THE RELATIONSHIP BETWEEN LEXICAL STRESS AND INTONATION IN THE PROSODICAL CHARACTERIZATION OF THE BRAZILIAN PORTUGUESE SPOKEN IN THE NORTH OF BRAZIL

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Abstract

This paper aims to present an intradialectal analysis of the modal intonation role on Brazilian Portuguese spoken in northern Brazil. We selected speech samples from four survey areas of Pará State from AMPER corpora. The corpus is formed by 12 sentences grouped by lexical stress and realized in both intonational modalities. The data analyzed in this work comprised 1,728 data (12 sentences x 2 intonation modalities x 3 best repetitions x 4 survey areas x 6 speakers) and to handle such an amount of data an automated data processing was carried out. So, the data reveal an identity between the spoken varieties in the north of Brazil with regard to modal intonation. The results support a hypothesis of a circumflex intonation contour to mark questions, valid in all survey areas, which reinforces the previous description for the interrogative in PB, rising on the stressed syllable, downward on the posttonic syllable.

Keywords

prosodic variation, Brazilian Portuguese, intonation, acoustic analysis, AMPER project

O PAPEL DO ACENTO LEXICAL E DA ENTOAÇÃO MODAL NA CARACTERIZAÇÃO PROSÓDICA DO PORTUGUES FALADO NO NORTE DO BRASIL

Resumo

Este artigo apresenta uma análise intradialetal do papel da entoação modal na caracterização da variedade do português falado no Norte do Brasil. Foram selecionadas para a análise amostras de fala

de 4 localidades paraenses dos *corpora* formados para o projeto AMPER-POR. Ao todo foram analisados 1728 dados (4 sentenças x 3 acentos lexicais (oxítono, paroxítono e proparoxítono) x 2 entoações modais (declarativa neutra e interrogativa total) x 3 melhores repetições x 4 localidades x 6 locutores) que foram submetidos a um tratamento automático dos dados. Os resultados revelaram uma forte semelhança entre as variedades faladas no norte do Brasil com relação a entoação modal, assim como confirmam a hipótese de contorno circunflexo para as interrogativas do PB, com movimento ascendente de F0 na última sílaba tônica seguida de movimento descendente nas sílabas postônicas do sintagma final.

Keywords

variação prosódica, Português Brasileiro, entoação modal, análise Acústica, projeto AMPER

1. Introduction

According to the dialectal division of Brazil proposed by Antenor Nascentes (1922), the Amazon dialect area comprises the Pará State and the Northeast states, forming the Northern Brazilian dialects, as shown in Figure 1 below which displays the map of Brazil with the dialectal division proposed by Nascentes (1922).

According to Nascentes (1922) the Northern dialects differ from the Southern ones in terms of speech modulation and the presence of open vowels in pretonic syllable position. After that publication several studies have been made that provided evidences in favor or against Nascentes's proposed dialectal division, among which the dialectal division proposed by the *Atlas Linguístico do Brasil* (ALIB)[1] research project.

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[1] *Linguistic Atlas of Brazilian Portuguese* < http://www.alib.ufba.br/>.

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Figure 1. Antenor Nascente's Brazilian Portuguese dialectal division.
Source: Razky, Lima & Oliveira (2012: 296)

The Brazilian Portuguese variety (henceforth BP) spoken in the Pará State has been mapped since 2007 (Cruz et al. 2012) by the UFPA[2] research team, working in the project AMPER-POR (*Atlas Multimédia Prosodique de l'Espace Roman* for the Portuguese Language) coordinated by Lurdes Moutinho. As a direct contribution to the AMPER North project, nine survey areas from the Pará State have already been mapped: Abaetetuba (Remédios 2013), Baião (Lemos 2015), Bragança (Castilho 2009), Cametá (Santo 2011), Curralinho (Freitas Neto 2013), Mocajuba (Costa 2015), Mosqueiro (Guimarães 2013), Santarém (Lima, in progress) and Belém, the Pará state's capital city (Cruz & Brito 2014).

The corpus and the methodological procedures used in this work are the ones established by the AMPER-POR project. The purpose of using the same corpus for all Portuguese varieties is to enable a comparative analysis of the target varieties and to contribute to a deeper understanding of the prosodic variation of the Portuguese language.

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[2] Federal University of the Pará State. There is an institutional project at the UFPA named AMPER North project (Prosodic Multimedia Atlas of Northern Brazilian Portuguese).

The usual motivation for describing the prosody of BP spoken in the Pará State has been the claim by Silva Neto (1957) that Pará encompasses a "dialectal island" in Antenor Nascentes' dialectal division. In this sense, the precise aim of this paper is to present an analysis of the AMPER-POR data enclosing four survey areas from the Pará State. Our primary concern is to investigate the degree of identity of the BP dialects spoken in the Pará State based on an intradialectal comparison.

For a better understanding of this paper, the main results of the prosodic descriptions concerning each of the survey areas (section 2) are presented first. Then, the methodological procedures adopted for the preparation of this paper (section 3) are introduced and a prosodic characterization of the BP spoken in the north of Brazil (section 4) is provided. The main results are highlighted in the conclusion (section 5). Following the references (section 6), there is an appendix.

2. The relationship between lexical stress and intonation in Brazilian Portuguese spoken in the north of Brazil

As mentioned above, this paper is linked to the AMPER project <http://dialecto.u-grenoble3.fr/AMPER/amper.html>. The intonation modality description is the main goal of its research projects and prosodic pattern as well. The target modalities comprise declarative (denoted by A) and yes/no question (denoted by I) sentences. The analysis focuses both on initial (pre-nuclear) and final (nuclear) nominal phrases of sentences.

Whereas the AMPER project investigates the contrasting behavior of modal intonation, the formed corpora have adopted all methodological procedures defined by the overall project for data formation, organization and processing.

The AMPER-POR project has two corpora for the investigation of Portuguese, a corpus composed of 66[3] sentences and another expanded corpus containing 102[4]

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[2] The corpus of 66 sentences has been recorded by Lemos (2015), Brito (2014), Santo (2011) and Castilho (2009).

[3] The corpus of 102 sentences has been recorded by Costa (2015), Guimarães (2013), Remédios (2013) and Freitas Neto (2013).

sentences. The Portuguese corpus is controlled syntactic, phonetic and prosodically. Syntactically, the corpus has only SVO – Subject, Verb and Complement – sentences. The sentences have the same size, same number of syllables, with 10, 13 or 14 syllables. The noun placed at the phrases core represents the three kinds of Portuguese lexical stress: a) oxytone stress (cv.cv.CV); b) paroxytone stress (cv.CV.cv) or c) proparoxytone stress (CV.cv.cv). At prosodic level, each sentence is pronounced in two intonation modalities, declarative and yes/no question (Cruz, Seara & Moutinho 2015).

The corpus is formed in order to verify the role of the physical parameters (fundamental frequency (henceforth F0), duration and intensity) in distinguishing target intonation modalities.

The results of acoustic analysis on data of Pará State's survey areas (Lemos 2015, Costa 2015, Brito 2014, Guimarães 2013, Freitas Neto 2013, Remédios 2013) indicate that:

1) F0 is the most important acoustic parameter in distinguishing A and I modalities;

2) Duration and intensity are also important in distinguishing A and I modalities, but only as complementary role;

3) The intensity has not proven an important physical parameter in distinguishing modal intonation;

3) The most important variations of physical parameters happen on final phrases (henceforth FP), more precisely on the last stressed syllable of FP.

The previous studies on prosodic variation of BP spoken in the north of Brazil from AMPER project have chosen the core elements of sentences to focus their analysis, more precisely the FP, because the most significant F0 variations have taken place precisely in this syntactic position. Nunes (2015), who provides a prosodic description of BP spoken in Santa Catarina and Aracaju with AMPER-POR data, proved that the nuclear part of the sentences contains the most important variations of physical parameters in the modal intonation distinction.

The results of the prosodic descriptions of the variety of BP spoken in the state of Pará (Lemos 2015, Costa 2015, Brito 2014, Guimarães 2013, Freitas Neto 2013,

Remédios 2013) also have shown a strong relationship between lexical stress and significative variation of acoustic parameters in distinguishing of modal intonation, as other prosodic studies (Nunes 2015, Milan 2015, Lira 2009, Abraçado et al. 2007, Madureira et al. 2007) on Brazilian Portuguese varieties have noted as well.

Based on the results found in the descriptions of the BP varieties spoken in the north of Brazil, we decided to expand our research and carry out a more robust statistical analysis that would allow a joint analysis of data of Pará's linguistic varieties, continuing with the relationship between lexical stress and intonation driving our intradialectal analysis. In this sense, we chose to analyze the prosodic-intonation behavior of A and I sentences. For this intradialectal analysis, we selected speech samples of speakers from four survey areas from Pará State.

3. Methodology

We borrowed data from four descriptions of the BP varieties spoken in Pará State linked to the AMPER project: Baião (Lemos 2015), Belém (Brito 2014), Curralinho (Freitas Neto 2013) and Mocajuba (Costa 2015). In Figure 2 below, we can see the survey areas of Pará State included by AMPER project, and we highlight the localization of the survey areas selected for this current paper.
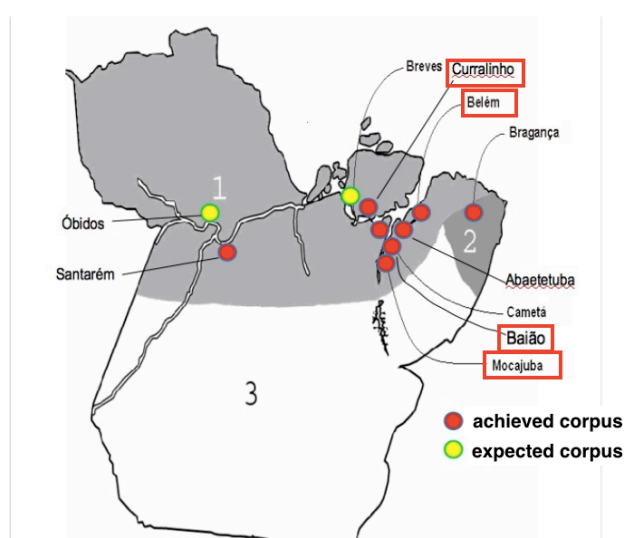

Figure 2. Covered areas in the state of Pará with prosodic mapping by AMPER-POR project

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Our intention with this conjoint analysis is to corroborate or refute the results obtained by these individual prosodic descriptions, namely:

i) Is F0 the most relevant physical parameter for characterization of modal intonation in BP spoken in Pará State?

ii) Are duration and intensity also relevant for characterization of modal intonation in BP spoken in Pará State? Do these physical parameters have a secondary role?

iii) Do the most important variations of physical parameters happen on FP, or more precisely at the last stressed syllable of FP?

Finally, we intend to investigate the performance of physical parameters in dialectal characterization, controlling the type of lexical stress of the word which occupies the core of FP. In this sense, we selected sentences of AMPER-POR corpus containing words representative of each type of Portuguese lexical stress, as we can see in Table 1 below.

	Oxytone	Paroxytone	Proparoxytone
Number	cv.cv.CV	cv.CV.cv	CV.cv.cv
1	O bisavô gosta do bisavô. 'The great-grandfather likes the great-grandfather'	O Renato gosta do Renato. 'Renato likes Renato'	O pássaro gosta do pássaro. 'The bird likes the bird'
2	O pássaro gosta do bisavô. 'The bird likes the great-grandfather'	O pássaro gosta do Renato. 'The bird likes Renato'	O Renato gosta do pássaro. 'Renato likes the bird'
3	O pássaro gosta do bisavô nadador. 'The bird likes the swimming great-grandfather'	O pássaro gosta do Renato pateta. 'The bird likes goofy Renato'	O Renato gosta do pássaro bêbado. 'Renato likes the drunk bird'
4	O pássaro gosta do Renato de Salvador. 'The bird likes Renato from Salvador'	O pássaro gosta do Renato de Veneza. 'The bird likes Renato from Venice)	O pássaro gosta do Renato de Mônaco. 'The bird likes Renato from Monaco'

Table 1. The 12 sentences of the corpus analyzed, shown by lexical stress

We selected the three best repetitions of each of these sentences in both intonation modalities (A and I) and their corresponding AMPER files, the audio files in .WAV format, the .TXT files in ascii format containing the acoustic measurements of vowel segments and the .TextGrid files of PRAAT software containing the phonetic segmentation of audio files.

We selected speech samples of six speakers present in the corpora of four selected survey areas for the intradialectal analysis proposed here and whose profile is described in Table 2 below.

The data analyzed in this work comprised 1,728 data (12 sentences x 2 intonation modalities x 3 best repetitions x 4 survey areas x 6 speakers) and to handle such an amount of data an automated data processing was carried out.

Sex	School level	Baião	Belém	Curralinho	Mocajuba
Female	Elementary School	BF91	BE01	BE41	BF51
	High School	BF93	BE03	BE43	BF53
	College	BF95	BE05	BE45	BF55
Male	Elementary School	BF92	BE02	BE42	BF52
	High School	BF94	BE04	BE44	BF54
	College	BF96	BE06	BE46	BF56

Table 2. The Speaker's Profile.

The F0 measures in Hz on segmentation of the vowel nuclei presented at the TXT files have been stylized the Program[5] software (Mertens 2004). This resulted in a stylization of intonation curve perceived as a set of straight lines. The tones perceived as dynamic (carrying a perceived intonation variable) modeled as upward (+), downward (denoted by -), falls add up (denoted by -+), rises add down (denoted by +-) and flat (denoted by 0). This stylization on Program allowed comparing the data of male and female speech that is not possible with the standard methodology of AMPER. In Figure 3, we can see an example of the same sentence – *O pássaro gosta do Renato*

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[5] http://bach.arts.kuleuven.be/pmertens/prosogram/.

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'The bird likes Renato' – from Baião (a), Belém (b), Curralinho and Mocajuba (d) after the stylization work on Prosogram.

The intensity and duration was normalized as well. For the duration, we grouped by V-to-V unities. The syllable duration has been measured between the vowel onsets (Barbosa 2007). Then, a normalization of duration by z-score of each speaker (Campbell 1992) has been made on the means for each of the last four syllables of every phrase.
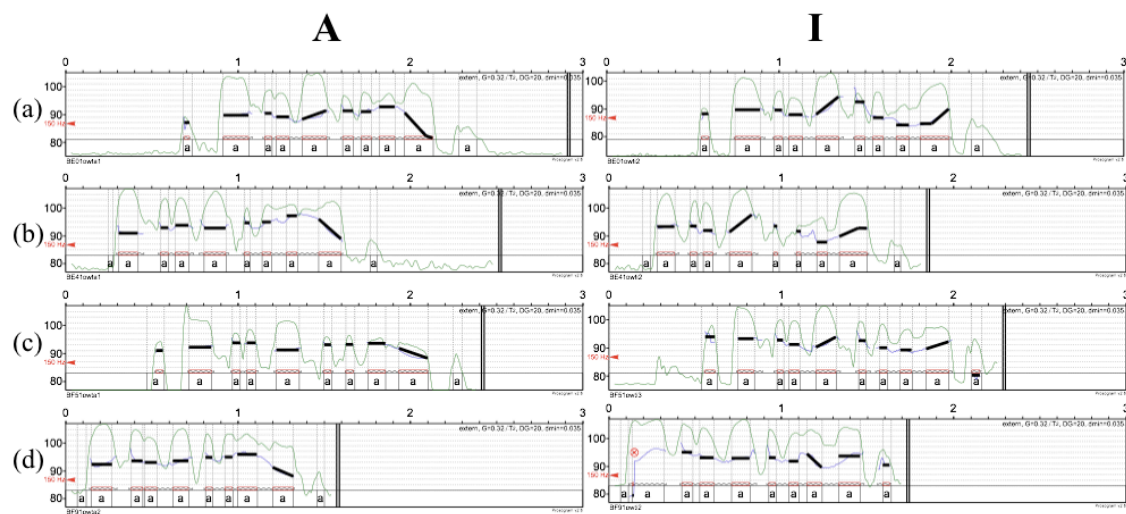

Figure 3. The pwt sentence – *O pássaro gosta do Renato* 'The bird likes Renato' – in both modalities – A and I – stylized by Prosogram; (a) Belém, (b) Curralinho, (c) Mocajuba and (d) Baião

4. Prosodic characterization of the Brazilian Portuguese spoken in the north of Brazil

As mentioned before, our data analysis is concentrated on the end of the sentence (FP), more precisely on the three last syllables.

Our main results comprise the form of intonation contours on the final stressed syllable (4.1) and a final intonation movement study on the prosodic contours of the final phrases, for each survey area and modality, considering the kind of lexical stress (4.2).

4.1 Analysis on the form of intonation contours on the vowel nuclei

Table 3 below contains the inventory of tones obtained with a melodic stylization by the Program software (Mertens 2004) on the final stressed syllable of the sentences.

Final Stressed Syllable	BE0		BE4		BF5		BF9	
Form	A	I	A	I	A	I	A	I
0	59	58	79	51	78	79	65	66
-	**38**	3	**20**	0	**20**	0	**32**	3
-+	3	0	0	1	0	0	1	0
+	0	**37**	0	**42**	0	**20**	1	**19**
+-	0	2	0	6	1	1	1	13

Table 3. The percentage of identified movement, by form, by variety and by modality (Total of 1714 totens).

We can note in Table 3 that:

i) A comparable quantity of flat (0) contours are found at both A and I, except for the BE4 survey area which has the more dynamic movements for I;

ii) The dynamic movements of the assertions are essentially downward;

iii) The dynamic movements of the interrogations are essentially upward.

Once the tones are dynamic, we can see that the assertions are essentially produced with the downward tones, whereas the interrogations keep the upward tones, in all survey areas. The speakers of the BE0 item do more dynamic tones than speakers of other survey areas.

Regarding the differences between survey area:

iv) BE0 and BE4 do more pretty dynamic movements than two other survey areas, BE4 especially for I sentences;

v) BF5 does less dynamic movements;

vi) for the assertions, every movement is downward, everywhere.

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For the I sentences:

vii) BE0, BE4 and BF5 have the simple movements upward;

viii) BF9 does both movements, upward and the circumflex, as we can see forward.

The following graphics contain another view of the data of Table 4 (appendix). The graphics show the percentage of stylized vowel nuclei with a dynamic form (or not) by Program software. For building these graphics, we considered only the final syllables of the sentence, whether (S (stressed) for the phrases with an oxytone word) or not (US (unstressed) for the phrases with a paroxytone or proparoxytone word) stressed, at both intonation modalities (A and I), for each survey area.

We can note in Table 4, for these A phrases that:

ix) There are virtually no dynamic movements on unstressed syllables (expected result);

x) The dynamic movements are more rare on the stressed syllables (except for BE0 making 30%; BF5 do almost none) as in the previous table;

xi) There must be more movement on paroxytone words. These movements are downward (same result as before).

For these I phrases, once again, there is almost no movement on the final unstressed syllables. However, there are many stylized stressed final syllables with a melodic movement, especially upward and circumflex for BF9 and a little for BE4. In the case of stressed final syllables of the interrogative sentences: xii) BE4 (75%) and BE0 (59%) show a majority for dynamic syllables; xiii) BF9 (30%) and BF5 (40%) show less, but still 30% to 40%.
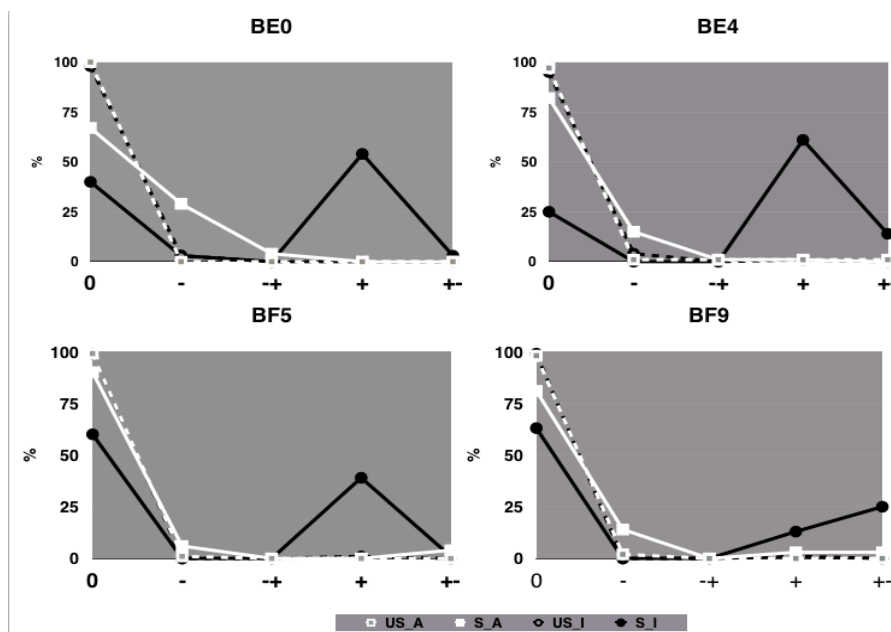
Figure 4. Percentage of stylized vowel nuclei

4.2 Final intonation movement study

This study focused primarily on I sentences, however we also looked at what happens in the case of A sentences for comparison.

As "intonation movement," we take into account the frequency variations on several syllables, not only the form of the stylized contours by the Program software on a particular vowel nucleus (cf. supra).

Accordingly, we look at the last three syllables of the phrase, so three assumptions are made:

xii) some sentences should show a rising intonation contour, which begins on the stressed syllable and continues on the following syllables (if there is a more);

xiii) some sentences should show a circumflex intonation contour, which rises on the stressed and falls on a/the following syllable(s);

xiv) could we observe other intonation patterns?

To quantify these three hypotheses, we looked at the average prosodic contours at the FP for each survey area and modality. The graphs below contain the results. Figures 5, 6 and 7 present the normalized F0 plots (left), intensity (middle) and normalized V-to-V duration (right), the means for each of the last four syllables of every phrase, grouped by survey area (color curves), for both modalities – declaratives

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(Assertion top) and interrogatives (Interrogation below) –, depending on the position of the stress on the last word, oxytone (Figure 5), paroxytone (Figure 6) and proparoxytone (Figure 7).
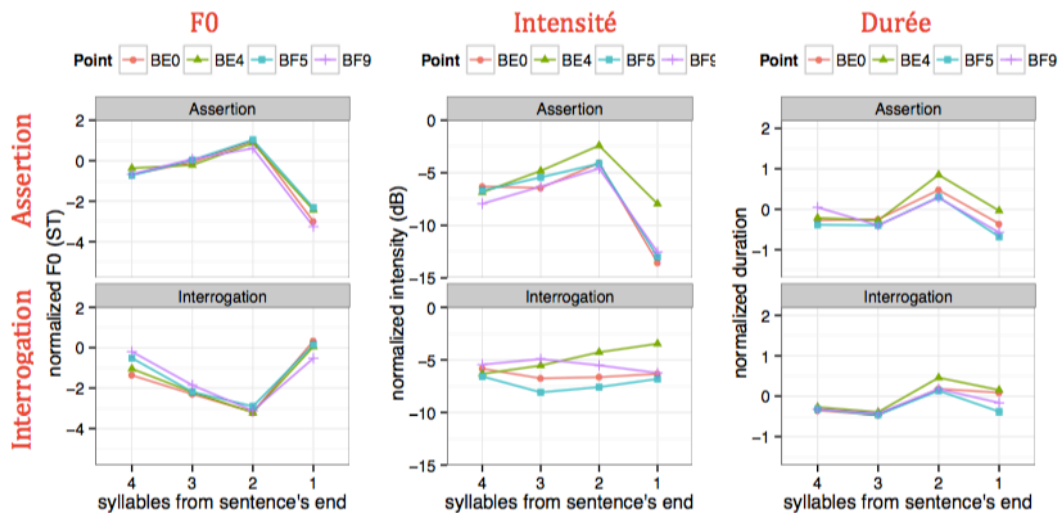

Figure 5. Graphics for phrases ending with an oxytone – cv.cv.CV – word

Now, the results on the phrases with a paroxytone word at the final position (Figure 6).
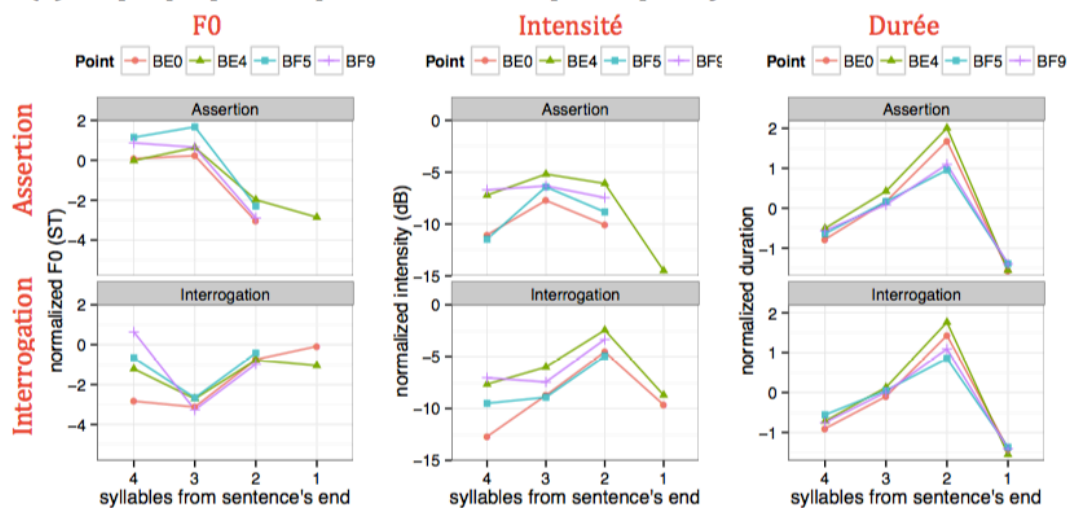

Figure 6. Graphics for phrases ending with a paroxytone – cv.CV.cv – word

The last figure (Figure 7) contains the results on the phrases with a proparoxytone word at the final position.
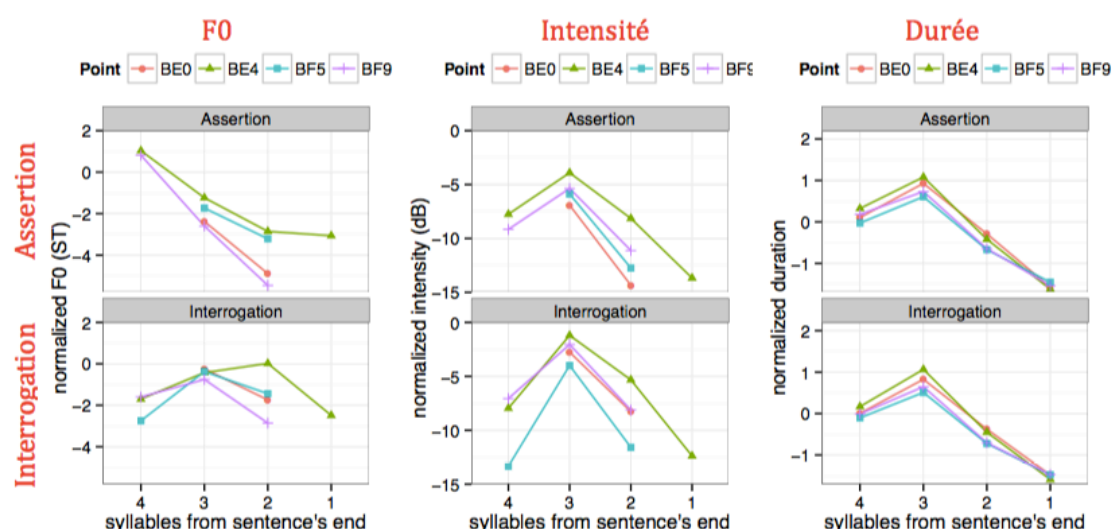
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Figure 7. Graphics for phrases ending with a proparoxytone word

According to the data displayed on the graphics for the declarative modality:

xv) the main F0 rising (and intensity) is located in the pretonic syllable when the latter is performed;

xvi) the main extension is on the stressed syllable, except for oxytone words (pretonic).

For the interrogative modality, the main rising of F0 is clearly on the stressed (not on pretonic as assertive) syllable. In fact, the majority of posttonic syllables present a F0 that falls or is devoiced. In both cases BE0 paroxytone, BE4 proparoxytone, we note a continuation of F0, but an intensity drop at the posttonic syllables. The duration is exactly the same in both the assertive sentence and yes/no question.

We note a small, almost nonexistent, difference between the survey areas on the mean plots.

These observations support a hypothesis of a circumflex intonation contour to mark questions valid in all survey areas. These results reinforce the Moraes (1998) description for the interrogative in PB, rising on the stressed syllable, downward on the posttonic syllable, if there is material. So, we can state that the Brazilian Portuguese varieties show a standard prosodic behavior.

The results show that the final stressed syllable carries important information for discrimination of the intonation modality in the Portuguese spoken in the north of Brazil.

According to the results, the declaratives are mainly made with downward tones, while the interrogatives carry upward tones for every survey area. So, the data reveal an identity between the spoken varieties in the north of Brazil with regard to modal intonation. However the social factors – genre and school level – are not useful for establishing a clear classification. There seems to be no major differences between them.

5. Conclusion

This paper presented the results of work linked to the AMPER project. We analyzed four survey areas – Belém, Baião, Curralinho and Mocajuba – from BP spoken in a north state of Brazil named Pará. Our main goal was to verify whether there would be a prosodic similarity between these dialects located in the same geographic region.

As all four target survey areas had AMPER corpus, a comparative analysis had been possible. So, a balanced corpus of 1,728 data (12 sentences x 2 modalities x 3 repetitions x 4 survey areas x 6 speakers) had been formed. The whole corpus was normalized by Program software (F0 plots, intensity and V-to-V duration).

The data reveal similarity between the spoken varieties in the north of Brazil with regard to modal intonation, because the declaratives are mainly made with downward tones, while the interrogatives carry upward tones for every survey area.

Finally, the results support a hypothesis of a circumflex intonation contour to mark questions, valid in all survey area, which reinforces the Moraes's description (1998) for the interrogative in PB. So, we can state that the Brazilian Portuguese varieties show a standard prosodic behavior.

Acknowledgements

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Appendix

	Ton Shape	US	S	US	S
		A	**A**	**I**	**I**
BE0	**0**	100	67	98	40
	-	0	**29**	2	3
	-+	0	4	0	0
	+	0	0	0	**54**
	+-	0	0	0	3
BE4	**0**	97	82	95	25
	-	1	**15**	4	0
	-+	1	1	0	0
	+	1	1	1	**61**
	+-	1	0	0	14
BF5	**0**	99	90	99	60
	-	1	6	0	0
	-+	0	0	0	0
	+	0	0	1	**39**
	+-	0	4	0	1
BF9	**0**	98	81	99	63
	-	2	14	0	0
	-+	0	0	0	0
	+	0	3	1	13
	+-	0	3	0	**25**

Table 4. Percentage of stylized vowel nuclei by Program on only final syllables of the sentence. S (stressed syllable of oxytone word), US (unstressed syllable of paroxytone or proparoxytone word). A (declarative), I (yes/no question) modalities.