
The effect of initial-prosodic boundary on vowel apertures in Galician

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Introduction
There is a recent change in the Galician prothetic vowel system. This change is characterized by the adaptation of the mid-prothetic vowels (in word initial non-onset syllable) as mid-open vowels, which contrast to the traditional mid-closed vowels in such position (Veiga, 1976). Despite the fact that there are some studies in which this change is described (Santamarina, 1972; Taboada, 1979; Porto Dapena, 1977; Reguina 2003), no many provide research on the reasons for this change, neither on the acoustic nature of this "new" vowel system. In addition, it seems like this variability is also perceived by speakers. They reveal having a certain degree of uncertainty in their production of prothetic vowels, especially when occurring in words which are newly introduced in Galician.

This behavior diverge from the confidence they have with respect to the opening of stressed vowels, where there is a clear opposition between mid-open and mid-closed vowels. This perception from Galician speakers leads us to consider the possibility that the production of initial vowels could vary depending on prosodic content, and particularly that this change could be triggered by the position of the vowel in an initial prosodic boundary. This idea has its basis in a study made by Fougeron & Keating (1995, 1996b) that examine the strengthening in the articulation of vowels in different domains on the prosodic hierarchy.

The hypothesis we propose is that the aforementioned change can be triggered by a prosodic strengthening. This is more specifically an articulatory strengthening in initial prosodic boundary, since, following the idea presented by Fougeron & Keating, this could benefit the strengthening of the syllable and, consequently, the aperture of the vowel.

If our hypothesis is confirmed, we could accept that the position of the vocalic segment on the prosodic domain is an influential factor in the variability of the vowels when they are in the initial-boundary on the pertinent domain.

Methodology
In order to verify our hypothesis a production experiment with 8 native female speakers of Galician has been carried out. Speakers were asked to read a sort of 50 statements where vocalic segment were in initial-boundary position in the different hierarchical prosodic domains. We take into account both mid-open and mid-closed front and back vowels of Galician (/i/, /e/, /a/, /o/).

We considered the four different domains whose existence is attested in Galician (Fernández Reis 2002): Phonological Utterance (U), Intonation Phrase (I), Phonological Phrase (P) and Phonological Word (W), both in weak and strong positions.

### Boundary prosodic domain

<table>
<thead>
<tr>
<th>Boundary prosodic domain</th>
<th>Example of statement</th>
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<tbody>
<tr>
<td>Phonological Utterance-Initial</td>
<td>[Dime que queres] [la desea]</td>
</tr>
<tr>
<td>Phonological Intonation Phrase-Initial</td>
<td>[Dime que te] [la desea]</td>
</tr>
<tr>
<td>Phonological Phrase-Initial</td>
<td>[Dime a Maria] [la desea]</td>
</tr>
<tr>
<td>Phonological Word-Initial</td>
<td>[Dime a Maria] [la desea]</td>
</tr>
</tbody>
</table>

Table 1. Examples of the statements used for the elicitation corpus

Each statement should be read three times by speaker, although some speakers refuse doing all repetitions. There were 1014 sentences in total, but we had to exclude 42 of them because of wrong production (of the expected prosodic boundaries). Thus, the amount of sentences analyzed was 972.

Those vocalic segments were acoustically analyzed, considering F1 and F2 for each vowel, as they are assumed to be the correlates of vowel quality. This allows us to look at the aperture of vowels objectively, and to verify if there is variability due to the initial-boundary position of the vowel on the hierarchy.

All vowels were segmented manually looking at the spectrogram. Formant values and duration were taken from the middle of the vowel, using a script made with that uses the Burg algorithm implemented in Praat.

In order to test our hypothesis a OLM-Multivariate analysis was made for each vowel, to testing the effects of boundary prosodic domain (U, I, P and W) and subject (8 speakers) on the three variables studied: F1 and F2.

Results
The following graphs show means and deviations of F1 and F2 for the four vowels in every prosodic domain. As we can see, there is much more variation of F1 for mid-open vowels /i/ (purple boxplot) and /o/ (red boxplot), as opposed to mid-closed vowels /e/ and /a/.

The analysis for the back mid-closed vowel /e/ shows a significant effect (sig. < 0.05) of both type boundary and speaker for F1 and F2. Between this, interaction between domain and speaker was no significative effect. Tukey post hoc comparisons, with critical significance at p < 0.05, reveal an increase of F1 in Utterance-initial position, and a decrease of F2 in Utterance and Intonation Phrase-Initial position.

For the back mid-closed vowel /a/, there is also a significative effect (sig. < 0.05) of prosodic domain and speaker. In this case we found a significative effect for the interaction between domain and speaker for F1. Post-hoc test indicates a decrease of F1 in Phonological Phrase Initial position and a rise in Utterance and Phonological Word Initial position. Considering F2 a significative decrease is found in Utterance-initial position while there is an increase in Phonological Phrase and Phonological Word Initial position.

The results reveal that there is a different behaviour between back mid-open vowels and back mid-closed vowels when variation is due to the effect of the initial-boundary prosodic domain.

The analysis for the mid-open vowel /i/ we found a significative effect of speaker for the two dimensions (F1 and F2) and a significative effect of prosodic domain for the F2 (sig. < 0.05). Interaction between domain and speaker was found only for F1. As we could see, there was no effect of any factor for F1, so we didn’t take the effect of the interaction into account. Post-hoc analysis indicate that there is an decrease for F2 in Phonological Phrase-Initial boundary.

For the mid-open vowel /o/ we found an effect of the prosodic domain and speaker for F1 and F2 (sig. < 0.05), while there is not effect of the interaction between domain and speaker. Post-hoc analysis indicate a decrease of F1 in Phonological Phrase. For F2 there is a decrease in Phonological Phrase , whereas a rise for Intonation Phrase and Utterance-Initial positions.

Conclusion
The aim of this approximation was to investigate whether initial-boundary prosodic position was a factor related to the variation existing in prothetic mid-vowels of Galician, and how is the behaviour for each vowel in every initial-boundary prosodic domain.

The results obtained allow us to confirm that they are differences between formant values (F1 and F2) in each vowel related to the position on the prosodic hierarchy, even thought the direction of prosodic domain for changes in F2 is similar for each pair. Despite the differences between speakers, we can assume that there is a decrease of aperture for mid-open vowels /i/ and /o/ in Phonological Phrase position, since F1 values decrease in this position. In the other hand, there is a strengthening of the mid-closed quality of /e/ in Utterance-Initial position.

Nevertheless, this study is just a first aproachment, and it become essential some new research, for taking into account duration of segments –since duration can be related to vowel quality-, or making experimental designs where every vowels were tested.

References
Taboada, M. (1972) El habla del Val de Ferrol, Verba, ano 11, Universidade de Santiago de Compostela