

High Initial Tones and Plateaux in Brazilian Portuguese: Implications for Stress in Portuguese and Spanish

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Abstract

This paper investigates the presence of phrase-initial high tones in Brazilian Portuguese (BP) and in Peninsular Spanish neutral declaratives. Like in other recent work, we observe that neutral declarative sentences in BP very frequently present high initial pitch events, which may be classified as either pitch accents or phrasal tones. We further observe that phrasal tones in initial position in BP neutral declaratives can be expressed as either a peak or a plateau. By analyzing comparable materials in Peninsular Spanish, we conclude that this language lacks the phrase-initial high tone phenomenon, also in agreement with previous work. We argue that F₀ is a less reliable cue of stress in BP than in Spanish, since pitch excursions frequently occur on phrase-initial syllables that lack lexical stress. To compensate for this diminished reliability, duration plays a much greater role as a cue of lexical stress in BP than in Spanish. As the reliability of F₀ as a cue of stress decreases, the reliability of another stress cue increases.

1. Introduction

Phrase-initial pitch rises (hereafter Hi) have been previously reported in Romance languages such as French (Jun and Fougeron [12] and Welby [19]) and Portuguese, but not for other languages of the same family, such as Spanish and Catalan. Regarding Portuguese, Frota [4] calls our attention to the fact that initial rises in European Portuguese (EP) show great variability of alignment, as they can be aligned with the first stressed syllable of the intonational phrase, with a prestressed syllable or even with a poststressed one. While Frota [5] proposes that the initial peak should be treated as a pitch accent, Vigário [18] analyzes the peak as a phrasal tone that would signal the beginning of the intonational phrase.

In more recent work, Frota [6] gives evidence for two types of initial peaks in EP intonation, which she classifies as accentual peaks and phrasal tones. While the first type would be aligned relative to the first stressed syllable of the intonation phrase, the second type is aligned with the left-edge of the same phrase and always happens within the limits of the first prosodic word of the phrase.

Regarding BP, comparative work has shown that it has a higher density of pitch events associated with the stressed syllables and non-stressed ones than EP Frota and Vigário [7]. In addition, like EP, it also has phrase-initial rises. As Fernandes [3] remarks, besides the pitch accent associated with the stressed syllable, BP presents “an additional H tone aligned with the second or third pretonic syllable [of a prosodic word]”.

Other Romance languages such as Spanish and Catalan, appear to lack this feature. Despite the great amount of literature addressing Spanish intonation (Navarro Tomás [14], Prieto et al. [15], Sosa [17], Hualde [11], and Face [1] among

others) to my knowledge there is no report of Hi pitch events in the Spanish sentence initial position that are additional to the pitch accent, such as phrasal tones.

The present study intends to compare sentence initial position in neutral declaratives in BP and Peninsular Spanish (hereafter Spanish) in search for these additional pitch events and evaluate the implications of the findings to the correlates of stress in these two languages.

The fact that additional H tones can co-occur with pitch accents in BP in phrase-initial position suggests a relative dissociation between pitch accent and stress in this variety of Portuguese.

The data collected for the present study confirms the presence of Hi pitch events in BP, suggesting however, a much more complex distribution than the one suggested by Fernandes [8]. While the literature thus far refers to the Hi pitch events in BP as peaks, our data shows that these events can be realized either by a peak or by a plateau. This is important for three different reasons. First, knowing that Hi's can appear in BP's pitch contours as either peaks or plateaux allows us to have a better understanding of BP intonational contours. Second, as this study proves the presence of these Hi events in Portuguese, but its absence in Spanish, we are able to draw conclusions about the relationship between pitch and stress in these two Languages. Third, the acknowledgment of Hi events in BP and its different shapes provides us with useful information to more efficiently model intonational contours in BP.

2. Corpus and experiments

We recorded four native speakers of BP, from Recife, and four native speakers of Spanish, from Bilbao. All subjects were born and raised in the metropolitan region of their respective cities and they were all females between 26 and 33 years old at the time of the recording. Seven of these subjects had completed a college education. The eighth subject had the equivalent of a high school diploma.

Subjects were asked to read a list of the sentences three times, in the same pace they speak to friends or family members in informal situations. Word size is an important variable in this experiment because both Frota [6] and Fernandes [3] suggest that words need to have more than two prestressed syllables available in order for an additional Hi pitch event to serve as an anchor at the prestressed location. Therefore, for the present experiment the number of syllables of the target words varies from two to seven, while the lexical word-stress is placed in a fixed position. Target words always have penultimate stress.

Target words for this experiment are always placed as the first phonological word and are always followed by a verb stressed on the fourth syllable. The decision to have a fixed stress pattern surrounding the target word was made with the intent of controlling possible influences on target contour. The

data was collected in the quietest room of the building where the researcher met with each subject. Speech was sampled at 22,000 Hz. After collection, the data was manually segmented. After removing the data affected by mispronunciation or truncation, a total of 561 target words were included in the statistical analysis.

3. Results

3.1 The shape

The first interesting thing we noticed was the shape of the F0 contour in Spanish and BP sentence initial position. In Spanish, we can notice the absence of visible meaningful variations on the pitch contour preceding the pitch accent (see Figure 1), as the first observable rise coincides with the stressed syllable. In the example in Figure 1, this syllable is /-lis/.

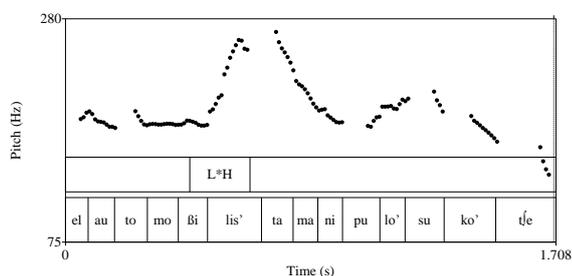


Figure 1: Pitch contour of absence Hi before first L*H (Spanish).

On the other hand, in the BP data, sentence initial position has three different variations. First, similar to what can be seen in Figure 1 for Spanish, it was sometimes possible to see an absence of major pitch variations preceding the first pitch accent in BP. In most BP tokens, however, Hi tones preceding the first word's lexical accent could be identified, as can be seen in Figure 2 and Figure 3.

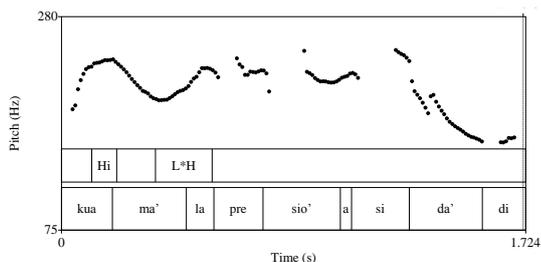


Figure 2: Pitch contour of Hi peak before first L*H. (BP)

These Hi tones in some cases were shaped like peaks (see Figure 2) as they are commonly presented as a brief sinusoid. This tended to occur most frequently when the target word was a short word, with two to four syllables.

Finally, we also find cases where the first pitch accent is preceded by a plateau, as the pitch rises at the beginning of the phrase or first prosodic word and remains high for several syllables, up to the immediate pretonic, see Figure 3:

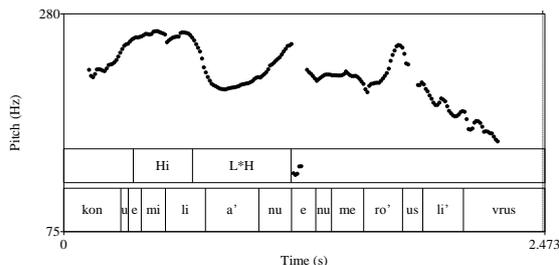


Figure 3: Pitch contour of Hi plateau before first L*H. (BP)

3.2 Presence or absence of phrasal peaks

Hi pitch events may be phonologically analyzed in one of two ways: (i) they may be phrasal tones or, (ii) they may be part of the lexical pitch accent [12][19][6]. In order to identify and categorize the phrase-initial rises in this corpus, we employed the following criteria (see Frota [6]): (i) we identified the pitch accent aligned to the stressed syllable of each target word, and (ii) once the pitch accent was established, if the token presented a pitch excursion superior to 15 hertz Hz preceding the pitch accent, this excursion was labeled as a phrasal tone in the BP corpus.

The difference in Hz was calculated from the peak to the lowest point before the following rise. The decision to have 15 Hz as a minimum value in order to call a pitch variation meaningful is based on the fact that normally F0 variations due to segmental influence are less than 15 (Hz) (See [9][13][19]). The results for BP are as follows:

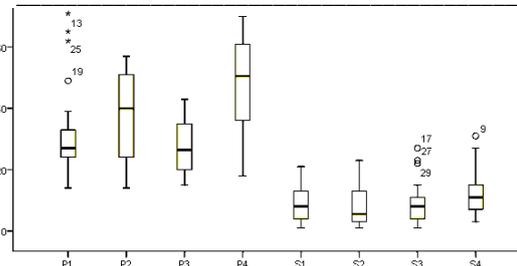


Figure 4: Value in Hz for Hi in BP and SP.

For subject P1, the pitch excursions preceding the pitch accent were higher than 15 Hz in 92% of the tokens; 59% for P2; 69% for P3, and 94% for P4. While the Spanish corpus normally did not present major variations on the pitch contour preceding the target word's pitch accent, we decided to label the highest point of the contour preceding the pitch accent in order to be able to compare its height to the measurements taken for BP.

Figure 4 shows that while in BP (P1-P4) the pitch events preceding the lexical stress range 20-60 Hz, in Spanish, they normally don't exceed 15 Hz. Based on these results, we claim that BP presents phrasal tones, but Spanish does not.

3.3 Location of the phrasal peak in BP

3.3.1 Using the beginning of the word as a reference

When trying to predict the location of the phrasal peak, Frota [6] counts the syllables starting from the left boundary of the phonological word and tries to identify with which syllable of

the word the phrasal peak may be aligned. Her results show that when the phrasal peak is present, it is normally aligned with either the second or the third syllable of the first prosodic word, being able to also occur in the second prosodic word.

The BP results for the present experiment show that for target words with two syllables the phrasal peak tends to be placed between the article and the first syllable of the word. The data show that as the number of syllables in the target word increases, the peak is displaced to the right. If the word is composed of three syllables, the peak is located after the beginning of the first syllable. For words with four syllables, the peak occurs around the beginning of the second syllable. As words increase in number of syllables, the peak does not keep on moving towards the right. In words with five, six and seven syllables, the phrasal peak is, on average, located at about the same point, which is between the second and the third syllables of the word.

3.3.2 Using the lexical stress as a reference

Following Frota [6], we calculate the distance between the location of the word's lexical stress and the Hi that precedes it to verify whether the pitch accent can serve as a reference point to predict the location of the phrasal peak.

To verify whether there is a fixed distance between the phrasal peak and the pitch accent that follows it, we plotted results from words that have a LH pitch accent preceded by a phrasal peak in Figure 5. As long and short words seem to behave differently in the measurements taken in 3.3.1, we plot the two types of words separately in Figure 5.

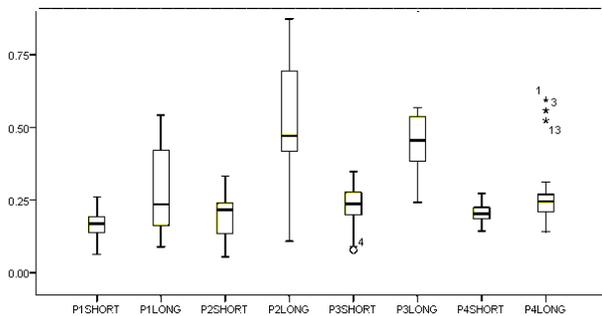


Figure 5: Distance in seconds between the phrasal peak and the L in the stressed syllable.

By comparing the left to the right plot for each one of the subjects (P1-P4), it is clear that the peak is much closer to the L target in the short words than in long words. First, for any given subject, the median line for the box plots in long words is always located higher than for short words. That implies that in shorter words the peak is normally located closer to the L target than in longer words. Second, in long words the boxes are normally larger than in short words. That indicates that the values of the distance between the peak and the L tone are more dispersed in long words than in short ones and that the standard deviation is larger in long words. R-square results show that in short words the phrasal peak is correlated to the stressed syllable 66-94% of the time, while in long words the phrasal peak is correlated to this syllable 24-54% of the time. Overall these results show a good correlation between the phrasal peak and the stressed syllables in short words, but show no relationship between the phrasal peak and the lexical stress in long words.

4. Peaks and plateaux

In the previous section, we showed that long and short words do not seem to behave in the same way regarding the position of the initial phrasal peak. A clear distinction in this data is that while in short words the phrasal tone is commonly presented as a peak, for longer words the phrasal tone resembles a plateau. Additionally, it is important to notice that the placement of the phrasal peak in a word with two to four syllables is clearly established at the top of a single sinusoid, whereas the location of the highest point within the plateau varies as the highest point of the plateau can be located at its beginning, middle or end. Moreover, it is important to take into consideration that the difference between the highest and the lowest values within a plateau are on average only 6 Hz in our data. Given the large variation in location of the highest point within plateau, and the small variation in Hz, we question whether the exact location of the plateau's highest point is really the only important point to focus on when dealing with the phrasal tone in BP. Perhaps, instead of focusing on the highest point of a plateau, we should be asking a different question, such as: why are there plateaux on longer words?

If we consider that both the peaks and the plateaux are expressions of the same pitch event, the phrasal tone, we will then be able to argue that the whole area of the plateau is of phrasal tone domain. Meaning that, independently of word size, the whole extension of the F0 contour preceding the first word's pitch accent can potentially be accessed by the phrasal tone in this data. Our mission then is to try to determine which criteria the phrasal tone follows when accessing the stressed portion of the pitch contour.

Our hypothesis is that a speaker just raises his/her pitch by assigning an H tone to the beginning of the phrase. Once this H tone has been assigned, it spreads for as long as possible within the phrasal tone domain and just when the next target needs to be reached, (e.g. the next L tone) the action loses its effect and the pitch lowers again.

If we assume that both the peak and the plateau are two different representations of the same H phrasal tone, we can use tonal spreading to explain these two different shapes for the same pitch event. A similar case has been reported in the literature by Grice, Ladd and Arvaniti [8] who have used the double association of phrasal tones to explain the formation of plateaux in Transylvanian Romanian. In contrast to the present study, the plateaux in Transylvanian Romanian are not located at a phrase initial position, but after the nuclear stress.

5. Discussion

In section 3.2 we show that while BP tends to present phrasal tones preceding the first pitch accent of the sentence, Spanish, in contrast, lacks any significant pitch event not related to the lexical stress in sentence initial position.

Next, we showed that in short words the phrasal peak tends to align between the article and the first syllable of the word. As words increase in number of syllables, the peak tends to migrate towards the right, but going no further than the second or third syllable of the first prosodic word of the sentence. Therefore we support the results of Frota [6] and Fernandes [3] while adding that the peak can be located before that as well.

We also tried to predict the location of the phrasal peak in relation to the lexical stress in the target words of this corpus. The results show a dichotomy between short and long words. While the phrasal peak seems to be closely related to the

stressed syllable in the first group of words, the peak was shown to vary more in location in the second group of words. These results are not surprising if we take into consideration that the longer the word, the further the stressed syllable is from the second and third syllables, which is the limit that was established for anchoring in section 3.3.1.

The present research adds to previous studies on this topic as it suggests that the peak is not the only possible presentation of the phrasal tones in Portuguese (more specifically in BP) and that this pitch event may assume the shape of a peak or a plateau.

Acknowledging the presence of sentence initial phrasal tones and plateaux in BP allows us to contemplate the tonal density of the intonational contour in this language. If compared to Spanish for example, which lacks this feature, we see that initial F0 rises in Portuguese fulfill functions beyond the expression of lexical stress, while in Spanish this is not the case.

Understanding the basic role of F0 rises for each language allows us to rethink the function of this acoustic correlate of stress in both of these languages. The present results are empirical proof that at this specific sentence position, F0 rises in Portuguese normally serve two different purposes, to express stress with pitch accents and to indicate the beginning of a prosodic unit using phrasal tones. By serving these two different purposes, it is obvious that F0 cannot be an acoustic correlate of stress in BP as reliable as it is in Spanish, where its only function is to express stress at this sentence position.

In related work we have shown that duration is a much less reliable stress cue in Spanish than in BP, Ferreira [2]. It is interesting to note the change of roles here, as F0 is a less reliable cue of stress in BP than in Spanish. It appears that the decreased reliability of one these two cues of stress is compensated by a greater use of the other cue.

In section 4, we suggested that the double association of the H tone could explain why in short words the phrasal tone is present as a peak, while in long words the same phrasal tone could be expressed as a plateau. If we accept this suggestion, we should consider the implications of having the phrasal tones in BP represented as either peaks or plateaux.

We can more efficiently model intonation by recognizing the existence of plateaux in BP sentence initial position. House et al. [10] have observed possible plateau formations at the neighborhood of the nuclear pitch accents in British English. Instead of just focusing on the highest single point of the pitch movement, the peak, they realized that when modeling the nuclear accent they obtained better results by marking two points, the beginning and the end of the plateau formation. Therefore, an important lesson that we can take from this study is that the peak is not necessarily always the most important pitch target in all situations.

6. Acknowledgements

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7. References

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