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Phonetic variants of Majorcan Catalan /ʒ/: A controlled study in societal language contact

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ABSTRACT: Some Majorcan Catalan speakers produce /ʒ/ as [j] rather than [ʒ]. We hypothesize that variation in the production of /ʒ/ is modulated by whether speakers are dominant speakers of Catalan or not. Majorcan Catalan exists in a contact situation with Spanish, and Catalan-Spanish bilinguals vary, on a spectrum, in terms of their language dominance. We recruited 18 bilinguals and divided them into two groups: Catalan- or Spanish-dominant. The participants repeated out loud auditory stimuli in which /ʒ/ had been produced by model talkers as either [j] or [ʒ]. The results revealed systematic differences between Catalan- and Spanish-dominant bilinguals in terms of two correlates that capture the distinction between [j] and [ʒ]: spectral center of gravity and skewness. While the effects of the subjects' profile were of a very large magnitude, the effects of imitation—having heard [j] or [ʒ] as the auditory model for /ʒ/—were negligible. This suggests that, in Majorcan Catalan, individual phonological (internalized) representations of /ʒ/, and not only production habits, are modulated by the speaker's background—some speakers have /j/ and others have /ʒ/.

KEYWORDS: Majorcan Catalan; language contact; fricatives; palatals; phonetics; phonology.

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1. Introduction

This article reports on a phonetic study of Majorcan Catalan /ʒ/. Impressionistic observations suggest that, in present-day Majorcan Catalan, many speakers produce /ʒ/ as [j], rather than [ʒ]. While we were aware of no scholarly reports on this phenomenon, impressionistic observations—including our own knowledge of the community as speakers of the dialect—led us to hypothesize that the variation in the production of /ʒ/ is regulated by the linguistic profile of Majorcans, that is, whether they are native (dominant) or nonnative speakers of Majorcan Catalan. We test this hypothesis here.

Majorcan Catalan exists in an intensive and extensive contact situation with Spanish. According to the most recent official census we are aware of (2011), 88.5% of the residents of the Balearic Islands report that they understand Catalan, and 63.4% of them report they can speak it. Since Catalan-Spanish bilinguals on Majorca can vary as to their patterns of linguistic dominance—some being dominant in Catalan and others in Spanish—it is reasonable to hypothesize that their linguistic profile might have an effect in their speech production patterns (presumably, in both Spanish and Catalan) (Amengual 2016b, 2016c; Ramírez & Simonet 2017; Simonet 2010, 2011a, 2011b). Our goal here is to examine the phonetic characteristics of Majorcan Catalan /ʒ/ as produced by speakers with different linguistic profiles. The production study we report here provides a snapshot of the present-day reality of Majorcan Catalan /ʒ/ in one phonetic context, the intervocalic position.[1]

1.1. Catalan-Spanish bilingualism

Several studies have explored the effects of contact with Spanish on the Catalan variety spoken on Majorca as well as that of Catalonia, which has received more attention. Manifold studies have examined the production and perception of the mid vowel contrasts (/e/-/ɛ/, /o/-/ɔ/), which are specific to Catalan (Amengual 2016b, 2016c; Bosch *et al.* 2000; Cortés *et al.* 2009; Lleó *et al.* 2008; Mora & Nadeu 2012; Navarra *et al.* 2005; Pallier *et al.* 1997; Sebastián-Gallés & Soto-Faraco 1999; Simonet 2011b, 2014). Simonet (2011b) recruited two groups of early, proficient Catalan-Spanish bilingual speakers from Majorca and classified them as a function of their linguistic profile: fundamentally, whether they had been raised in predominantly Spanish- or Catalan-speaking homes. Simonet analyzed the production of the Catalan /o/-/ɔ/ contrast. The finding was that, indeed, Spanish-dominant speakers showed a tendency to merge the two back vowel phonemes into one single phonetic category while Catalan-dominant ones maintained the contrast in their speech, producing two distinct acoustic categories. Mora and Nadeu (2012) recorded productions from several groups of bilinguals from Catalonia and found that, in terms of the amount of acoustic overlap between /e/ and /ɛ/, individuals who had been raised

[1] For Central Catalan, other phonetic contexts have been examined elsewhere (Hualde *et al.* 2015): /ʒ/ can surface as either [ʒ] or [dʒ] depending on its position within a word and its immediate phonetic context. This is intra-individual (rather than inter-individual), allophonic variation, and is not our concern here.

in Catalan-speaking households differed as a function of whether they used Catalan, as opposed to Spanish, more (or less) often as adults. Together, the results of these studies suggest that speech production patterns in Catalan-Spanish bilinguals are affected by both early language experience and preferences in language usage patterns as adults.

Most studies on the transfer of Spanish phonetics to the production and perception of Catalan sounds are concerned with the Catalan mid vowel contrasts, but some research on the production and perception of other categories also exists (Ramírez & Simonet 2017; Sebastián-Gallés & Soto-Faraco 1999; Simonet 2010, 2011a). It is important that we continue to map any effects of bilingualism in this speech community by means of investigations of various phonetic categories and phonemic contrasts beyond the mid vowels. Mora and Nadeu (2012) and Nadeu and Renwick (2016) pointed out that the Catalan mid vowel contrasts are particular in more than one way. It appears that the Catalan mid vowels are subjected to a great deal of regional and idiolectal variability—the contrast is marginal relative to other phonemic contrasts in the language (Hall 2013; Renwick & Ladd 2016; Renwick & Nadeu 2019). Catalan-dominant speakers from the same region differ as to the lexical sets they assign to, for instance, /e/ and /ɛ/; that is, even when they produce and perceive two distinct phonetic categories, one per phoneme, speakers of Catalan may be insecure as to which words have which phoneme (see also Bosch & Ramon-Casas 2011; Renwick & Ladd 2016). Arguably, this would make it extremely difficult for Spanish-dominant bilinguals to develop and maintain accurate representations of the vowels involved in these contrasts and of their lexical sets. Therefore, if we are to learn anything about bilingual speech behavior more generally rather than merely about a possibly peculiar Catalan vowel contrast, we need to verify prior findings with other, more stable phonetic features and phonemic categories. By means of a comparative acoustic investigation of /ʒ/, the present study contributes to (and expands) the literature on the challenges to nonnative speakers' phonetic plasticity, most particularly in the Catalan-Spanish bilingual speech community, and on contact-induced phonetic variation and change more generally.

1.2. The fricatives of Majorcan Catalan

In its phonemic inventory, Majorcan Catalan has six fricatives and four affricates, and these can differ along three phonological parameters: sibilance, place of articulation, and voicing (e.g. Recasens 2014; Wheeler 2005). Thus, Majorcan Catalan has voiced (/v/: *vaig* [vatʃ] 'I go') and voiceless (/f/: *faig* [fatʃ] 'I do') labiodental fricatives, voiced (/z/: *casa* [ˈkazə] 'house') and voiceless (/s/: *caça* [ˈkasə] 'hunt') apicoalveolar fricatives, and voiced (/ʒ/: *joc* [ʒɔk] 'game') and voiceless (/ʃ/: *xoc* [ʃɔk] 'crash') palatoalveolar fricatives.[2] Castilian Spanish (that is, the variety spoken in north-central Spain) has a much sparser fricative inventory. This dialect of Spanish does not possess voiced fricatives of any kind, and it distinguishes between labi-

[2] Central Catalan, the regional dialect upon which the standard variety is based, does not have /v/, and thus has fewer fricative phonemes.

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odental (/f/: *fama* ['fama] 'fame'), dental (/θ/: *zapato* [θa'pato] 'shoe') and apicoalveolar (/s/: *saco* ['sako] 'sack') fricatives. Importantly, while it has a palatoalveolar affricate (/tʃ/: *choque* ['tʃoke] 'crash'), it does not have any palatoalveolar fricatives, let alone a voiced one. In contrast with Majorcan Catalan, which has four, Castilian Spanish has a single sibilant fricative, /s/. It is, therefore, reasonable to hypothesize that, in a language-contact situation in which Majorcan Catalan coexists with Castilian Spanish (and in which every Catalan speaker is bilingual in Spanish), effects of the phonology and phonetics of one language will be observed on those of the other language, especially in nonnative or nondominant speech, and that such effects will affect the fricatives.

As far as we know, there are no scholarly reports on the *dissibilation* (or loss of sibilance) of Catalan /ʒ/ (/ʒ/ → [j]).[3] Our knowledge of the Majorcan speech community suggests to us that this phenomenon is by no means exceptional on the island. We have observed pronunciations of /ʒ/ as [j] in the productions of many speakers and in numerous lexical items. For instance, we have observed this phenomenon in items such as *gent* [ˈʒeɲt]~[ˈjeɲt] (< Lat. GENTE) 'people', *jornal* [ʒorˈnał]~[jorˈnal] 'daily, salary' (< Lat. DIURNALE) and *gener* [ʒəˈne]~[jəˈne] 'January' (< Lat. IANUARIU), items varying in their historical origin (cf. Hualde *et al.* 2015: 246).

Importantly, Majorcan Catalan contrasts /ʒ/ with /j/. Catalan /ʒ/ derives from the fortition of word-initial and intervocalic Vulgar Latin /j/ (IANUARIU > *gener* [ʒəˈne] 'January'; MAIORE > *major* [məˈʒo] 'bigger'), the palatalization of word-initial (and some) intervocalic Latin /ɡ/, when followed by a front vowel (GENTE > *gent* [ˈʒeɲt] 'people'; PAGENSE > *pagès* [pəˈʒəs] 'country folk'), and the palatalization of /d/ + /j/ sequences (DIURNALE > *jornal* [ʒorˈnał] 'daily') (Hualde *et al.* 2015: 246; Moll 1991: 92-95). In mainland Catalan, the phoneme /j/ appears to be present exclusively in borrowed and learned words (*iogurt* [joˈɣurt] 'yogurt'; *iac* [ˈjak] 'yak'). In Majorcan Catalan, however, a palatal glide is also found in words that, in other Catalan dialects, have /ʎ/, such as in *ull* 'eye', which is pronounced [uʎ] in Central Catalan but [uj] (or [uj̯]) in Majorcan Catalan. This sound contrasts with /ʎ/, e.g., *poll* /poʎ/ 'chick' ~ *poll* /poj/ (or [poj̯]) 'flea'. Majorcan Catalan [j] derives from Vulgar Latin C'L, G'L, T'L and LY, which in other Catalan dialects produced [ʎ]. Majorcan Catalan also has [ʎ], but this phoneme derives from other sources, such as LL (Moll 1991).

Spanish-dominant speakers of Catalan, we hypothesize, assimilate Catalan /ʒ/ to Spanish /j/. Interlingual assimilations may be predictive of phonetic behavior in bi-

[3] While, to our knowledge, there are no scholarly accounts of the phenomenon that concerns us here, this has not prevented the appearance of anecdotal observations in the media. In an opinion piece on the pronunciation patterns of José Montilla, 128th president of the Autonomous Government of Catalonia (Generalitat de Catalunya), author Màrius Serra says the following (in Spanish): "En cuanto a las iodizaciones, tendió a transformar 'major' en *maió* y habló sin ambages de *proiectes*, *aiuts* u *oiectius*" (La Vanguardia, 11/24/2006). Màrius Serra comments negatively on the fact that, in his public addresses, president José Montilla, who was born in Córdoba (Andalusia, southern Spain) and moved to Catalonia at 16, consistently produced /ʒ/ as [j]. Serra attributes the Catalan pronunciation patterns of José Montilla to his dominance in Spanish, his native language. We may thus conclude that, according to Serra, the dissibilation of /ʒ/ is due to phonetic transfer from Spanish. (We thank Kathryn Woolard, UC San Diego, for identifying this document and making it available to us.)

linguals and second language learners (Best & Tyler 2007; Escudero 2005; Flege 1995). In terms of Catalan-Spanish cognate correspondences, Catalan /ʒ/ may correspond to either Spanish /j/ (MAIORE > Cat. *major* [məˈʒo], Span. *mayor* [maˈjoɾ] 'bigger') or /x/ (IUSTUS > Cat. *just* [ˈʒust], Span. *justo* [ˈxusto] 'fair, righteous'). In addition to any phonetic similarities between Catalan /ʒ/ and Spanish /j/, cognate correspondences may contribute to the interlingual assimilation of these two sounds in Spanish-Catalan bilingual phonologies. Indeed, in a study directly relevant to the present one, Ramírez and Simonet (2017) found that Spanish-dominant bilinguals had a hard time perceptually discriminating [ʒ], [ʎ], and [j], presumably because all three Catalan sounds have been assimilated to a single Spanish phonetic category, [j]. Crucially, Ramírez and Simonet found that Spanish-dominant (but not Catalan-dominant) Majorcans are perceptually insensitive to the difference between [ʒ] and [j].

We hypothesize that transfer from Spanish initiated by Spanish-dominant speakers is responsible for the apparent dissibilation affecting /ʒ/ on Majorca, which we have informally observed. However, since Majorcan Catalan possesses both /ʒ/ and /j/, it is certainly possible that innovations affecting /ʒ/ represent a mere extension of /j/ to the lexical set of /ʒ/, one not necessarily caused by contact. It could be the case that the dissibilation of /ʒ/ is due to an innovation independent from contact—one that could easily be accounted for from the perspective of language-internal lenition, for instance. We reason that, if the production of /ʒ/ is found to be modulated by the profile of the speakers (in terms of their patterns of bilingual language dominance), we could assume that variation in the production of this phoneme is indeed induced by contact with Spanish. If, on the other hand, production of /ʒ/ is *not* modulated by the profile of the speakers but widespread across the dominance spectrum, one cannot discard the possibility of language-internal sources of variation (or even change).

1.3. The present study

A group of Catalan-Spanish bilinguals born and raised on the island of Majorca were asked to produce a list of speech materials with intervocalic /ʒ/. With the help of a language-profile questionnaire, the speakers were classified into two groups: dominant in Catalan and dominant in Spanish.

Data were collected with the delayed repetition technique, widely used in second-language speech studies (Guion 2003). Speakers repeated out loud speech materials in which /ʒ/ was produced as [j] or as [ʒ]. This data-gathering technique allowed us to see how (or whether) different auditory models trigger different speech productions or, better, the degree to which speakers deviate from the auditory models towards (what we would assume to be) their own long-term, internal phonological representations. As we implemented it, this technique instructs participants to first listen to an auditory stimulus and to then repeat it out loud without necessarily trying to imitate the voice—or acoustic-phonetic detail—of the auditory model.

Imitation is, obviously, relative. Even imitators who strive to emulate someone else's voice are unable to produce exact voice copies. Factors such as the presence and length of a delay between the auditory model and the repetition can reduce the

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effects of acoustic imitation (Goldinger 1998). The presence of intervening sounds and words between auditory model and repetition—which may activate top-down perception processes—has been suggested to trigger the activation of the participants' own phonological representation of the words involved (Guion 2003). Most importantly, as second language speech research suggests, imitation is limited by whether the speaker has formed the target phonological categories in their own mental representation or not (Guion 2003; Simonet 2014). Lack of (or limited) imitation of the acoustic-phonetic features of the auditory model would suggest that the speakers relied, at least to some extent, on their own phonological representations. The phonetic substance of such mental representations constitutes our object of study here.

2. Method

2.1. Speakers

We initially recruited 18 Catalan-Spanish bilinguals born and raised on the island of Majorca. The participants' ages ranged between 18 and 35, and they were classified as a function of their gender (ten male, eight female) and language dominance profile (nine Catalan-dominant, nine Spanish-dominant). There were five men and four women in each dominance group.

The participants were classified into dominance groups with the help of the Bilingual Language Profile (Gertken *et al.* 2014), a language background questionnaire that has been used to assess language dominance patterns in this bilingual community and others (Amengual 2016a, 2016b, 2016c; Simonet 2014). For the purposes of the present study, Catalan-dominant participants were those with negative scores (M = –50.2, SD = 44.28) and Spanish-dominant participants were those with positive ones (M = 95.4; SD = 32.94). Participants were early Catalan-Spanish bilinguals, having acquired both languages in childhood. The order of acquisition of each language, however, was different for each participant group. Catalan-dominant participants came from exclusively Catalan-speaking homes, and they acquired Spanish elsewhere. Their answers to the questionnaire report more positive attitudes towards Catalan, a higher usage rate of Catalan than of Spanish, and a high proficiency in both languages. Spanish-dominant participants came from exclusively Spanish-speaking homes and acquired Catalan elsewhere. Their self-reports indicate more positive attitudes towards Spanish than towards Catalan, a higher overall use of Spanish than of Catalan, and a high proficiency in both languages.

2.2. Recordings

The data were collected by means of a delayed repetition task. Participants were asked to listen to a list of auditory materials in Catalan and to repeat them out loud without necessarily trying to imitate the voice in the auditory models. We asked the participants to "repeat out loud what they heard as naturally as possible." In a quiet room, the speakers were presented with the auditory stimuli over headphones using *Praat* (Boersma 2001). The stimuli were presented in random order. The presenta-

tion of stimuli was divided into two equal parts of 108 tokens, with a short pause in between. The experiment lasted approximately 15 minutes.

All recordings were made with a Marantz PMD660 digital recorder connected to a Sound Devices MM-1 microphone preamplifier. The microphone was a Shure SM10A (head-mounted, dynamic). The recordings were digitized at 44.1 kHz sampling rate and 16-bit quantization. After they were transferred to disc, the recordings were resampled to 22.05 kHz, and then low-pass filtered to 11.025 kHz (Jongman *et al.* 2000).

2.3. Materials

The auditory models for the delayed repetition task consisted of naturally produced instances of short Catalan phrases as uttered by six different talkers, in two forms each. In one form, target sentences were produced with the fricative variant (/ʒ/ → [ʒ]): *està a**j**aguda* 'she's lying down' was thus produced as [əs'ta əʒə'ɣuðə]. In a second form, the sentences were produced with the palatal approximant variant of the phoneme (/ʒ/ → [j]): *està a**j**aguda* 'she's lying down' was thus produced as [əs'ta ə**j**ə'ɣuðə].

A total of eight target words were selected to be used as materials: *just* 'fair', *joguina* 'toy', *jornades* 'working days', *gegant* 'giant', *girafa* 'giraffe', *girar* 'to turn', *aborigen* 'indigenous', *ajaguda* 'lying down'. These target words consisted of items which, in standard Catalan orthography, are rendered with the spelling combinations <j + {a,o,u}> or <g + {e,i}>. The letters <j> and <g>, in these spelling (consonant + vowel) combinations, are unambiguously associated with /ʒ/. The target phoneme appeared in either word-initial or word-medial position but was always intervocalic. The words were inserted into meaningful short sentences (two or three words long). The intervocalic position was selected in order to avoid the production of an affricate allophone of /ʒ/, [dʒ], which surfaces in utterance-initial position (Hualde *et al.* 2015). Twenty fillers were selected and interspersed with the target sentences. This resulted in a total of 28 different items (8 target items + 20 fillers). Once again, the target words, but not the fillers, were produced by the talkers in two model forms, resulting in a total of 36 word forms per model talker (16 target tokens + 20 fillers).

The auditory models, including the fillers, were produced by 6 different Catalan-dominant model talkers. These talkers were all born and raised in Catalan-speaking homes and used predominantly Catalan in their daily lives. Three of the talkers were men and three were women; the auditory models were recorded in a quiet room in their home. Each talker rendered two productions of each target sentence, as mentioned above: /ʒ/ → [ʒ] ([əs'ta əʒə'ɣuðə] 'she is lying down'), and /ʒ/ → [j] ([əs'ta əjə'ɣuðə] 'she is lying down'). The talkers were initially instructed to read out loud a series of sequences in Catalan presented to them on a sheet of paper containing both the target sequences and the fillers. They produced, by-default, all instances of /ʒ/ as [ʒ]. After the first reading, the talkers were asked to read the same sentences while making sure to produce /ʒ/ as [j]. The first author, who ran the tasks, provided them with an example, such as "for instance, instead of [əs'ta əʒə'ɣuðə], say [əs'ta əjə'ɣuðə]." All six participants readily understood our instructions and were able to follow them easily, producing the expected target sound in the expected word po-

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sitions. This resulted in the production of all target sequences with /ʒ/ as [j]. The authors, both native speakers of Majorcan Catalan and trained phoneticians, verified that each target /ʒ/ was produced with either [ʒ] or [j] as expected. Each talker produced 36 sentences (16 target tokens + 20 fillers), which resulted in a total of 216 auditory stimuli to present to the participants in auditory form: 6 talkers × ({8 target sequences × 2 forms} + 20 fillers). The stimuli were transferred to disc and normalized for peak-amplitude.

2.4. Analysis

A total of 1728 target tokens were recorded and extracted for analysis: 16 target auditory stimuli × 6 talkers × 18 participants. The fillers, amounting to a total of 2160 tokens, were discarded. Due to recording errors or disfluencies, 40 tokens were missing or removed. This rendered a total of 1688 tokens for analysis.

The data were submitted to an instrumental, acoustic analysis, and we extracted two acoustic metrics to conduct our study. Synchronized waveform and spectrographic displays were used to inspect the recordings. Observations of intensity curves allowed us to find and mark the lowest intensity point in each target consonant, which we took as a proxy of the consonant's midpoint.

The two metrics we chose were spectral center of gravity and spectral skewness. We obtained the center of gravity and skewness metrics (also known as the first and second spectral moments) from a spectrum computed from a portion of the signal extracted from the consonantal midpoint. Each target spectrum was generated extracting a 40-ms Gaussian window from the midpoint of the consonant (Jongman *et al.* 2000). These metrics were obtained using Praat's built-in functions. The center of gravity of the spectrum corresponds to the average height of the frequencies in a spectrum. Fricatives have higher center of gravity values than approximants due to the presence of turbulence in the higher frequency bands in the former (Jongman *et al.* 2000; Maniwa *et al.* 2009). Approximants have higher positive skewness than fricatives due to the concentration of energy in the lower frequencies (due to a lack of turbulence in the higher ones) in the former.

The metrics were analyzed with reference to two factors. The first factor, a between-subjects one, was *dominance group*, with two levels: Spanish-dominant (9 speakers), Catalan-dominant (9 speakers). The second factor, a within-subjects one, was *auditory model*, also with two levels: whether the speaker was responding to an auditory model word with [ʒ] or one with [j]. For our analyses, we focused on estimating the magnitude of the effects rather than restricting ourselves to dichotomous null hypothesis testing. While we utilized frequentist tests to obtain 95% confidence intervals and margins of error, we refrained from limiting ourselves to dichotomous thinking ("is there a statistically significant difference?") where possible. The approach we take, focused on magnitude estimation, has come to be known as "the new statistics" (Calin-Jageman & Cumming 2019; Cumming 2013a, 2013b, 2014; Cumming & Calin-Jageman 2016). Since we have a particularly small data sample, it is crucial that we focus on estimating effect sizes and uncertainty rather than proceeding carelessly to null hypothesis testing. Data were organized into summary sets (obtaining the by-speaker and by-auditory model

median) via an *R* script, using the package *tidyverse* (tidyverse.org), and statistical analyses were run in *Jamovi* (jamovi.org), an open GUI for *R*, using package *esci* (github.com/rcalinjageman/esci).

3. Results

3.1. Center of Gravity

Table 1 has the center of gravity descriptive statistics shown as a function of the two factors in the study. The data are plotted in Figure 1, which also plots effect sizes with a focus on one of the factors, dominance group. A cursory examination of the values in the table and figure suggests that there is a large difference in the acoustic metric between the Catalan- and Spanish-dominant participants. On the other hand, any difference between the production responses to the two auditory models seems, at most, negligible.

Table 1

Mean (*M*), standard deviation (*SD*), and 95% confidence interval (*CI*) values for spectral center of gravity, as a function of dominance group and auditory model

Group	Auditory Model	*M*	*SD*	95% *CI*
Catalan-dominant	[j]	1197	(374.6)	[1001, 1394]
	[ʒ]	1250	(412.6)	[1054, 1447]
Spanish-dominant	[j]	415	(72.5)	[218, 612]
	[ʒ]	463	(140.9)	[267, 660]

An inferential pairwise comparison confirms the effects of dominance group to be, not only significant, but also very large: raw ($t(34) = -8.34$, $p < .001$, $M_{diff} = -785$, 95% CI [–976, –594]), standardized units ($d_{unbiased} = -2.72$, 95% CI [–3.85, –1.93]). A separate pairwise comparison averaging over group reveals the effects of auditory model to not be significant: raw ($t(17) = -0.94$, $p > .05$ [.36], $M_{diff} = -50.8$, 95% CI [–164, 62.9]), standardized units ($d_{avg} = -0.10$, 95% CI [–0.33, 0.12]). There is little evidence of an interaction between the two factors—the effects fail to reach the significance threshold ($\alpha = 0.025$) in Catalan-dominant speech, $d_{avg} = -0.13$, 97.5% CI [–0.83, 0.52], but marginally reach significance in Spanish-dominant speech, $d_{avg} = -0.41$, 97.5% CI [–0.89, –0.08]. However, the minor auditory-model effects in Spanish-dominant speech are due to a single outlier speaker. Whereas, on average, there is a large difference in spectral center of gravity mean between the two dominance groups, Figure 1 shows that, only in response to a [ʒ] auditory model, one Spanish-dominant speaker does produce a median consonant that approximates those of the Catalan-dominant speakers and deviates from those of the other Spanish-dominant participants. This explains the minor interaction between the two factors.

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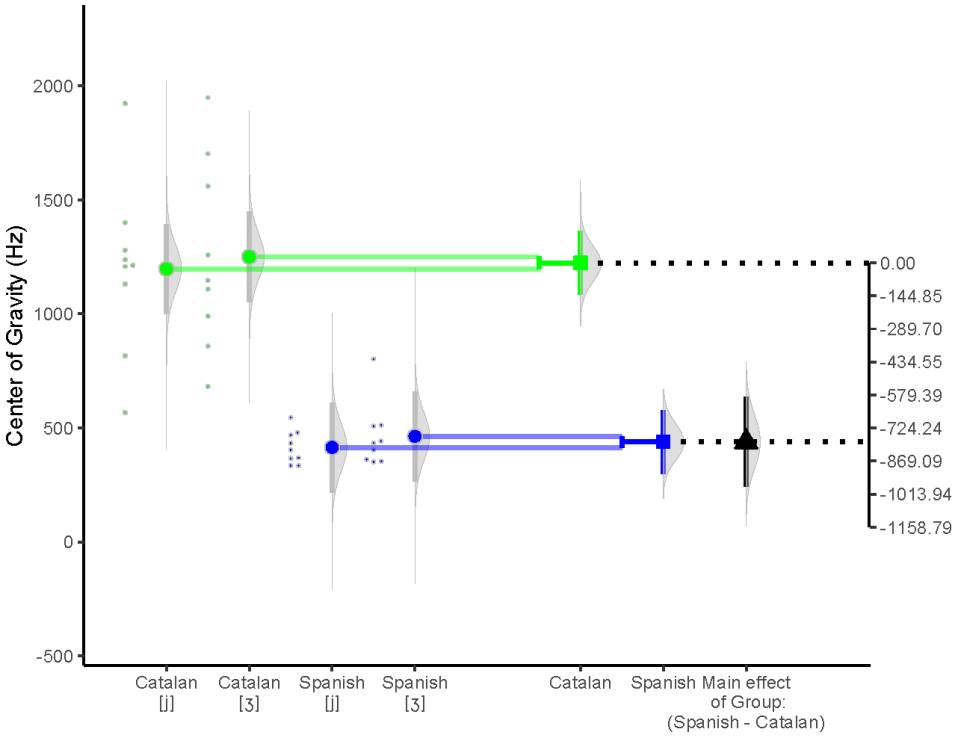

Figure 1

Spectral center of gravity (mean and 95% CI) at the consonantal midpoint as a function of speaker group and auditory model, with a focus on the effect of group, which size is estimated. Data points represent by-speaker and by-condition medians

One of the nine Spanish-dominant speakers produced, on average, a sound with acoustic characteristics suggestive of a palatoalveolar fricative, but only in response to fricative auditory models. The other eight Spanish-dominant speakers produced median sounds with extremely low center of gravity, which suggests they produced approximants, not fricatives. Interestingly, one Catalan-dominant speaker approximates the low values of Spanish-dominant bilinguals. In sum, as a group, Catalan-dominant speakers tend to produce sounds with a higher center of gravity than Spanish-dominant bilinguals.

3.2. Skewness

Table 2 includes the descriptive statistics for spectral skewness. The values in the table suggest that there is a large difference in skewness between the Catalan- and the Spanish-dominant speakers' median productions, with the Catalan-dominant par-

ticipants displaying little (and the Spanish-dominant ones displaying much) positive skewness. Any effects of auditory model seem to be negligible but there might be a condition effect in the Spanish-dominant speakers' productions, hence a potential interaction between the two factors. The information, plotted in Figure 2, visually confirms these observations.

Table 2

Mean (*M*), standard deviation (*SD*), and 95% confidence interval (*CI*) values for spectral skewness, as a function of dominance group and auditory model

Group	Auditory Model	*M*	*SD*	95% *CI*
Catalan-dominant	[j]	1.88	(0.86)	[0.47, 3.28]
	[ʒ]	1.74	(0.73)	[0.34, 3.14]
Spanish-dominant	[j]	9.10	(2.80)	[7.70, 10.50]
	[ʒ]	7.56	(2.82)	[6.15, 8.96]

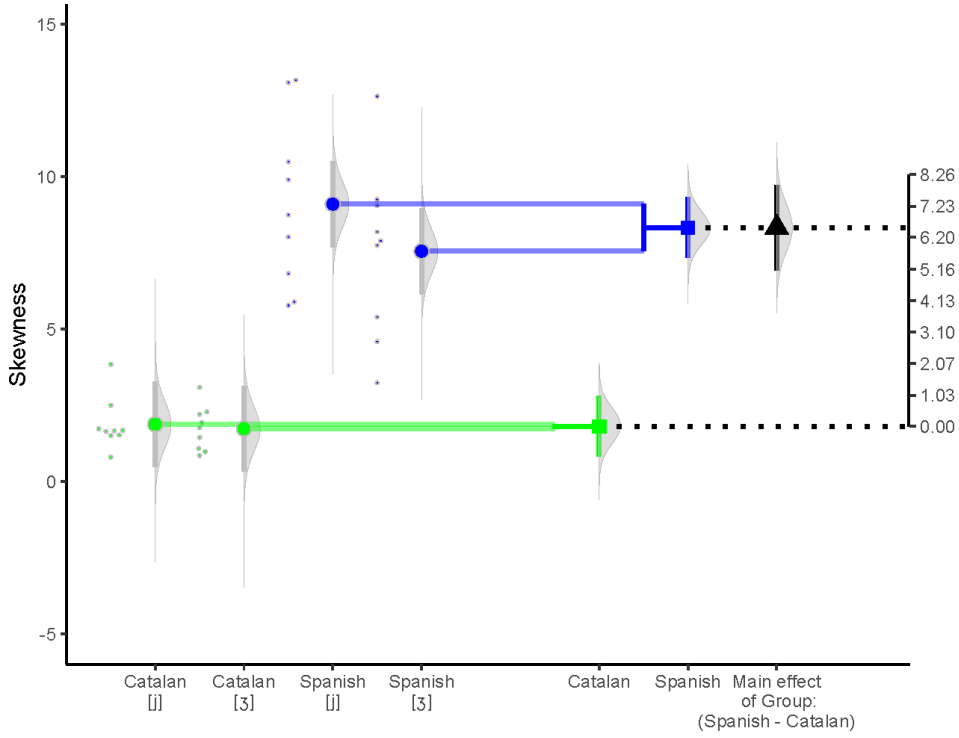

Figure 2

Spectral skewness (mean and 95% CI) at the consonantal midpoint as a function of speaker group and auditory model, with a focus on the effect of speaker group, which size is estimated. Data points represent by-speaker and by-condition medians

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An inferential pairwise comparison shows that the effects of group are significant and also very large: raw ($t(34) = 9.40$, $p < .001$, $M_{diff} = 6.52$, 95% CI [5.11, 7.93]), standardized units ($d_{unbiased} = 3.06$, 95% CI [2.23, 4.28]). Averaging over group, a separate pairwise comparison assessing the effects of auditory model shows that, though marginally significant (at $\alpha = .05$), the size of the effect is very small: raw ($t(17) = 2.80$, $p = .01$ [.36], $M_{diff} = 0.84$, 95% CI [0.21, 1.48]), standardized units ($d_{avg} = 0.21$, 95% CI [0.08, 0.37]). In fact, the effects of auditory model are restricted to the Spanish-dominant speakers, $d_{avg} = 0.52$, 95% CI [0.13, 1.11], and not found in Catalan-dominant speech, $d_{avg} = 0.17$, 95% CI [–0.27, 0.67]. This shows that there is an interaction between dominance group and auditory model, with Spanish-dominant speakers being slightly affected, as a group, by the auditory model they are responding to. The information in Figure 2 suggests that the auditory-model effects are due to the behavior of only three of the nine Spanish-dominant speakers. In sum, the findings suggest that, as a group, Spanish-dominant speakers produce sounds with strong positive skewness. Catalan-dominant speakers, on the other hand, tend to produce sounds with little positive skewness, suggestive of fricatives.

4. Discussion and conclusion

This study reported on a production experiment on the phonetic structures of /ʒ/ in present-day Majorcan Catalan. At the outset of the study, we mentioned that, as speakers of Majorcan Catalan ourselves, we had noted that many Majorcans produce /ʒ/ as [j] rather than [ʒ]. We hypothesized that this pronunciation was restricted to speech produced by Catalan-Spanish bilinguals for whom Spanish (not Catalan) is the dominant, native language. There is reason to believe that the intensive and extensive language-contact environment found on Majorca is influencing the phonetic structures of Majorcan Catalan: some phonetic features of Majorcan Catalan seem to be converging towards those of Castilian Spanish (Simonet 2010, 2011b).

While we have no quantitative sociophonetic evidence at this point that the innovative pronunciation variant of /ʒ/ (/ʒ/ → [j]) is gaining grounds in the Majorcan speech community—i.e., that it is being diffused through the population and being adopted by the younger generations—it is certainly possible that this is the case or that it will soon be. It might, therefore, be crucial for us to document the production of Majorcan Catalan /ʒ/ at this precise point in time (rather than later) and to correlate the production of this sound to the linguistic experience of the speakers. If this is later found to be a change in progress, or if it later becomes one, we might have been able to document its inception. The main goal of the present study was to document the production of /ʒ/ in two groups of bilingual speakers classified as a function of their linguistic experience.

The results of our acoustic study confirmed that the production of /ʒ/ differed as a function of the linguistic profile of the bilingual speakers: The fricatives produced by the Catalan-dominant bilinguals had, on average, a high spectral center of gravity and little positive skewness. These patterns of energy concentration are consistent with the phonetic structures of palatoalveolar sibilant fricatives. Energy concentrations are at higher frequencies in sibilants than in nonsibilants, but palatoalveolar fricatives have their energy concentrations at lower frequencies than other sibilants,

such as /s/ (Jongman *et al.* 2000). Acoustic data for English /ʒ/, as described in Jongman *et al.* (2000) and Maniwa *et al.* (2009), show this sound to be similar (in terms of center of gravity and skewness) to the Catalan-dominant tokens we have collected here, but an apparent difference may be relevant: Catalan /ʒ/ has a lower center of gravity than English /ʒ/. Skewness values are comparable across Catalan and English.

A secondary purpose of our study was to test a data-collection method, which we devised for its use in situations where there exists variation in the speech community but one wishes to maintain control over the speech materials rather than use spontaneous speech. We devised a task in which speakers were asked to listen-to-and-then-repeat auditory stimuli, half of which presented one variant of the target phonological variable and the other half presented the other variant. In our case, speakers listened to phrases in which /ʒ/ had been produced as either [ʒ] or [j]. The exact same language materials were heard in these two phonetic forms an equal number of times. Studies in automatic imitation suggest that speakers tend to imitate the phonetic details of their interlocutors, even in laboratory tasks in which their "interlocutor" is a tape-recorded utterance they are asked to repeat out loud (Goldinger 1998). As studies of second language speech suggest, however, such imitation is limited by whether the speaker has formed a novel phonetic category for the target sound or not (Guion 2003; Simonet 2014). One could interpret this literature as suggesting that speakers are likely to authentically imitate a sound only if they have a long-term phonological representation of the sound, that is, if they possess the category in their phonology. This task seemed ideal for us to begin to capture the phonetic variation of present-day Majorcan Catalan /ʒ/. Even in a situation in which most speakers would have imitated the productions in the auditory models (which was not the case here), it would have been relevant to see the degree to which each speaker deviated from the models (or 50% variant production).

The findings were as follows. With regards to the two spectral measures, a very large difference was found between the Catalan- and the Spanish dominant bilingual speakers. For Catalan-dominant speech, the spectral measures were consistent with those of palatoalveolar fricatives (Jesus & Shadle 2002; Jongman *et al.* 2000; Maniwa *et al.* 2009; Recasens 2014). On the other hand, the productions of the Spanish-dominant speakers were consistent with what would be expected for a nonturbulent, approximant sound such as [j]. The acoustic findings are in line with the prediction that, on average, Catalan-dominant speakers tend to produce [ʒ] while Spanish-dominant speakers tend to produce [j] as variants of /ʒ/. Finally, any effects of imitation—that is, any differences between the productions that had been induced by a [ʒ] or a [j] auditory model—were, at most, negligible. The productions of the Catalan-dominant speakers seemed to be largely unaffected by this experimental condition, while those of the Spanish-dominant speakers were only slightly so. For the Spanish-dominant speakers, auditory model effects seemed to be limited to one to three speakers. Additionally, the acoustic effects were small, and they did not suggest that, in responding to a [ʒ] (rather than a [j] auditory model), Spanish-dominant speakers were indeed producing [ʒ], but perhaps just a slightly more obstructed [j].

Our results add to a growing body of research that documents that, in cases of societal language contact, early proficient bilinguals differ as a function of their dominant language. Specifically for the Catalan-Spanish contact community investigated

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here, most evidence points to the fact that sequential learning has a robust impact in the phonetic behavior of bilinguals, even into adulthood (Pallier *et al.* 1997; Sebastián-Gallés & Soto-Faraco 1999; Simonet 2011b). At least for the Catalan-Spanish contact community on Majorca, robust production differences are found between Catalan- and Spanish-dominant speakers. These results are in line with prior research on this community, most of which had been based on other phonetic and phonological features, including alveolar laterals (Simonet 2010), declarative intonational contours (Simonet 2011a), and the mid vowel contrasts (Amengual 2016a, 2016b, 2016c; Simonet 2011b).

Even though we do not yet have any evidence that the dissibilation of /ʒ/ is a change in progress (instead of a stable pattern of variation circumscribed to dominance groups), it is indeed possible for this innovative pronunciation to spread out across the speech community in the future. If future variationist studies were to find this, the present study would allow us to postulate that the phenomenon had originated as a cross-linguistic (L1 → L2) transfer whose initial agents were Spanish-dominant speakers, a form of contact-induced (*external*) change. There would be no evidence to postulate *internal* change.

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