WORD EDGE TONES IN SPANISH PRENUCLEAR ACCENTS

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ABSTRACT

In this paper we analyse the alignment patterns of H prenuclear accents in Spanish so as to examine whether prenuclear rises in declarative sentences can be interpreted as a sequence of an L* pitch accent and an H word edge tone. A production test was designed consisting of 20 pairs of ambiguous sentences with a different word boundary location (e.g. *bebo vinos* "I drink wines" vs. *ve bovinos* "(s)he sees cows"). Sentences were read by four speakers of Peninsular Spanish. The results showed that for all speakers the H is always anchored right after the accented syllable. However, H alignment does seem to be affected by the stress distribution of words, since the F0 peak is more displaced in proparoxytones that in paroxytones and in paroxytones than in oxytones, suggesting the presence of a loosely aligned H word edge tone. Furthermore, two perception tests (a discrimination test and an identification test) were carried out to investigate whether H alignment can be a helpful cue to identify otherwise ambiguous sentences. The results showed that words with a stress on the penultimate or antepenultimate syllable are more easily distinguished than words with a final accent, which indicates that H alignment differences due to word position are an important cue for word-boundary identification.

Key words: *prenuclear accents, word edge tones, declarative sentences.*

RESUMEN

Este estudio analiza los patrones de alineación de los acentos ascendentes prenucleares en frases declarativas en español y examina la posibilidad de interpretar estos contornos mediante un acento tonal bajo (L*) y un tono alto de frontera de palabra (H). Estos patrones se analizaron mediante un experimento de producción que consistía en 20 pares de frases ambiguas con diferente frontera de palabra (e.g. *bebo vinos* vs. *ve bovinos*) leídas por cuatro hablantes de español peninsular. Los resultados evidenciaron que para todos los hablantes la H siempre se encuentra después de la sílaba acentuada. De todas formas, la alineación de la H está afectada por la distribución acentual de las palabras ya que el pico de F0 está más desplazado en esdrújulas que en llanas y en llanas que en agudas. Esto sugiere la presencia de un tono alto de frontera de palabra (H) sin alineación fija. Además, se llevaron a cabo dos experimentos de percepción (uno de discriminación y otro de identificación) para investigar si la alineación de la H puede ser decisiva para

identificar frases ambiguas. Los resultados demostraron que las palabras con acentos en la penúltima y la antepenúltima sílaba se identifican con mayor facilidad que las palabras con acento final. Esto indica que diferencias en la alineación de la H en relación a la posición de la sílaba acentuada son una pista clave para identificar fronteras de palabra.

Palabras clave: *acentos prenucleares, tono de frontera de palabra, frases enunciativas.*

1. INTRODUCTION

Several studies have shown that in many languages prenuclear accents in neutral declarative sentences involve a rising movement which is usually described by means of LH tones aligned with the segmental string in different ways. Most studies coincide in interpreting the F0 valley as an L* pitch accent given the stability in the alignment and in the scaling of the L (see Caspers and van Heuven 1993 for Dutch; Sosa 1999 for Spanish; Arvaniti, Ladd and Mennen 1998 for Greek, Ladd and Shepman 2003 for English; Estebas-Vilaplana 2000 and Prieto 2005 for Catalan).

Conversely, the behaviour of H varies cross-linguistically and differences in its alingment have prompted different phonological interpretations. In Spanish, the analysis of prenuclear rises has been subject to controversy. Some studies (Prieto, van Santen and Hirschberg 1994, 1995, and Nibert 2000) have classified Spanish prenuclear rises as H* with a peak delay since the F0 maximum was found to be located after the accented syllable. Prieto *et al*. have shown that the amount of peak delay is subject to factors such as segmental duration or an upcoming prosodic boundary. F0 peaks are more delayed as the duration of the accented syllable increases and retracted when adjacent to a word, a phrase boundary and in stress clash contexts. On the other hand, Sosa (1999), Face (1999, 2001), Beckman, Díaz-Campos, McGory and Morgan (2002) and Calleja (2004) have postulated a different interpretation for the rising movement of prenuclear accents in Spanish, namely, L*+H. This accent involves a low F0 within the accented syllable and a sharp rise after the accented syllable. Hualde (2002), in his turn, finds that neither H* nor L*+H describe prenuclear rises in Spanish satisfactorily. He claims that H* fails to account for the fact that the tone is low at the onset of the stressed syllable.

However, he discards L*+H on the basis that it is not contrastive with L+H*. He proposes a pitch accent where both tones are associated with the stressed syllable (L+H)*. This type of picth accent has also been postulated by Arvaniti, Ladd and Mennen (2000) for Greek. In languages such as Catalan (Estebas-Vilaplana 2000, 2003a, b) prenuclear rises have been described as instances of a low pitch accent (L*) followed by a word edge tone (H) since the F0 peak was consistently aligned with the end of the accented word irrespective of the number of post-accentual syllables. Similar results are reported in Pamies (in press) for the Spanish spoken in Granada. Also a perceptual study carried out by Arranz and Garrido (ms) for Spanish has provided evidence for a strict alignment of H with the word boundary location. However, other reseach on Catalan and Spanish word edge tones (Prieto 2005, Estebas-Vilaplana and Prieto 2005, in press, and de la Mota 2005) has shown that despite differences in H alignment relative to the position of the accented syllable, no strict word anchoring was found, thus discarting the idea of word edge tones as part of the phonological system of these languages.

In this paper, we would like to clarify the role of word edge tones in Castilian Spanish and we will examine the possibility of analysing prenuclear rises in neutral declaratives by means of the combination of a low pitch accent (L*) and a high word edge tone (H). The presence of word edge tones in Spanish is investigated by means of three tests: a production test and two perception tests (an identification test and a discrimination test). For the production test 20 pairs of ambiguous sentences distinguished by word boundary location (e.g. *bebo vinos* "I drink wines" vs. *ve bovinos* "(s)he sees cows") were read by four speakers of Castilian Spanish. Sentences included words with different stress distributions: oxytones, paroxytones and proparoxytones.

The results showed that the H is always aligned after the accented syllable and no strict anchoring of H at the end of the accented word was found. However, H location was affected by the stress condition of the word. The greater the number of post-accentual syllables within the word, the more displaced the F0 peak. For the perception tests, 20 listeners heard 10 ambiguous sentences in isolation (identification test) and 20 ambiguous sentences presented in pairs (discrimination test) and had to identify where the word boundary was located. The results of both tests suggested that Spanish listeners seem to employ tonal alignment details due to word boundary position to correctly identify word boundary location.

2. PRODUCTION TEST

The aim of the production test is to examine whether H anchoring is used to disambiguate sentences. The hypothesis is that if an H word edge tone is present the F0 peak should be aligned at the end of words regardless of the number of post-accentual syllables.

2.1. Experimental procedure

2.1.1. Data recording

The data used in the production test consisted of 20 pairs of potentially ambiguous sentences which have the same segmental and stress composition and are *only* distinguished by word boundary location. Words with three different stress distributions were used, i.e. oxytones (words with stress on the final syllable), paroxytones (words with stress on the penultimante syllable) and proparoxytones (words with stress on the antepenultimate syllable). Each pair of sentences included a paroxytone in contrast with an oxytone or a proparoxytone, as illustrated in (1) below. The labels *fin*, *pen* and *ante* stand for stress on the final, penultimate and antepenultimate syllables respectively. The list of sentences used in the production test can be found in Appendix 1.

(1)

1a.	***Ve** bovinos*	"(s)he sees cows"	fin
	***Be**bo vinos*	"I drink wines"	pen
1b.	***Su**be Melino*	"Melino goes up"	pen
	***Sú**beme lino*	"Bring up the linen for me"	ante

Four speakers of Castilian Spanish read the 20 pairs of ambiguous sentences 4 times. Each speaker read 160 sentences. Overall, a total of 640 utterances were recorded. The recordings took place at the Phonetics Laboratory of the UNED. The speakers were asked to read the sentences as if they wanted to distinguish them from one another but without any pause or intonational break. Sentences had to be pronounced in a single intonational phrase in order to avoid the presence of an H- phrase accent indicating an intermediate phrase.

2.1.2. Data analysis

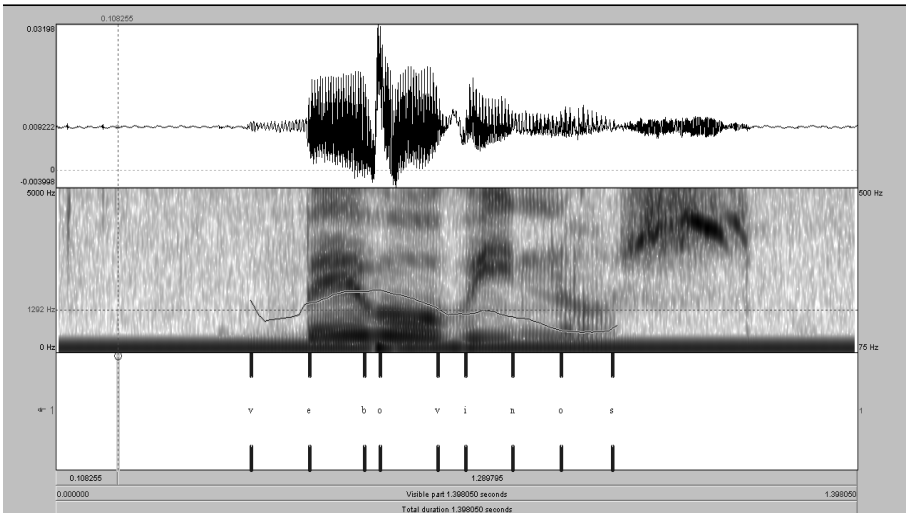
Sentences were analysed by means of *Praat* (Boersma and Weenik 1992-2001) which allows for a time-aligned inspection of the speech waveform and the F0 trace. The displays in Figures 1 and 2 show two pairs of potentially ambiguous sentences produced by speaker EV. The sentences in Figure 1 illustrate a contrast with a final vs. a penultimate accent (***ve*** *bovinos* vs. ***be****bo vinos*), whereas the sentences in Figure 2 exhibit a penultimate vs. an antepenultimate accent (***su****be Melino* vs. ***sú****beme lino*). The three boxes displayed in each graph show the speech waveform, a spectrogram with an overlapped F0 trace and the labels corresponding to the segmental boundaries for all syllables.

For each sentence the following segmental and pitch labels were placed in the two test syllables:

1. Segmental landmarks: onset of each vowel and consonant/s of the target syllables.
2. Pitch landmarks: F0 valley (L) and F0 peak (H) of the first pitch accent.

After segmentation, a Praat script collected the data points into an SPSS file, where the distance measures relevant for our study were calculated, namely, the location of H relative to the different segmental landmarks (syllable onset/offset and word boundary), as well as duration measures such as the duration of the segments in the accented and post-accentual syllables.

Ve bovinos



Bebo vinos

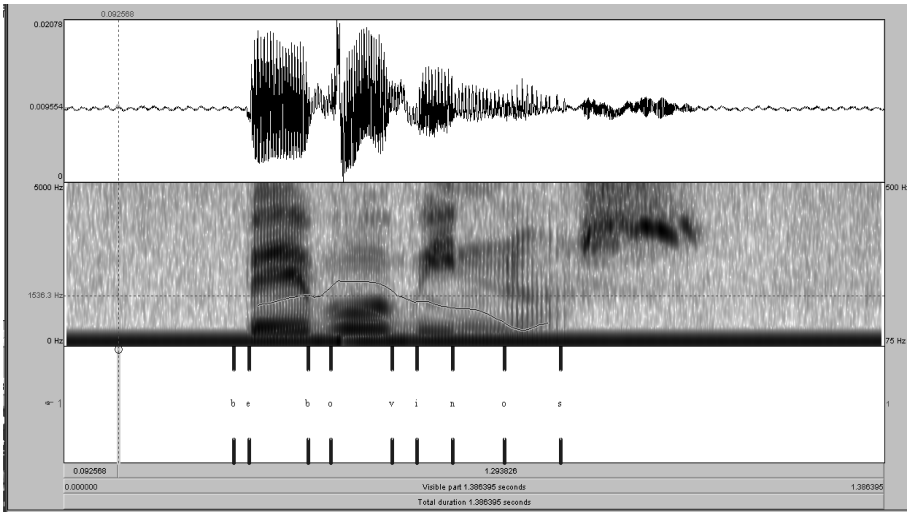


Figure 1. *Diplays of speech waveform, spectrogram with an overlapped F0 trace, and the segmental boundaries for the sentences* ve bovinos *vs.* bebo vinos *produced by speaker EV.*

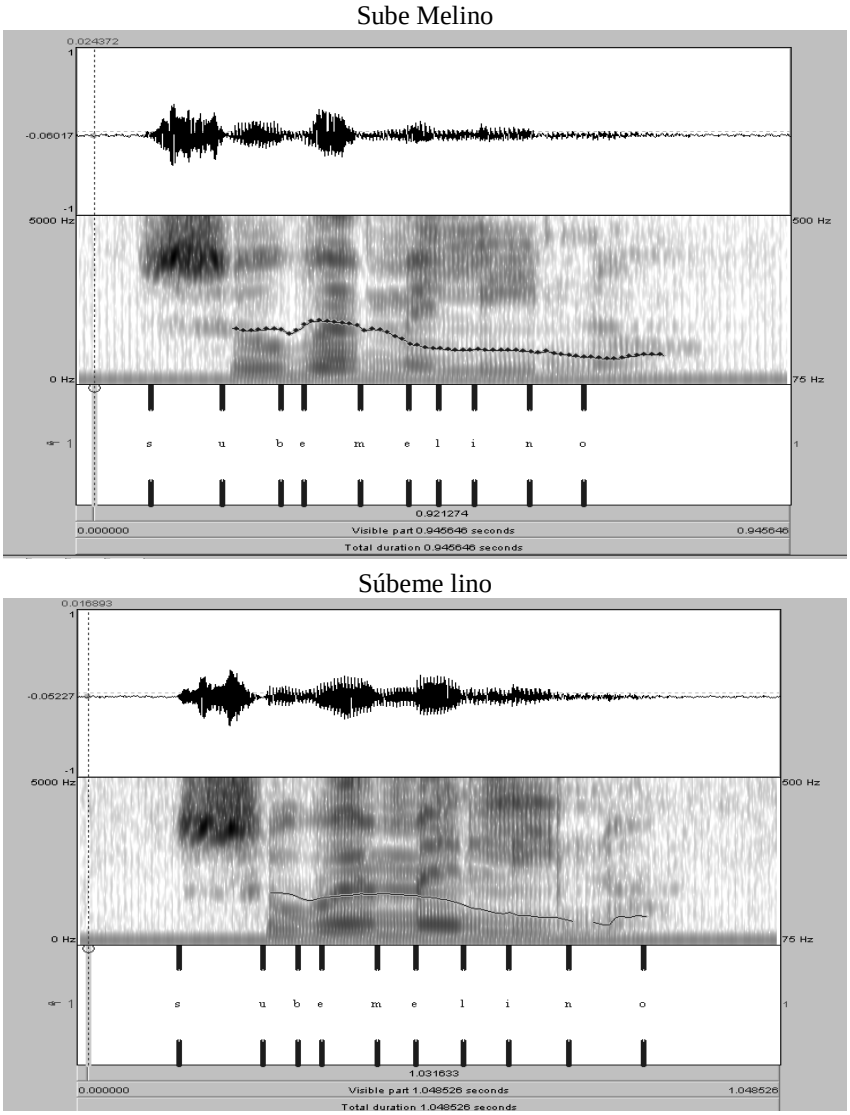


Figure 2. *Diplays of speech waveform, spectrogram with an overlapped F0 trace, and the segmental boundaries for the sentences* sube Melino *vs.* súbeme lino *produced by speaker EV.*

2.2. Results

The results will be presented in three sections: 1) H peak delay as a function of the duration of the accented syllable; 2) the effects of within-word position on H location; and 3) the effects of within-word position on syllable duration.

2.2.1. H peak delay as a function of the duration of the accented syllable

The four graphs displayed in Figure 3 plot H peak delay (or distance between the onset of the accented syllable and the F0 peak in ms) as a function of the duration of the accented syllable for all speakers in the three stress conditions (fin, pen, ante).

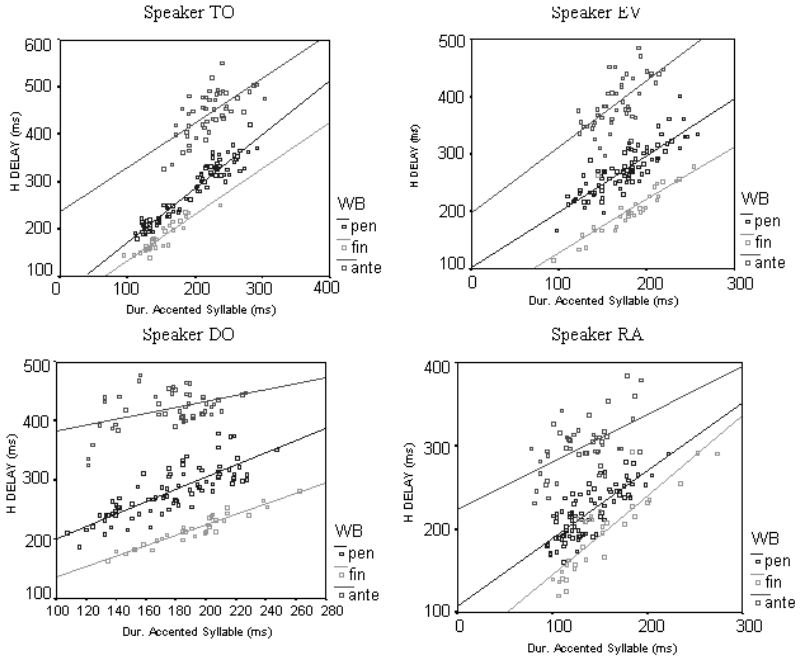


Figure 3. *Peak delay (or distance between the onset of the accented syllable and the F0 peak) in ms as a function of the duration of the accented syllable in ms in three stress conditions (words with final, penultimate and antepenultimate stress) for speakers TO, EV, DO and RA.*

The results show a strong correlation between H delay and syllable duration for all speakers especially in the fin and pen stress conditions (correlation coefficients are 0,92 (pen) and 0,83 (fin) for speaker TO; 0,73 (pen) and 0,74 (fin) for speaker EV; 0,69 (pen) and 0,61 (fin) for speaker DO; and 0,63 (pen) and 0,77 (fin) for speaker RA). The effects of the duration of the accented syllable on the location of H are found in a variety of languages (Silverman and Pierrehumbert 1990 for English, Prieto, van Santen and Hirschberg 1995 for Spanish, and Prieto 2005 for Catalan, among others), showing that the longer the syllable, the more delayed the F0 peak. In our data, however, this tendency is less strong in words with stress on the antepenultimate syllable which exhibit much lower correlation coefficients between H delay and syllable duration (0, 44 for speaker TO; 0,42 for speaker EV; 0,27 for speaker DO; and 0,32 for speaker RA). The results plotted in Figure 3 also show that Hs in words with a final accent (e.g. *ve bovinos*) are less delayed than Hs in words with a penultimate accent (e.g. *bebo vinos*). Similarly, Hs in words with a penultimate accent (e.g. *sube Melino*) are less delayed than Hs in words with an antepenultimate accent (e.g. *súbeme lino*). This seems to indicate that the location of the H is highly influenced by within-word position. These effects will be examined in the next section.

2.2.2. Effects of within-word position on H location

The effects of within-word position will be analysed in four different ways:

1. H peak delay as a function of within-word position;
2. H distance to the end of the accented syllable as a function of within-word position;
3. H distance to the end of the post-accentual syllable as a function of within-word position;
4. H distance to the word boundary as a function of within-word position.

2.2.2.1. H peak delay as a function of within-word position

The graph displayed in Figure 4 plots the mean H peak delay or distance in ms between the H peak relative to the beginning of the accented syllable in words with final, penultimate and antepenultimate stress. The results show clear effects of within-word position on H placement: peaks are less displaced in words with a final accent than in words with an accent on the penultimate syllable. Furthermore, words with an antepenultimate accent show a longer H delay than words with a

penultimate accent. Thus, F0 peaks are more displaced in paroxytones than in oytones and even more displaced in proparoxytones than in paroxytones.

ANOVAs were done for the measure of H alignment relative to the beginning of the accented syllable for the four speakers. The ANOVAs revealed a significant effect of word boundary on peak delay: Speaker TO: $F(2, 159) = 269{,}505$; $p<0{,}001$; Speaker EV: $F(2, 159) = 204{,}951$; $p<0{,}001$; Speaker DO: $F(2, 159) = 348{,}952$; $p<0{,}001$; and Speaker RA: $F(2, 159) = 109{,}751$ $p<0{,}001$. Thus, all speakers showed that peak location is affected by within-word position in a way that the peak is more displaced as the number of post-accentual syllables within the word increases.

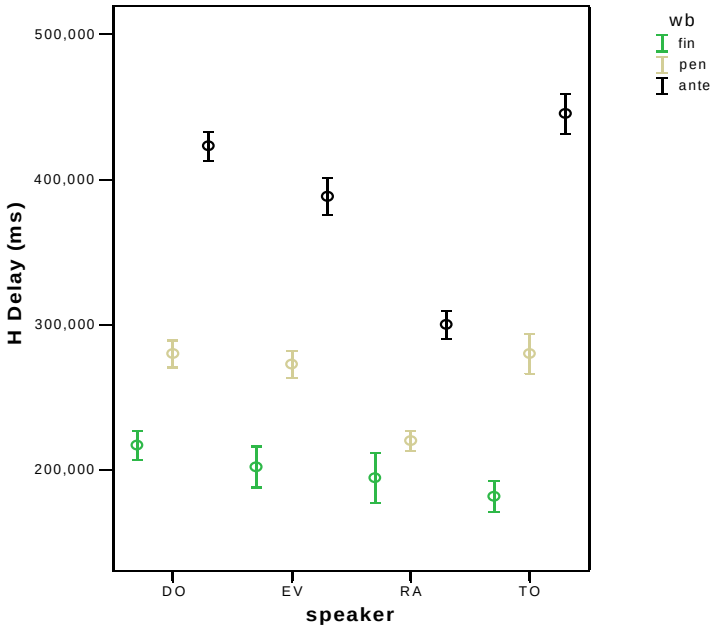


Figure 4. *Mean H peak delay (or distance in ms between the H peak relative to the beginning of the accented syllable) as a function of within-word position for all speakers: fin (words with a final accent), pen (words with a penultimate accent) and ante (words with an antepenultimate accent). The bars represent standard errors.*

2.2.2.2. H distance to the end of the accented syllable as a function of within-word position

The results in Figure 5 show the distance in ms between the location of the H relative to the end of the accented syllable in words with final, penultimate and antepenultimate accents. Taking the 0 value as the end of the accented syllable, the plots show that all F0 peaks are displaced to the post-accentual syllable or syllables, since all peaks are located beyond the 0 value. The results also show that in words with antepenultimate stress F0 peaks are even more displaced than in words with penultimate stress. These results indicate that even though the alignment of the F0 peak seems to be influenced by the stress condition of the word, there is no strict anchoring of the H at the end of the word, since in words with final stress the F0 peak is located after the accented syllable. Thus the presence of a word edge tone is not clear according to these data.

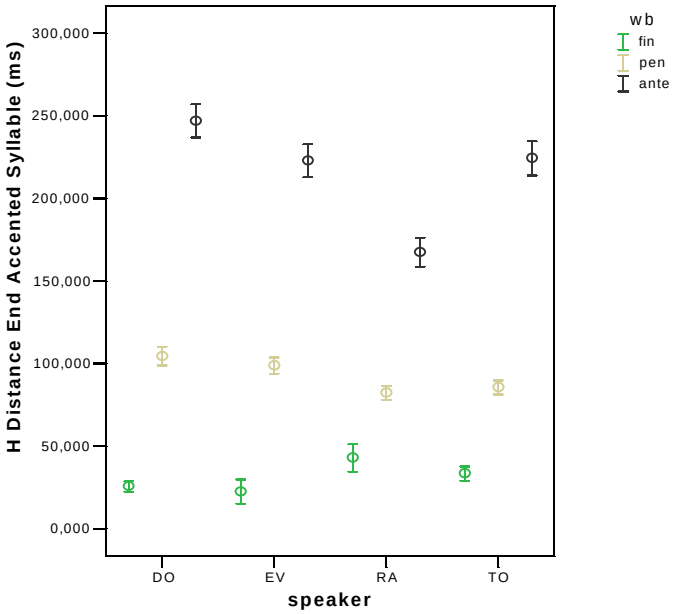


Figure 5. *Mean distance in ms between the H peak relative to the end of the accented syllable as a function of within-word position for all speakers. The bars represent standard errors.*

ANOVAs were done for the measure of H alignment relative to the end of the accented syllable for the four speakers. The ANOVAs revealed a significant effect of word boundary on peak distance to the offset of the accented syllable for all speakers: Speaker TO: $F(2, 159) = 726{,}453$; $p<0{,}001$; Speaker EV: $F(2, 159) = 629{,}163$; $p<0{,}001$; Speaker DO: $F(2, 159) = 780{,}654$; $p < 0{,}001$; and Speaker RA: $F(2, 159) = 306{,}809$ $p<0{,}001$. Thus, all speakers showed that peak location is affected by within-word position since there is more H displacement in proparoxytones than in paroxytones and in paroxytones than in oxytones.

2.2.2.3. H distance to the end of the post-accentual syllable as a function of within-word position

The results presented in the previous section showed that the F0 peak is always located after the accented syllable in all types of words. However, given the clear effects of within-word position on the location of H and the greater F0 displacement in proparoxytones than in the other stress conditions, the alignment of H in relation to the offset of the post-accentual syllable was analysed so as to find out the exact anchoring of the F0 peak. The results in Figure 6 show the distance in ms between the location of the H relative to the end of the post-accentual syllable in words with final, penultimate and antepenultimate accents. Taking the 0 value as the end of the post-accentual syllable, the graph shows that in words with final and penultimate stress the F0 peak is anchored within the post-accentual syllable. However, in proparoxytones the H is located after the post-accentual syllable.

ANOVAs were done for the measure of H alignment relative to the end of the post-accentual syllable for the four speakers. The ANOVAs revealed a significant effect of word boundary on peak distance to the offset of the post-accentual syllable for all speakers: Speaker TO: $F(2, 159) = 1029{,}056$; $p<0{,}001$; Speaker EV: $F(2, 159) = 776{,}406$; $p<0{,}001$; Speaker DO: $F(2, 159) = 963{,}459$; $p < 0{,}001$; and Speaker RA: $F(2, 159) = 425{,}925$ $p<0{,}001$. These results corroborate the effects of within-word position on H location in prenuclear accents in Spanish declaratives and suggest the possible presence of word edge tones.

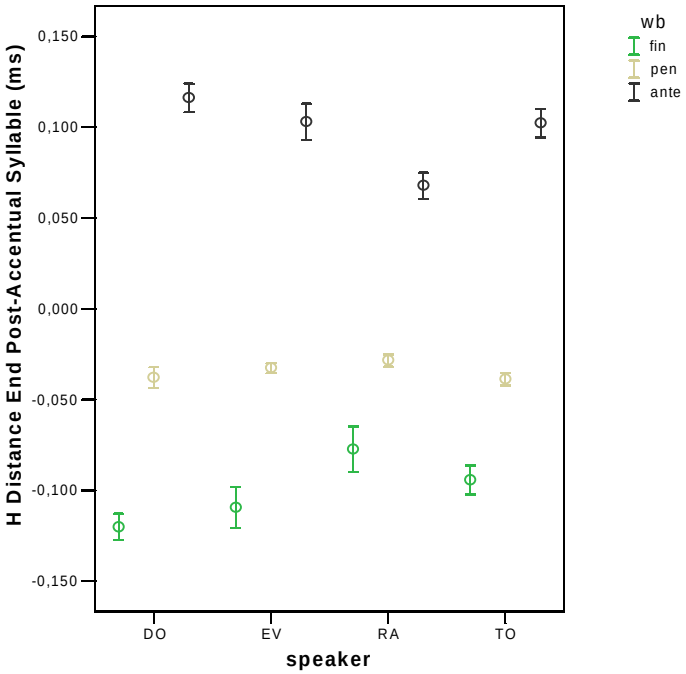


Figure 6. *Mean distance in ms between the H peak relative to the end of the post-accentual syllable as a function of within-word position for all speakers. The bars represent standard errors.*

2.2.2.4. H distance to the word boundary as a function of within-word position

Finally, the location of H in relation to the end of the word was examined. The graph in Figure 7 plots the distance in ms between the H and the end of the word in words with final, penultimate and antepenulimate accents. Taking the 0 value as the end of the word, the results show that in words with a final accent, the H is placed after the end of the word. On the other hand, in words with a penultimate or an antepenultimate accent, the H is located before the end of the word.

The results of ANOVAs performed on each speaker showed a significant effect of within-word position on the location of H relative to the word boundary: Speaker TO: $F(2, 159) = 307{,}098$; $p<0{,}001$; Speaker EV: $F(2, 159) = 124{,}680$; $p<0{,}001$;

Speaker DO: $F(2, 159) = 139{,}942$; $p < 0{,}001$; and Speaker RA: $F(2, 159) = 255{,}077$ $p<0{,}001$. As in the previous sections, these results showed that even though there is no strict anchoring of H at the end of the word, there is a clear effect of the distance in syllables to the end of the word on H location. This might suggest the presence of a loosely aligned word edge tone, that is, a word boundary tone which is able to signal word boundaries although its location is not strictly fixed at the end of the word.

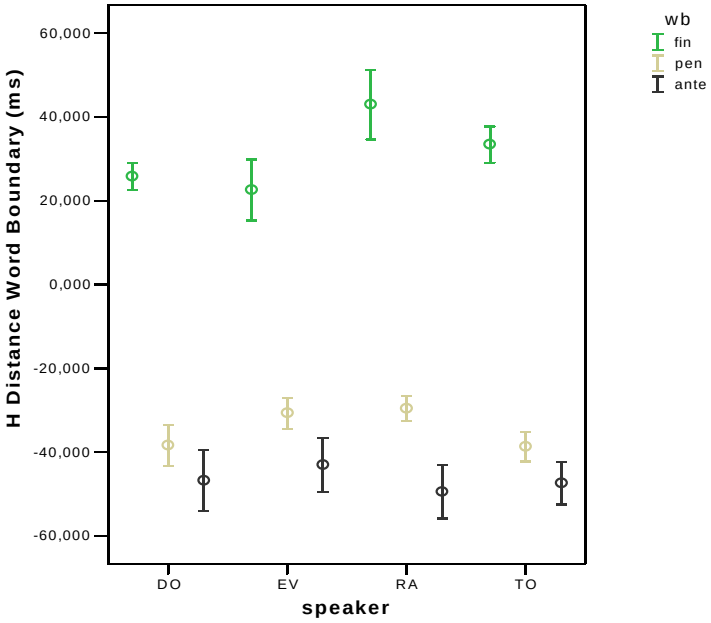


Figure 7. *Mean values of distance between H peak location relative to the right edge of the word (in ms) as a function of within-word position for all speakers. The bars represent standard errors.*

2.2.3. Effects of within-word position on syllable duration

Well-kown studies on the effects of word boundary location on syllable duration (Lehiste 1960) have shown that syllables in word-initial and word-final positions

are longer than word-medial syllables. In addition, she also showed that the duration of the stressed syllable also depends on the number of the following syllables, so that the duration of the stressed syllables in the set of words *fine – final – finality* decreases as the number of post-accentual syllables increases. According to this, the duration of the stressed syllable in the Spanish sentences should be longer in *ve (bovinos)* than in *bebo (vinos)*. Furthermore, Turk and White (1999) found that word-final lengthening only occurred in syllables containing a pitch accent. In this study, the effects of within-word position on syllable duration will be analysed in two ways: 1) the duration of the accented syllable as a function of within-word position (it is expected that accented syllables before a word-boundary will be longer than accented syllables in medial position), and 2) the duration of the post-accentual syllable as a function of within-word position (it is expected that post-accentual syllables before a word-boundary will be longer than non-accented syllables in medial position).

2.2.3.1. Duration of the accented syllable as a function of within-word position

The results displayed in Figure 8 show the mean values of duration of the accented syllable in words with final, penultimate and antepenultimate stress. The data show inter-speaker variability. On the one hand, speaker DO shows no effects of within-word position on the duration of the accented syllable. This is confirmed by the results of an ANOVA performed on her data which showed no significant effects of word boundary location on syllable duration ($F(2, 159)=0{,}007$; $p=0{,}993$). The results of speakers EV and RA show a slight effect of within-word position on the duration of the accentd syllable since the accented syllable is a bit longer in oxytones than in paroxytones and proparoxytones. However, ANOVAs done on the data of these speakers show that these effects are not significant (Speaker EV: $F(2, 159)=1{,}791$; $p=0{,}170$ and Speaker RA: $F(2, 159)= 3{,}188$; $p=0{,}044$). Finally, the results of speaker TO show a completely different behaviour. Contrary to all expectations, the duration of the accented syllable is shorter in oxytones than in paroxytones or proparoxytones. Given the unexpectedness of these results, the data of speaker TO were analysed separately, that is, we compared the fin-pen condition and the pen-ante condition on their own. The results are presented in Figure 9, which plots the differences in the duration of the accented syllable in words with a final and a penultimate accent (left graph) and in words with a penultimate and an antepenultimate accent (right graph).

The data plotted in Figure 9 show no effects of within-word position on the duration of the accented syllable. This is confirmed by the results of two two-

paired t-tests which showed no significant differences between the two durations in both conditions (fin vs. pen: p=0,35 and pen vs. ante: p=0,31). Thus, the odd results observed in Figure 8 for speaker TO are due to the fact that he produced very different durations of the accented syllable in words with a penultimate stress in the fin vs. pen condition and in the pen vs. ante condition. Overall, the results show no effects of within-word position on syllable duration. These findings do not agree with those of Lehiste for English but are similar to those obtained in Prieto (2005) for Catalan and suggest that whereas F0 peak location was a recurrant strategy used for all speakers to disambiguate sentences with the same segmental string, duration differences were not exploited in our data.

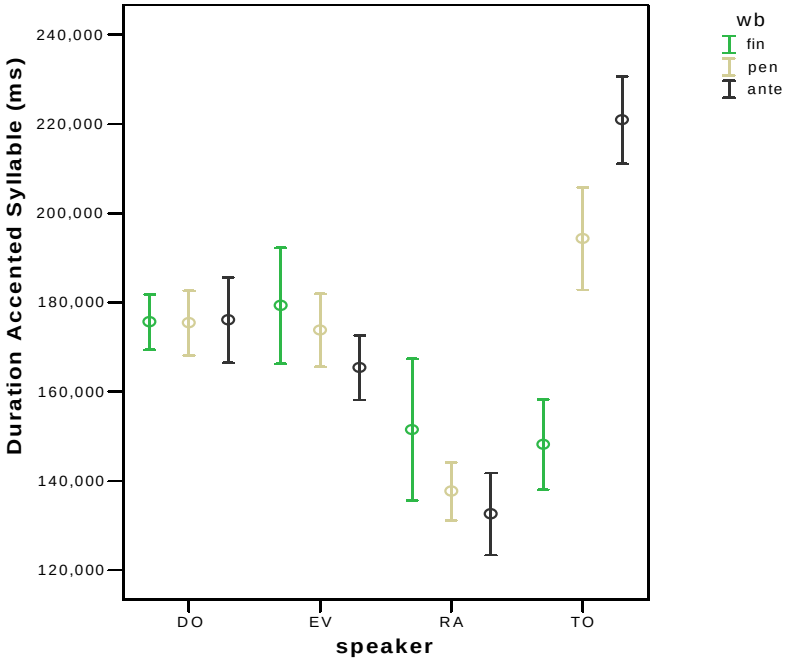


Figure 8. *Mean values of duration of the accented syllable (in ms) as a function of within-word position for all speakers. The bars represent standard errors.*

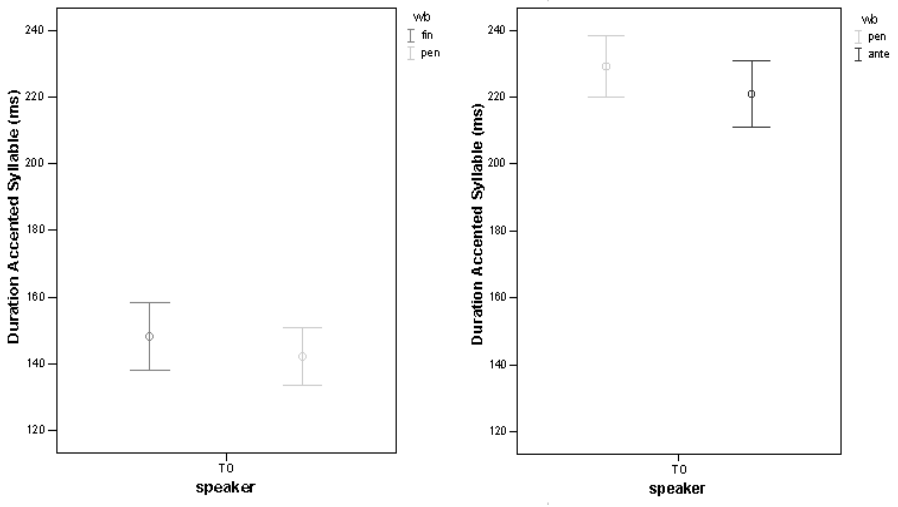


Figure 9. *Mean values of duration of the accented syllable (in ms) as a function of within-word position for speaker TO in the fin vs. pen condition and in the pen vs. ante condition. The bars represent standard errors.*

2.2.3.2. Duration of the post-accentual syllable as a function of within-word position

The results displayed in Figure 10 show the mean values of duration of the post-accentual syllable in words with final, penultimate and antepenultimate stress. The graph shows a tendency to have a longer post-accentual syllable in oxytones and in paroxytones than in proparoxytones. However, the results of ANOVAs performed for all speakers showed no significant effects of word boundary on the duration of the post-accentual syllable for speakers EV, DO and TO (Speaker EV: $F(2, 159)=3,996$; $p=0,02$; Speaker DO: $F(2, 159)=4,321$; $p=0,015$; and Speaker TO: $F(2, 159)=0,939$; $p=0,393$). Speaker RA, on the other hand, shows an effect of within-word position on the duration of the post-accentual syllable $F(2, 159)=9,725$; $p<0,001$. However, if we compare the results separately as we did in section 2.2.3.1 for speaker TO, no differences are found in the duration of the post-accentual syllable in the fin vs. pen condition and in the pen vs. ante condition as presented in Figure 11. The results of two two-paired t-tests showed no significant

effects of within-word position on the duration of the post-accentual syllable (fin vs. pen: p=0,24 and pen vs. ante: p=0,19).

Thus, the data show no clear duration effects of the post-accentual syllable in the contexts under investigation. This indicates that the hypothesis that the post-accentual syllable will be longer before a word boundary is not confirmed by the data.

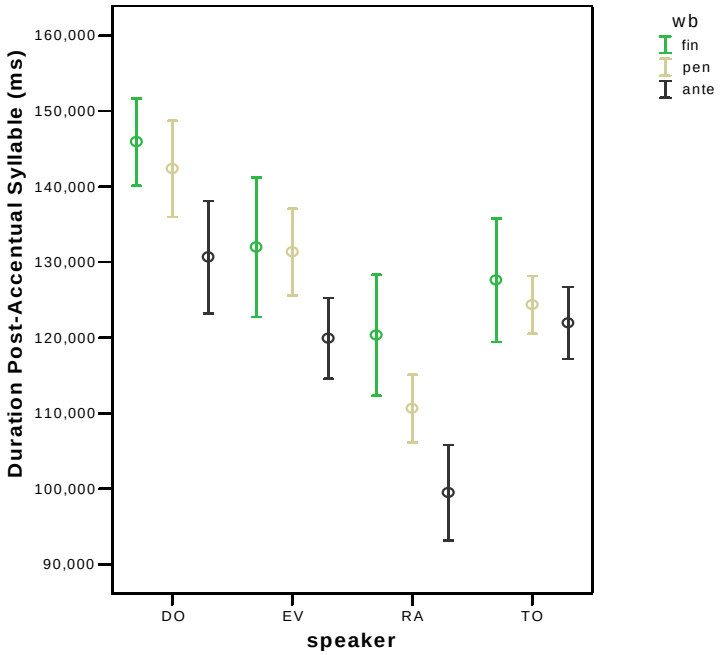


Figure 10. *Mean values of duration of the post-accentual syllable (in ms) as a function of within-word position for all speakers. The bars represent standard errors.*

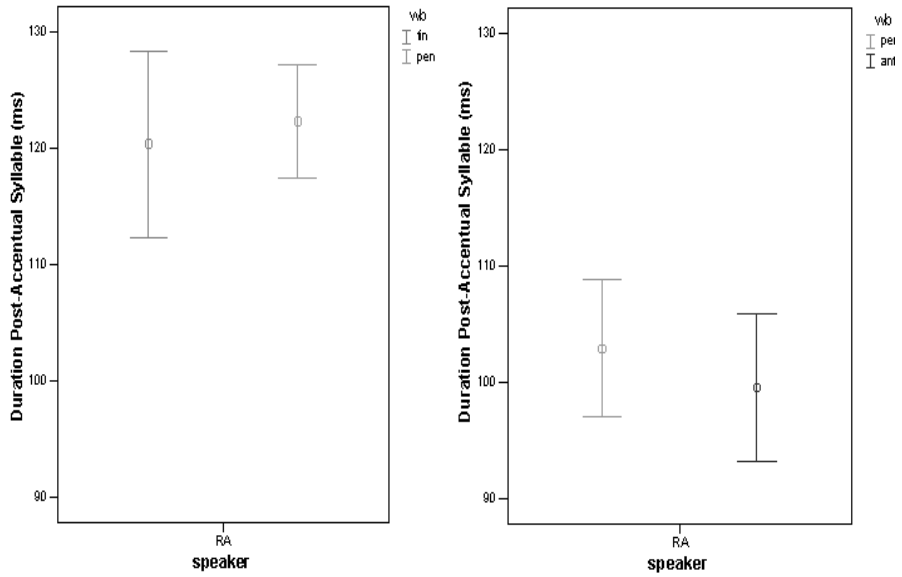


Figure 11. *Mean values of duration of the post-accentual syllable (in ms) as a function of within-word position for speaker RA in the fin vs. pen condition and in the pen vs. ante condition. The bars represent standard errors.*

3. PERCEPTION TESTS

The main goal of the perception tests was to check whether H alignment differences could be used to identify word boundaries between otherwise identical sentences. Two types of perception tests were designed: an identification test in which sentences were presented in isolation and a discrimination test in which sentences were presented in pairs.

3.1. Identification test

The identification test investigates whether tonal alignment differences are used in the identification of utterances contrasting in word-boundary locations in Spanish.

3.1.1. Experimental procedure

The materials used in the identification test consisted of 12 ambiguous utterances from the production test. Sentences were randomly selected from the productions of the four speakers. 20 Spanish listeners heard the ambiguous utterances a maximum of three times and had to identify the sentence in a two-choice task. This is illustrated below in (2). The informants were 12 female and 8 male native Spanish speakers with a Castilian accent. At the time of the experiment, all of them were studying their third year of Spanish Philology at the UNED.

(2)	*Stimuli*	*Task* - choose between:
	Da balazos	1. Da balazos 2. Daba lazos
	Súbeme lino	1. Sube Melino 2. Súbeme lino

The stimuli used in the identification test are included in Appendix 2.

3.1.2. Results

The results of the identification test are presented in Figure 12 which shows the mean percentage of correct identification responses for each of the 12 ambiguous sentences for the 20 listeners. The graph separates the data in three types of words: with a final accent (fin), with a penultimate accent (pen) and with an antepenultimate accent (ante).

The results of this test show a variable rate of identification of sentences which ranges from 25% to 95% of correct identification. As a general tendency, words with an antepenultimate accent are much better identified than words with other types of stress (between 85% and 95% of correct identification responses). In their turn, words with a penultimate accent have higher correct identification scores (between 50% and 80%) than words with a final accent which, except for one case (80% of correct answers), show a low correct identification (between 25% and

45%). These results are similar to those found in Prieto (2005) and they seem to indicate that the clear displacement towards the right edge of the word in paroxytones and proparoxytones may help the hearer to a better identification. In oxytones, H placement is more ambiguous and hence contributes to a more difficult identification.

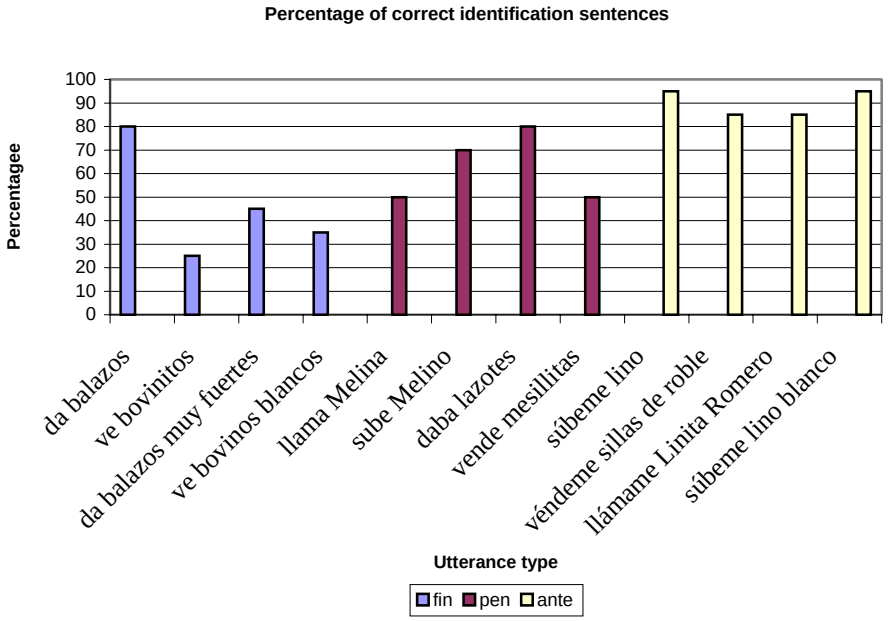


Figure 12. *Mean percentage of correct identification responses for each of the 12 ambiguous sentences for the 20 listeners.*

3.2. Discrimination test

The discrimination test investigates whether listeners could identify sentences in a better way when heard in pairs. It was expected that the presentation of both sentences one after the other could lead to a more accurate distinction.

3.2.1. Experimental procedure

The stimuli used in the discrimination test were the same twelve sentences used in the identification test along with the other member of the pair. The same 20 listeners as for the identification test heard the 12 pairs of sentences for a maximum of three times. After listening to each pair of sentences, subjects had to decide in which order sentences were presented. This is illustrated below:

(3) *StimuliTask* - choose the order in which sentences are presented:

Da balazos/Daba lazos	1. Da balazos/daba lazos 2. Daba lazos/da balazos
Súbeme lino/sube Melino	1. Sube Melino/súbeme lino 2. Súbeme lino/sube Melino

See Appendix 3 for the whole list of stimuli.

3.2.2. Results

The results of the discrimination test along with those of the identification test are presented in Figure 13. The graph plots the percentage of discrimination responses (dark bars) in contrast with the percentage of identication responses (light bars) so as to check whether sentences in pairs were better distinguished than in isolation. The bars with the lighter colour (sentences in isolation) are identical to those displayed in Figure 12. Thus, the first four light bars correspond to oxytones (sentences from 1 to 4), the second four light bars to paroxytones (5-8) and the last four light bars to proparoxytones (9-12). Taking this distinction into consideration, the results present two clear tendencies, namely, sentences including an oxytone and a paroxytone (sentences from 1 to 8) show a higher percentage of correct identification when heard in pairs than in isolation. Conversely, sentences with a proparoxytone (sentences from 9 to 12) show similar identification rates when heard alone and in pairs. These results suggest that listeners do seem to rely on H alignment to distinguish sentences. The close location of H after the word

boundary in oxytones causes some difficulties in identifying single sentences. However, some improvement on the identification rates is observed when sentences appear in pairs. This indicates that H alignment differences due to word position are a strong cue for word-boundary identification.

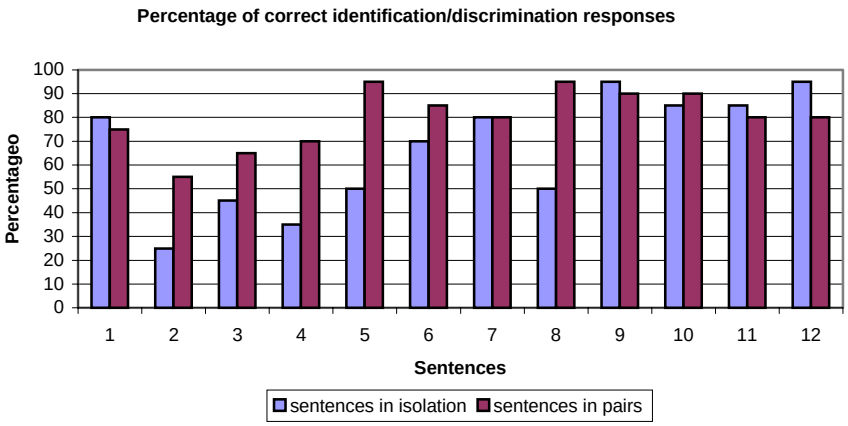


Figure 13. *Mean percentage of correct identification (sentences in isolation) and discrimination (sentences in pairs) responses for the 12 pairs of sentences for the 20 listeners.*

4. DISCUSSION

The results obtained in the production test clearly showed that the F0 peak is aligned after the accented syllable in all kinds of words (oxytones, paroxytones and proparoxytones) indicating that there is no strict anchoring of H at the end of the word. These results agree with those found in Prieto (2005) for Catalan, Estebas-Vilaplana and Prieto (2005, in press) for Catalan and Spanish, and de la Mota (2005) for Spanish. According to these findings, the presence of an H word edge tone in Spanish prenuclear accents is not clear since the F0 peak is not strictly aligned with the end of the word. However, the data also showed a clear effect of within-word position on the alignment of H, since the F0 peak is more retracted (slightly beyond the accented syllable) in oytones than in paroxytones and proparoxytones. Also, proparoxytones showed the largest peak delay with the H

anchored after the post-accentual syllable, namely, on the last syllable of the word. These results indicate that, even though there is no strict anchoring of H at the word offset, the hypothesis of a word final boundary tone is not completely rejected since the location of H is clearly affected by the distance in syllables to the end of the word. This may suggest the presence of a loosely aligned H word edge tone[1]. In this respect, it has been observed that the accentual L in prenuclear accents is not always strictly aligned with the onset of the stressed syllable, especially when stressed patterns are varied. Thus, a similar behaviour can apply to the H accent. The presence of word edge tones in declarative prenuclear accents has also been proposed in Pamies (in press) for the Spanish of Granada and in Estebas-Vilaplana (2000, 2003a, b) for Central Catalan.

The analysis of Spanish prenuclear accents as L*+H bitonal accents, as proposed in Sosa (1999), Face (1999, 2001), Beckman, Díaz-Campos, McGory and Morgan (2002) and Calleja (2004), would clearly account for the location of the F0 peak after the accented syllable. However, this interpretation fails to explain the effect of the stress condition on H alignment. According to Grice (1995), the trailing tone of a bitonal accent is fixed in time with respect to the starred one and this is not the behaviour found in Spanish prenuclear rises where the location of the F0 peak is affected by the number of post-accentual syllables within the word. Given these observations, we propose to account for Spanish prenuclear rising accents by means of an L* pitch accent followed by a loosely aligned H word edge tone.

Similarly, the results of the perception tests seemed to indicate that Spanish speakers rely on H position for a correct identification of ambiguous sentences with respect to word boundary location. Most listeners had less problems in identifying words with stress on the penultimate or antepenultimate syllables than words with a final accent. This can be due to the fact that in oxytones the location of H after the accented syllable may induce to confusion with paroxytones. Similar tendencies were found in Prieto (2005) for Catalan. Further research is currently carried out with synthesised data so as to be able to modify and control the F0 peak location and thus see at which point speakers change their interpertation of the sentences (Prieto, Estebas-Vilaplana and Vanrell, 2006).

In this paper the effects of word boundary location on the duration of the accented and post-accentual syllables were also examined. The results showed no effects of within-word position on the duration of the accented and post-accentual syllables.

[1] This interpretation was suggested by one of the reviewers to whom I am greatly indebted.

Thus, the disambiguation of sentences mainly depended on the location of the H accent. These findings reinfore the idea of an H word edge tone as the main strategy for word boundary identification.

5. CONCLUSION

In this paper we analysed the alignment patterns of rising prenuclear accents in Castilian Spanish by means of a production and two perception tests (an identification test and a discrimination test). In particular, we examined the possibility of modelling the F0 peak as an H word edge tone. The results of the production test showed no strict alignment of H with the end of the word since for all speakers the H was always anchored after the accented syllable. However, H alignment showed to be affected by the stress distribution of words, that is, the F0 peak was more displaced in proparoxytones that in paroxytones and in paroxytones than in oxytones. In oxytones and paroxytones the H was located at the post-accentual syllable and in proparoxytones after the post-accentual syllable. These results seem to indicate the possible presence of an H word final boundary tone with no strict alignment with the word offset. With respect to duration differences, no effects of within-word position were found on the duration of the accented and post-accentual syllables, reinforcing the idea of H location as the main strategy for word boundary identification. Furthermore, a discrimination test and an identification test were carried out to find out whether H alignment can be a helpful cue to identify otherwise ambiguous sentences. The results showed that H alignment differences due to word position were used for a correct identification of word boundaries, giving further support to the idea of an H word-final boundary tone.

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6. REFERENCES

ARRANZ, P. and J. M. GARRIDO (ms): *Un estudio perceptivo del desplazamiento del pico acentual en español*, Barcelona, Universitat Autònoma de Barcelona.

ARVANITI, A.; D. R. LADD and I. MENNEN (1998): «Stability of tonal alignment: the case of Greek prenuclear accents», *Journal of Phonetics*, 26, pp. 3-25.

ARVANITI, A.; D. R. LADD and I. MENNEN (2000): «What is a starred tone? Evidence from Greek», in M. Broe and J Pierrehumbert (eds.): *Papers in Laboratory Phonology V: Acquisition and the Lexicon*, Cambridge, Cambridge University Press, pp. 119-131.

BECKMAN, M.; M. DÍAZ-CAMPOS, J. T. MCGORY and T. A: MORGAN (2002): «Intonation accross Spanish, in the Tones and Break Indeces Framework», *Probus*, 14, pp. 9-36.

BOERSMA, P. and D. WEENINK (1992-2001): *Praat: a system for doing phonetics by computer*, available at http://www.praat.org.

CALLEJA, N. (2004): «Alineamiento fonético de acentos tonales en el castellano de Vitoria», *Estudios de Fonética Experimental*, XIII, pp. 39-63.

CASPERS, J. and V. VAN HEUVEN (1993): «Effects of time pressure on the phonetic realization of the Dutch accent-lending pitch rise and fall», *Phonetica*, 50, pp. 161-171.

DE LA MOTA, C. (2005): «Alignment, word boundaries and speech rate in Castilian Spanish», poster presented in the *Phonetics and Phonology in Iberia conference*, Barcelona, Universitat Autònoma de Barcelona.

ESTEBAS-VILAPLANA, E. (2000): *The use and realisation of accentual focus in Central Catalan with a comparison to English*, University College London, PhD dissertation.

ESTEBAS-VILAPLANA, E. (2003a): «Catalan prenuclear accents: evidence for word edge tones», in D. Recasens, M. J. Solé and J. Romero (eds.): *Proceedings*

of the 15th International Congress of Phonetic Sciences, vol. II, Barcelona, Universitat Autònoma de Barcelona, pp. 1779-1782.

ESTEBAS-VILAPLANA, E. (2003b): «The modelling of prenuclear accents in Central Catalan declaratives», *Catalan Journal of Linguistics*, 2, pp. 97-114.

ESTEBAS-VILAPLANA, E. and P. PRIETO (2005): «The role of word edge tones in Catalan and Spanish», poster presented at the *Phonetics and Phonology in Iberia conference*, Barcelona, Universitat Autònoma de Barcelona.

ESTEBAS-VILAPLANA, E. and P. PRIETO (in press): «Production and perception of word edge tones in Catalan and Spanish», *Proceedings of the III Congreso de Fonética Experimental*, Universidad de Santiago de Compostela, 2005.

FACE, T. (1999): «A Phonological analysis of rising pitch in Castilian Spanish», *Hispanic Linguistics*, 11.

FACE, T. (2001): *Intonational marking of contrastive focus in Madrid Spanish*, Berlin, Lincom Europa.

GRICE, M. (1995): «Leading Tones and Downstep in English», *Phonology*, 12, pp. 183-234.

HUALDE, J. I. (2002): «Intonation in Spanish and the other Ibero-Romance languages: overview and status quaestinois», in C. Wiltshire and J. Camps (eds.): *Romance phonology and variation*, Amsterdam, J. Benjamins, pp. 101-115.

LADD, D. R. and A. SHEPMAN (2003): «"Sagging transitions" between high pitch accents in English: experimental evidence», *Journal of Phonetics*, 31, pp. 81-112.

LEHISTE, I. (1960): «An acoustic-phonetic study of internal open juncture», *Phonetica*, 5, pp. 5-54

NIBERT, H. (2000): *Phonetic and phonological evidence for intermediate phrasing in Spanish intonation*, University of Illinois at Urbana-Champaign, PhD dissertation.

PAMIES, A. (in press): «Observaciones sobre la estructura melódica en enunciados declarativos», *Proceedings of the III Congreso de Fonética Experimental*, Universidad de Santiago de Compostela, 2005.

PRIETO, P. (2005): «Word edge tones in Catalan», submitted to M. D'Imperio (ed.): *Italian Journal of Linguistics*, 17 (Special issue on Autosegmental-Metrical approaches to intonation in Europe: Tonal targets and anchors).

PRIETO, P.; E. ESTEBAS-VILAPLANA and M. M. VANRELL (2006): «The role of tonal alignment and velocity of the rise on word-boundary identification in Catalan and Spanish», poster presented at the *10th Conference on Laboratory Phonology*, Paris.

PRIETO, P.; J. VAN SANTEN and J. HIRSCHBERGH (1994): «Patterns of F0 peak placement in Mexican Spanish», *Proceedings of the ESCA/IEEE Workshop on Speech Synthesis*, New Paltz, New York, pp. 33-37.

PRIETO, P.; J. VAN SANTEN and J. HIRSCHBERGH (1995): «Tonal alignment patterns in Spanish», *Journal of Phonetics*, 23, pp. 429-451.

SILVERMAN, K. and J. PIERREHUMBERT (1990): «The timing of prenuclear high accents in English», in J. Kingston and M. Beckman (eds.): *Papers in Laboratory Phonology V: Between the grammar and physics of speech*, Cambridge, Cambridge University Press, pp. 72-106.

SOSA, J. M. (1999): *La entonación del español: su estructura fónica, variabilidad y dialectología*, Madrid, Cátedra.

TURK, A. E. and L. WHITE (1999): «Structural influences on accentual lengthening in English», *Journal of Phonetics*, 27, pp. 171-206.

APPENDIX 1

List of the pairs of ambiguous sentences used in the production test.

1.	Ve bovinos Bebo vinos	11.	Ve bovinitos Bebo vinitos
2.	Ve bovinos blancos Bebo vinos blancos	12.	Ve bovinitos blancos Bebo vinitos blancos
3.	Da balazos Daba lazos	13.	Da balazotes Daba lazotes
4.	Da balazos muy fuertes Daba lazos muy fuertes	14.	Da balazotes muy fuertes Daba lazotes muy fuertes
5.	Sube Melino Súbeme lino	15.	Sube Melinito Súbeme linito
6.	Sube Melino Blanco Súbeme lino blanco	16.	Sube Melinito Blanco Súbeme linito blanco
7.	Llama Melina Llámame Lina	17.	Llama Melinita Llámame Linita
8.	Llama Melina Romero Llámame Lina Romero	18.	Llama Melinita Romero Llámame Linita Romero
9.	Vende mesillas Véndeme sillas	19.	Vende mesillitas Véndeme sillitas
10.	Vende mesillas de roble Véndeme sillas de roble	20.	Vende mesillitas de roble Véndeme sillitas de roble

APPENDIX 2

List of the stimuli used in the identification test.

1. Da balazos
2. Ve bovinitos
3. Da balazos muy fuertes
4. Ve bovinos blancos
5. Llama Melina
6. Sube Melino
7. Daba lazotes
8. Vende mesillitas
9. Súbeme lino
10. Véndeme sillas de roble
11. Llámame Linita Romero
12. Súbeme lino blanco

APPENDIX 3

List of the stimuli used in the discrimination test.

1.	Da balazos Daba lazos	7.	Daba lazotes Da balazotes
2.	Ve bovinitos Bebo vinitos	8.	Vende mesillitas Véndeme sillitas
3.	Da balazos muy fuertes Daba lazos muy fuertes	9.	Súbeme lino Sube Melino
4.	Ve bovinos blancos Bebo vinos blancos	10.	Véndeme sillas de roble Vende mesillas de roble
5.	Llama Melina Llámame Lina	11.	Llámame Linita Romero Llama Melinita Romero
6.	Sube Melino Súbeme lino	12.	Súbeme lino blanco Sube Melino Blanco