# PARADIGM EFFECTS AND FUZZY CONTRASTS IN SPANISH SYLLABIFICATION

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## ABSTRACT

Although the syllabification of sequences of two vocoids in Spanish is generally predictable from vowel height and stress, there are exceptions to the general rules. There is also variation among speakers in this respect, so that this is a 'fuzzy' contrast. Here we report on an experiment on the production of this contrast, analyzing data from a much larger number of participants than in all previous work on this topic (n=37). Results show that the vowel sequence in words with a predicted exceptional hiatus /i.á/ (as in e.g. *enviamos* 'we send') differs significantly from the diphthong /já/ (as in e.g. *saciamos* 'we satiate') both in duration and in formant trajectories. Speaker's intuitions regarding exceptional syllabification in hiatus were particularly consistent in verbal forms, which we explain as resulting from a paradigm effect. Although we conducted our experiment in a Spanish-Basque bilingual town, there were no effects of language dominance.

**Keywords**: syllables, hiatus, diphthongs, Spanish, fuzzy contrasts

## 1. INTRODUCTION

In Spanish a sequence of two different vocoids may be produced either as tautosyllabic, that is, a diphthong, or as heterosyllabic, in hiatus. Whether there is a diphthong or a hiatus is generally predictable from the rules in Table 1[1, 9, 13]. (In our transcriptions, instead of placing a stress mark preceding the stressed syllable, we use an acute accent on the stressed vowel, since this makes the nature of the contrast easier to interpret):

**Table 1**. Syllabification of vowel sequences

a. Hiatus if neither vowel is high; e.g. *teatro* /te.á.tro/ 'theater', *maestro* /ma.és.tro/ 'teacher', *león* /le.ón/ 'lion'.

b. Hiatus if one of the vowels is high and bears word-stress; e.g. *María* /ma.rí.a/.

c. Otherwise, diphthong. e.g. *feria* /fé.rja/ 'fair', *fiesta* /fjés.ta/ 'feast'.

Although the complementary distribution of hiatus and diphthong configurations in Table 1 generally applies, the facts are complicated in some Spanish varieties by the existence of lexical exceptions to (c). We will refer to words that are an exception to (1c) as containing an exceptional hiatus.

Exceptional hiatus is found almost exclusively in rising-sonority sequences like /ia/, and particularly when word-stress falls on the second vowel of the sequence. In some cases, the exceptional syllabification of a vowel sequence in hiatus may be attributed to paradigm effects or the presence of morphological boundaries, but there are also seemingly random exceptions. Thus, whereas, for instance, *viaje* /bjá.xe/ contains a diphthong according to the general syllabification rules, for some speakers, the word *diablo* /di.á.blo/ 'devil' contains an exceptional hiatus instead [9]. Similarly, *el piano* /el.pi.á.no/ 'the piano' is a lexical exception to (c) in Table 1 and contrasts with *Ulpiano* /ul.pjá.no/ 'a name' for some speakers [12]. A considerable amount of variation has been reported in speakers' intuitions regarding the distribution of exceptional hiatus [4, 10, 19] and there are no minimal pairs, involving sequences such as /já/ vs /i.á/ (the only minimal pair for any other sequence of this type is /pjé/ 'foot' vs /pi.é/ 'I chirped' [9]. The situation may be described as a marginal, fuzzy or quasi-phonemic contrast [8, 17]. The situation is complicated by the fact that exceptional hiatus words also allow reduction to diphthong. Crucially, diphthong words, instead, do not allow a heterosyllabic realization of the sequence. That is, the contrast is between, e.g. [elpi.áno] ~ [elpjáno] 'the piano', not * [ulpi.áno] *Ulpiano*.

Here we report on an experiment involving the production of this quasi-phonemic contrast and on the syllabification intuitions of the same set of participants.

## 2. METHODS

### 2.1. Participants

All prior experimental work on the topic of exceptional hiatus in Spanish has been conducted with very small numbers of subjects. In [10] the intuitions and productions of 4 speakers from Madrid, Spain, are reported. In [6], the data that are reported are from 5 speakers from Barcelona. In [4] the authors report on intuitions on syllabification from 15 speakers Spanish from different areas of Spain, but did not conduct a production study.

Here we attempt to replicate this prior work, but with a larger number of speakers of a single geographical variety. We obtained data from 37 participants (20 female, 17 male) from the same town.

By testing a larger set of speakers of the same local variety, we hope to obtain evidence regarding the consistency with which specific contexts condition exceptional hiatus in a given dialect.

Our experiment was conducted in Irun, Gipuzkoa, Spain, a Basque town of 60,000 inhabitants, of which about 40% are bilingual in Basque. 19 of our participants reported Spanish as their preferred language and 18 reported Basque. It should be noted that the latter are also fully fluent in Spanish and use this language every day. The most common language of social interaction in Irun in Spanish, with a reported public use of Basque of 7.6% [16].

We expect two possible effects from bilingualism in Basque. On the one hand, Gipuzkoan Basque, unlike Spanish, consistently favors hetero-syllabification in sequences of rising sonority, regardless of the position of the stress; instead, a hiatus-breaking onset glide may be inserted, e.g. *mendia* [mendi.a] ~ [men.di.ja] 'the mountain'; *mendietan* [mendi.etan] ~ [mendi.jetan] 'in the mountains' [7]. Influence from Basque on Spanish may thus result in a higher percentage of hiatus productions. On the other hand, bilingualism may favor the elimination of lexical exceptions and, in particular, lexically fuzzy contrasts such as those created by exceptional hiatus (see [18] syllabification in heritage Spanish).

## 2.2. Experimental materials and procedure

For this experiment, we included the same set of 20 target words as in [10] in order to facilitate comparison. All target words contain the sequence /iá/, with word-stress on the low vowel. The items include 8 verbal forms (see Table 2), 4 with expected hiatus /i.á/ and 4 with an expected diphthong /já/. Expected syllabification derives from a difference in the position of the stress in certain other forms of the verb, such as the third person singular present indicative form (also shown in Table 2, right column). The paradigm of expected hiatus verbs contains forms where the word stress falls on the high vowel /i/, so that there is an obligatory hiatus, according to the rule in (1b) above. These are paired in the test materials with 4 other verbal forms that have an expected diphthong, since no other form in the verbal paradigm has stress on the /i/ of the sequence.

In addition to the verbal forms in Table 1, 3 other expected-hiatus words in the stimulus materials are derivationally related to words with stress on the high vowel: *riada* 'high waters' (related to *río* 'river'), *diario* 'daily' (*día* 'day') and *semiviable* 'semiviable' (*vía* 'way'). Finally, the set of exceptional hiatus words also includes two words without any morphological justification for the hiatus, but, which nevertheless has been described as belonging to the exceptional hiatus category in [10] and other work, *piano* and *liana*.

**Table 2**. Verbal forms: stimuli (left column) and 3rd sg form for comparison between the two groups

| Target verbal forms | Cf. 3rd sg |
|---|---|
| a. Expected hiatus | |
| *guiamos* /gi.ámos/ 'we guide' | *guía* /gí.a/ |
| *vaciamos* /baθi.ámos/ 'we empty' | *vacía* /baθi.a/ |
| *enviamos* /enbi.ámos/ 'we send' | *envía* /enbí.a/ |
| *piando* /pi.ándo/ 'chirping' | *pía* /pí.a/ |
| b. Expected diphthong | |
| *elogiamos* /eloxjámos/ 'we praise' | *elogia* /elóxja/ |
| *saciamos* /saθjámos/ 'we satiate' | *sacia* /sáθja/ |
| *aliviamos* /alibjámos/ 'we alleviate' | *alivia* /alíbja/ |
| *limpiando* /limpjando/ 'cleaning' | *limpia* /límpja/ |

Participants were asked to produce the 20 target words, together with 25 distractors, all in random order, in the context *digo__porque sí* 'I say__just because'. Answers were recorded with a Sony Microtrack 24/96 using a Sony F-720 external michorphone.

Once they had completed this production experiment, a paper-and-pencil experiment was performed, where participants were asked to syllabify the target words that they had just recorded according to their own intuitions as speakers (rather than being guided by any word-division rules they might have learned in school). The materials for this task included only a list of words in orthographic representation; there were no aural stimuli.

The soundfiles obtained in the production experiment were analyzed in Praat [3]. We manually segmented the /ia/ or /ja/ sequence in the textgrids, without attempting to find a boundary between the two vocoids. After discarding 28 tokens because of data extraction difficulties, 707 tokens were analyzed. We then used FormantPro [23] to automatically extract formant values at 20 equally spaced points in the duration of the segment.

Statistical analysis was conducted in R [14] and RStudio [15], using the package *tidyverse* [21] for data organization.

## 3. HYPOTHESES

Participants' performance was expected to largely agree with the hypothesized lexical distinction between diphthong and hiatus, with expected syllabification being a significant factor both in participants' production and in their intuitions regarding syllable boundaries.

In production, this should result in significantly longer duration of /ia/ in words hypothesized to contain an exceptional hiatus than in words hypothesized to contain a diphthong [1, 6, 10]. Differences should also be observed in a difference in formant trajectories depending on whether the sequence has been produced with a glide [j] or with a vowel [i] [1].

Regarding syllabification intuitions, we expected, in general, our participants to agree with the expected syllabification of words, although we also expect some variation and for some participants to have more clear intuitions than others and for there to be some variation regarding specific words, as has been found in previous work [4, 6, 10, 19], given the fuzzy nature of the contrast.
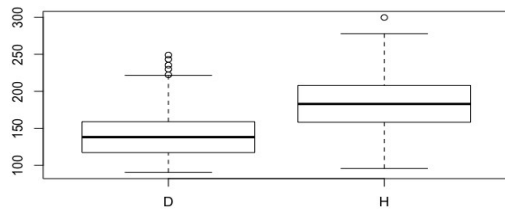
Basque-dominant speakers were expected to have a stronger preference for syllabification in hiatus than Spanish-dominant speakers, given the preference for syllabification of rising sonority vowel sequences in hiatus in Basque. The strongest agreement with the expected syllabification is expected in verbal forms, because of analogical effects with paradigms, and the weakest in words lacking any morphological justification for an unexpected hiatus.

# 4. RESULTS

## 4.1. Duration

Our participants produced expected exceptional hiatus sequences with longer duration (mean = 183.6 ms, st. = 30 ms) than expected diphthongs (mean = 139.9 ms, st. = 36 ms), see Figure 1.

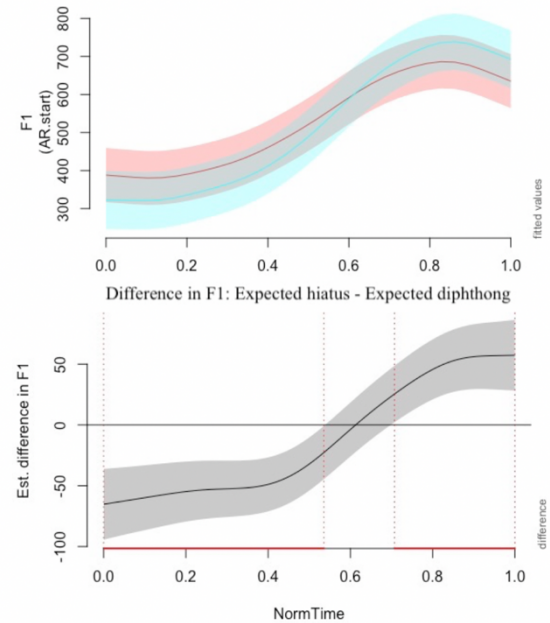**Figure 1**. Duration (ms) by expected category: D(iphthong) vs H(iatus)



A mixed-effects linear regression analysis (*lmer*) [2] on duration, with the fixed factors of Expected Category (diphthong vs hiatus) and Preferred Language, and random factors of Participant (random intercepts and slopes) and Word (random intercepts) (which was the maximum random effect structure that allowed the regression to converge), returned a significant effect for the expected distinction between diphthong and hiatus, $\beta = 45.5$, t= 6.4, p < 0.0001. On the other hand, there was no significant effect of language preference. (P-values were obtained with the default Satterthwaite approximation in *lmerTest* [11]).

## 4.2. Formant values

In the two panels of Figure 2 (made with *itsadug* [20]), we show the distribution of F1 trajectories for words expected to have a diphthong and to have a diphthong and to have a hiatus. In the bottom panel, the non-overlap of the shaded confidence bands of the smooths at the beginning and end of the sequences is indicated by the red line on the x-axis.
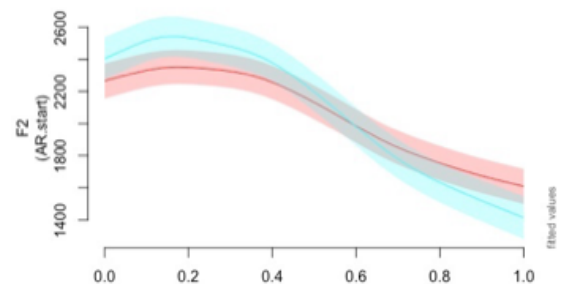
**Figure 2**. Non-linear smooths (fitted values) and confidence bands (shaded) of F1 formant trajectories by expected category: Diphthong (red) vs Hiatus (blue) (top panel) and difference between the two smooths (bottom panel).
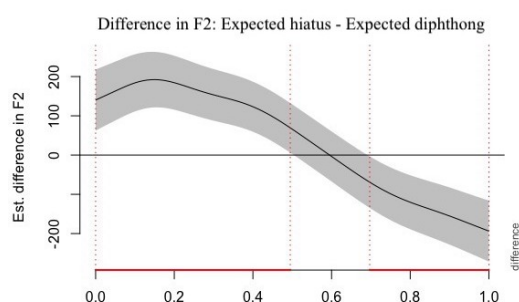


A generalized additive model (*bam*, package *mgcv* [21], see [22, 23]) was fit on F1 trajectory values, with Expected Category (diphthong vs hiatus) as fixed factor, smooths on normalized time by Expected sequence, and normalized time by Participant (non-linear random slope) and a random intercept for each Word. The results indicated a significant effect of expected sequence by time for both diphthong and hiatus. Significant differences between the two formant trajectories are indicated with a red line on the x-axis of the bottom panel in Figure 2.

In the two panels of Figure 3, we show the same distribution of formant trajectories as in Figure 2 but for F2, with differences between the Expected sequence smooths indicated with a red line on the x-axis of the bottom panel.

**Figure 3.** Non-linear smooths (fitted values) and confidence bands (shaded) of F2 formant trajectories by expected category: Diphthong (red) vs Hiatus (blue) (top panel) and difference between the two smooths (bottom panel).

Difference in F2: Expected hiatus - Expected diphthong

The trajectory of both formants shows a more abrupt change and slope for expected exceptional hiatuses than for expected diphthongs. Expected hiatus words show a lower F1 and a higher F2 than diphthong words at the beginning of the sequence, and the opposite relation at the end.

## 4.3. Syllabification intuitions

Three participants did not show any variation in their responses: two always chose 'diphthong' and one always chose 'hiatus'. Excluding these three participants we obtain the results in Table 2:

**Table 2**. Syllabification of Expected Diphthong and Hiatus words (Counts and percentages).

|             | Response- D   | Response-H  |
|-------------|---------------|-------------|
| Expected-D  | 286 (90.8%)   | 29 (9.2%)   |
| Expected- H | 95 (28.4%)    | 239 (71.5%) |

As shown in Table 2, the great majority of all responses agreed with the predicted syllabification. It is also apparent that agreement with the predictions was even stronger for expected diphthong words (the unmarked syllabification, with over 90% agreement) than for words expected to have exceptional hiatus.

Examining responses for each target word separately, and separating verbs from other forms, we obtain that hiatus responses were above 80% for conjugated verbs with predicted hiatus and ranged from 0% to 4% for conjugated forms with predicted diphthong. The pattern was only slightly weaker for the two gerunds (in -*iando*) included in our stimuli, see Table 3. The contrast between the two classes of words in this Spanish variety is, thus, robust and consistent among speakers.

**Table 3**: Hiatus responses for verbal forms (%)

| Predicted hiatus | Predicted diphthong |
|------------------|---------------------|
| guiamos = 88 %   | aliviamos= 0%       |
| vaciamos = 84 %  | elogiamos = 4%      |
| enviamos= 82%    | saciamos = 4%       |
| piando = 76%     | limpiando = 13%     |

For non-verbal forms, agreement with the predictions was somewhat lower, but three of the predicted diphthong words were still identified as such in over 90% of all responses.

For non-verbal exceptional-hiatus words, agreement with predicted hiatus ranged from 81%, for the word *riada*, to only 41% for the word *semiviable*. The words *piano, liana* and *diana*, which do not have any morphological connection to other words with stress on /i/, scored lower than verbs with hiatus tendency, but still close to or above 60%. See Table 4.

**Table 4**: Hiatus responses for nonverbs (%)

| Predicted hiatus | Predicted diphthong |
|------------------|---------------------|
| riada = 81%      | envidiable = 3%     |
| diario = 77%     | italiana = 3%       |
| liana = 72 %     | indiana = 6%        |
| diana = 62%      | presidiario = 9%    |
| piano = 59%      | ulpiano = 18%       |
| semiviable = 41% | barriada = 29%      |

That is, the great majority of all responses were according to the predicted syllabification for the specific item. In general, there was a greater preference for syllabification as a diphthong (which is the unmarked option), but conjugated forms of verbs with lexical hiatus triggered over 80% of hiatus responses and so did the word *riada* 'high waters', transparently related to *río* 'river'. Other predicted hiatus words showed much more variation.

A mixed-effect logistic regression on written response (*glmer* [2], family = binomial) returned a significant effect of predicted syllabification ($\beta = 5.2$, $z = 8.3$, $p < 0.0001$), but no effect of language preference.

## 5. DISCUSSION AND CONCLUSIONS

In Spanish, the sequence /iá/ is usually syllabified as a diphthong /já/. Nevertheless, several authors have noticed an exceptional syllabification in hiatus /i.á/ for some lexical items with the relevant sequence, in Iberian Spanish, with variation in intuitions. Our investigation of a Spanish variety in contact with Basque, with a larger number of speakers than all previous studies, has shown considerable agreement among speakers in the existence and distribution of the contrast, both in production and in intuitions. Sequences in hypothesized exceptional-hiatus words are longer and differ in formant structure from regular diphthong sequences. Intuitions about exceptional hiatus are particularly strong in forms of verbs whose paradigm includes other forms with stress on the high vowel. Even though there are no minimal pairs and agreement on specific lexical items is not complete, this is a lexically-encoded contrast in the phonology of speakers of this Spanish variety. The perception of this contrast remains to be tested. No effect of Basque bilingualism was found in either production or intuitions.

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