the Spanish sibilant. With regards to the position of the sibilant in the syllable and in the word, I hypothesize that words that contain the sibilant in onset medial position will have higher COG values than words that contain the sibilant in other positions (onset initial or coda), as in Jurado Noriega [15]. Finally, I hypothesize that stress will have an effect on the production of the sibilants [33]. More specifically, sibilants in stressed syllables will have higher COG values than sibilants in unstressed syllables.

3. Results

3.1. Statistical Analysis

All the statistical analyses were carried out using the R Project for Statistical Computing [34]. First, mixed-effects linear regression modeling was carried out in order to analyze the effects of letter (<x>/<s>/<z>), language dominance (Basque/Spanish), word/syllable position (onset initial/onset medial/coda medial), and stress (stressed/unstressed) on the COG, and to evaluate whether the interactions between letter and the other variables have an effect on this acoustic measurement. When performing the mixed-effects linear regression modeling, the independent variables were added stepwise, and both word and speaker were included as random factors. ANOVA was used to compare the different models. In addition, a series of post hoc Tukey Honestly Significant Difference (HSD) pairwise comparisons were carried out in order to explore the differences among the levels within each independent factor and to further explore any possible interactions. The statistical significance level is set at $p < 0.05$.

3.2. Results for Center of Gravity

Table 3 shows the mean COG values and the standard deviations for the three sibilants under study. It also shows the mean COG values and standard deviations by letter and language dominance. The COG value is the lowest for <x> (5142 Hz) and the highest for <z> (5756 Hz), whereas the <s> is in between the COG values for <x> and <z> (5461 Hz).

Table 3. Mean Center of Gravity (COG) values in Hz and standard deviations for the three letters in the present study by language dominance and letter.

Letter	Mean COG	Std. Dev.	Basque Dominant		Spanish Dominant	
			COG	Std. Dev.	COG	Std. Dev.
<x>	5142 Hz	2584	5770 Hz	2604	4178 Hz	2240
<s>	5461 Hz	2885	6242 Hz	2914	4271 Hz	2399
<z>	5756 Hz	2889	6610 Hz	2919	4460 Hz	2308

The results from Table 3 are represented in Figure 4 to clearly visualize the relevant differences and trends. The boxplot shows that Basque-dominant speakers have higher COG values in general than Spanish-dominant speakers. For all the speakers in the present study, <z> has the highest COG value, whereas <x> has the lowest. Nevertheless, the differences between <z>, <s> and <x> are smaller for the participants in this study than for the speaker of Goizueta Basque in Hualde (2010) reported in Section 1.2.

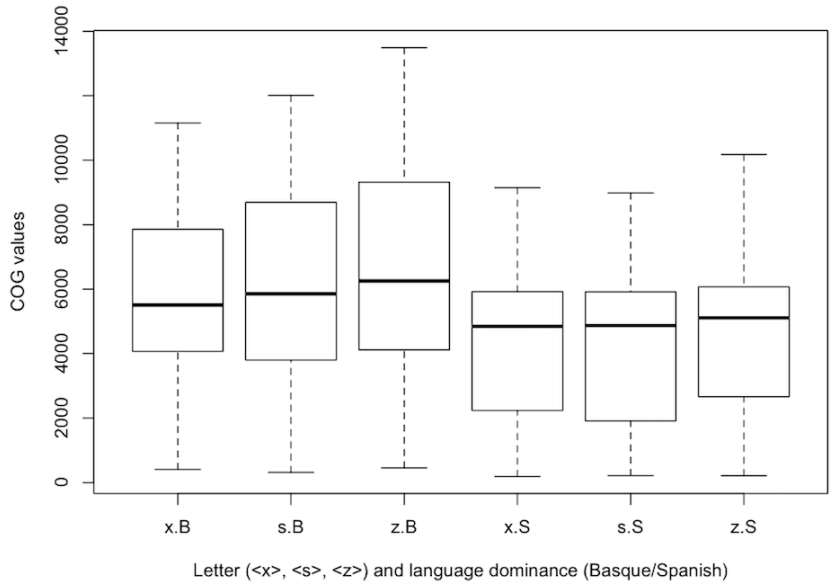

Figure 4. Boxplot with mean Center of Gravity (COG) by letter (<x>, <s>, and <z>) and language dominance (Basque and Spanish).

The best fit model of the regression analysis includes letter, word/syllable position, stress, and the interaction between letter and language dominance. Table 4 shows the components of the best fit model in the analysis.

Table 4. Estimate, standard error, *t* value, and *p*-value of the best fit model in the mixed-effects regression modeling.

	Estimate	Std. Error	*t* Value	*p*-Value
(Intercept)	6713.6	992.7	6.763	6.94×10^{-5} ***
Letter (reference level is <s>)				
<x>	−487.5	272.2	−1.791	0.077
<z>	397.3	230.1	1.727	0.088
Dominance (reference level is Basque)				
Spanish dominant	−1957.8	1513.3	−1.294	0.232
Word/Syllable position (reference level is coda position)				
Onset initial	−287.4	265.3	−1.083	0.282
Onset medial	−350.3	273.2	−1.282	0.204
Stress (reference level is stressed)				
Unstressed	**−452.6**	**192.9**	**−2.347**	**0.022 ***
Interaction between letter and dominance (reference level is letter <s> and Basque dominant)				
Letter <x> and dominance	**431.3**	**191.6**	**2.251**	**0.025 ***
Letter <z> and dominance	−170.5	160.0	−1.066	0.287

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

There are no significant statistical differences between <s> and <x> ($p = 0.077$), and <s> and <z> ($p = 0.088$). However, when relevelling the intercept, there is a statistically significant difference between <x> and <z> ($p = 0.001$ **). The factor of dominance is not statistically significant by itself ($p = 0.232$), but its interaction with letter is significant. Pairwise comparisons were done in order to see which differences Basque- or Spanish-dominant speakers show in their treatment of letters. The pairwise comparisons show that there is a significant difference between the COG values of <z> and <x> among Basque-dominant speakers ($p = 0.002$). However, there is not a statistically significant difference between <z> and <x> among Spanish-dominant speakers ($p = 0.90$). The other letter comparisons were not significant for either language dominance level. As for the effects of word/syllable position on the COG values, it is not statistically significant. However, the pairwise comparisons show that the COG values for <z> and <x> are significantly different only in coda position ($p < 0.001$). Likewise, the COG values for <z> and <s> are significantly different in coda position ($p < 0.001$). However, there are no significant differences among the letters in onset position. The effect of stress on the COG values is statistically significant ($p = 0.0215$). The stressed sibilants have an overall higher COG value than sibilants in unstressed syllables, as can be seen in Table 5, which indicates the COG values and standard deviations for the three letters in stressed and unstressed positions.

Table 5. Mean COG values in Hz and standard deviations by letter and stress.

Letter	Stressed		Unstressed	
	COG	Std. Dev.	COG	Std. Dev.
<x>	5287 Hz	2556	4984 Hz	2612
<s>	5820 Hz	2883	5165 Hz	2858
<z>	5928 Hz	2923	5555 Hz	2841

An additional mixed-effects linear regression modeling was carried out in order to check whether the sibilants in the present study have statistically significant differences in their COG values when they are preceded by the high front vowel /i/ and when they are preceded by a different segment. There are 178 instances of sibilants that are preceded by /i/. The overall results show that the COG values of <z> and <x> that are preceded by the high front vowel /i/ (e.g., *bizi* 'to live') are lower than when they are preceded by a different segment. However, this difference is not statistically significant ($p = 0.752$).

3.3. Results for Minimal Pairs

A post hoc analysis of a subset of the entire data set was conducted to check whether the status of a word as being a minimal pair influences the sibilant production or not. That is, the objective was

to check whether sibilants that are part of minimal pairs are pronounced differently or whether they are merged. In order to do that, six minimal pairs containing the letters <s> and <z> were included. The prediction was that being part of a minimal pair makes it more likely to preserve the sibilant contrast [35]. All of the minimal pairs in the study have one to three syllables that contain the sounds of interest in the onset. Table 6 shows the minimal pairs that were included. The rest of the words included as stimuli in the present study do not form minimal pairs in the language.

Table 6. Minimal pairs with the letters <s> and <z>.

Minimal Pairs Containing <s> and <z>	
Soroa 'meadow'	*Zoroa* 'crazy'
Saila 'field'	*Zaila* 'difficult'
Saman 'in the neck'	*Zaman* 'in the load'
Su 'fire'	*Zu* 'you' (singular)
Hasi 'to start'	*Hazi* 'to grow up'
Hesi 'fence'	*Hezi* 'educate'

The minimal pairs were also inserted into the middle of carrier sentences. Only minimal pairs containing the letters <s> and <z> were included in the study. The reason for this is that, while some minimal pairs containing the apico-alveolar and the lamino-alveolar sibilant phonemes can be found, minimal pairs with <x> and <z> or <x> and <s> are rare. This lack of minimal pairs involving <x> has led Jurado Noriega to question the phonemic nature of the prepalatal sibilant [15]. However, Hualde et al. argue that the prepalatal sibilant is in fact a phoneme in the Basque from Goizueta and explain that the prepalatal is used as "the affective/diminutive correlate of the other two sibilant fricatives" [36] (p. 8). According to Hualde et al., the difference between *xakur* [ʃa.ˈkuɾ] and *zakur* [s̻a.ˈkuɾ] in Goizueta Basque is that *xakur* means 'little dog', whereas *zakur* means 'dog'. However, this alternation between the affective/diminutive prepalatal sibilant (<x>) and the lamino-alveolar sibilant (<z>) does not work for every word containing <z> or <s>. For instance, there are words such as *xerra* [ˈʃe.ra] 'steak' that are never written with the letter <z> [36]. Furthermore, according to Hualde, affective palatalization is productive in the eastern territories of the Basque Country [18].

The effect of the status of a word as being a minimal pair or not was explored with a mixed-effects linear regression modeling that included the factors of letter, minimal pair, and language dominance. The results indicate that the status of a word as a minimal pair is not significant overall ($p = 0.145$). Table 7 shows the components of the best fit model in the analysis.

Table 7. Estimate, standard error, *t* value, and *p*-value of the best fit model in the mixed-effects regression modeling.

	Estimate	**Std. Error**	***t* Value**	***p*-Value**
(Intercept)	6624.16	1015.98	6.520	7.95×10^{-5} ***
Letter (reference level is <s>)				
<z>	364.35	242.43	1.503	0.138
Minimal pair and nonminimal pairs (reference level is minimal pair)				
Nonminimal pair	−460.36	312.22	−1.474	0.145
Language dominance (reference level is Basque)				
Spanish	−2052.34	1532.71	−1.339	0.217

***: $p < 0.001$.

The mean COG values of <s> and <z> are very similar in both words that have a minimal pair status and for those that do not have a minimal pair status, as can be seen in Table 8.

Table 8. Mean COG values in Hz and standard deviations by letter and status as a minimal pair or not.

Letter	Minimal Pair		Not a Minimal Pair	
	COG	Std. Dev.	COG	Std. Dev.
<s>	5883 Hz	2686	5349 Hz	2928
<z>	6005 Hz	2705	5710 Hz	2922

Overall, the results of the mixed-effects linear regression model indicate that dominance does not have a significant effect on the COG values (p = 0.217), even though Basque-dominant speakers have higher COG values than Spanish-dominant speakers as Table 9 shows. Moreover, the difference between <s> and <z> is not significant for neither Basque-dominant speakers nor for Spanish-dominant speakers.

Table 9. Mean COG values in Hz and standard deviations by letter, status of the word as a minimal pair or not, and language dominance.

Status as a Minimal Pair or Not	Letter	Basque Dominant		Spanish Dominant	
		COG	Std. Dev.	COG	Std. Dev.
Minimal pair	<s>	6647 Hz	2705	4738 Hz	2231
	<z>	6755 Hz	2635	4846 Hz	2408
Not a minimal pair	<s>	6135 Hz	2961	4146 Hz	2433
	<z>	6583 Hz	2971	4390 Hz	2288

The results from Table 9 can be visualized in Figure 5. The interaction between the status of a word as being part of a minimal pair and language dominance is not significant. The results indicate that neither Basque- nor Spanish-dominant speakers maintain the difference between the two letters for minimal pairs.

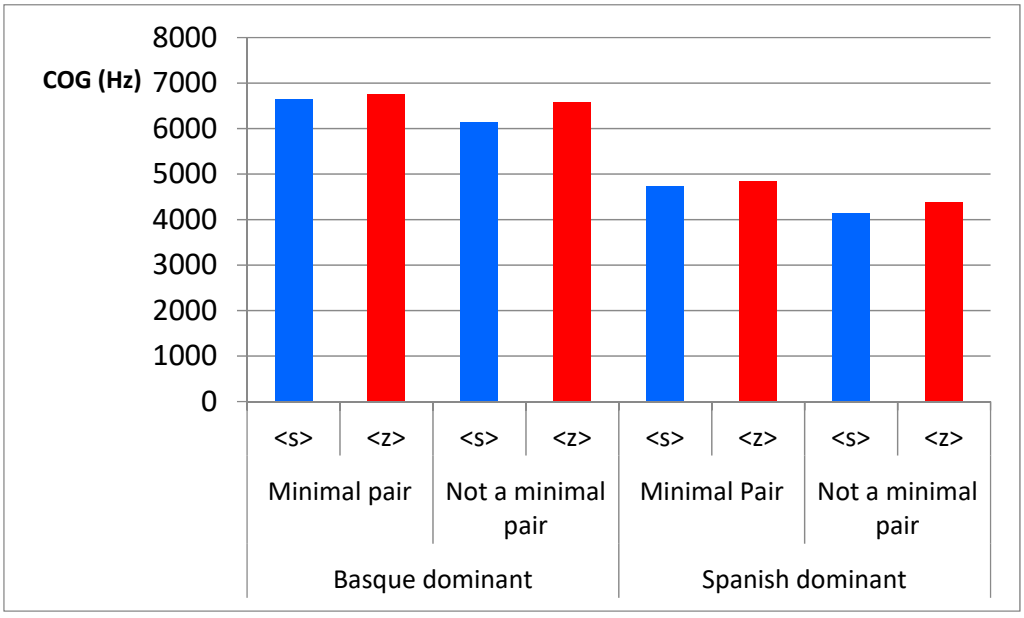

Figure 5. Graph for the letter, language dominance, status of the word as having a minimal pair or not and mean COG values.

4. Discussion

The present study shows that <z> has the highest mean COG value of the three sibilants (5756 Hz), whereas <x> has the lowest COG value (5142 Hz). These results are similar to those for Goizueta Basque presented by Hualde (2010), as he also reports that <z> has the highest mean COG value (6645 Hz), whereas <x> has the lowest one (3531 Hz). Nevertheless, the differences between the COG values of <z> and <s> are smaller in the present study than in Hualde's study [2].

With regard to the interaction between the letters <z>, <s>, and <x>, and speakers' language dominance, Basque-dominant speakers in the present study made a significant distinction in the production of <x> and <z>, whereas Spanish-dominant speakers did not. It seems that the three-sibilant merger, i.e., the production of a single sibilant for the three letters, is completed among participants who are dominant in Spanish. However, there is a significant difference between the lamino-alveolar and prepalatal sibilants. In a nutshell, Basque-dominant participants present a two-way distinction of sibilants, but Spanish-dominant speakers display one single sibilant. These results taken together, especially the fact that it is Spanish-dominant speakers who merge the three sibilants into one, seem to support the claim that contact with Spanish is influencing the neutralization process that is taking place in Basque.

Furthermore, the resulting merged sibilant of Spanish-dominant speakers in the present study resembles the sibilant that Jurado Noriega describes for Spanish more than the merged sibilant of Basque-dominant speakers. In the present study, bilingual speakers who are dominant in Spanish have mean COG values that range from 4178 Hz to 4460 Hz for their merged sibilant in Basque; and, according to the results in Jurado Noriega, the mean COG value of the Spanish sibilant among bilingual speakers whose L1 is Spanish is 3945 Hz [15]. However, Basque-dominant speakers in the present study have higher mean COG values than Spanish-dominant speakers for their Basque sibilants, and they show more resistance to the total merger. More specifically, Basque-dominant speakers have COG values that range from 5770 Hz to 6610 Hz. As the center of gravity correlates with the different articulatory configurations among fricatives [5], the results in the present study seem to reflect that Basque-dominant and Spanish-dominant speakers have distinct places of articulation for their sibilants. According to the results, it seems that Basque-dominant speakers pronounce their sibilants in a more fronted region of the alveolar ridge than Spanish-dominant speakers.

In the present study, letter, word/syllable position, stress, and the interaction between letter and dominance condition the COG. As for the effect of stress on the COG values, <x>, <s> and <z> have higher COG values when they are in stressed syllables than in unstressed syllables. Moreover, the effect of stress on the COG values is statistically significant. With regards to the effects of the position of the sibilant in the syllable and the word, sibilants have higher COG values when they appear in the coda of the syllable. More specifically, the COG values for <z> and <x> are significantly different only in coda position. Likewise, the COG values for <z> and <s> are significantly different in coda position.

The results also show that neither Basque- nor Spanish-dominant speakers maintain the difference between the apico-alveolar and the lamino-alveolar sibilants for minimal pairs or nonminimal pairs. One of the reasons why the results show no difference between minimal pairs and nonminimal pairs could be that some of the minimal pairs included in this study have a low frequency of occurrence. Therefore, a future step of this project would be to analyze the effects of word frequency on the merger or nonmerger of sibilants.

5. Conclusions

The present study classified informants as dominant in Basque or Spanish using the BLP Questionnaire, which is a novel approach to quantifying language dominance in a standardized manner. The BLP Questionnaire offers an alternative to the manner in which informants have been classified in previous studies of sibilants, and it avoids classifying informants based on their origin or the experimenter's criteria. The BLP Questionnaire made it possible to classify informants into two groups in the present study, and the results show that the two groups behave differently. Beyond the

number of sibilants that are merged in the two groups, the present study also showed that Basque- and Spanish-dominant speakers seem to have different places of articulation in the production of their sibilants, as Basque-dominant speakers produce their sibilants in an area closer to the front of the alveolar ridge than Spanish-dominant speakers. Consequently, the present study contributes to the study of Basque−Spanish bilingualism, and, more generally, it provides a description of three sibilants with different places of articulation, which may be useful to analyze and describe the sibilants of other languages with rich sibilant inventories.

The present study explores the production of sibilants of younger speakers. Based on Hualde's observations [15], we may hypothesize that older speakers tend to maintain a two-way contrast among the sibilants in a more robust fashion than younger speakers. Looking at a wider range of participants would contribute to the generalizability of the findings in this study. In the present study, we did not place participants on a continuum based on their BLP scores. As a result, bilingual speakers who were almost balanced in Spanish and Basque were treated as more dominant in one or the other language. In future research, BLP scores could be treated as a continuous variable, which would allow us to use the BLP scores in a more nuanced manner. Additionally, including data from different types of tasks, such as an interview, would allow us to explore the role of style on the neutralization of Basque sibilants, and to explore the hypothesis that the merger will be more likely to occur in a more informal or spontaneous style than when informants are reading sentences in standard Basque.

The present study analyzed the effects of the preceding front vowel /i/ on the COG values of the sibilant, but it did not consider the effect of the following vowels or consonants. According to Jurado Noriega [15], the following vowels also have an effect on the acoustic characteristics of the sibilant, and, consequently, future studies should also analyze whether the following front vowels have an effect on the COG of the sibilant in Amorebieta-Etxano.

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