Sentence type and prenuclear contours in Brazilian Portuguese: production and perception

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Abstract

In this paper we examine the intonation of the interrogative sentence mode in Brazilian Portuguese (BP), and how questions differ from their declarative counterparts. With this purpose, we characterize the nuclear patterns, as well as the prenuclear contours. Our aim is to identify which specific prosodic features, including prenuclear pitch range values, are systematically associated with the interrogative mode of enunciation. In the interdialectal comparison, we contrast how the speakers from Blumenau (SC) in the South and Aracaju (SE) in the Northeast, distinguish themselves from speakers of other varieties in their prenuclear patterns. These are significantly higher for the yes/no interrogatives than for the declarative types, which is not the case within other dialects in our study, including the standard varieties of Rio de Janeiro and Sao Paulo. Perception tests have corroborated the production results.

Index Terms: Phonology and phonetics of prosody, Prenuclear contours, Brazilian Portuguese

1. Introduction

In this paper, we analyse how the interrogative sentence mode is encoded in some dialects of Brazilian Portuguese (BP), and how yes/no questions differ from their neutral declarative counterparts. Our aim is to identify which specific prosodic features, including prenuclear pitch range values, are systematically associated with the yes/no interrogative mode of enunciation.

The distinction between statement and question intonation has been widely studied and has been claimed to be universal. The link between sentence mode and intonational contours has been established and the use of rising question intonation in yes–no questions has been reported for the great majority of languages, including those that are tonal.

In a number of Romance languages, such as Spanish and Brazilian Portuguese (BP), intonation is the sole method of distinguishing a yes–no question from a declarative statement. Patterns are generally assumed to be falling in statements and rising in questions, as they are in English, but as we show, this is an oversimplification. In the case of BP, more accurate is the statement by Bolinger [1] of "higher pitch somewhere in the utterance", mostly but not necessarily, rising intonation.

Indeed, the typical patterns for yes-no interrogatives in BP, although high in pitch, have been reported to have a final 'circumflex' falling intonation, and not a rising one. Lucente and Barbosa [2] transcribe the intonation of yes-no questions in BP as L+H*L%, stating that "there is a peak in the middle of the accented vowel and its fall coincides with the end of the vowel."

Moraes [3] has characterized the nuclear contours for declaratives and yes-no interrogatives in BP as H+L*L% and L+H*L% respectively, that is, both are falling intonations. The final peak for declaratives utterances happens categorically on the pre-stressed syllable, whereas the peak for the yes-no interrogative is on the accented syllable. In this same study the final contour of yes-no questions in BP is characterized as a nuclear tonal rise on the stressed syllable, followed by a fall in the following unstressed syllables. The AM notation used is the 'hat pattern' L+H*L%.

Although the unmarked, neutral yes-no questions in BP have been described as falling, as we saw, this does not exclude rising final contours with H% boundary tones. In our reseach, we have found a number of such rising contours in more marked interrogatives such as confirmatory or incredulous questions [4]. Also, some rising yes-no questions arise from truncation, that is, the incomplete rendition of the rising-falling pattern due to lack of segmental material; this occurs in utterances with stress on the final syllable, and also in cases of final vowel deletion.

It has also been reported that many dialects of BP regularly use a rising contour for the unmarked yes-no questions; for instance, in the South (Porto Alegre-- RS) [5], Lages – SC [6] and the Northeast (Aracaju - SE) [7]. In each of these dialects, a nuclear pattern L H*H% has been proposed for the nuclear region.

Some studies, such as the one in [8] have even proposed a kind of division of varieties of BP based on the final contour of interrogatives, with an isogloss that would divide the country into two halves: the one using rising contours in North, the one using the falling, 'circumflex' contour in the South.

In our data of different varieties of BP, we have found a number of such rising contours, but the analysis of their specific contexts and pragmatic uses (USE) is still in progress.

Our current findings indicate that, for the interrogative tonal nucleus in some southern regions, the pronunciation of the speakers from the cities of Florianopolis and Blumenau show a circumflex contour (L+H*L%), with or without truncation [4,6]. The performance of the two speakers from the city of Lages showed two terminal contours: L+H*H% and L+H*L%, the latter being the most frequent. We noted how the production of these utterances by the Aracaju informant had a recurrent rising contour L+H*H%, in spite of also exhibiting the L+H*L% contour [7].

Our research has also uncovered a kind prenuclear contour that is different from the one described in the literature for BP, which was like the prenuclear reported for Spanish, i. e., higher for questions than for declaratives.

In order to present the results of this research, in the following Section 2 we describe the data collection, analysis and results for the prenuclear contours that resulted from the production tests. In section 3, we present the methods used and results obtained in the perception experiments; and finally we present the conclusions we can draw from our results.

2. Production of prenuclear contours

Studies in languages such as Spanish [9] have established that sentence-initial f0 peaks of interrogatives are significantly higher than those in statements, by values that are strikingly regular in terms of tonal targets. It is for this reason, it has been claimed, that the Spanish spelling system uses the inverted question mark "¿" in order to indicate the beginning of the question.

This phenomenon of higher initial peaks has also been noted in languages such as Danish and Swedish and Bengali, but it does not seem to occur in English or French. But what about BP? Given some preliminary observations about this phenomenon, we investigated whether the prenuclear contour marked as well.

Moraes [3] for instance, has observed that the neutral yes-no question is characterized by a melodic rise on its first accented syllable, which is slightly higher than that observed in statements; this rise often reaches the post-stressed syllable. However, he also remarks that perceptual tests for the Rio de Janeiro dialect, have not shown that the distinction observed in relation to statements concerning the pre-nuclear accent, does plays a role in the auditory recognition of the two modalities [10]. Thus it seems that, at least for the Rio variety, it is on the nuclear accent that the contrast is concentrated. Other studies have confirmed that for the Florianópolis variant, the prenuclear region is not significantly different [11].

As we argue, yes/no questions in Brazilian Portuguese differ from declaratives based largely on the tonal structure of the nuclear contour. However, in a number of dialects such as the varieties of BP spoken in Blumenau, Santa Catarina (South), and Aracaju, Sergipe (Northeast), the increased height of prenuclear peaks seems to be a recurrent feature that characterizes yes-no questions (as well), as it occurs in the other languages referred to such as Spanish [9].

In order to test the occurrence of the wider interrogative prenuclear register span, we compared neutral declarative utterances and neutral yes/no questions in these dialects of BP.

2.1. The production experiments

Our data was collected from the AMPER-POR Project [12], with informants of both genders from the target cities in the state of Santa Catarina, Brazil: Florianopolis, Lages and Blumenau; and from the state capital of Sergipe, Aracaju

Our goal was to observe if there were differences in the prenuclear, as well as in the nuclear contours of yes-no questions between the speakers of those localities. For this, we compared the intonations of neutral declarative utterances and their corresponding (the) yes-no questions.

We analised a total of 382 neutral declarative sentences, and 382 yes-no questions. The samples were analysed automatically by the interface software of the AMPER Project [12] which generated figures that overlap the pitch curves of the declarative and interrogative modes, on the basis of three repetitions of the same sentence, as in Figure 1.
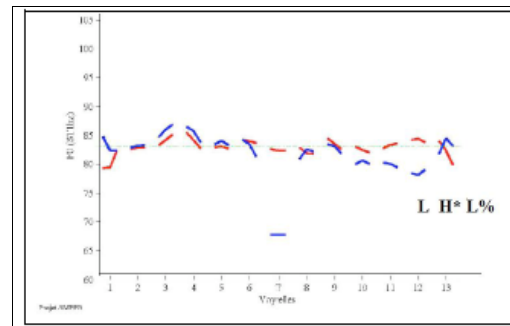

Figure 1: *Yes/no Interrogative (blue) and declarative (red) renditions of the sentence: "O Renato gosta do pássaro nadador" of the Florianopolis speaker.*

The statistical tests were done with SPSS, to verify if there were significant differences in the declarative and interrogative modes. For the statistical analysis we used SPSS Program (SPSS Statistic 17.0. Polar Engineering and Consulting, copyright 1993-2007). The dependent variable was the fundamental frequency (*f*0) and the independent variables were the position of the vowel in the prenuclear region (stressed and post-stressed) and the sentence type (declarative and interrogative). Since the data for each variable group was rather small, around 20 items in each, we chose the non-parametric Mann-Whitney U, which compares two independent groups [13]. With the value p<0.05, we could see whether the differences were or not.

2.2. Production results

Now we describe the initial part of sentences in order to characterize the prenuclear contour.

The male speaker from Florianópolis did not have substantial prenuclear differences between declaratives and interrogatives, as we see in Figure 1. For the male speaker from Lages, the prenuclear contour was also virtually identical for declaratives and interrogatives.

For the male speaker from Blumenau on the other hand, the first stressed syllable is much higher in interrogatives than declaratives; this was statistically significant, as shown in Table 1.

Table 1. *Mean values and standard deviation patterns of the fundamental frequency (F0) in Hz, found in the stressed and post-stressed positions of the prenucleus of the declarative and interrogative types, for males and females, and comparison of these types for the Blumenau (SC) data.*

| Position | Subject | Declarative | | Interrogative | | Test* |
		Mean (SD)	N. data	Mean (SD)	N. data	
Stressed	Male	125 (3)	20	151 (10)	20	Z = -5,42, *p<.001*
	Female	204 (11)	20	283 (47)	20	Z = -3,89, *p<.001*
Post-stressed	Male	147 (6)	20	138 (6)	20	Z = -4,64, *p<.001*
	Female	253 (29)	20	319 (37)	20	Z = -4,77, *p< .001*

*The statistic test was *Mann-Whitney U*, applied to compare the types of sentences (declarative x interrogative). SD = standard

deviation; Z = value of statistical test; *p* = significance; significant results are in bold (*p*<,05).

Our first relevant finding was that in the interdialectal comparison, the speakers from Blumenau, both male and female, distinguish themselves from the speakers of the other varieties in their prenuclear patterns, significantly higher than the declarative counterparts (as in Figure 2). This does not appear to happen with the speakers from Florianópolis [11] and Lages (as in Figure 3).
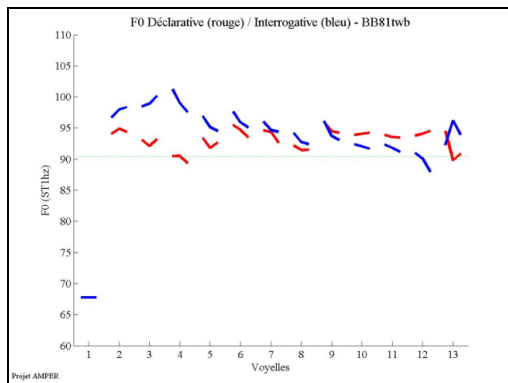
Figure 2: *Contours of yes-no questions and neutral declaratives: production of a Blumenau speaker of a yes-no question (blue) and a neutral declarative (red) of the sentence "O Renato gosta do pássaro nadador"* [7].
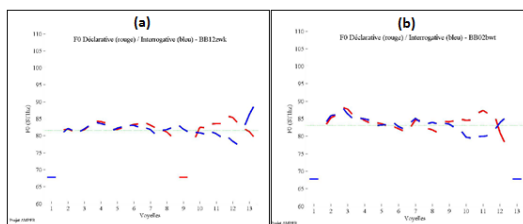
Figure 3: *Contours of yes-no questions and neutral declaratives: in (a) the production of a yes-no question (blue) and a neutral declarative (red) of the sentence "O Renato bêbado gosta do bisavô" by the Lages speaker; and in (b) the production of a yes-no question (blue) and a neutral declarative (red) of the sentence "O pássaro nadador gosta do Renato"* [7].

We found that the Aracaju data also presented this behavior (as in Figure 4), and that difference between declaratives and interrogatives in the prenuclear contour for the Aracaju data are statistically significant, as shown in Table 2.
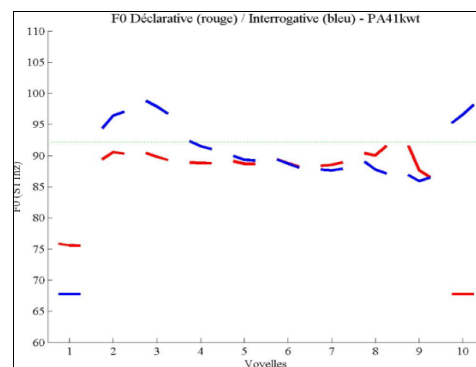
Figure 4: *Yes-no question (blue) and declarative (red) of the sentence "O bisavô gosta do Renato" by the male informant from Aracaju* [7].

Table 2. *Mean values and standard deviation of the fundamental frequency (F0) in Hz, found in the stressed and post-stressed prenuclear positions for the declarative and interrogative, of the Female group, and comparison of the two types for the Aracaju (SE) data.*

Position	Declarative		Interrogative		Test
	Mean (DP)	N. data	Mean (DP)	N. data	
Stressed	191 (22)	20	230 (54)	25	Z=3,30, **p=.001**
Post-stressed	198 (27)	20	231 (51)	22	Z=2,79, **p=.005**

These results were then verified in perception experiments with stimuli that tested whether listeners could perceive the differences in the prenuclear region, as is explained in the next section.

3. Perception of prenuclear contours

3.1. The perception experiments

We conducted three different perception experiments. In these tests, 40% of the items were distractors and 60% corresponded to sentences that showed prenuclear differences between the declarative rendition and the interrogative. The tests were set and applied as follows.

The first one (1) was to verify whether the sentence types would be recognized with only the f0 contour of the whole sentence. In this test, the subjects only heard the f0 contour, without any segmental information (filtered utterance); (2) the second was to verify if the sentence types would be perceived with only the subject NP (the first prenuclear peak) of the sentences with the actual words without hearing the end of the sentence. In this test, the subjects heard the beginning of a sentence in natural speech, either a yes/no question or a neutral declarative utterance. The listener had to decide whether he/she heard the stimulus as a statement or a question, with only the subject NP prenuclear contour to be heard; (3) the third aimed to verity if the listeners could perceive the mode of the sentence hearing only the f0 contour of the subject NP of the sentence. In this test the subjects only heard the filtered beginning of each sentence, and again

had to decide whether he/she heard the stimulus as a statement or a question, purely with the tonal information of this subject NP (see Figure 5).
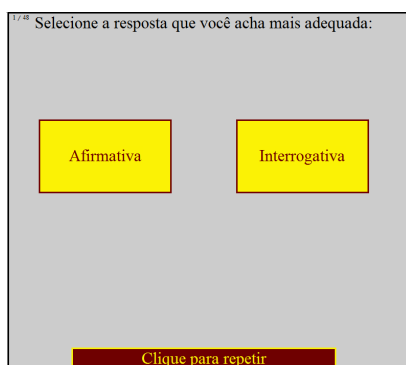

Figure 5: *Sample of perceptual discrimination test of dialects and sentence types.*

For each of the tests there were 116 stimuli for a total of 348. Each of the three types of tests were taken by six listeners. 116 stimuli X 3 tests X 6 listeners = 2088 stimuli in total. This test was staged with Praat and the results were collected automatically, also with Praat. Results proved to be consistent and significant when related to speakers from Blumenau (SC).

3.2. Perception results

Results of the perception tests were far more consistent when related to speakers from Blumenau than those from Florianopolis and Lages. Consistency was considered in terms of the number of correct responses of the subjects in relation to the type of sentence to which the subject NP belongs.

Test 1, which evaluated whether the sentence was declarative or interrogative by means of solely the information given by the filtered stimuli, resulted in the greatest score of correct responses, 67% (Figure 6).

Test 2, which evaluated the stimuli that consisted of the words that integrated the prenucleus of the sentences without any filtering, resulted in 57% of correct responses (Figure 6), with three of the listeners scoring a percentage above 60%.

Test 3, which consisted of the filtered prenuclear contour, only received 51% of correct responses (Figure 6), although two listeners scored a percentage of correct responses close to 60%.

This last result seemed to show more random responses. This was likely due to the very limited information presented to the listeners; in addition to not having the segmental information, the stimuli were very short in duration.

Thus, we can consider the results of test 2 to be more consistent regarding the initial part of the utterance, which presented real words that integrated the prenucleus of the declarative and interrogative sentences. These perceptual results seem to confirm the significant differences found in the prenuclear region in the production of the Blumenau speakers.
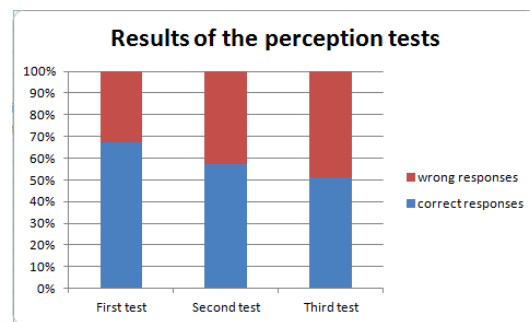

Figure 6: *Graph with the responses to the three perception tests.*

4. Conclusions

The results of our research in Brazilian Portuguese, suggest that at least in some dialects, the vertical, quantitative dimension is used significantly to distinguish sentence modes (Tables 1 and 2), as well as categories of pragmatic meaning. There is overwhelming evidence that it is in the nuclear contour that the distinctive clues are encoded, that is, in the trajectory and direction of the terminal melodic line.

The typical contours of these sentences have been shown in BP to differ in significant ways, based not only on contour shape but also on pitch-height-related phenomena. The final contour can be either rising or falling, but the peaks tend to be consistently higher in interrogatives than in declaratives.

The different sentence types are typically represented by a specific tune, or variety of tunes. Yes-no interrogatives tend to be remarkably regular in terms of the tonal design, as well as in the value of the tonal targets. We have, however, identified more than one typical tune, according to the dialect. These differences are also perceived in the prenuclear contour. We conclude that the prenuclear contour, although significant in at least those dialects of BP we described here, do not seem to be used in all the varieties we have studied thus far.

What the analysis shows is that there are significant differences for Blumenau as well as for Aracaju, and that the percentage of identification of the two sentence types, especially for Test 2, was nearly 60%.

More results and further discussion will be available as our research progresses.

5. Acknowledgements

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