

# THE ACOUSTIC REALIZATION OF THE /a/-/ə/ ALTERNATION IN MAJORCAN CATALAN

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## ABSTRACT

This study examines the acoustic realization of the Catalan /a/-/ə/ alternation as a function of lexical stress together with the production of the Majorcan Catalan stressed /ə/ by 30 Spanish-dominant and 30 Catalan-dominant early Spanish-Catalan bilinguals in Majorca (Spain). The acoustic analyses show that there are no differences between language dominance groups in the implementation of the phonological Catalan vowel reduction rule: both groups consistently produced /a/ as a central mid-vowel [ə] in unstressed position. The analysis of Majorcan stressed /ə/ revealed that both groups differed in their phonetic behavior: the stressed /ə/ of Spanish-dominants was realized with a higher F2, approximating the front mid-vowel acoustic region. A closer analysis of the individual data confirms that the degree of language dominance plays a significant role in the production of this dialectal feature.

**Keywords:** schwa, vowel reduction, bilingualism, language dominance

## 1. INTRODUCTION

Schwa [ə] is often characterized as a weak or reduced vowel commonly restricted to unstressed syllables due to a process of vowel reduction [21]. Even though this weakening process has been well documented from a theoretical approach in many languages, including English [10], Dutch [9], Southern Italian dialects [19], and Catalan [1, 6, 20, 31], much less attention has been devoted to the phonetic characteristics of this mid central vowel [14], particularly in the speech of bilingual speakers whose first and second language sound systems frequently interact [13].

Spanish has five vowel phonemes (/i e a o u/) whereas Standard Catalan has seven (/i e ε a o ɔ u/). These vowels are contrastive only in stressed syllables. Catalan also has a phonological rule of unstressed vowel reduction. Whereas /i/, /u/ and /o/ are maintained in unstressed position, all other vowels change when unstressed: /e/, /ε/ and /a/ are reduced to [ə], and /ɔ/ is reduced to /o/. In marked contrast to Catalan, Spanish does not present a similar process of vowel reduction. Therefore, in

Spanish /a/ and /e/ surface as [a] and [e] in both stressed and unstressed syllables, while in Catalan, /a/ and /e/ systematically alternate with [ə] as a function of lexical stress.

In contrast to other Catalan dialects, Majorcan Catalan has been characterized as having an additional vowel phoneme /ə/, which appears in both stressed and unstressed position, raising the number of vowel phonemes to eight [16, 24, 26]. This phoneme, exclusive to the Catalan varieties spoken in the Balearic Islands, corresponds to /ε/ in Central Catalan [25]. In particular, stressed /ə/ has been described as being targetless or specified for a widely defined mid central target [24], and allows differentiating minimal triplets with the mid-front vowels (e.g. /deu/ ‘God’, /deu/ ‘ten’, and /dəu/ ‘he/she owes’).

In order to sound native-like, Spanish-Catalan bilinguals must be able to produce the Catalan phonemic contrast between /a/ and /ə/ and learn the phonological rule that creates the [a]-[ə] alternation, but previous studies report that the use of schwa has been steadily decreasing in the last forty years, particularly in the Catalan spoken in Barcelona [22, 23, 30]. Even though the substitution of /ə/ for /a/ in unstressed position has been attributed to the influence of Spanish [11, 12, 17, 18, 26], the degree of cross-linguistic influence from Spanish and, more specifically, the effects of language dominance in the productions of these bilinguals still remains to be investigated. Furthermore, little is known about the role of language dominance in the production of non-standard Majorcan Catalan stressed /ə/.

The present study analyzes the acoustic realization of the Catalan /a/-/ə/ alternation, and Majorcan stressed /ə/ by 60 early and highly proficient Spanish-Catalan bilinguals from Majorca (Spain) along a continuum of language dominance. The goal of this study is to address the following questions: (1) Do Spanish-Catalan bilinguals in Majorca produce /a/ as a reduced, centralized [ə] in unstressed position? (2) Does language dominance affect the acoustic realization of the [a]-[ə] alternation? And (3) Are there acoustic differences based on language dominance in the production of Majorcan Catalan stressed [ə]?

## 2. METHOD

### 2.1. Participants

Sixty Spanish-Catalan bilinguals (33 females) born, raised, and educated exclusively in Majorca were recruited to participate in the study. Their ages ranged from 18 to 36 (M=21.5, SD=3.79). Participants reported having extensive exposure to both languages on a daily basis, using Catalan and/or Spanish in the household, being educated in Catalan, and not being native in any other language. All participants reported normal speech and hearing and normal or corrected to normal vision, and received a stipend for their participation in the study.

Each participant completed the Bilingual Language Profile (BLP) questionnaire [8]. The BLP is an instrument for assessing language dominance through self-reports and it produces a continuous dominance score and a general bilingual profile taking into account multiple dimensions: language history, language use, language proficiency, and language attitudes. For more information on the BLP, see [15]. The responses to the questionnaire generated a language particular score for each module and a global score for each language. The point system was converted to a scale score with the Catalan score subtracted from the Spanish score. Dominance scores ranged from -117 (strongly Spanish-dominant) to 133 (strongly Catalan-dominant). Participants with negative points were classified as Spanish-dominant (N=30) while participants with positive points were classified as Catalan-dominant (N=30).




### 2.2. Materials

The productions of the target Catalan /a/ in stressed position and the reduced [ə] in unstressed position were elicited in a picture-naming task. Pictorial representations of 20 experimental items that represented non-ambiguous objects were selected instead of the written form to avoid orthographic effects. The selected words were cognates in Catalan and Spanish. There is ample evidence suggesting a special relationship between cognates in the bilingual lexicon showing that cognates enhance the acoustic similarities of linked phonetic categories in bilingual speech [3]. Based on this, it was predicted that there would be a greater tendency in unstressed syllables containing an orthographic <a> to produce [a] instead of a [ə] in words that are cognates, as /a/ is the matching vowel in Spanish.

In order to elicit the Majorcan Catalan stressed /ə/, the stimuli were designed to consist of the diminutive forms of the original 20 experimental items. For instance, *caixa* /'kafə/ 'box' appeared

alongside *caixeta* /kə'fətə/ 'little box'. In these cases, unstressed /ə/ in the last syllable becomes a stressed /ə/ when the Catalan suffix *-et/eta* is added to the root of the noun. This vowel that orthographically appears as <e> is produced as [ɛ] in Central Catalan but surfaces as stressed [ə] in most varieties of Majorcan Catalan. In these dialects, this alternation is systematic and exceptionless. Each experimental item contained an /a/ in stressed position as well as at least one unstressed /ə/, whereas the diminutive varied in the number of unstressed /ə/ but elicited a stressed /ə/. A sample of the experimental items in the production task is presented in Table 1.

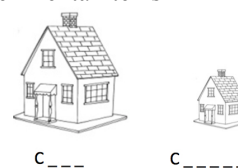
**Table 1:** Sample stimuli from the production task

Word	Diminutive	English	Picture
Rata /'ratə/	Rateta /rə'tətə/	Rat	
Barba /'barbə/	Barbeta /bər'bətə/	Beard	
Campana /kəm'panə/	Campaneta /kəmpə'nətə/	Bell	

### 2.3. Recording procedure

The experiment was conducted individually in a quiet room with participants comfortably seated in front of a computer display. Participants were presented with pictures and asked to name the target items by embedding them in a carrier phrase, *Diuen targetword sempre* '(They) say *targetword* always'. There were a total of 40 target items, and because each combination of word and diminutive was presented in two possible orders (word-diminutive or diminutive-word) there were a total of 160 experimental items. The set of stimuli was presented in randomized order and each picture appeared on a computer screen for five seconds together with the first letter of the target word (Figure 1).

**Figure 1:** Sample of visual stimuli presented to elicit the experimental items



The speech samples were recorded using a head-mounted microphone (Shure SM10A) and a solid-state digital recorder (Marantz PMD660), digitized (44kHz, 16 bit quantization), and computer-edited for subsequent acoustic analysis. Each participant

produced 388 target vowels. Fifteen tokens were excluded due to mispronunciations or recording errors, resulting in a total of 23,265 tokens.

## 2.4. Acoustic analysis

Vowels were segmented using synchronized waveform and spectrographic displays in Praat. Formant trajectories, especially the trajectory of the second formant (F2), as well as intensity displays, were taken as indicators of vowel onsets and offsets. Vowel formant measurements (F0, F1, F2) were automatically extracted at the center of the steady-state period of the vowel. Formant tracks were calculated with the Burg algorithm as implemented in the Praat program. The effective window length for the calculation was set at 25ms, and was maintained across tokens and speakers. The maximum number of formants to be located by the formant tracker was always five, and the ceiling was set at 5.0 kHz for males and 5.5 kHz for females. These gender-specific formant ceilings reflect the different average vocal tract lengths of men versus women and were deemed appropriate after visual inspection of the sound files. Formant values were extracted in Hertz and were further converted to Bark [29, 32]. In order to minimize physiological inter-speaker variation, a vowel-intrinsic bark distance normalization procedure was applied where B1 minus B0 (B1-B0) represented vowel height, and B2 minus B1 (B2-B1) degree of vowel frontedness/backness [7, 28].

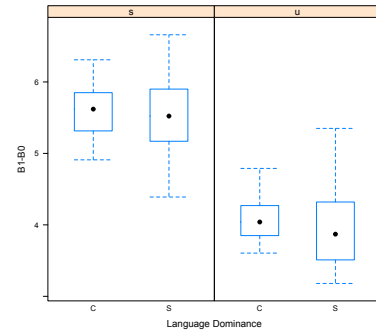
## 3. RESULTS

The normalized vowel data were analyzed through repeated-measures ANOVAs with group (Spanish-dominant, Catalan-dominant) as the between-subjects factor and vowel (stressed /a/, unstressed /ə/, stressed /ə/) as the within-subjects factor. Individual speaker was the error term. The analysis of the height dimension (B1-B0) yielded a main effect of *vowel* ( $F(2,114) = 371.7, p < 0.001$ ) but not a significant effect of *language dominance* ( $F(1,57) = 0.95, n.s.$ ), and no significant interaction between *vowel* and *language dominance* ( $F(1,57) = 0.01, n.s.$ ).

The repeated measures ANOVA with the B2-B1 data as the dependent variable revealed a significant effect of *vowel* ( $F(2,114) = 549.5, p < 0.001$ ) but also a significant effect of *language dominance* ( $F(1,57) = 11.2, p < 0.01$ ), and a significant interaction between *vowel* and *language dominance* ( $F(2,114) = 31.2, p < 0.001$ ). In order to explore the interaction, the main effects of language dominance were investigated for each vowel separately. Bonferroni-corrected pairwise comparisons yielded significant differences between Catalan-dominants

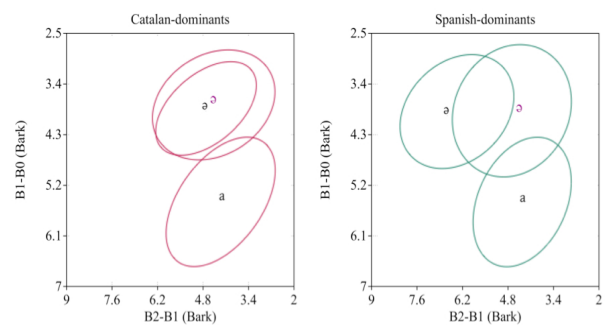
and Spanish-dominants only in the stressed /ə/ (diff.=-1.08,  $t(47) = -6.91, p < 0.001$ ) and there were no significant differences in vowel frontedness for stressed /a/ (diff.=0.01,  $t(54) = 0.05, n.s.$ ) or unstressed /ə/ (diff.=-0.01,  $t(54) = 0.04, n.s.$ ). Both groups produced /a/ as a central mid-vowel [ə] in unstressed position (Figure 2).

**Figure 2:** B1-B0 values in the production of Catalan stressed /a/ (“s”) and unstressed /ə/ (“u”) as a function of language dominance



Majorcan stressed /ə/ showed a different pattern. Even though Spanish-dominants’ productions of stressed [ə] were found not to differ from the Catalan-dominants in terms of vowel height, overall they produced these vowels with a higher F2 than their Catalan-dominant counterparts. Figure 3 shows that in comparison to Catalan-dominants, Spanish-dominants produce the Majorcan Catalan stressed /ə/ in a more fronted position, as an /ε/-like vowel.

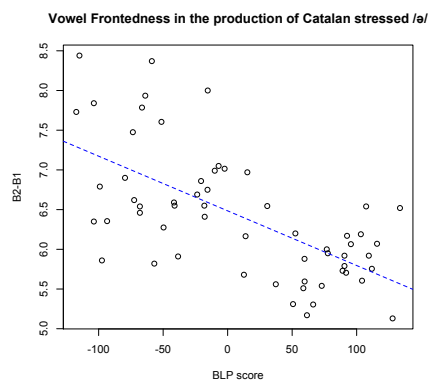
**Figure 3:** Mean acoustic values of /a/, and /ə/ produced in stressed (black) and unstressed (red) position by Catalan-dominant (left) and Spanish-dominants (right). Ellipses enclose 2 SD



In order to gain more insight into the individual variation of the data, the average frontedness values (B2-B1) of stressed /ə/ was calculated for each individual participant. Individual B2-B1 values were correlated with the participant’s language dominance score as reported in the BLP. The correlations between BLP score and vowel frontedness in the production of stressed /ə/ provided a significant correlation ( $n=60, df=58, r=.62, R^2=.40, p < 0.001$ ). As shown in Figure 4, the Bark values are overall

higher for Spanish-dominants (i.e., individuals with a negative BLP score) than Catalan-dominants (i.e., individuals with a positive BLP score). This pattern confirms that the degree of language dominance plays a significant role in the acoustic realization of the stressed /ə/ by these Majorcan Spanish-Catalan bilinguals.

**Figure 4:** Individual values (B2-B1) in the production of Majorcan Catalan stressed /ə/ plotted as a function of a speaker's BLP score. Fitted line for all participants



#### 4. DISCUSSION AND CONCLUSIONS

The present study has reported on the results of a production experiment set out to examine the effects of language dominance on the acoustic realization of the /a/-/ə/ alternation and stressed /ə/, a dialectal feature of Majorcan (Balearic) Catalan, by 60 early Spanish-Catalan bilinguals in Majorca (Spain).

Regarding the process of vowel reduction that creates the /a/-/ə/ alternation, this study found that both Spanish-dominants and Catalan-dominants systematically produced /a/ as a reduced, centralized [ə] in unstressed position, contrary to previous results in Barcelona, [30, 22, 23]. These findings suggest that even Spanish-dominants in Majorca are not replacing unstressed [ə] with /a/. A review of the literature indicates that the target-like production of unstressed [ə] and the mid-vowel contrasts /e/-/ɛ/ and /o/-/ɔ/ is disappearing in the speech of the younger generations in Barcelona, particularly in districts with a strong presence of Spanish [11, 12, 17, 18, 26]. Recent studies in Majorca, however, have shown that these bilinguals are maintaining robust mid-vowel contrasts in their Catalan productions [4, 5]. This study presents further evidence of differences between the Catalan vowel systems of Barcelona and Majorca also with respect to the production of the /a/-/ə/ alternation.

With respect to the acoustic realization of Majorcan Catalan stressed /ə/, this study found differences between the language dominance groups. Catalan-dominants produced a central mid-vowel

that was not acoustically different from the centralized reduced [ə] in unstressed position, but Spanish-dominants produced a mid-vowel with a higher F2, acoustically in a more fronted position. Further analysis of individual data revealed great variation of stressed /ə/ across speakers, with the most extremely Spanish-dominants producing a more fronted mid-vowel instead of the mid central target produced by Catalan-dominants.

Recasens & Espinosa [27] report high contextual variability of Majorcan stressed and unstressed /ə/. In unstressed position, such variability can be accounted for in terms of coarticulatory effects due to the vowel being shorter than other vowels. As a result the articulation of this central vowel is susceptible to undershoot (i.e., assimilation to its context). In contrast to the unstressed reduced [ə], the duration of stressed /ə/ is comparable to other stressed vowels (i.e., /a/) so it is unlikely that undershoot can account for why Spanish-dominants are producing a more fronted vowel, acoustically more similar to the Standard Catalan /ɛ/.

There is increasing evidence that maintenance of Catalan-specific vowels in Barcelona is closely related to the region, district, and social network of the speakers [11, 18]. Based on the information from the BLP it was found that those Spanish-dominants who produced a fronted mid-vowel instead of the Majorcan-specific central /ə/ reported an exclusive use of Spanish at home and a more restricted and limited use of Catalan on a daily basis. If these Spanish-dominant bilinguals were receiving highly variable and inconsistent Catalan input (i.e., Spanish-accented Catalan), it would be expected that in addition to having difficulties pronouncing stressed /ə/, they would also be prone to producing /a/ instead of [ə] in unstressed position.

A possible interpretation of the findings on stressed /ə/ is that in addition to differences in their language dominance and use, these bilinguals vary by their personal identification with Majorcan cultural autonomy and a separate, Majorcan linguistic identity [2]. As such, the productions of Spanish-dominant bilinguals who do not use much Catalan in their daily life would not be a result of cross-linguistic influence from Spanish but rather a construction of socio-indexical phonological categories based on a stronger identification with the prestigious Standard Catalan variety. These results point to the need for more research on the standard and regional varieties of Catalan that coexist in Majorca by incorporating sociolinguistic variables to account for why some speakers are appropriating the Standard (Central) Catalan seven-vowel system instead of the eight vowels of the local dialect.

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