LANGUAGE DOMINANCE AND THE PERCEPTION OF THE MAJORCAN CATALAN /ʎ/-/ʒ/ CONTRAST: ASYMMETRICAL PHONOLOGICAL REPRESENTATIONS

Abstract

Purpose: Bilinguals tend to experience “difficulties” with contrasts specific to their nondominant language. This study investigates the discrimination of the /ʎ/-/ʒ/ contrast of Majorcan Catalan by two groups of Catalan-Spanish bilinguals differing in their linguistic experience, Catalan- vs. Spanish-dominant. **Methodology:** Participants completed a categorical discrimination task to examine their perception of the following pairwise comparisons, relevant to assessing the perceptibility of the Majorcan Catalan /ʎ/-/ʒ/ contrast: [ʎ]-[ʒ], [ʎ]-[j], and [ʒ]-[j]. **Data:** Data consisted of arcsine-transformed proportion-correct responses obtained by means of a categorical discrimination task using the odd-item-out AXB paradigm. **Findings:** The results indicate that Spanish-dominant bilinguals are less accurate than Catalan-dominant ones in terms of their discrimination of the sounds involved in the /ʎ/-/ʒ/ contrast. Catalan-dominant participants discriminate any pairs involving [ʒ] very accurately. Interestingly, however, all participants find the [ʎ]-[j] pair difficult to discriminate. **Originality:** This study examines perception of a contrast not examined before, and its results suggest a surprising pattern of asymmetry in phonological representations of the target contrast. **Significance:** The results suggest that language dominance in the Catalan-Spanish contact community modulates discrimination of the /ʎ/-/ʒ/ contrast. The findings also suggest that Catalan-dominant listeners’ representation of /ʎ/ and /ʒ/ may be asymmetrical: The representation of /ʎ/ may be fuzzier than that of /ʒ/.

Introduction

On Majorca, Catalan exists in an intensive and extensive contact with Spanish: Catalan-Spanish bilingualism is the norm rather than the exception, and most inhabitants of Majorca are very proficient in both languages, having learned both in childhood. A number of studies have demonstrated that the linguistic experience of Catalan-Spanish bilinguals — whether Catalan is their dominant or, rather, their nondominant language — modulates the way speakers produce and perceive the sounds of Majorcan Catalan (Amengual, 2016a, 2016b; Simonet, 2011, 2014). The present study is concerned with a consonantal contrast of Majorcan Catalan, that between /*ʎ*/ and /*ʒ*/, which has no direct equivalent in Spanish.

Informal observations suggest that, in many dialects of Catalan (including Majorcan), some speakers tend to merge /*ʎ*/ and /*ʒ*/ into a single sound, a palatal approximant, [j]. This study asks whether what modulates the way Majorcans implement the /*ʎ*-/*ʒ*/ contrast is their linguistic experience — in terms of whether they are dominant or nondominant speakers of Catalan. Rather than phonetic production, this study investigates the *perception* of the phonemic contrast of concern. Given the fact that some studies have found that linguistic experience affects the production and perception of Catalan-specific phonological contrasts, but since some of these findings lead to potentially conflicting results (Amengual, 2016a; Simonet, 2011, 2014), we see the need to revisit this speech community by means of an examination of a consonantal contrast that has not been investigated before.

*The Majorcan Catalan /*ʎ*-/*ʒ*/ contrast*

Catalan possesses a phonemic contrast between /*ʎ*/ and /*ʒ*/.¹ (In addition to the /*ʎ*/ and /*ʒ*/ phonemes, Catalan has /*j*/.) Our anecdotal observations lead us to believe that, in present-day Majorcan Catalan, there is a process of delateralization of /*ʎ*/ (/*ʎ*/ → [j]) impacting the words that etymologically present this phoneme. It is our observation as well that there is a simultaneous process of dissibilization affecting /*ʒ*/ (/*ʒ*/ → [j]). As a consequence of these two processes, the historical /*ʎ*-/*ʒ*/ contrast of Majorcan Catalan seems to be merged to [j] in the pronunciation of at least some Majorcans.

The delateralization of /*ʎ*/ has been reported in scholarly sources for several mainland Catalan dialects, but there is little quantitative evidence on this phenomenon (Recasens, 1991; Segura, 2003; Wheeler, 2005). Segura (2003) transcribed speech collected in the Baix Vinalopó, province of Alacant (Alicante), from speakers of various age groups. In Segura's study, only speakers 65 years old or older

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¹ Majorcan Catalan differs from other Catalan dialects, such as Central Catalan, in the lexical set assigned to /*ʎ*/ (but not that of /*ʒ*/). Thus, not all the lexical items that have /*ʎ*/ in Central Catalan have it in Majorcan Catalan — some have /*j*/ instead. Majorcan Catalan /*j*/ derives from Vulgar Latin C'L, G'L, and LY (these sound sequences produced /*ʎ*/ in Central Catalan). In the cases in which Catalan /*ʎ*/ has a different origin, such as when it comes from a Latin lateral geminate (LL), Majorcan Catalan does not differ from other Catalan dialects — it also has /*ʎ*/ (Moll, 1991). Majorcan Catalan /*j*/ contrasts with /*ʎ*/. This phenomenon — the fact that Majorcan Catalan has /*j*/ in a subset of words in which Central Catalan has /*ʎ*/ — has been called “historical iodization” in the Catalan dialectological literature. The present study is *not* concerned with “historical iodization”

tended to pronounce / Λ / as [Λ]; younger speakers tended to pronounce it as [j]. Indeed, [Λ] was fundamentally absent in the speech of individuals 17 years old or younger (in 2003). Segura's data are very suggestive of a change in progress according to which / Λ / is losing its laterality, at least for this Southern dialect. (We do not know whether an age-dependent variation pattern holds for Majorca, but we have indeed observed delateralized / Λ / (/ Λ / $\rightarrow$ [j]) in the speech of many young Majorcans.) To our knowledge, there are no published scholarly reports — let alone any quantitative, variationist evidence — on the loss of the dissibilant of / β / (/ β / $\rightarrow$ [j]) in any regional dialect of Catalan, but our informal observations for the island of Majorca suggest to us that this process is certainly not rare on the island. To the extent that the same speaker dissibilates / β / and delateralizes / Λ /, one can speak of a merger of this contrast, at least for this speaker. (Future studies should investigate the social diffusion of this merger in order to determine whether there is a change in progress in the community, but the present study is *not* concerned with this question.)

Most scholars who have observed the delateralization of / Λ / in their published work suggest that this process is due to intensive contact with Spanish (Segura, 2003; Wheeler, 2005). While some conservative dialects of Spanish contrast / Λ / with /j/, most show evidence of having undergone a merger of the two phonemes in favor of /j/, a process called *yeísmo* in the Spanish dialectological literature. Since the Spanish varieties that are in contact with Catalan on Majorca lack the / Λ /-/j/ contrast (and since they also lack / β /), one could hypothesize that the merger of Majorcan Catalan / Λ / and / β / comes from the interlingual assimilation of Catalan / Λ / and / β / to Spanish /j/ in the phonologies of bilinguals, especially if Spanish is their dominant language (c.f., Best & Tyler, 2007; Escudero, 2005; Flege, 1995; for operationalizations of “interlingual assimilations”). If this were the case, we should be able to observe differences in the perceptual behavior of Catalan-Spanish bilinguals as a function of their linguistic experience. Sebastián-Gallés and colleagues have indeed shown how Spanish-dominant bilinguals experience “difficulties” when perceiving contrasts specific to Catalan, such as /s/-/z/, / β /-/ β /, /e/-/ɛ/, and /o/-/ɔ/, which have no obvious Spanish counterpart (e.g., Sebastián-Gallés & Soto-Faraco, 1999). These authors explicitly hypothesized that the difficulties faced by these bilinguals might also affect the second-language learning of Catalan / Λ / and / β / — the / Λ / and / β / contrast, however, was not tested in their study. Our study follows up on Sebastián-Gallés and Soto-Faraco's (1999) note, and it explicitly tests the perception of the / Λ /-/ β / contrast.

The phonetics of bilingualism and the Catalan-Spanish speech community

All current models of nonnative phonetic behavior operationalize the existence of interactions between the native and nonnative phonologies of bilinguals (Best & Tyler, 2007; Escudero, 2005; Flege, 1995). One way in which the two phonologies of a bilingual interact is by creating sound equivalences across languages. It is certainly possible that, since neither / Λ / nor / β / exist in Spanish, Spanish-dominant bilinguals have difficulties with the / Λ /-/ β / contrast of Catalan because they equate both sounds to the closest sound in Spanish, /j/. While, in the present study, we do not assess whether Catalan-Spanish

bilinguals establish these interlingual interactions, we do assess whether the perceptual discrimination of this Catalan contrast is more difficult for Spanish-dominant bilinguals than it is for Catalan-dominant ones.

A number of studies have examined the behavioral limitations of sequential bilinguals in terms of their speech development, and the Catalan-Spanish contact community has been instrumental in providing relevant data (e.g., Bosch, Costa, & Sebastián-Gallés, 2000; Mora & Nadeu, 2012; Navarra, Sebastián-Gallés, & Soto-Faraco, 2005; Pallier, Bosch, & Sebastián-Gallés, 1997; Sebastián-Gallés & Soto-Faraco, 1999). Most of these data have been gathered in Barcelona, and these studies typically deal with the mid-vowel contrasts of Catalan (/e/-/ɛ/, /o/-/ɔ/). In a fundamental study, Pallier et al. (1997) investigated the perception of one of these contrasts (/e/-/ɛ/) by bilinguals who, although very proficient in both languages as adults, had grown up in Catalan- vs. Spanish-speaking homes. This study showed that sequential bilingualism — in this specific case, having been raised in a Spanish- rather than Catalan-speaking home — impacted the participants' abilities to categorically identify an acoustic continuum ranging from [e] to [ɛ]. Many corroborating findings have been reported since (Bosch et al., 2000; Navarra et al., 2005; Sebastián-Gallés & Soto-Faraco, 1999, among many others). Mora and Nadeu (2012) added an important piece to this puzzle. In their study, only bilinguals who had been raised in Catalan-speaking homes participated, and they were grouped as a function of how frequently they used their native language daily. Two groups were formed, a low-Catalan-use group and a high-Catalan-use group. Interestingly, patterns of language use as adults were able to predict the degree to which the bilingual participants would perceive (and produce) [e] and [ɛ] as two distinct categories. Together, these studies suggest that both early-in-life and recent experience with the two languages determine to some extent the phonetic behavior of bilinguals.

The data for Majorca are possibly more puzzling than that for Barcelona, or at least they seem to lead to conflicting results. Simonet (2011) assessed the production of the /o/-/ɔ/ contrast by Catalan- vs. Spanish-dominant speakers born and raised on the island. The findings were in line with those from Barcelona: Spanish-dominant speakers tended to merge the vowel contrast while Catalan-dominant ones maintained a robust acoustic distinction between the two phonemes. In terms of perception, Simonet (2014) found that Spanish-dominant listeners were unlikely to discriminate the /o/-/ɔ/ accurately, as prior research in Barcelona had found as well. But these findings were challenged in a subsequent investigation. In a follow-up study, Amengual (2016a) found that *both* Catalan- and Spanish-dominant speakers were able to maintain a robust acoustic distinction between /o/ and /ɔ/ (and between /e/ and /ɛ/). Listeners were also likely to perceive the mid-vowel contrasts in terms of two categories. The main point we wish to raise at this juncture is that the findings for Majorca are not as consistent (across studies) as those for Barcelona.

There are reasons to believe that the mid-vowel contrasts are qualitatively different on Majorca from what they are in Barcelona. The acoustic distance between the mid-vowels is much larger in Majorcan than it is in mainland Eastern dialects (Recasens & Espinosa, 2006), which may make this

contrast easier to learn — for second-language speakers — in the former than in the latter. Second, recent evidence for mainland Eastern Catalan dialects suggests that the mid-vowel contrasts are not lexically robust; that is, native speakers differ as to their lexical sets for the phonemes (Nadeu & Renwick, 2016) — and this would obviously complicate the developmental scenario. (This may or may not be the case for Majorcan Catalan.) Obtaining data from contrasts *other than* the mid-vowel ones may provide us with a novel perspective: a window into the Catalan-Spanish contact community of Majorca that the vowel contrasts are not able to provide. The inconsistent findings of studies focusing on the mid-vowel contrasts of Catalan suggest that other contrasts, perhaps those involving consonants, should be explored as well (c.f., Sebastián-Gallés & Soto-Faraco, 1999).

The present study

The present study investigates the perceptual discrimination abilities of two groups of bilinguals classified as a function of their bilingual language dominance. The target phonemic contrast we investigate is the /ʎ/-/ɜ/ contrast, and that is why we study the discrimination of the two allophones associated with this phonemic contrast, [ʎ] and [ɜ]. Two other phone distinctions were also explored, those that involved not only [ʎ] and [ɜ], but also [j]. This is due to the fact that we wished to examine the perception of the Catalan /ʎ/-/ɜ/ phonemic contrast as well as that of the “new” sound which many young Majorcans seem to use to produce these phonemes — [j] is also the Spanish sound with which, we would expect, Catalan [ʎ] and [ɜ] are equated. Thus, we examined the discrimination of three pairwise distinctions: [ʎ]-[ɜ], [ʎ]-[j], and [ɜ]-[j]. Note that [j] is investigated as a *phonetic variant* of /ʎ/ and /ɜ/, not as an independent phoneme — in our design, [j] always appears in words with either /ʎ/ or /ɜ/. Our main research question is as follows: How does bilingual language dominance affect the perception of the sounds involved in the Majorcan Catalan /ʎ/-/ɜ/ phonemic contrast?

Method

Participants

A total of 20 Catalan-Spanish bilinguals born and raised on the island of Majorca were recruited for participation in a perceptual task. They were all between the ages of 18 and 35. An equal number of males and females were recruited. Ten were classified as dominant in Catalan and ten, in Spanish. In both dominance groups, females and males were represented in equal numbers.

The classification of the participants in language-dominance groups was done with the assistance of a language background questionnaire, the *bilingual language profile* (BLP) of Birdsong, Gertken, and Amengual (2012). This questionnaire has been used in prior work to assess language-dominance patterns in the Catalan-Spanish contact community (Amengual, 2016a, 2016b; Simonet, 2014). The BLP produces a dominance score and a general bilingual profile for each

participant. Participants' self-reports provide data for both languages on four equally weighted modules: history, use, proficiency, and attitudes. The answers to these four modules result in one score per module. The sum of the values from all four modules renders an index of language orientation (per language). The score obtained for a language is then subtracted from the score obtained for the other language to generate a final dominance score.

The data obtained from the questionnaire separated participants into two non-overlapping groups. Participants in the Catalan-dominant group received scores on the negative side of the continuum ($M = -50.2$; $SD = 44.28$), while participants in the Spanish-dominant group received scores on the positive side of the continuum ($M = 95.4$; $SD = 32.94$). Table 1 shows averages and standard deviations for the BLP scores of each of the four modules. We follow most prior research by first classifying our participants into two discrete groups. We close our Results section with an analysis of discrimination accuracy in which dominance is a gradient factor, operationalized as the BLP score obtained for each participant. We follow the example of Amengual (2016a, 2016b) and Amengual and Chamorro (2015) in doing so.

INSERT TABLE 1 ABOUT HERE

All of our participants were early, proficient Catalan-Spanish bilinguals, and all had acquired both languages in childhood. The order of acquisition of the two languages differed for the two groups of participants. Catalan-dominant participants grew up in Catalan-speaking homes, learning Catalan first and Spanish later, perhaps in a school setting (at 6 years of age at the very latest). Spanish-dominant participants came from Spanish-speaking households, learning Spanish first and Catalan later. The Catalan-dominant group reports a higher (past and current) use of (and a more positive attitude towards) Catalan than of (towards) Spanish, the Spanish-dominant one reports a higher use (and a more positive attitude towards) Spanish. Self-reports suggest a similarly high level of proficiency in both languages for both groups of participants.

Procedure and auditory stimuli

The perceptual discrimination experiment was an oddity task with three stimuli per trial, an AXB paradigm in which participants were to select the “odd” item in the triad rather than the item matching the one in the middle. For this study, participants listened to a series of trials, each of which had three acoustically-different stimuli (a triad) with the caveat that two contiguous sounds belonged to the same phonetic category and one, obviously, did not. The participants' task was to identify the odd-stimulus-out.²

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² In many implementations of the AXB task, participants are asked to identify the sound that matches the one in the middle — i.e., whether X is *like* A or *like* B. Another way in which the same paradigm can be run is by asking the participants to

Two short sentences were selected to be used as materials. The selected minimal pair was: *dóna lloc* ([^ldonə ^lʎək], ‘gives rise to, leads to’), and *dóna joc* ([^ldonə ^lʒək], ‘provides scope, plays a part in’). The first word was included so as to avoid that the target consonant would appear in utterance-initial position. By introducing auditory materials between the target sounds in the trial ([ʎ], [ʒ], [j]), one expects perceptual categorization on the basis of acoustic memory to be severely hindered. Listeners are induced to rely exclusively on mid-term, phonetic memory — they must carry out categorical phonetic comparisons rather than mere acoustic identity checks (e.g., Pisoni & Tash, 1974). This is so because, among other things, the time lapse between the three target consonants in any given triad is long, and because other sounds occur between them, destroying unencoded acoustic representations.

The stimuli were recorded in a quiet room at the home of each of the talkers (six native Catalan talkers) with a Marantz PMD660 digital recorder, a Sound Devices MM-1 microphone preamplifier, and a Shure SM10A head-mounted, dynamic microphone. The recordings were done at 44.1 kHz sampling and 16-bit quantization. The stimuli were later transferred to disc and normalized for peak-amplitude.

The stimuli consisted of naturally-produced instances of both target sentences, *dóna lloc* and *dóna joc*, in two forms each. In one form, the two sentences were produced each with their etymological allophones: *dóna lloc* was produced as [^ldonə ^lʎək], and *dóna joc* was produced as [^ldonə ^lʒək]. The materials were also produced in a merged form; that is, with [j] instead of [ʎ] or [ʒ]: [^ldonə ^ljək].³ A total of six Catalan-dominant “talkers” were asked to produce the auditory stimuli to be used in the perception experiment. Three of the talkers were female, and three were male. Each talker was asked to render two productions of each of the three conditions: (i) [^ldonə ^lʎək], (ii) [^ldonə ^lʒək], and (iii) [^ldonə ^ljək]. This resulted in an archive of 36 auditory tokens to be used as stimuli: 6 talkers × 6 productions.

Each triad consisted of three acoustically different stimuli, each from a different talker — this ensured that no two stimuli in one triad were acoustically identical. Female voices were used alongside female voices, and male voices were used alongside male voices; that is, each triad presented stimuli from one gender only. Excepting this condition for gender, all remaining possible combinations of tokens, categories and talkers were exploited in the triads. Each of the six productions of every talker appeared once as the first item, once as the second item, and once as the third item. In each triad there was always one stimulus that belonged to a different phonetic category. The “odd” item was always in first or third position, never in second position: ABB, AAB, BAA, BBA. The interstimulus interval

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identify whether it is A or B that *differs* from the other two. The design of the task is exactly the same in both cases, but, in these two implementations, the participants are asked to do just the opposite.

³ The talkers were asked to produce both /ʎ/ and /ʒ/ as [j] — i.e., [^ldonə ^ljək] — “as if a Spanish speaker were to pronounce these words.” This was readily understood by all 6 talkers, and they easily produced the sentences with [j] in the place of /ʎ/ and /ʒ/. The authors, both native Majorcan Catalan speakers, verified that each allophone was produced as expected; that is, with [ʎ], [ʒ], and [j]. This was done auditorily as well as visually, with the help of spectrographic displays.

(ISI) was set at 500 ms. The actual distance between the target consonants was, however, much greater due to the presence of the carrier utterance.

There were a total of 288 triads presented to each listener. There were three different within-listener experimental conditions according to which the triads were organized: 92 trials were different iterations (i.e., with different voices, different tokens, etc.) of the [ʌ]-[ɜ] condition, 92 were examples of the [ɜ]-[j] condition, and 92 were examples of the [ʌ]-[j] condition. Of each of the 92 trials per condition presented to each listener, 24 were in the ABB order, 24 in the BAA order, 24 in the AAB order, and 24 in the BBA order. The triads were presented in random order, a different randomization per listener. We used Praat (Boersma, 2001) to run our experiment. Participants were told that they would listen to sequences of three sentences, and they were asked to report “whether the first or the third (never the second) differed from the other two in terms of the sounds used in the words.”

Statistical analysis

The analysis consisted of a statistical exploration of by-subject proportion-correct scores as a function of experimental condition. For each participant, three scores were obtained: (i) the proportion of correct responses to the [ʌ]-[ɜ] condition (over 96 responses), (ii) the proportion of correct responses to the [ʌ]-[j] condition (over 96 responses), and (iii) the proportion of correct responses to the [ɜ]-[j] condition (over 96 responses). This resulted in a total of three proportion-correct scores per subject, 60 scores in total (3 scores $\times$ 20 participants). The by-listener proportion-correct scores constitute the independent variable examined in this study.

In order to prepare the data for a statistical exploration using parametric tests, an arcsine transformation was applied to the by-participant proportion-correct scores. The arcsine-transformation is commonly used to increase the normality of bound data, such as proportion counts (Gotelli & Ellison, 2004; but see Warton & Hui, 2011). The transformation is the arcsine of the square root of the proportion. While we use arcsine-transformed values in our statistical explorations, the tables and figures report proportion-correct scores, as these are more easily interpretable. The *alpha* criterion was set at $p < 0.05$.

Results

Figure 1 plots the mean by-listener proportion-correct responses as a function of phonetic distinction ([ʌ]-[j], [ɜ]-[j], [ʌ]-[ɜ]) and language-dominance group. Table 2 shows the mean (and standard deviation) by-listener proportion-correct responses as a function of phonetic distinction, language-dominance group, and gender.

INSERT FIGURE 1 ABOUT HERE

INSERT TABLE 2 ABOUT HERE

The arcsine-transformed proportion-correct scores were submitted to a mixed-design, three-way $(3) \times 2 \times 2$ ANOVA with *contrast* ([λ]-[j], [3]-[j], [λ]-[3]) as a within-subjects factor, and *gender* (male listener, female listener) and *dominance* (Catalan-dominant, Spanish-dominant) as between-subjects factors. The ANOVA yielded significant main effects of *contrast* ($F(2,32) = 41.66$; $p < 0.05$ [1.23e-09]), *dominance* ($F(1,16) = 75.44$; $p < 0.05$ [1.88e-07]), and *gender* ($F(1,16) = 6.96$; $p < 0.05$ [0.0179]). The main effect of *gender* was due to the fact that, overall, female listeners were more accurate than male listeners, but the size of the effect was very small (Cohen's $d = 0.384$). The main effect of dominance group was much larger in size, and it was due to the fact that, overall, Catalan-dominant listeners were much more accurate than Spanish-dominant listeners were (Cohen's $d = 1.601$). The only significant interaction was that between *contrast* and *dominance* ($F(2,32) = 13.69$; $p < 0.05$ [5.06e-05]). In order to explore the *contrast* by *dominance* interaction, the data were explored in two different ways: (i) The data frame was divided into three separate subsets as a function of consonant distinction ([λ]-[j], [3]-[j], [λ]-[3]), and then the effects of language *dominance* were analyzed for each of these three subsets. (ii) Additionally, the dataset was divided into two subsets as a function of language dominance, and then the effects of *contrast* ([λ]-[j], [3]-[j], [λ]-[3]) were explored for these two subsets separately. The latter is discussed first. In pairwise comparisons, the *alpha* criterion was Bonferroni-adjusted for six pairwise comparisons ($0.05/6 = 0.008$).

The Catalan-dominant scores were submitted to a repeated measures ANOVA with *contrast* ([λ]-[j], [3]-[j], [λ]-[3]) as the sole factor. The ANOVA shows a significant main effect ($F(2,18) = 34.4$; $p < 0.008$ [7.09e-07]). These listeners discriminate both the [λ]-[3] and the [3]-[j] distinctions relatively accurately (see Table 2), and any apparent perceptual differences between these two distinctions fail to reach significance ($t(9) = 1.93$; $p > 0.008$ [0.085]; Cohen's $d = 0.827$). On the other hand, when [λ]-[3] and the [λ]-[j] are compared with each other, a paired *t-test* yields a significant result, and the effect size is very large ($t(9) = 11.51$; $p < 0.008$ [1.09e-06]; Cohen's $d = 3.197$). While the [λ]-[3] distinction is discriminated quite accurately, the [λ]-[j] distinction is not — the latter has a 0.63 (63%) accuracy rate. The pairwise comparison between the [λ]-[j] and the [3]-[j] distinctions also yields significant results ($t(9) = 5.01$; $p < 0.008$ [0.00072]; Cohen's $d = 2.421$), once again because the discrimination of the [λ]-[j] consonant distinction is particularly poor.

The Spanish-dominant scores were also submitted to a repeated-measures ANOVA, which also yielded significant *contrast* effects ($F(2,18) = 7.52$; $p < 0.05$ [0.0042]). An important finding was that all three consonant distinctions were discriminated relatively poorly, but some consonant distinctions were, evidently, discriminated better than others — see Table 2. Regarding the pairwise comparisons, a paired *t-test* found no difference between the [λ]-[3] and [3]-[j] distinctions ($t(9) = 0.32$; $p > 0.008$ [0.754]; Cohen's $d = 0.069$). After Bonferroni-correction of the alpha criteria ($0.05/6 = 0.008$), there were no significant differences between the [λ]-[3] and [λ]-[j] consonant distinctions ($t(9) = 3.16$; $p >$

0.008 [0.011]; Cohen's $d = 0.997$), nor between the [ʒ]-[j] and [ʎ]-[j] distinctions ($t(9) = 2.99$; $p > 0.008$ [0.014]; Cohen's $d = 1.191$). Thus, the Spanish-dominant listeners, as a group, discriminate all binary distinctions rather poorly. There might, however, be a marginal tendency for the [ʎ]-[j] consonant contrast to be particularly difficult for this group. As a group, these listeners are effectively at chance for the latter consonant distinction.

A second way in which the *contrast* by language *dominance* interaction of the omnibus ANOVA was explored is by examining the effects of language dominance as pairwise comparisons for each consonant distinction separately. The *alpha* criterion was Bonferroni-corrected for three pairwise comparisons ($0.05/3 = 0.016$). Two of the pairwise comparisons reached significance and one of them failed to do so, which explains the interaction in the omnibus ANOVA. Thus, there were significant effects of language dominance both for the [ʎ]-[ʒ] distinction ($t(9) = 8.68$; $p < 0.016$ [1.13e-05]; Cohen's $d = 3.123$) and the [ʒ]-[j] distinction ($t(9) = 7.77$; $p < 0.016$ [2.77e-05]; Cohen's $d = 2.836$), the contrasts that involve [ʒ]. The size of the effects is relatively large in both cases, but it appears to be slightly larger for the [ʎ]-[ʒ] than for the [ʒ]-[j] distinction. Importantly, the discrimination of the [ʎ]-[j] distinctions was poor for both groups of participants, and any (apparent, superficial) difference in the accuracy of the two groups disappears after Bonferroni-correction ($t(9) = 2.48$; $p > 0.016$ [0.034]; Cohen's $d = 0.991$), rendering any differences in their behavior effectively negligible. It appears, therefore, that, for both groups of listeners, the [ʎ]-[j] distinction is discriminated rather poorly.

In a final analysis, we explored the linear relation between arcsine-transformed accuracy responses and dominance profile as provided by the BLP questionnaire — i.e., the dominance score of each of the 20 individual participants. Three different least-squares linear regression models were fitted, one per experimental condition (phone distinction: [ʎ]-[ʒ], [ʒ]-[j], [ʎ]-[j]). Recall that, in this study, positive BLP scores indicate dominance in Spanish. The *alpha* criterion was Bonferroni-corrected ($0.05/3 = 0.016$). The model analyzing the [ʎ]-[ʒ] condition yielded a significant linear relation between perceptual accuracy and BLP scores ($F(1,18) = 31.62$, $p < 0.016$ [2.46e-05], $r^2 = 0.63$, $\text{coeff.} = -0.00251$, $t = -5.623$) so that, as BLP scores increased, accuracy decreased linearly. The model predicted 63% of the variance. For the [ʒ]-[j] condition, the corresponding linear model also found a significant relation between the two numeric variables ($F(1,18) = 20.83$, $p < 0.016$ [0.00024], $r^2 = 0.53$, $\text{coeff.} = -0.0018$, $t = -4.56$) so that, as BLP scores increased, accuracy decreased. This model predicted 53% of the variance. Finally, regarding the [ʎ]-[j] distinction, the corresponding model did *not* result in a significant finding ($F(1,18) = 5.039$, $p > 0.016$ [0.037], $r^2 = 0.21$, $\text{coeff.} = -0.0006$, $t = -2.24$); in other words, perceptual accuracy and BLP scores were not linearly related in the case of this phonetic distinction. (Note that, in addition to fitting linear models, we fitted quadratic models. The fit did not significantly improve in any case.) In sum, bilingual dominance scores were found to be linearly related with discrimination accuracy for the [ʎ]-[ʒ] and [ʒ]-[j] experimental conditions, but not for the [ʎ]-[j] condition. This fundamentally corroborates the findings of the factorial analyses reported above.

Discussion

Summary of findings

We hypothesized that bilingual language dominance would predict perceptual discrimination patterns of the Catalan /*ʎ*/-/ɜ/ contrast among speakers of Majorcan Catalan. Overall, Catalan-dominant listeners were more accurate in their discrimination of the phonetic distinctions examined in this study than Spanish-dominant listeners were. This difference, however, was modulated by the specific experimental conditions in the study. Firstly, the Catalan-dominant listeners were highly sensitive to the [*ʎ*]-[ɜ] binary distinction, which directly tested the /*ʎ*/-/ɜ/ phonemic contrast of Catalan, while the Spanish-dominant listeners were not. Secondly, the Catalan-dominant listeners were also accurate in their discrimination of the [ɜ]-[j] distinction, but Spanish-dominant ones were only slightly above chance. Thirdly, and rather surprisingly, neither the Spanish- nor the Catalan-dominant listeners were found to be accurate when discriminating the sounds involved in the [*ʎ*]-[j] distinction.

Interpretation and implications

The results of the study demonstrate that bilingual language dominance modulates the perceptual sensitivity of Majorcan Catalan speakers to the /*ʎ*/-/ɜ/ contrast. As a group, Spanish-dominant Catalan-Spanish bilinguals are less sensitive to this contrast than Catalan-dominant bilinguals are. This was examined directly in one of the experimental conditions in our study, the one that investigated the [*ʎ*]-[ɜ] distinction. These findings are consistent with comparable studies that have examined how Catalan-Spanish bilinguals perceive Catalan-specific phonemic contrasts, both on Majorca and in Barcelona (Amengual, 2016a, 2016b; Bosch et al., 2000; Mora & Nadeu, 2012; Navarra et al., 2005; Pallier et al., 1997; Sebastián-Gallés & Soto-Faraco, 1999; Simonet, 2014). These studies, among others, have been fundamental in articulating the scientific view that early linguistic experience is a decisive determinant of phonemic and phonetic learning (or lack thereof). According to this view, exposure to phonetic categories (or contrasts) occurring after the offset of a sensitive period shall lead to robust learning only sporadically, and is most likely to lead to “failure” (Pallier et al., 1997; Sebastián-Gallés & Soto-Faraco, 1999). To the extent that our results could be predicted from the lessons learned by prior, related investigations with the Catalan-Spanish contact community, they corroborate (or are in line with) the conclusions put forward in those studies. However, since, in our study, Catalan- and Spanish-dominant participants differed not only in terms of their linguistic histories — their experiences in infancy — but also in their patterns of language use as adults and in their self-assessed proficiencies, it remains to be seen whether the existence of a sensitive period during childhood, *as opposed to* the cumulative effects of language experience, is the single best predictor of phonetic development (Mora & Nadeu, 2012).

We noted that the data for Barcelona seemed to be more conclusive than that for Majorca — recall, for instance, the diverging findings in Amengual (2016a) and Simonet (2011) with respect to how Spanish-dominant speakers on Majorca produce the sounds involved in the Catalan /o/-/ɔ/ contrast. One possibility is that the mid-vowel contrasts of Catalan, which constitute the basis of most studies on this issue, are easier to learn on Majorca than they are in Barcelona due to the fact that the vowels involved in the contrast are acoustically more distinct in Majorcan Catalan than they are in Catalan of Barcelona (Daniel Recasens & Espinosa, 2006), or perhaps the contrast is lexically more robust on Majorca than it is in the mainland (Nadeu & Renwick, 2016). The findings of the present study are in line with those from Barcelona: Regarding Catalan-Spanish bilinguals, linguistic experience *is* a strong predictor of perceptual sensitivity to language-specific contrasts. There seems to be no reason, therefore, to postulate that Spanish-dominant bilinguals are more likely to learn the contrasts specific to Catalan on Majorca than they are to do so in Barcelona (perhaps due to a constellation of unknown sociolinguistic factors). It would appear that the mid-vowel contrasts in particular *may be* easier to learn on Majorca than they are in Barcelona (Amengual, 2016a), but that, when other Catalan-specific contrasts are examined, the findings are fundamentally the same for both Catalan-Spanish contact locations (Sebastián-Gallés & Soto-Faraco, 1999).

In addition to examining the /ʎ/-/ʒ/ contrast by means of assessing the perceptual discrimination of bilinguals to the [ʎ]-[ʒ] distinction, we examined their sensitivity to two additional phonetic differences, the [ʎ]-[j] and [ʒ]-[j] distinctions. As mentioned above, these distinctions were not explored as involving a phonemic contrast because [j] would appear, in all cases, in /ʎ/- or /ʒ/-words, never in /j/-words. Let us first discuss the findings relative to the [ʒ]-[j] distinction: The results show that Catalan-dominant listeners are able to discriminate between these two sounds with a high degree of accuracy, while the Spanish-dominant listeners are not. Together with the results for the [ʎ]-[ʒ] distinction, these results suggest that Catalan-dominant bilinguals are sensitive to any phone distinctions involving the palatoalveolar fricative, [ʒ]. It would seem that this phonetic category is part of their phonological (mnemonic) representation. For the Spanish-dominant bilinguals, on the other hand, these findings suggest that [ʒ] is not accurately discriminated from any other neighboring Catalan (or Spanish, for that matter) palatal sound. We surmise that, in the phonological systems of Spanish-dominant bilinguals, [ʒ] is not represented as a sound distinct from neither [ʎ] nor [j]. Since the Spanish dialect spoken on Majorca does not possess /ʒ/, it appears that Spanish-dominant speakers of Catalan equate Catalan [ʒ] with Spanish [j].

The results for the remaining phonetic distinction, [ʎ]-[j], are particularly puzzling. The finding was that *both* the Catalan- and the Spanish-dominant listeners had difficulties discriminating this phonetic distinction. The fact that Spanish-dominant listeners were relatively insensitive to this phonetic distinction is not surprising given the findings pertaining to the other two distinctions investigated in this study. The fact that Catalan-dominant bilinguals had difficulties with this distinction *is* somewhat surprising. One possibility is that discriminating between the sounds in this

pairwise distinction ([ʎ]-[j]) is very difficult overall (across language backgrounds), perhaps due to extreme acoustic similarity between these two sounds. Consider, however, the following: Santos Oliveira et al. (2016) investigated the perceptual discrimination of Portuguese /ʎ/ by native and nonnative speakers of the language. (The lateral palatal, /ʎ/, is phonemic in Portuguese, as it is in Catalan.) Among other distinctions, Santos Oliveira and colleagues tested the discrimination of the [ʎ]-[j] distinction in a word in which Portuguese has /ʎ/, *olho* [ˈɔʎu] ‘eye’, thus exploring whether listeners could discriminate between [ˈɔʎu] and [ˈɔju] (this is akin to our design). With an AXB paradigm similar to ours, these authors found that native Portuguese listeners were sensitive to this phonetic distinction — accuracy rates were very high. The results of Santos Oliveira et al. (2016) suggest that speakers of a language that possesses /ʎ/ in its phonemic inventory can discriminate [ʎ] from [j] with a high degree of accuracy. The Catalan-dominant data in our study are, therefore, not in line with the Portuguese data discussed in Santos Oliveira (2016). It would seem that the phonological representation of Catalan /ʎ/ of our Catalan-dominant participants includes both [ʎ] and [j].

It seems that our Catalan-dominant listeners have accurate representations of /ɜ/ (as [ɜ]), and they can distinguish [ɜ] from both [ʎ] and [j]. The evidence is not conclusive in terms of their representation of /ʎ/ (as [ʎ]). There may be a pattern of asymmetry according to which, with respect to the /ʎ/-/ɜ/ contrast, /ɜ/ is more robustly (concretely) represented than /ʎ/. Asymmetrical representations of the sounds involved in phonemic contrasts have been reported in prior studies (Barrios, Jiang, & Idsardi, 2016; Cutler, Weber, & Otake, 2006; Darcy, Daidone, & Kojima, 2013; Weber & Cutler, 2004), including for the Catalan-Spanish contact community (Larsson, Constán, Sebastián-Gallés, & Deco, 2008; Núria Sebastián-Gallés, Echeverría, & Bosch, 2005; Núria Sebastián-Gallés, Vera-Constán, Larsson, Costa, & Deco, 2009). For instance, Sebastián-Gallés et al. (2005) tested Catalan-Spanish bilinguals on a lexical decision task in which half of the Catalan stimuli in the experiment were nonwords created by switching the quality of one vowel: /e/-words turned into nonwords by changing [e] to [ɛ] (*fin[e]stra* ‘window’ incorrectly produced as *fin[ɛ]stra*), and /ɛ/-words turned into nonwords by changing [ɛ] to [e] (*gall[ɛ]da* ‘bucket’ incorrectly produced as *gall[e]da*). Spanish-dominant participants did not detect these differences with any systematicity, while Catalan-dominant participants did (as anticipated). Interestingly, however, Catalan-dominant listeners were more likely to detect a nonword if it was an /e/-word turned into a nonword by changing [e] to [ɛ] than they were to detect cases in which /ɛ/-words turned into nonwords by changing [ɛ] to [e]. In other words, it would appear that their /ɛ/-words can include both [ɛ] and [e] — /ɛ/-words have fuzzier phonological representations. The authors attribute these findings to the fact that Catalan-dominant speakers in Barcelona are heavily exposed to a bilingual environment where mispronunciations by Spanish-dominant bilinguals using [e] in the place of /ɛ/ (but never [ɛ] in the place of /e/, as [e] is a vowel of Spanish and [ɛ] is not) abound. While this argument is certainly compelling, one must note that the ecological evidence necessary to support this view has not yet been presented.

Catalan-dominant (but, obviously, not Spanish-dominant) bilinguals may possess detailed phonological representations of the words in the /**3**/ set, and a detailed phonetic representation of this category as [b]. Words in the /**Λ**/ set, on the other hand, may have fuzzier phonological representations. Even in the phonologies of Catalan-dominant bilinguals, /**Λ**-words may be variably represented with [Λ] or [j] or both (but likely not [b]). It is possible that the delateralization of /**Λ**/ is so extended in Majorcan Catalan, perhaps even amongst Catalan-dominant bilinguals, that [j] is now the most common rendering of /**Λ**/ in Majorcan Catalan (but perhaps mostly among the younger speakers). Recall, for instance, that Segura (2003) shows this to be the case in the Baix Vinalopó, in Alacant (Alicante). If pronouncing /**Λ**/ as [Λ] is no longer an index of dominance in Catalan on Majorca, perhaps pronouncing /**Λ**/ as [j] is now the default “norm”. If this were the case, the present perception findings would not be surprising: If Catalan-dominant listeners are consistently exposed to delateralized /**Λ**/ (perhaps even in the speech of other Catalan-dominant ones), sensitivity to the [Λ]-[j] distinction would be handicapped. This would explain the asymmetry in the perception of the sounds involved in the /**3**/-/**Λ**/ contrast. We acknowledge, however, that, for Majorca, no variationist, ecologically-valid data have yet been presented to support this view. Future sociophonetic research should address this issue, and this could lead us to revise our current proposal. For now, following the findings in our study, we are willing to speculate that a hypothetical variationist study of /**Λ**/ would find that its rendering as [j] is largely abundant on Majorca, and that this pronunciation is common amongst both the Spanish- and the Catalan-dominant communities of speakers.

Conclusion

This study reported on the results of a perception experiment on the Majorcan Catalan /**Λ**/-/**3**/ contrast. The results indicated that, whereas Spanish-dominant bilinguals did not discriminate any of the three pairings in any robust manner, Catalan-dominant bilinguals discriminated the pairings containing [b] ([Λ]-[b] and [b]-[j]) robustly. This confirmed our hypothesis that bilingual language dominance modulates the perceptual discrimination of the sounds involved in the /**Λ**/-/**3**/ contrast. Additionally, our results showed that all bilingual participants, including the Catalan-dominant ones, found the [Λ]-[j] to be very difficult to discriminate. For the Catalan-dominant listeners, this is suggestive of an asymmetry in the phonological representation of the sounds involved in the /**Λ**/-/**3**/ contrast. We surmise that, whereas Catalan-dominant speakers possess a detailed phonological representation of /**3**/ (as [b]), their representation of /**Λ**/ is fuzzier, including renderings such as [Λ] and [j]. The Spanish-dominant representations of both /**Λ**/ and /**3**/ are symmetrically fuzzy.

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Table 1. Means (and standard deviations) of the bilingual language profile (BLP) data for the two groups of participants, the Catalan-dominant (CD) and the Spanish-dominant (SD) groups.

Group		Age	History		Use		Proficiency		Attitudes		Score
			Cat.	Span.	Cat.	Span.	Cat.	Span.	Cat.	Span.	
CD	M	27.2	46.3	36	38.9	13.6	53.2	51.9	50.2	35.6	-50.2
	std.d.	3.5	3.4	11.1	10.4	10.2	1.3	2.5	8.3	14.4	44.2
SD	M	27.9	31.5	48.8	4.3	49.4	41.7	52.8	30.6	52.4	95.4
	std.d.	2.7	8.7	1.8	4.5	4.7	4.8	1.9	16.3	2	32.9

Table 2. Mean (and standard deviations) proportion-correct scores as a function of consonant contrast ([ʎ]-[j], [ʒ]-[j], [ʎ]-[ʒ]), gender of the listener, and language-dominance group (Catalan-dominant, Spanish-dominant).

Conditions		Catalan-dominant			Spanish-dominant		
		females	males	all	females	males	all
[ʎ]-[ʒ]	M	0.95	0.92	0.94	0.74	0.51	0.63
	std.d.	0.03	0.06	0.05	0.07	0.03	0.13
[ʒ]-[j]	M	0.89	0.87	0.88	0.68	0.56	0.62
	std.d.	0.08	0.08	0.08	0.08	0.03	0.09
[ʎ]-[j]	M	0.62	0.64	0.63	0.56	0.48	0.52
	std.d.	0.15	0.11	0.12	0.08	0.04	0.07