The Pitch Accents in Brazilian Portuguese: analysis by synthesis

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Abstract

This study offers a phonetic description and phonological analysis of a variety of melodic contours in Brazilian Portuguese. These are commonly referred to as conveying the modal, or illocutionary, functions of intonation, as well as some attitudinal uses. The phonological analysis follows the AM framework and aims at distinguishing what is contrastive and what are merely allophonic variations of a given melodic pattern with the help of a resynthesis technique, in order to propose a more consistent (phonological) representation of the contours examined.

1. Introduction

Although a number of studies have already discussed punctual aspects of Brazilian Portuguese (BP) intonation - mainly phrasing and the manifestation of narrow focus in declarative sentences [2, 4, 8, 9, 10] - the BP tonal system as a whole have received less attention [3, 6].

From a phonetic perspective, this study offers a brief description of 14 melodic contours of BP, in order to determine, with the help of resynthesis, which of its prosodic characteristics should be considered effectively contrastive and which are merely allophonic variations of a given melodic pattern, and to propose a more consistent (phonological) representation of the contours examined using the AM framework.

The melodic contours that were used as a basis for this study were obtained in laboratory setting, and produced by a female native speaker of the Rio de Janeiro dialect. Three single-IP utterances were used: *Renata jogava* [Renata used to play] (declarative sentence), *Destranca a janela* [Unlock the window] (imperative sentence) and *Como ela jogava* [How did she play?/How (well) she played!] (wh-morpheme sentence) [lexical stressed syllables in bold type], all with 6 phonetic syllables, two pitch accents[1] and containing, in the final position, a word with a pre-stressed, a stressed and a post-stressed syllable.

These utterances were inserted in small contexts to help the speaker identify the melodic patterns to be produced. To check the relevance of the interpretation attributed to each contour, and indirectly to assess the quality of the speaker's performance, a first auditory test was carried out with 20 listeners, who were asked to identify, in a closed choice task, the intonational meaning of each one of the original utterances, associating it to one of the labels proposed (regular statement, contrastive statement, question, exclamation, self-evident assertion, request for confirmation, irony...). The utterances were presented to the listeners in four groups, according to their similarity: those with closer melodic contours were put together, making them thus more difficult to distinguish. Depending on the group, they were given, from 4 to 5 interpretation possibilities. The same contexts established for the speaker were given to the listeners. All the original melodic contours were correctly recognized by the listeners in this test, in a rate considered statistically significant.[2]

In a second step, the declarative contour[3] was gradually modified using Praat software [1], by introducing prosodic changes, in order to simulate each one of the other patterns. The resulting resynthesized stimuli, totaling 105, were submitted to a second auditory test, aiming at evaluating the effect of the modifications in the identification by the twenty listeners of the pattern, according to the same categories of the original utterances. In this way, it is possible to test whether the presence of a given prosodic characteristic determines a given interpretation - either alone or together with others - or at least whether this characteristic correlates to the interpretation in a statistically significant way. In this case this characteristic should be considered for the phonological representation.

2. Melodic contours

I will present the melodic contours in three families: falling, rising, and lengthened tunes, according to the behavior of its nuclear contours, so as to allow a better view of the contrasting patterns.

Falling melodic contours

2.1 neutral statement

Phonetics
The general shape of the melodic contour of the neutral, broad focus statement lies in a medium register, except for the last stressed syllable and eventual post-stressed ones, which are found in the lower register of the speaker's range.

In the non-final stressed syllables there is a rising melodic movement both from a strictly intra-syllabic point of view, as much as in relation to the preceding unstressed syllable, that often goes on to the following one: the average level of the pre-stressed syllable is lower than the stressed one, which in its turn tends to be lower than the post-stressed one. This movement could be rendered by [l + m* + h] in a phonetic notation. It is worth noting that the post-stressed syllable can also lie in a lower average level than the preceding syllable, without operating any change in the utterances' intonational meaning; in other words, the melodic rise between stressed and post-stressed is less regular than between the pre-stressed and the stressed one.
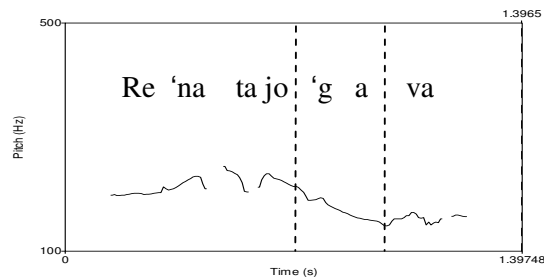

Figure 1: *"Renata jogava" uttered as a neutral statement.*

The final pre-stressed syllable is found in a medium level, therefore higher than that of the final stressed syllable which comes in a low level, and takes a falling configuration; this level remains low in case of the presence of post-stressed syllables.

Phonology
This rising melodic configuration in the pre-stressed, stressed and post-stressed syllables of words in pre-nuclear position, justifies, in principle, the AM analysis of this pre-nuclear pitch accent as both /L+H*/ and /L*+H/.

Considering the variability in the melodic behavior of the pre-nuclear post-stressed syllable, it seems more adequate to leave it tonally unspecified, and to represent the typical rise of the pre-nuclear pitch accent by a bitonal L+H* (with a leading tone) which refers to the behavior of the pre-stressed and stressed syllables respectively, instead of the L*+H commonly proposed [4, 9], although both are justified, as we have seen, by the phonetic facts. An advantage in doing so would be to unify pre-nuclear pitch accents that, in spite of being phonetically distinct, function as allophonic variants, as the [l+m*+h] of the statement *vs.* the [l+m*+l] of the alternative question, for instance, both represented by the same pitch accent /L+H*/. Concerning the nuclear pitch accent, I propose to represent the fall between the pre-stressed and the stressed final syllables by an H+L* accent, followed by an L% boundary tone.

2.2 self-evident assertion and suggestion

Phonetics
The self-evident melodic pattern (that is, implying "of course") contrasts with the neutral declarative one by an upward movement of its terminal part: the final pre-stressed syllable reaches a high (or extra-high) melodic level and the stressed one lies in a medium (or high) level, the F0 in this syllable showing a smooth falling configuration. Eventual post-stressed syllables remain in a low melodic level. There are no significant differences between this pattern and the declarative one concerning the initial part of the utterance. This pattern (fig. 2a), in imperative sentences, gives the force of suggestion to the utterance (fig. 2b).
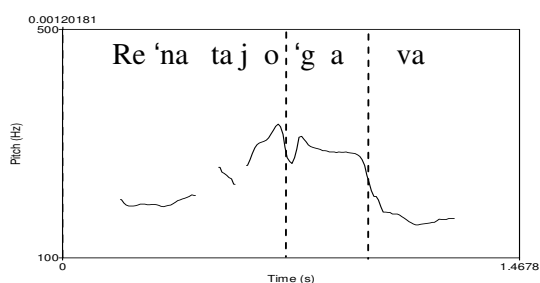

Figure 2a: *"Renata jogava" uttered as a self-evident assertion.*

Phonology
The point here concerns what representation to propose to its nuclear pitch accent, more specifically whether the final upward melodic movement observed from a production point of view on the final stressed and pre-stressed syllables must be attributed, from a phonological (contrastive) perspective, to both syllables, or if the pattern is better captured by limiting it to the stressed syllable, in which case the high level of the pre-stressed syllable would be taken as a secondary feature.
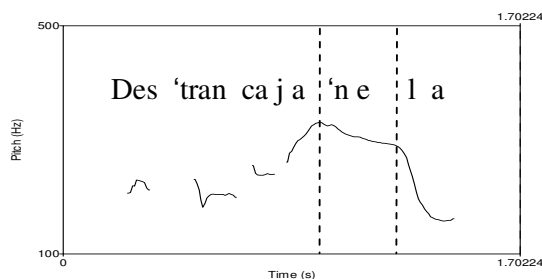

Figure 2b: *"Destranca a janela" uttered as a suggestion.*

The results of the perceptual tests with resynthesized stimuli demonstrated that the upward melodic movement of the stressed syllable by itself is responsible for the identification of the pattern: when this feature is added to the declarative pattern, the answers for the self-evident meaning jump from 0% to 60%.[4]

The phonological representation of this phonetic [¡h + m*] nuclear pitch accent will be /H+¡L*/, where the diacritic [¡] preceding the low starred tone marks its upstep in relation to the low tone of statements. Its pre-nuclear accent will be L+H*, as in statements.

2.3 contrastive emphasis

Phonetics
The contrastive pattern presenting the focused word in final position[5] is characterized by a melodic rise to an extra-high level on the syllable that precedes the stressed syllable of the focused word and a fall to a low level on the stressed one, a level slightly higher, though, than the one observed at the end of the neutral declarative sentence, and that remains low on the post-stressed syllables. The F0 in the stressed syllable often assumes a convex melodic shape, instead of the regular falling one. The focused word also presents an increase in duration and in loudness, mainly in its stressed syllable.
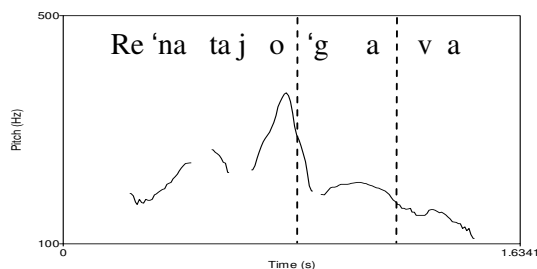

Figure 3: *"Renata jogava" uttered as a contrastive statement.*

Phonology
The results of the perceptual tests showed that the main melodic features of the corrective pattern are the extra-high melodic level in the final pre-stressed syllable and the convex melodic shape of the low final stressed syllable. They are not strong enough, even when combined (see Graphic 1), to allow a clear identification of the contrastive meaning. Only when we add non-melodic features, namely the increase in duration and intensity, the majority of the answers is for the contrastive meaning. In fact, we have here the typical situation in which several features of distinct nature conspire to build the prosodic pattern.[6]

%
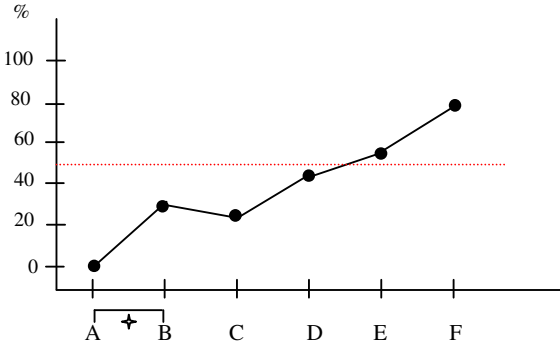
Graphic 1: *Percentage of votes obtained by the utterance "Renata jogava" for the "contrastive" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral statement matrix, B = A + extra-high final pre-stressed syllable, C = B + raised final stressed syllable, D = C + convex shape of the final stressed syllable, E = D + increased vocalic duration, F = E + increased intensity. The sign ✦ between two bundles of features (A and B, for instance) means that the difference in number of votes they obtained is at a statistical significant level.*

From a pure notational point of view, it can be proposed for the corrective pattern an /¡H + L* L%/ nuclear pitch accent, where the sign (_) underlying the L* tone means the increase in duration and intensity, as long as we are aware that its phonetic implementation and its phonological nature is more complex than its notation may lead us to expect.

2.4 request for confirmation

Phonetics

The request for confirmation, a question to which a reply of the same polarity of the proposition contained in the question is expected, presents a melodic contour very close to that of the contrastive one: there is a rise to an extra-high pitch level on the final pre-stressed syllable followed by a fall to a low level on the stressed one, a level that remains low on the post-stressed syllables. However, we can notice that the shape of the intra-syllabic contour of the final stressed syllable is different, assuming here a sharp falling configuration instead of a sort of a slightly convex plateau, typical of the contrastive pattern (fig. 3 x fig. 4).
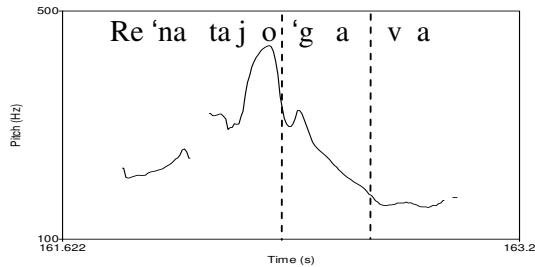

Figure 4: *"Renata jogava" uttered as a request for confirmation.*

Also, the extra-high level on the pre-stressed syllable is generally still higher in the request for confirmation. In addition, there is a distinction concerning the melodic behavior of the syllables that precede this extra-high tone, starting from the first stressed syllable of the utterance, since they are also in a higher level in the confirmation pattern. The same phenomenon occurs in the final post-stressed syllable: it is as if the entire pattern were slightly shifted upwards, except for its first unstressed syllable and the final, nuclear stressed one.

Phonology

The results of the perceptual tests reveal that, from the four melodic characteristics pointed out as potential candidates to mark the distinction between the confirmation and the contrastive pattern, only the first two participate, namely (i) the sharp falling intra-syllabic melodic shape on the final stressed syllable, which corresponds to an early alignment of the F0 peak in the L* tone (instead of a central alignment), and (ii) the "extra" extra-high pre-stressed syllable. However, neither is capable of determining the recognition of the "confirmatory" meaning: with the change of a high pre-stressed syllable to an extra-high one (in a mild fall stressed syllable stimulus) the votes for the confirmatory meaning grow only from 5% to 15%, and the change from a mild falling to a sharp falling F0 in the stressed syllable (in a high pre-stressed syllable stimulus) improves the rate from 5% to 30%. When both features are combined, the resulting stimulus receives 60% of the votes for the confirmatory meaning, showing a strong interaction. The other mentioned features, namely, the higher level in the beginning of the utterance and in its final post-stressed syllable did not improve the recognition of the "confirmation".
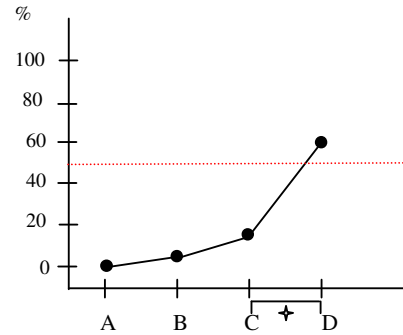
Graphic 2: *Percentage of votes obtained by the utterance "Renata jogava" for the "confirmatory" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral statement matrix, B = A + extra-high pre-stressed syllable, C = B + "extra" extra-high pre-stressed syllable, D = C + sharp fall in the final stressed syllable.*

A tentative notation of this nuclear contour would be /¡H+L*>L%/, in which the diacritic > following the L* tone means that the F0 peak of the L* tone is aligned at the left, by contrast of the alignment at the middle portion of the vowel, in the contrastive pattern.

2.5 wh-question

Phonetics

The melodic contour of the wh-question presenting an unmarked word order[7] is characterized by an extra-high melodic level in the wh-word and a gradual fall over the following syllables, until the last stressed syllable (and eventual post-stressed ones), which lies in a low melodic level. Owing to this constant fall along the utterance, the melodic contrast between the final pre-stressed and the stressed

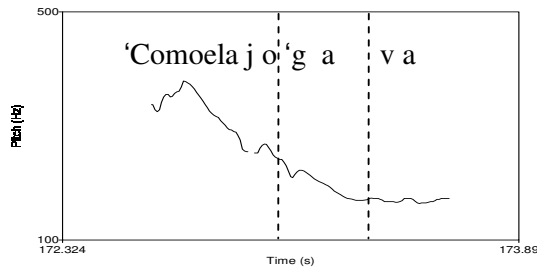syllables is somewhat reduced, in comparison to that observed in the statement pattern.

Figure 5: *"Como ela jogava" uttered as a wh-question.*

Phonology
Perceptual tests with stimuli in which the nuclear pitch contour of the statement was replaced by that of the wh-question and vice-versa showed that the difference found in the production level is not relevant from the perceptual level, that is, it is not capable alone to lead to the identification of the original pattern, which allow us to consider them as allophonic variants of the same /H+L*L%/ nuclear contour. Concerning its pre-nuclear pitch accent, however, we have here an accent that contrasts with the default L+H* one, and is responsible for the opposition between question *vs.* statement. This high pre-nuclear accent is represented as /H+H*/, surfacing phonetically as an [h+¡h*], which becomes an [¡h*] when the wh-question begins by a stressed syllable.

2. 6 command

Phonetics
The prototypical command presents a contour that is similar to that of the wh-question, with the difference that its melodic onset is often less high than that of the wh-question, though still higher than that of the statement. There are no relevant melodic distinctions concerning the terminal part of these three modalities, besides those signaled in regard to the wh-question.
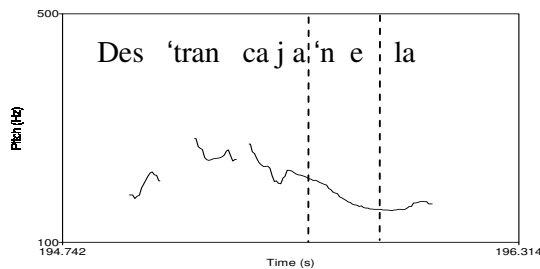

Figure 6: *"Destranca a janela" uttered as a command.*

Phonology
Just like the distinction between the wh-question and the statement, it is by its pre-nuclear accent that the command distinguishes itself from the statement. So, though there is potentially a ternary contrast from a production point of view between the melodic level of the first stressed syllables of the wh-question, the command and the statement, the morpho-syntactic constraints of the sentence type (verb in the imperative mode in command *vs.* interrogative word in wh-question) prevent the finding of intonational "minimal pairs" for these two modalities This would be the only way to test with resynthesis if the observed difference was phonologically relevant. Thus, the similarity of the contours and the absence of such possible "minimal pairs" lead us to consider that these pre-nuclear accents are allophonic variants of the same /H+H*/ accent, that is, that there is a phonological identity between the patterns of command and wh-question, which in turn contrast with the pattern of the statement by its pre-nuclear pitch accent.[8]

2.7 wh-exclamation

Phonetics
The exclamatory utterance marked with an opening exclamation word presents a melodic contour also very close to that of the wh-question, that is, an extra-high level in its beginning and a continuous fall during the utterance. It presents, however, a subtle melodic distinction (although perfectly recognized at the audition) concerning the final pre-stressed and stressed syllables, which are respectively lower (pre-stressed) and higher (stressed) in relation to those of the wh-question. This distinction is sometimes reinforced by a slight convex shape of the F0 or, at least, by a smoother fall in the final stressed syllable in the wh-exclamation, and by a post-stressed syllable in a slightly higher level. In addition, the duration pattern behaves differently: the exclamation tends to present a longer overall duration, and specially a lengthening of the consonantal duration of the final stressed syllable.
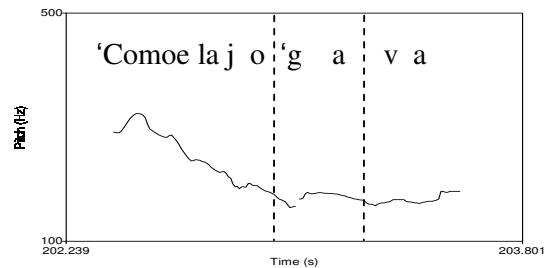

Figure 7: *"Como ela jogava" uttered as a wh-exclamation.*

Phonology
The results of perceptual tests revealed that the lengthening of the consonant and the raised post-stressed syllable added to the melodic pattern of the wh-question are not alone capable of changing the votes from the "question" interpretation to that of "exclamation", as the latter got 0% and 10% of the answers, respectively. The lowering of the final pre-stressed syllable has a stronger effect, with 45% of the votes going for "exclamation", but it is the F0 shape of the stressed syllable, when showing a gentler fall, that is on its own the more important feature. It received 60% of the votes, and this is confirmed when it is combined with any one of the other three features: the "exclamatory" meaning then receives from 70% to 80% of the votes. With the four features together, the resynthesized stimulus gets 95% of the votes for the "exclamatory" meaning, as Graphic 3 illustrates. The proposed notation of this nuclear contour is /¡L+¡L*L%/, keeping in mind that what is responsible for the distinction between the wh-question and the wh-exclamation is rather the F0 shape of the stressed syllable than its average level properly speaking.[9]
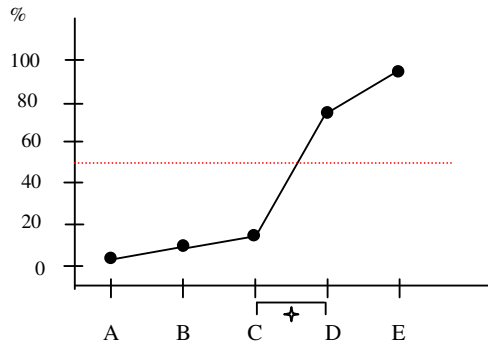
Graphic 3: *Percentage of votes obtained by the utterance "Como ela jogava" for the "exclamation" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral statement matrix with high onset (wh-question intonation)   B = A + raised post-stressed syllable,   C = B + consonant lengthening, D = C + lowered final pre-stressed syllable, E = D + gentler fall in the final stressed syllable.*

Rising melodic contours

2. 8 neutral yes-no question

Phonetics
The neutral yes-no question[10] is characterized by a melodic rise on its first stressed syllable, situated at a medium level, slightly higher than that observed in statements. This rise often reaches the post-stressed syllable, and is followed by a continuous fall until the final pre-stressed syllable, which lies in a low level, and by a melodic rise on the final stressed syllable, falling again in eventual post-stressed syllables.
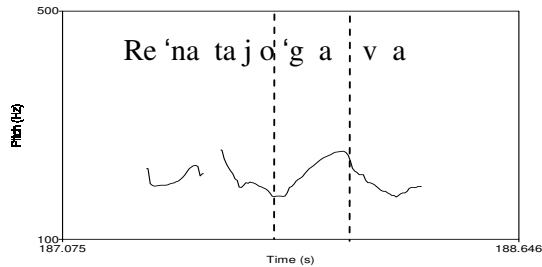

Figure 8: *"Renata jogava" uttered as a neutral yes-no question.*

Phonology
Perceptual tests [5] revealed that the distinction observed in relation to statements concerning the pre-nuclear accent does not play a role in the auditory recognition of the two modalities: it is on the nuclear accent that the contrast is concentrated. So, though there is a strong tendency to have a slightly higher pre-nuclear accent in questions, since this difference is not perceptually relevant, the pre-nuclear accent of yes-no questions will be considered as a variant of the default pitch accent /L+H*/. As to the nuclear contour, it will be represented by /L+<H* L%/, in which the melodic rise between the pre-stressed and the stressed syllable is rendered by the accent L+H*, the diacritic < preceding the H* tone signaling the alignment of its F0 peak at the right margin of the stressed vowel (late alignment). This is the main feature that will distinguish this pattern from that of the request, as we will see below.

2.9 request and rhetoric yes-no question

Phonetics:
Requests present a melodic contour with a pre-stressed syllable in a low level, a rise in the final stressed syllable and a fall in the post-stressed syllable(s), which is also the behavior of the neutral yes-no question. In contrast with the rise-fall contour of the neutral yes-no question, however, the F0 peak in the last stressed syllable is located at the beginning of the vowel, not at the end, which makes its intra-syllabic configuration a "falling", instead of a "rising" one. Two further points help to distinguish these patterns: (i) the final rise in the request contour reaches a lower level than in neutral yes-no question, and (ii) the first stressed syllable is located in a much higher level in requests than in yes-no questions, similar to that of wh-questions. The request pattern (fig. 9b) is often used in yes-no questions to convey a rhetorical meaning, that is, the question does not have the illocutionary force of a real question (request of information), since the speaker knows the answer in advance (fig. 9a).
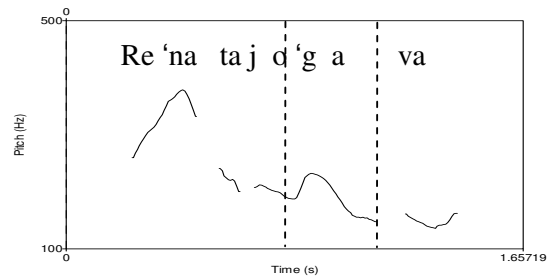

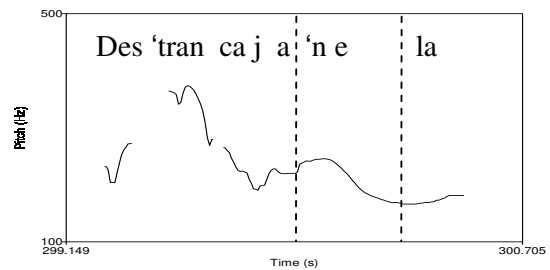Figure 9a: *"Renata jogava" uttered as a rhetorical question.*

Figure 9b: *"Destranca a janela" uttered as a request.*

Phonology:
Perceptual tests [7] have shown that it is the falling shape of the last stressed syllable that distinguishes this pattern from the neutral yes-no question. The F0 peak alignment is thus incorporated to the representation proposed to this nuclear contour - L+>H*L% -, being signaled by the diacritic > preceding the H* tone, and points to the early alignment of this tone. The high pre-nuclear accent present in requests/rhetorical questions will be represented as a /H+H*/ accent, as in wh-questions.

2.10 incredulous yes-no question

Phonetics:
The prototypical contour of the incredulous yes-no question[11] distinguishes itself from the neutral one in four points: (i) a higher final pre-stressed syllable, (ii) a delayed rise on the final stressed one, which starts in the second half of the vowel, (iii) a lower level at the end of the final stressed syllable, and (iv) an extra vocalic lengthening of this syllable.

In both patterns the F0 peak in the final stressed syllable is aligned at the right margin of the stressed vowel.
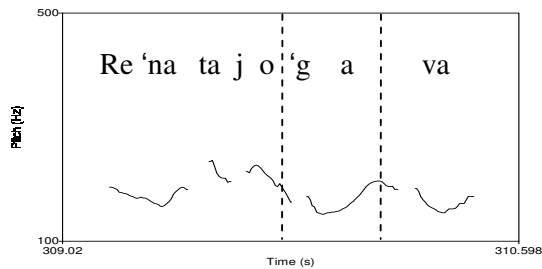

Figure 10: *"Renata jogava" uttered as an incredulous question.*

Phonology:
The perceptual tests, using this time the neutral yes-no question as the basis for the modified stimuli, showed that neither the final lengthening nor the lower melodic level reached in the stressed syllable is relevant for the identification of the pattern. This identification relies basically on the presence of the low valley in the first half of the final stressed vowel, together with the high final pre-stressed syllable. Although the low valley is its main feature, whose presence alone determines the attribution of the "incredulity" meaning with 65% of the votes, its rate of recognition increases to 100% when the raised pre-stressed syllable is added, as can be seen in Graphic 4. This is the reason I consider it in the phonological representation of its nuclear contour, which presents a complex pitch accent with two melodic targets in the stressed syllable, one L at the first half of the vowel, and one H in the second half: /H+ [LH]*L%/.
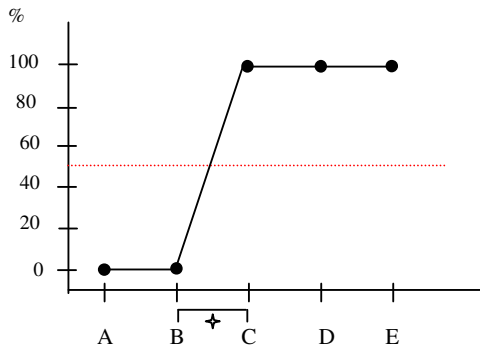
Graphic 4: *Percentage of votes obtained by the utterance "Renata jogava" for the "incredulous question" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral yes-no question matrix, B = A + raised final pre-stressed syllable, C = B + delayed rise on stressed syllable, D = C + lowered final stressed and post-stressed syllables, E = D + vocalic lengthening in final stressed syllable.*

Lenthened melodic contours

2.11 warning

Phonetics:
The warning contour is characterized by an extra-high final pre-stressed syllable, followed by a fall to a low-medium level on the final stressed syllable, that is, a level slightly higher than that of the neutral statement pattern. This final stressed syllable always presents an important lengthening and often shows an intra-syllabic convex shape, instead of a falling one. Eventual post-stressed syllables are low. Concerning the beginning of the utterance, there is no relevant differences as regards the declarative contour.
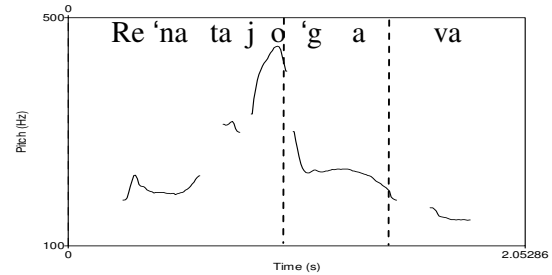

Figure 11: *"Renata jogava" uttered as a warning.*

Phonology:
The perceptual tests have shown that the lengthening of the final stressed syllable together with the high pre-stressed syllable is crucial for the identification of the pattern, obtaining 90% of the votes. Both are indeed the features that distinguish this pattern from the neutral statement. Without the extra-high pre-stressed syllable, the recognition rate drops from 90 % to 55%. The slightly higher level and the convex shape also observed in the final stressed syllable do not play a relevant role in the identification of the patterns. Graphic 5 shows the correlation between the progression of the perceived meaning of "warning" and the gradual accumulation of the three features convex shape + extra-high pre-stressed syllable + lengthened stressed syllable, in that given order.
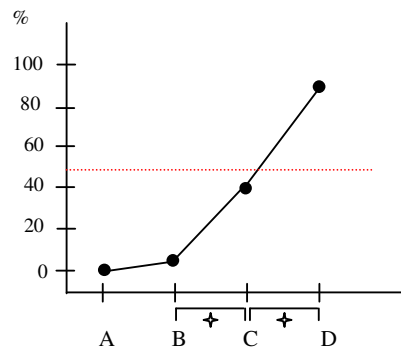
Graphic 5: *Percentage of votes obtained by the utterance "Renata jogava" for the "warning" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral statement matrix, B = A + convex shape of the final stressed syllable, C = B + extra-high final pre-stressed syllable, D = C + lengthened final stressed syllable.*

The proposed representation of this nuclear contour is /¡H+L꞉* L%/; the diacritic (꞉) following the L* tone signals its distinctive lengthening.

2.12 ironic assertion

Phonetics:

Just like warning, the ironic assertion presents an extra-high final pre-stressed syllable, followed by a fall to a low-medium level on a lengthened final stressed syllable. The intra-syllabic melodic configuration of the final stressed syllable is, however, quite different (rather opposite) as it presents a plateau or a very slight rise in the first half of the syllable and a rise to a medium level in its terminal part (a sort of melodic "glissando"). Eventual post-stressed syllables are low. Concerning the initial part of the utterance, there are no relevant differences as regards the neutral statement.
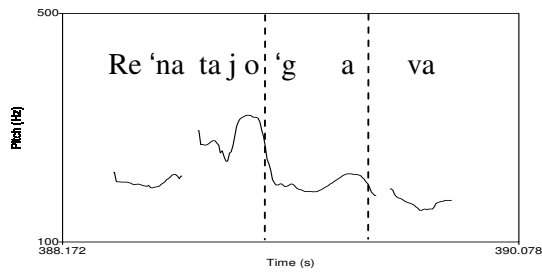
Figure 12: *"Renata jogava" uttered as an ironical assertion.*

Phonology:

The combination of the three features, the "plateau plus rise" F0 modulation in the stressed syllable, its lengthening and the extra-high pre-stressed syllable determines the recognition of the ironic pattern, with 100% of the votes. Alone, all three features present a poor performance, not getting more than 20% of the votes. The combination of the features "plateau plus rise" F0 with "extra-high pre-stressed syllable" obtains only 25% of the votes, while "plateau plus rise" F0 plus "vowel lengthening" reaches 70% of "ironic meaning" answers, which points out the importance of the lengthening in the ironic pattern. Graphic 6 illustrates the evolution of the listeners' judgement when the features are accumulated, in the following order: F0 modulation in the stressed syllable, extra-high pre-stressed syllable and lengthening.
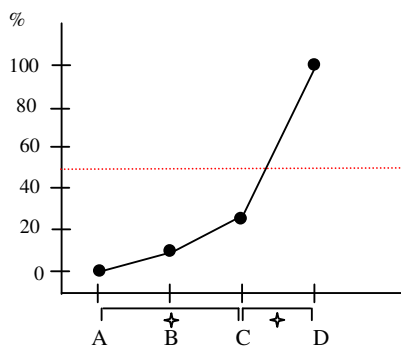
Graphic 6: *Percentage of votes obtained by the utterance "Renata jogava" for the "ironic assertion" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral statement matrix, B = A + [plateau + rise] modulation in final stressed syllable, C = B + extra-high pre-stressed syllable, D = C + lengthened final stressed syllable.*

The proposed representation for the ironic nuclear contour is /¡H + [L¡L]:* L%/.

2.13 incredulous assertion

Phonetics:

The incredulous assertion[12] is characterized by a very special, typical melodic cliché, with a low register throughout the utterance, showing highly reduced F0 modulations, and presenting only a slight F0 declination. The final stressed syllable usually presents a lengthening as well, and a tendency to show an increased consonantal duration. It is worth noting that even without a single rise to a high (or even medium) level, this pattern is not perceived as deaccented in BP.
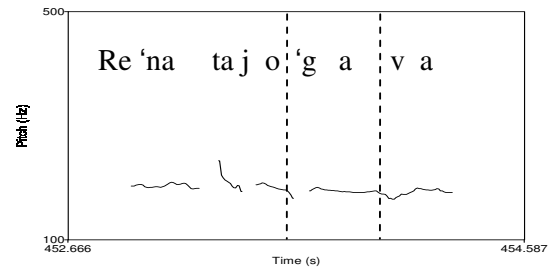
Figure 13: *"Renata jogava" uttered as an incredulous assertion.*

Phonology:

The perceptual tests showed that the low overall melodic register without any melodic modulation, only with a slight F0 declination is enough to lead to the recognition of the pattern, with 65% of votes. The addition of the final vowel lengthening contributes only moderately to its better identification, which then obtained 75% of the votes. On the other hand, the effect of adding the consonantal lengthening to the final stressed syllable is quite strong, leading to a recognition rate of 95%. It is worth noting that after removing the F0 declination of the stimulus with vocalic lengthening, the pattern is no longer recognized by the majority of the listeners as an assertion of incredulity, going then from 75 % to only 45 % of the votes, as can be seen in Graphic 7.
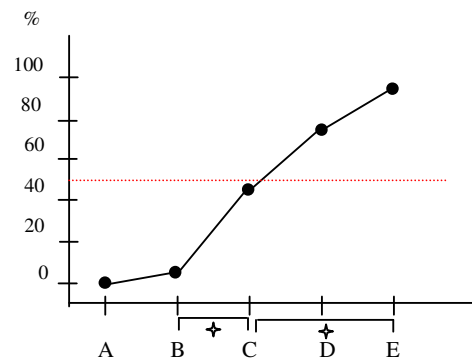
Graphic 7: *Percentage of votes obtained by the utterance "Renata jogava" for the "incredulous assertion" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = neutral statement matrix, B = A + vowel lengthening in the final stressed syllable, C = B + low (monotonous) register, D = C + F0 declination, E = D + consonant lengthening in the final stressed syllable.*

Concerning the phonological representation of this pattern, there is here a third pre-nuclear pitch accent, represented by /L + L*/. As to the nuclear contour, from a notational point of view an /L + L:* L%/ could be acceptable, as long as we are

aware of the need of specifying that the F0 declination and the consonantal lengthening are also relevant features of this pattern.

2.14 intensive emphasis

Phonetics:

The intensive emphasis contour[13] is characterized by a low melodic level on the final pre-stressed syllable followed by a rise reaching a high (or extra-high) level in the stressed syllable, which is also lengthened. The melodic level remains high on the eventual post-stressed ones. As in the wh-exclamation and the incredulous assertion, the lengthening of the final stressed and post-stressed syllables, very clear at the perceptual level, is mainly due to an increase in the consonantal rather than in the vocalic duration.
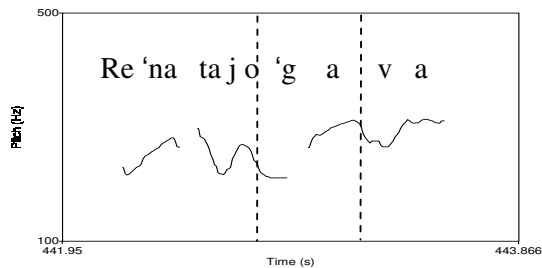

Figure 14: *"Renata jogava" uttered as an intensive emphasis statement.*

Phonology:

The results of the perceptual tests with the modified stimuli, obtained this time from the neutral yes-no question pattern, suggest that the extra-high level on the final stressed syllable and the high or even extra-high melodic level on the post-stressed syllable, which corresponds to a high boundary tone, show a very a poor performance leading to the attribution of the "intensive meaning", particularly when alone. In fact, they obtained 0%, 10%, and 15% of the votes, respectively. Even when combined (extra-high level on both, stressed and post-stressed syllables) the resulting stimulus receives only 45% of the votes for "intensive meaning".
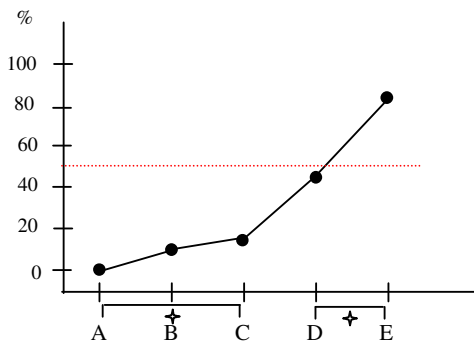
Graphic 8: *Percentage of votes obtained by the utterance "Renata jogava" for the "intensive emphasis" meaning (y axis) with each addition of prosodic features to the resynthesized stimuli (x axis): A = yes-no question matrix, B = A + high final post-stressed syllable, C = extra-high final post-stressed syllable, D = C + extra-high final stressed syllable, E = consonantal lengthening in the final stressed syllable.*

The picture changes radically when a consonantal lengthening of the stressed and post-stressed syllables is added to the stimulus with a high post-stressed syllable: the "intensive" votes jump from 10% to 80%, stressing the relevance of this feature (Graphic 8). The proposed representation for this nuclear contour is /L+ H**:*** H%/.

3. Final remarks

It is not a simple task to decide what is contrastive by visual inspection of melodic contours and/or by acoustic measurements of F0 tracks. The auditory judgement of modified prosodic patterns by resynthesis seems to be a useful tool as an investigative procedure for assessing the relative importance of concomitant features, revealing sometimes the presence of unsuspected features, such as the consonantal lengthening, for instance.

The distinctive intonational features of the contours examined are concentrated on the nuclear position, and specially on its last stressed syllable, and take, basically, the form of bitonal accents with leading tones (T + T*). Pre-stressed syllables (leading tones) and mainly the post-stressed ones (boundary tones) show a limited tonal productivity, and are poorly explored contrastively. The opposite occurs with the stressed syllable, which is over-explored.

Concerning the features themselves, the basic, canonical nuclear pitch accents, built up with two primitive L and H tones, as proposed by ToBI notation and adopted in a large number of languages, need to be modified basically in three ways to account for the BP intonational system, and should specify:

(i) a tonal upstep, that allows an upward scaling of the pitch of both L and H tones, thus generating modified (contrastive) versions of the regular L and H tones (opposing neutral statements to contrastive contours, for instance);

(ii) the intra-syllabic melodic shape of the final stressed syllable, by means of a contrastive alignment of its F0 peak (opposing yes-no questions to requests, for instance);

(iii) the lengthening of the stressed syllable (opposing statements to warnings, for instance).

Notes

[1] The sentence *Como ela jogava* shows a fluctuation concerning the location of its first pitch accent, which can be realized on its first syllable [kõ] or on the second one [mwɛ].

[2] The proportion test was applied twice in a row: first to verify if the "correct" identification of the intonational meaning (that is, the one that matches the speaker's intention) was statistically beyond chance, and the second time to see if the difference observed between the number of votes obtained by the winning category and the one that was second was also significant. All the utterances obtained a p-value < 0.05 in both tests, except for the confirmative question, where the p-value was, in the second test, slightly above this level (p < 0.055).

[3] In a few cases the matrix contour was not the declarative one, as mentioned in the text.

Nuclear contours

#	Label	phonetics	phonology	Contexts
1	low fall	m + l* l%	H + L* L%	statement, wh-question, command
2	high fall	¡h + ¡l* l%	¡H + L* L%	contrastive emphasis
3	sharp high fall	¡h + ¡l*>l%	¡H + L*> L%	request for confirmation
4	medium fall	¡h + h*l% (h + m*l%)	H + ¡L* L%	self-evident assertion, suggestion
5	rise-fall	l + <m*l%	L + <H*L%	neutral yes-no question
6	early rise-fall	l + m*>l%	L + >H*L%	request, rhetorical yes-no question
7	low rise - fall	¡l + ¡l l%	¡L + ¡L* L%	wh-exclamation
8	fall-delayed rise-fall	m + [lm]*l%	H + [LH]* L%	incredulous yes-no question
9	lengthened fall	¡h + ¡l:*l%	¡H + L:* L%	warning
10	lengthened rise	l + h:*h%	L + H:* H%	intensive emphasis
11	lengthened low level	l + l:*l%	L + L:* L%	incredulous assertion
12	lengthened fall-smooth rise-fall	¡h + [l¡l]*l%	¡H + [L¡L]* L%	ironic assertion

Pre-nuclear contours

#	Label	phonetics	phonology	Contexts
1	rise	l + m* (+h)	L + H*	statement, yes-no question...
2	low	l + l*	L + L*	incredulous assertion
3	high	¡h + h* (m + h*)	H + H*	wh-question, wh-exclamation, command

[4] In fact, though the presence of a melodic extra rising in the pre-stressed syllable contributes to the natural character of the pattern, it does not improve significantly its recognition as self-evident assertion, which goes from 60% to 75%.

[5] When the focused word is not in the final position the rise to an extra-high level may optionally fall on the stressed syllable, instead of the pre-stressed one, so characterizing another melodic variant: the /H+L/ pitch accent has now a different association, /¡H*+L/, instead of /¡H+L*/.

[6] The duration and intensity features were also not capable alone to convey the contrastive meaning.

[7] That is, with the wh-word in the initial position.

[8] The existence of "almost minimal pairs" such as the wh-question *Como tudo?* (What do you mean by "everything"?) *vs.* the command *Come tudo!* (Eat it all!), that can be uttered exactly with the same melodic contour, confirms this assumption.

[9] In this case, it is not possible to represent the difference in the F0 shapes by different alignments, since both can have falling shapes.

[10] The neutral yes-no question corresponds to a request for information without the presence of focus over a single word and without the expectation of a positive or negative answer.

[11] By incredulous yes-no question I mean a question that conveys disbelief about the expressed propositional content, which generally has just been asserted by the listener, characterizing a sort of echo-question: Speaker (Sp) B *Ele esteve lá ontem.*[He was there yesterday]. Sp A *Ele esteve lá ontem?!* (He was there yesterday?! Are you sure? I really don't think so…)

[12] As in an incredulous question, the speaker repeats here a statement that has just been made, to show, through its melodic pattern, disagreement with its propositional content (a sort of "echo statement").

[13] The so-called intensive emphatic contour applies only to utterances containing quantifiable nouns and verbs, as in *Ele correu!...* (He ran [implying: a lot, or very fast]), but not, for instance, **Ele morreu!...* (He died).

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