THE PHONETICS AND PHONOLOGY OF INTONATIONAL PHRASING IN ROMANCE*

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This paper examines the phonetics and phonology of intonational boundaries in five Romance languages/varieties. A typology of the boundary cues used is given, as well as their relative frequency. The phonology of the tonal boundary gesture is described by means of the inventory of nuclear accents used plus their possible combinations with the two dominant end contours: continuation rise (H) and sustained pitch (!H). A detailed inspection of the phonetics of the H boundary tone, which is the main cue observed across languages, is provided: namely, the impact on H scaling of nuclear accent choice, phrase length and first peak height is assessed. Overall, it is shown that the variation found consistently groups languages in two sets: the Catalan-Spanish group and the Italian-European Portuguese group.

1. *Introduction*

Intonational phrasing in Romance has been the topic of recent research conducted within the Romance languages intonational phrasing project (Elordieta et al. 2003; Elordieta, Frota & Vigário 2005; D'Imperio et al. 2005; Prieto 2005, 2007; Frota & Vigário forthcoming). The main goals of this project are to establish the patterns of placement of intonational boundaries, to determine the influence of syntactic and prosodic factors on boundary placement, and to describe the phonetics and phonology of intonational boundaries. To attain these goals intonational phrasing has been studied on a corpus of laboratory speech which was designed to be comparable across languages – the Romance Languages Database (RLD). The present paper emerges from this research project and deals with its third goal: how

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intonational boundaries are realized in Central Catalan, in two varieties of European Portuguese (Standard and Northern EP), in Neapolitan Italian, and in Central Peninsular Spanish.

Our approach to intonation is couched within the autosegmental-metrical theory (cf. Pierrehumbert 1980; Beckman & Pierrehumbert 1986; Ladd 1996, among the landmarks in the development of this theoretical model). For all the languages under observation, the utterances were prosodically annotated using language-specific versions of a ToBI-like transcription (cf. Price et al. 1991, Beckman & Ayers 1994), which took into account the work available on the intonation of each language developed with the autosegmental metrical model (e.g., for Catalan, Prieto 1995; Estebas-Vilaplana 2000; Prieto et al. 2006b; for European Portuguese, Vigário 1998; Grϕnnum & Viana 1999; Frota 2000, 2002a, 2002b; Vigário & Frota 2003; for Italian, D'Imperio, 2000, 2001, 2002; for Spanish, Prieto et al. 1995, 1996; Prieto 1998; Sosa 1999; Nibert 2000; Beckman et al. 2002; Face 2002; Hualde 2002; McGory & Díaz-Campos 2002, among others). Thus the account of the phonetics and phonology of intonational phrasing we provide is necessarily informed and constrained by the tenets of the approach we adopted. Using the same framework for describing intonation makes cross-language comparisons possible, and work on other languages has shown that languages may differ not only in the phonology (the inventory of tones and their permitted combinations) but also in the phonetics (the realization of tones) of intonational boundaries. For example, phonological differences between German and English question intonation are described in Ladd (1996), namely, the use of H* LH% and L*H LH%, respectively, and phonetic differences between German and British English in the way they exploit the phonetic space of H% are reported in Chen (2003).

This paper is organised as follows. Section 2 reviews the main findings of previous research within the Romance languages intonational phrasing project and describes the RLD. In section 3, a typology of the boundary cues used in each language, as well as their relative frequency, is given. In section 4, the phonological choices that characterize each language are described: the inventory of nuclear accents used and the shape of nuclear contours. Section 5 deals with the phonetics of the dominant boundary cue used by all the languages under study: the H boundary tone. The impact of different factors on the realization of the H boundary tone, such as the type of nuclear accent, or the length of the phrase, is inspected. The paper concludes with an assessment of the similarities and differences that characterize intonational boundaries across Romance languages.

2. *Background*

2.1. *Previous compared work on intonational phrasing in Romance*

Previous comparative work on intonational phrasing in Romance languages focused on the role of syntactic and prosodic factors on the placement of intonational boundaries in broad focus declarative sentences containing a subject, a verb and an object (i.e., SVO). The import of syntactic branching (i.e., constituency), prosodic branching (i.e., number of prosodic words), and length (i.e., number of syllables) was examined in a systematic fashion by approaching intonational phrasing from an empirical perspective.

It was shown that Romance languages differ in their phrasing patterns. In Catalan, the most common phrasing is (S)(VO) across all conditions observed. However, Catalan was the only language where the (SV)(O) phrasing pattern was found. This phrasing obtains due to a strong tendency to balance the length of the prosodic constituents in terms of number of syllables and also of number of stresses and/or prosodic words. An effect of branchingness was also found in Catalan, but the relevant factor is prosodic and not syntactic (Prieto 2005; D'Imperio et al. 2005). Standard European Portuguese (SEP) deviates from the other languages due to the prevalence of the (SVO) phrasing pattern. Phrase length, but not prosodic or syntactic branching, is the crucial factor that triggers the alternative pattern, (S)(VO), found in the data. By contrast, Northern European Portuguese (NEP) shows a higher frequency of (S)(VO) phrasing, with prosodic branchingness being more important than constituent length (Elordieta et al. 2005; D'Imperio et al. 2005; Frota & Vigário forthcoming). The phrasing patterns shown by Italian are similar to NEP: both (SVO) and (S)(VO) are found, and the main factor triggering (S)(VO) is prosodic branchingness (D'Imperio et al. 2005). In Spanish, like in Catalan, the most common phrasing is (S)(VO) across all conditions. However, differently from the other languages, syntactic branching seems to be a major factor in phrasing decisions in Spanish (Elordieta et al 2003, 2005; D'Imperio et al. 2005).

In previous work, intonational boundaries were identified and marked, but no inspection of the type and frequency of boundary cues was made. This is the topic of the present paper. To investigate the phonetics and phonology of intonational phrasing, we took the utterances previously classified as containing a clear phrasing boundary, as perceived by two judges for each language or language variety. In other words, we inspected a subset of the RLD.

2.2. *The RLD*

The Romance Languages Database contains a set of comparable SVO sentences designed with exhaustive combinations of two constituent length conditions (*short*, meaning 3 syllables, and *long*, meaning 5 syllables) and the syntactic branching conditions non-branching, branching and double branching S and O. In a subset of these materials, the syntactic branching condition is substituted with a prosodic branching condition, namely a phrase with two prosodic words that are syntactically non-branching (for a full description of the RLD, see D'Imperio et al. 2005). The speech materials were read three times each in random order (with distractor sentences in between) by two speakers of each of the five languages/varieties under study. Examples of the speech materials are given in (1):

(1) Non-branching Subject and branching Object (Long-Short-Long)
Cat: *La boliviana mirava la melmelada meravellosa*
"The Bolivian woman watched the marvelous marmalade."
EP: *A boliviana gravava uma melodia maravilhosa*
"The Bolivian woman recorded a wonderful song."
It: *La boliviana mirava la serenata meravigliosa*
"The Bolivian woman observed the wonderful serenade."
Sp: *La boliviana miraba la mermelada maravillosa*
"The Bolivian woman watched the marvelous marmalade."

For the present paper, we analysed a subset of this database. As we were interested in the nature of the cues used to signal phrasing, we decided to consider only the *uncontroversial* cases of intonational phrasing, that is, those cases that were perceived by two judges (one author and one external judge) as undoubtedly containing a clear phrasing boundary. Those cases where the judges did not agree, or cases perceived as unclear by both, were not included in the analysis. The results reported below are thus based on a total of 998 utterances: 239 for Catalan, 267 for EP (117 for SEP and 150 for NEP), 233 for Italian, and 259 for Spanish. Although only the speech of two speakers from each language/variety was inspected, both the fact that we took the clear phrasing cases and the fact that the same speakers had already been recorded together with other speakers for the study of different aspects of intonation and did not show deviant or atypical patterns (see Frota 2000 for Standard EP, Vigário & Frota 2003 for NEP, and D'Imperio 2000 for Italian) make us confident that we are indeed describing intonational properties of the languages and varieties under observation.

3. *Typology of boundary cues*

The phrasing boundaries inspected show one (or more) of the following boundary cues: (i) the preboundary stretch is realized as a rise from/on the last stressed syllable into the boundary syllable, that is, a *continuation rise*; (ii) the preboundary stretch is realized as a rise on the last stressed syllable followed by a high plateau up to the boundary, that is, *sustained pitch*; (iii) the boundary is signalled by a *High* tone; (iv) the boundary is signalled by a *Low* tone; (v) there is *pitch reset* after the boundary, at the beginning of the second phrase; (vi) the F0 level *drops to the speaker's base level* at the boundary; (vii) there is *preboundary lengthening*; and (viii) a *pause* (defined as a stretch of silence) is present at the phrasing boundary. Of this set of cues, pitch reset and preboundary lengthening turned out to the extremely hard to capture in a systematic and comparable way across languages, as it will be explained below. For all the other cues the criteria just given was systematically applied to all the data.

Pitch reset was found to be either full or partial and measuring it in a comparable fashion across languages was problematic. For EP the peak line delineated by two (or more) preboundary peaks was used as a reference line to place the first peak of the second phrase, and peaks above the line were classified as cases of reset. This criterion matched well with the perception of pitch reset. For Italian, a purely perceptual decision was made. For Spanish and Catalan, ratios of 0.90 or higher between the first peaks of the first and second phrases were considered cases of reset. Again, the criteria seemed to match with the perception of pitch reset. Establishing the presence of preboundary lengthening in a comparable way across languages was even harder. The database was not designed to measure lengthening, and only by chance could we get the same sentence uttered with and without a phrasing boundary by the same speaker, the ideal case to examine lengthening effects. In the different languages, the few ideal pairs found were measured (for the duration of the last stressed syllable and the preboundary syllable) and the result of the presence or absence of lengthening was extended to the utterances that were perceptually similar (with regard to the impression of lengthening) to those that were actually measured.[1]

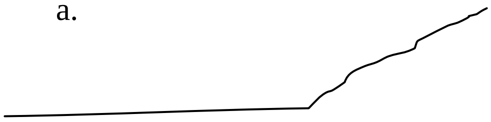
Table 1 shows the frequency of the different boundary cues in the languages studied. It is clear that prosodic breaks in Romance are predominantly marked by a High boundary tone. The preboundary stretch tends to be realized as a continuation rise. Italian deviates from the other languages due to the high frequency of the second possible boundary configuration: sustained pitch. In either case, the boundary is marked by a H tone. The two boundary configurations, sustained pitch and continuation rise, are phonetically distinct in all the languages that show both types of contours, that is, Italian, Spanish, and NEP. The configurations in (2), taken from Italian examples, illustrate the general patterns found throughout the data. Further exemplification is provided in Figures 1 and 2, which show typical contours with a continuation rise or with sustained pitch in NEP and Spanish, respectively.

	Cont. Rise	Sustained Pitch	Boundary Tone		Pitch Reset	Drop BL	PB Length.	Pause
			H	L				
Cat	100.0	0.0	**100.0**	0.0	28.0	0.0	100.0	10.5
Sp	88.4	11.2	**99.3**	0.7	76.0	0.7	40.2	28.2
SEP	95.0	0.0	**95.0**	4.0	25.0	4.0	15.0	5.0
NEP	89.0	8.0	**97.0**	3.0	21.0	1.0	72.0	17.0
It	54.5	45.5	**98.7**	1.3	98.0	0.0	100.0	16.7

Table 1: *Frequency of boundary cues (% relative to total of utterances with perceived boundary)*

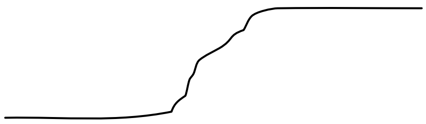
[1] In future work we plan to address the issues of pitch reset and preboundary lengthening by means of specifically designed experiments that can produce comparable data and the application of identical criteria for all languages.

(2) a. *Continuation rise*



Ba da L O na

b. *Sustained pitch*



Ba da L O na “Badalona”

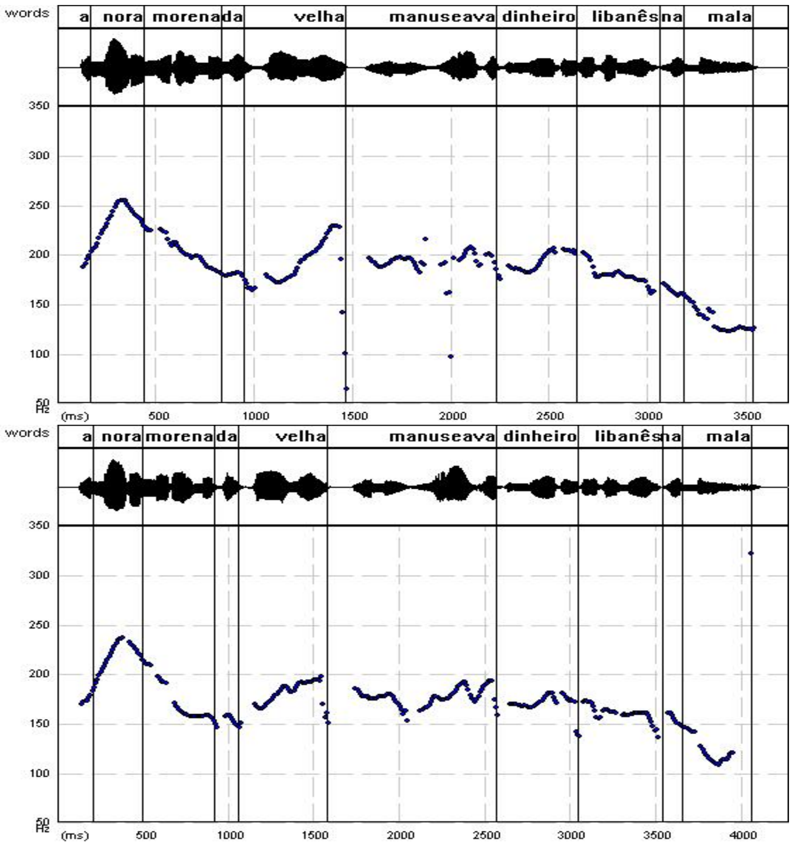


Figure 1: *Waveform and F0 contour of the utterance (A nora morena da velha) (manuseava dinheiro libanês na mala) ‘The dark-hair daughter-in-law of the old woman was holding Lebanese money in her handbag’ produced with a prosodic break after the subject noun phrase, by speaker MI from NEP. The top panel shows a continuation rise; the bottom panel shows sustained pitch.*

As shown in Table 1, Low boundary tones occurred in all languages to the exception of Catalan, but are rare. The F0 drop to the speaker's base level is also rare. Pauses, although present in all languages, are not a frequent cue either.[2] As to pitch reset and preboundary lengthening, these cues appear in all languages but are very frequent in only some of them.

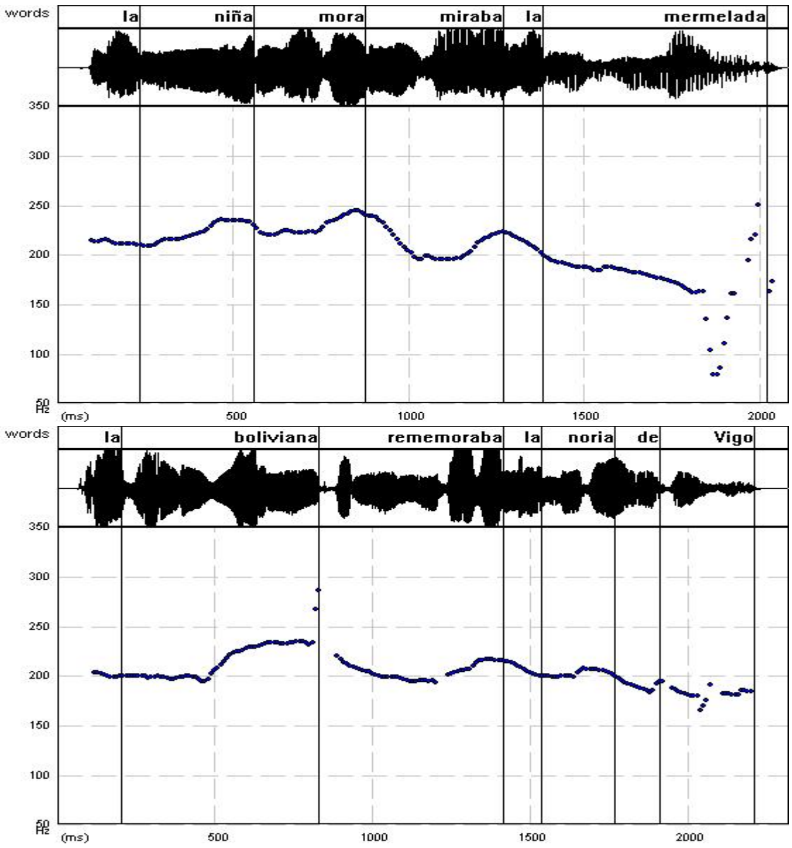


Figure 2: *Waveform and F0 contour of the Spanish utterances: Top panel (La niña mora) (miraba la mermelada) 'The mourish girl watched the marmalade' produced with a prosodic break after the subject noun phrase and showing a continuation rise (speaker MR); Bottom panel: (La boliviana) (rememoraba la noria de Vigo) 'The Bolivian girl remembered the turning-wheel from Vigo', showing a prosodic break with sustained pitch after the subject (speaker LM).*

Due to the dominant use of the H boundary tone across languages and its contribution to both a continuation rise and a sustained pitch boundary configuration, this paper will focus on the phonology and phonetics of the whole tonal gesture that signals phrasing boundaries in Romance.

4. *Phonological choices*

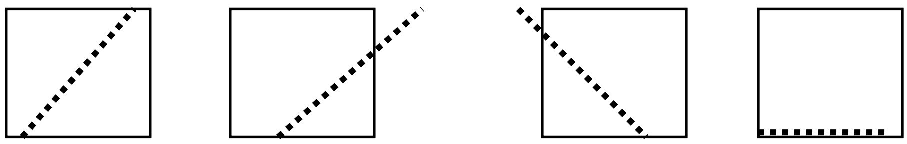
This section is devoted to the phonology of the continuation rise or sustained pitch tonal gesture. In section 4.1 we describe the nuclear accents found in each language, that is, the pitch accent preceding the boundary tone. In section 4.2 we examine the shape of the nuclear contours as a whole.

[2] In our data speech rate was not controlled, as speakers were simply asked to produce the utterance in a natural way at a normal speech rate. It may thus be the case that speech rates differences are behind the differences in pause occurrence.

4.1. *Nuclear accents*

Across languages, four different nuclear accents were found before the phrasing boundary. The shapes of the tonal trajectory within the stressed syllable are depicted in (3). We describe tune-text alignment of these shapes as in (4).

(3) a. L+H* b. L*+H c. H+L* d. L*



(4) Alignment description:
- a. L+H*: high target attained within the stressed syllable (at the end of the vowel)
- b. L*+H: low target in the stressed V and high target in the post-stressed syllable
- c. H+L*: low target in the stressed V preceded by a high target
- d. L*: the stressed vowel remains low almost throughout

The descriptions in (3) and (4) were instrumental in the identification of the nuclear accents across languages, so that we could systematically apply the same category label to similar objects cross-linguistically: in addition, it is important to note that all these accents had independently been described in previous work as part of the tonal inventory of the languages that show them in our data (e.g., Prieto 1995 for Catalan; Frota 1997, 2002b; Vigário 1998; Vigário & Frota 2003 for EP; D'Imperio 2000, 2002 for Italian; Beckman et al. 2002; Face 2002; Hualde 2002; McGory & Díaz-Campos 2002; Sosa 1999, among others for Spanish).[3]

The distribution of the different nuclear accent types across languages is given in Table 2. The five languages/varieties clearly form two groups: (i) those only with rising accents or where rising accents are the overwhelming choice, that is, Spanish and Catalan; and (ii) those with both rising and falling accents, that is, SEP, NEP and Italian. Within the latter group, a further distinction can be made: SEP is different from both NEP and Italian, in not showing the accents L+H* and L*. This does not come as a surprise, as L* has been reported to be the most frequent nuclear accent in NEP declarative accents, whereas SEP has H+L* as the declarative nucleus (Vigário & Frota 2003), and L+H* has never been reported as a possible accent in SEP to our knowledge.

[3] The rare cases of falling accents found in Catalan require a further comment. These cases may fall either in the H+L* or L* category, as they are ambiguous between the two and may well be variants of the same accent. We have classified them as H+L* for the sake of simplicity.

		L+H*	L*+H	H+L*	L*
Cat	NM	97	0	3	0
	PG	100	0	0	0
Sp	LM	27	73	0	0
	MR	5	95	0	0
SEP	AG	0	57	43	0
	MC	0	11	89	0
NEP	MI	19	57	7	17
	MS	0	0	14	86
It	LC	47	0	0	53
	LD	41	0	59	0

Table 2: *Distribution of nuclear pitch accent types (% relative to total of utterances by speaker) across languages and speakers*

4.2. *Nuclear contours*

We will now consider the contribution of the nuclear accents to the two types of dominant nuclear contours we have found: continuation rise and sustained pitch. The four different accents participate in the continuation rise and sustained pitch boundary configurations as described in Table 3. Not surprisingly, falling/low accents only appear with continuation rises. Rising accents, on the other hand, show two interesting patterns which again divide Romance languages into the same two groupings: (i) Catalan and Spanish; and (ii) SEP, NEP and Italian. In the latter group there is a strong connection between L+H* and sustained pitch, and L*+H and continuation rise. In the former group, the connection is much less strong or simply does not hold: in Spanish, L+H* does not have to be followed by sustained pitch (in fact, with L+H* sustained pitch is observed in only 26% of the cases), and sustained pitch may appear with L*+H (9% of the cases); in Catalan, L+H* is almost the only accent (except for 3% of H+L*) and sustained pitch was not found.

Based on our data, we have to conclude that from a cross-language perspective, nuclear accent type (L+H* and L*+H) and a sustained pitch or continuation rise configuration at the intonational boundary are independent choices and different languages combine these two properties of the nuclear contour in different ways.

	L+H*	L*+H	H+L*	L*
Cat	ContRise			
Sp	ContRise/SusPitch	ContRise/SusPitch		
SEP		ContRise	ContRise	
NEP	SusPitch	ContRise	ContRise	ContRise
It	SusPitch	ContRise	ContRise	ContRise

Table 3: *Dominant nuclear contour types across languages*

Finally, we would like to comment on the phonology of the two types of boundary contours. Continuation rises involve a H boundary tone, that may be preceded in some cases by a Low tone (i.e., in Catalan and Spanish, though not frequently) yielding a boundary of the (L)H type. Sustained pitch also involves a H boundary tone, and the high plateau may be analyzed as the result of a HL boundary where the L tone is responsible for the final sustained level (as proposed in Pierrehumbert 1980), or simply as the result of a !H boundary, assuming that downstep is an independent intonational feature (along the lines of work by Ladd, e.g., Ladd 1983, 1996). The second analysis would have the advantage of leaving the HL boundary type for complex boundaries that do involve a real rise-fall gesture (as in the case of yes-no questions in NEP – Vigário & Frota 2003, or exhortative utterances in Catalan – Prieto et al. 2006b).

5. *The phonetics of the H boundary tone*

This section examines the phonetics of the dominant boundary cue used by all the languages under study: the H boundary tone. A detailed analysis of the impact of different factors on the realization of the H boundary tone is provided, namely the type of nuclear accent (section 5.1), the length of the phrase (section 5.2), and the interdependence with the scaling of the first peak of the phrase (section 5.3). The section concludes with a summary and discussion of the main findings.

5.1. *The impact of nuclear pitch accent choice on the scaling of the H boundary*

We have seen that all languages, to the exception of Catalan, may show different types of accents that frequently appear in nuclear position before the phrasing boundary. The realization of the H boundary tone (HBT) may thus be affected by the choice of nuclear pitch accent in these languages, along the lines suggested by Pierrehumbert (1980) for the upstep of H% after a H tone, but not after a L tone. A detailed examination of nuclear pitch accent choice as a factor constraining the scaling of HBT shows important and consistent effects across SEP, NEP, Italian and Spanish.

In SEP, HBT is higher after L*+H than after H+L*. The effect is consistent across speakers. Figure 3 (top panel) displays the data for AG (who shows a significant difference in the scaling of HBT, $p<0.0001$). In NEP, HBT is also higher after rising accents than after falling/low accents ($p<0.001$). HBT is also higher after H+L* than L*, for both speakers (though it does not reach significance). This is illustrated by the data for MI, the speaker that shows all the four types of nuclear accent (Figure 3, bottom panel).

The data from Italian replicates the same basic finding that rising accents promote higher HBT than low/falling accents (for both speakers $p<0.0001$), as shown in Figure 4.

In Spanish two types of rising accents were found, and HBT is consistently higher after L*+H than after L+H* across speakers and the difference reaches significance for speaker LM ($p<0.05$), who shows a more balanced distribution between accents (Figure 5). This result is not surprising, as L*+H is followed by a continuation rise in 92% of cases, whereas a continuation rise appears after L+H* in only 74% of the ocurrences of this accent.

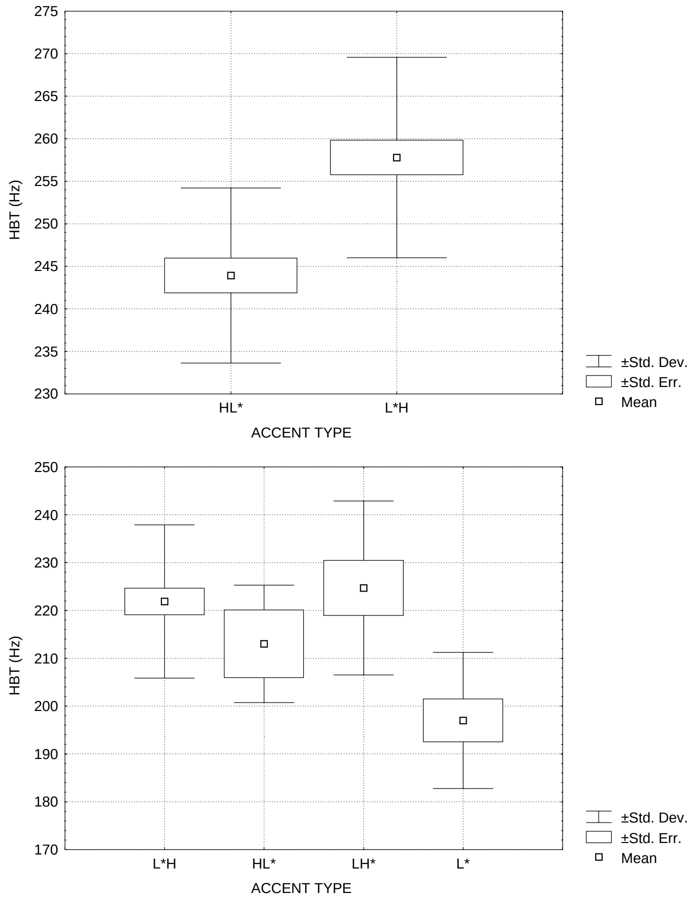


Figure 3: *HBT scaling by type of nuclear accent. Top panel: speaker AG from SEP; Bottom panel: speaker MI from NEP*

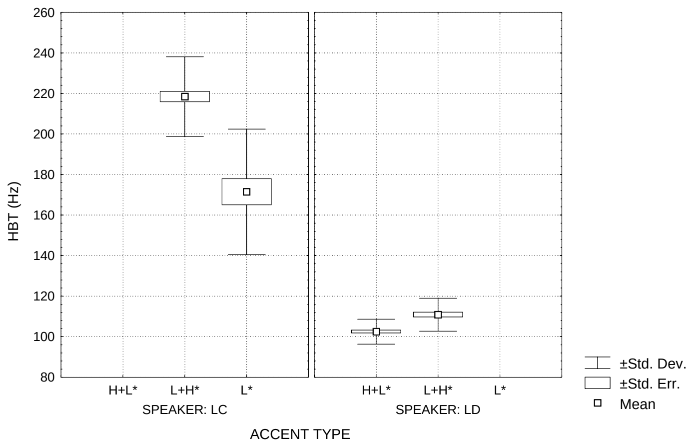


Figure 4: *HBT scaling by type of nuclear accent for the two Italian speakers*

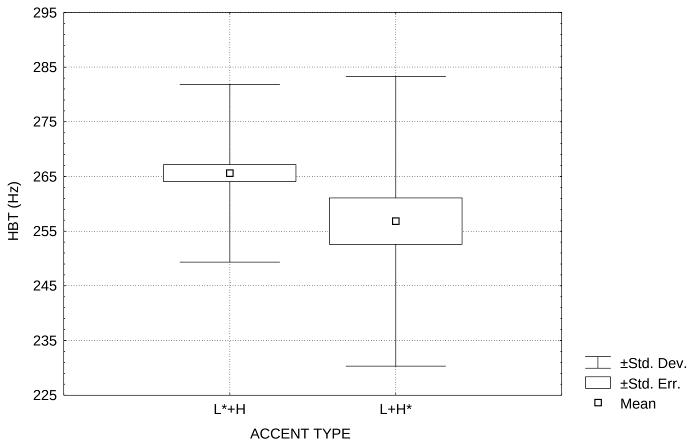


Figure 5: *HBT scaling by type of nuclear accent for speaker LM from Spanish*

We can conclude that nuclear pitch accent choice affects the scaling of HBT in a similar and consistent way in all languages studied that use different pitch accents. The trend is the following: HBT is higher after L*+H/L+H* than after H+L*/L*. Within rising accents, L*+H promotes higher HBT than L+H* in Spanish. Within accents with a (final) Low tone, H+L* promotes higher HBT than L* in NEP. The Catalan data, although only containing L+H* is consistent with the cross-linguistic findings, in that the H boundary tone shows high values in this language. This fact is captured by a cross-language comparison of the ratios between HBT and the F0 values at the beginning of the utterance: in Catalan the ratios are very high (indeed it is the only language with ratios above 1.30), as expected from a rising accent plus HBT sequence where only continuation rises are found.

The findings just described can be interpreted as resulting from the upstep of HBT after an accentual H. This would account for the higher scaling of HBT after rising accents in general, relative to low/falling accents. Moreover, this implemention rule is independent of the downstep (phonological) feature we proposed to represent the sustained pitch configuration (!H). Thus, a downstepped HBT would tend to be phonetically lower than a non-dowstepped HBT, even if preceded by an accentual H.[4]

5.2. *The impact of phrase length on the scaling of HBT*

It has long been known that F0 tends to decline over the course of phrases (and utterances) in many languages, whether we consider the trend shown by the topline or the baseline (e.g., Bruce & Garding 1978; Liberman & Pierrehumbert 1984; Pierrehumbert & Beckman 1988; Ladd 1996; Prieto, Shih

[4] The reason why H+L* promotes higher HBT than L* is not totally clear at this point. However, we would like to suggest a functional interpretation in terms of contrast enhancement, along the lines of suggestions made in Rialland (2001): after a fall a higher target is required to facilitate both the perception of the low tone and of the following high tone.

& Nibert 1996; Prieto 1998, among many others). However, languages seem to differ in the sources of global trends, as the scaling of any given tone may depend on a variety of factors like phrasal length, phrasal position, temporal distance to preceding accent, F0 values of preceding accent, etc. For some languages, the global trend seems to be mainly due to localised changes in the contour (as proposed in Liberman-Pierrehumbert's model), whereas for others some amount of global pre-planning is required (see Rialland 2001; Gussenhoven 2004). In the former languages, phrasal length is not a crucial factor, unlike the F0 value of preceding accents (e.g., Prieto, Shih & Nibert 1996); in the latter languages, the length of the phrase is crucial and speakers tend to begin higher as the phrase is longer (e.g., Rialland 2001). Within the same language, the factors affecting the scaling of different tones may also vary: for example, scaling of accentual peaks in Mexican Spanish is mainly predicted by the F0 value of the previous peak (Prieto, Shih & Nibert 1996), whereas scaling of L tones requires a combination of contextual factors, phrasal length included (Prieto 1998).

In this section we examine the impact of the length of the phrase on the scaling of HBT. We have measured phrase length in number of syllables, and thus the distance between HBT and the beginning of the phrase (which is also the beginning of the utterance in our data) may vary from 3 to 15 syllables. In our analysis of the length factor, we looked at the ratio between HBT and the F0 value at the beginning of the utterance (UttIni) across languages, for each speaker and by nuclear pitch accent type. We then checked whether the results found were mainly due to the impact of length on HBT scaling, on UttIni scaling, or both.

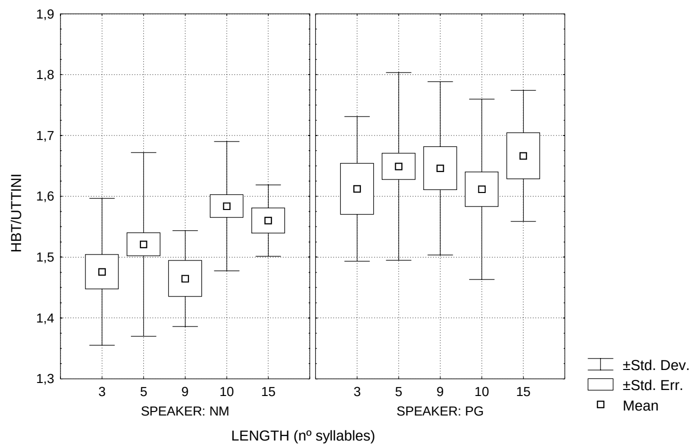


Figure 6: *Ratio HBT/UttIni as a function of phrase length in number of syllables, for both Catalan speakers*

In Catalan, although there is a slight tendency for the ratio HBT/UttIni to be higher in longer phrases, the effect is not consistent, nor significant, as shown in Figure 6 (p>0.01). Phrase length has also no consistent effect on the scaling of UttIni (for speaker NM, phrases with 10 syllables tend to show lower scaling than phrases with 5 or 3, and phrases with 15 low scaling than phrases with 9; for speaker PG, there is a slight tendency for higher scaling of UttIni with increasing length, but it is not significant p>0.01). Thus phrase length is clearly not a main factor constraining the scaling of the beginning and final points of the phrase in Catalan.

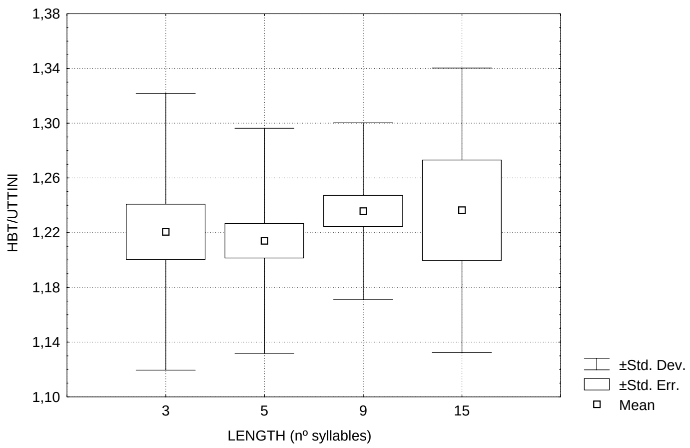


Figure 7. *Ratio HBT/UttIni as a function of phrase length in number of syllables, for the phrases produced with a L*+H nuclear accent by the Spanish speaker LM*

Spanish is similar to Catalan, in that no significant effect of phrase length was found, for both speakers and either accent type (ANOVA results for HBT/UttIni: speaker LM, L*+H and L+H* p>0.05; speaker MR, L*+H and L+H* p>0.1; ANOVA results for UttIni: LM, L*+H and L+H* p>0.1; MR, L*+H and L+H* p>0.1). This is illustrated by the data for speaker LM showing the L*+H nuclear accent plotted in Figure 7. In addition, there is no consistent tendency in Spanish to have higher or lower HBT/UttIni ratios, across speakers or accent types.

The European Portuguese data offers a very different picture. There is an overall tendency, consistent across speakers and accent types, to have lower HBT/UttIni ratios with increasing phrase length. This effect is clear in SEP (though not statistically significant) and in NEP, where it is significant for both speakers and the different accents, whether rising or falling (NEP; speaker MI p<0.01 for L*+H and p<0.05 for L+H*; speaker MS p<0.0001 for L*). The EP results are illustrated in Figure 8.

An inspection of whether this clear effect of length was mainly due to an impact on the scaling of UttIni or on the scaling of HBT, or both, revealed an interesting finding. In SEP, no effect of length on HBT was found (ANOVA results: speaker MC, H+L* accent p>0.1[5]; speaker AG, H+L* and L*+H p>0.1). However, phrase length has a strong significant effect on UttIni: the beginning of the utterance is higher with increasing phrase length (ANOVA results: speaker MC p<0.01; speaker AG p<0.05). This is shown in Figure 9,

[5] For this speaker there are not enough cases of L*+H across the different length conditions.

for speaker AG. Figure 9 thus shows the reverse effect of that depicted in Figure 8 (left panel): UttIni is scaled higher as the phrase becomes longer (Figure 9), whereas the ratio HBT/UttIni becomes lower with phrase length (Figure 8). Clearly, then, the effect of length on the HBT/UttIni ratio in SEP is crucially due to an effect on UttIni scaling, and not on HBT scaling.

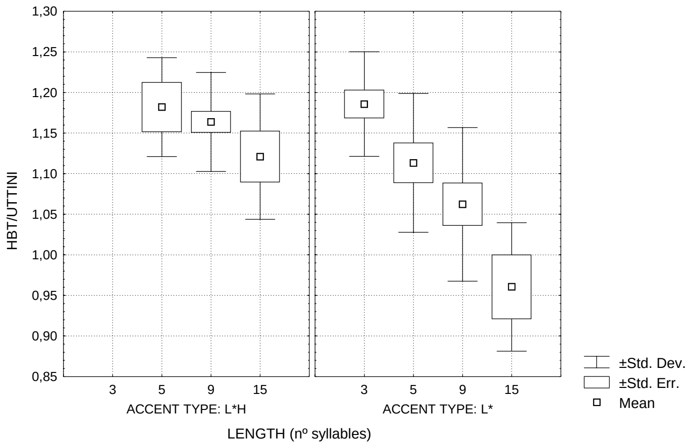


Figure 8: *Ratio HBT/UttIni as a function of phrase length in number of syllables. Left panel: phrases produced with a L*+H nuclear accent by the SEP speaker AG; Right panel: phrases produced with a L* nuclear accent by the NEP speaker MS*

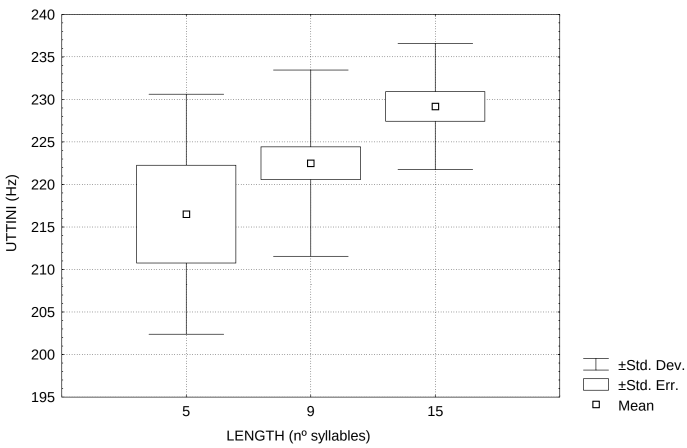


Figure 9: *UttIni scaling as a function of phrase length for speaker AG from SEP*

In NEP, by contrast, there is a consistent effect of phrase length on the scaling of HBT: HBT becomes lower as phrase length increases (ANOVA results: speaker MI L*+H p<0.05; speaker MS L* p<0.0001).[6] This is shown in Figure 10. As to the scaling of UttIni, there is only a slight tendency for UttIni to be higher with increasing length, but the effect is not significant (ANOVA results: speaker MI and speaker MS p>0.1). Thus in NEP, unlike in

[6] The other nuclear accent types have no sufficient number of cases in the different length conditions.

SEP, the significant effect of length on the HBT/UttIni ratio is crucially due to an effect on HBT scaling. The HBT/UttIni ratio becomes lower with increasing length (Figure 8, right panel) because HBT is scaled lower as length increases (Figure 10). The effect is still reinforced by the slight tendency for UttIni to be scaled higher in longer phrases.

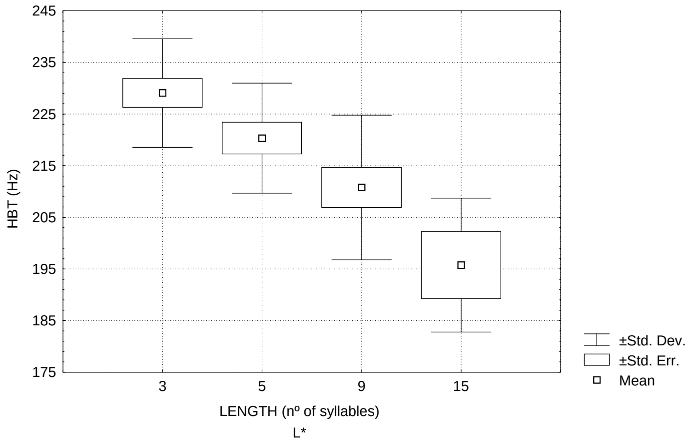


Figure 10. *HBT scaling as a function of phrase length, for the phrases produced with a L* nuclear accent by the NEP speaker MS*

In short, phrase length is a crucial factor in European Portuguese: lower HBT/UttIni ratios are obtained as the length of the phrase increases. However, in SEP length is crucial to the scaling of the beginning of the utterance, whereas in NEP length mainly affects the scaling of end of the phrase, that is, HBT.

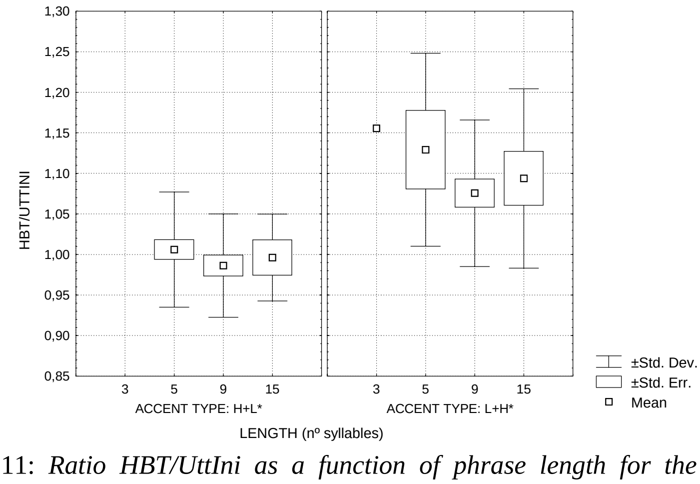


Figure 11: *Ratio HBT/UttIni as a function of phrase length for the Italian speaker LD, by nuclear accent type*

Italian is similar to EP, as it also shows a tendency for HBT/UttIni ratios to be lower as the phrase becomes longer (although not significant). This is consistent across speakers and nuclear accent types. Figure 11 provides an illustration of this pattern, for speaker LD. In Italian, the effect of length is clearly not due to an impact on the scaling of UttIni, as shown in Figure 12 (ANOVA results: speaker LD and speaker LC $p>0.1$). The scaling of the beginning of the utterance is not sensitive to phrase length in this language. Like in NEP, the tendency shown by the HBT/UttIni ratios seems to be due to an effect of length on the scaling of HBT (that reached significance for speaker LD at $p<0.01$).[7]

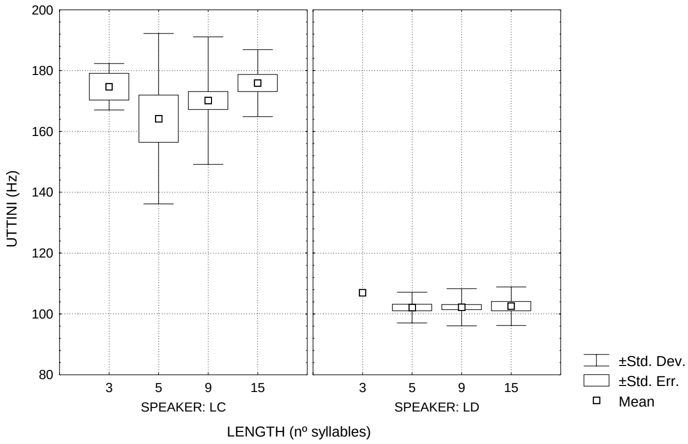


Figure 12: *UttIni scaling as a function of phrase length for the two Italian speakers*

Summing up, the impact of length on the scaling of HBT and UttIni reveals important differences across Romance languages. The languages observed seem to cluster in two main groups: (i) those showing an effect of length, such as European Portuguese and Italian; (ii) those with no effect of length, such as Spanish and Catalan. Within the two groups, some further differences were found: (i) the first group shows lower ratios with increasing length; in SEP this is due to higher scaling of UttIni, while in Italian there is no effect on UttIni but an effect on HBT, and in NEP there is a strong effect on HBT (that becomes lower with increasing length) combined with a tendency for higher scaling of UttIni; (ii) in the second group there is no clear effect of length, but a slight tendency to higher ratios in the longer phrases appears in Catalan, whereas in Spanish this is not consistent across speakers or nuclear accent types.

5.3. *Scaling correlation between the first peak and HBT*

We have seen in section 5.2 that Romance languages vary with respect to the importance of phrase length for the scaling of HBT (and for the beginning of the utterance). In the present section we examine the relation between the scaling of HBT and the scaling of the first peak of the phrase (which is also the first peak of the utterance in our data). It is known that, at

[7] For a detailed analysis of the scaling of UttIni, as well as of the first peak, in phrases with rising acents in our data, see Prieto et al. (2006a).

least in some languages, the first peak sets the beginning F0 value from which the following peak value is computed, being the process locally iterated between adjacent peaks within the same phrase (e.g., Liberman & Pierrehumbert 1984; van den Berg, Gussenhoven & Rietveld 1992; Prieto, Shih & Nibert 1996). The question we set out to answer is whether the first peak has an influence on the scaling of the boundary peak in the languages observed. In case the iterated changes mentioned above do apply, a correlation between the scaling of the first peak and the scaling of HBT is expected. If HBT is scaled independently from the first peak (and the other peaks in the phrase), no correlation is expected.

Nuclear	Catalan		Spanish		SEP		NEP		Italian	
accents	PG	NM	LM	MR	MC	AG	MI	MS	LC	LD
L+H*	0.36*	-0.14	0.13	-0.25			0.36		0.01	0.04
L*+H			0.43*	0.44*		-0.13	0.16			
H+L*					-0.07	0.17		-0.53		0.06
L*							0.52	0.20	0.26	

Table 4: *Correlation coefficients for first peak in the phrase and HBT, by speaker and nuclear pitch accent type (significant results are signaled with *; for all significant cases found p<0.001)*

The correlation results are given in Table 4.[8] In Catalan, a highly significant correlation was found for one of the speakers. Significant correlations were also found in Spanish, for both speakers but only when the nuclear accent is of the L*+H type. Unlike in Catalan or Spanish, no significant correlations were found in European Portuguese (at $p<0.05$). The Italian data patterns like the EP data.

Again, the languages cluster in two groups: (i) those without significant correlations between H1 and HBT, that is, European Portuguese and Italian; and (ii) those showing significant correlations, that is, Catalan and Spanish. Notably, this is the same grouping that was found previously when analysing the phrase length effect on the scaling of the H boundary tone (section 5.2).

5.4. *Summary and discussion*

The phonetics of the dominant boundary cue used by Romance languages – the H boundary tone – was inspected in section 5. It was found that the choice of nuclear pitch accent is a major factor constraining the scaling of HBT in all the languages observed, and that this factor affects HBT height in a similar and consistent way across languages: HBT is higher after rising accents (L*+H/L+H*) than after falling or low accents (H+L*/L*). This finding was interpreted as resulting from the upstep of HBT after an accentual H, along the lines suggested by Pierrehumbert (1980) for upstep relations between H tones.

[8] Blank cells in the table indicate that either the relevant accent type is not present in the speaker's data, or the number of cases with that accent type and a H boundary tone and a first peak is too small (i.e., less than 5).

Unlike nuclear pitch accent choice, the impact of phrase length on the scaling of HBT as seen by the ratio between HBT and the beginning of the phrase (UttIni) is not consistent across languages, and both major and minor differences were found. The languages observed cluster in two groups: (i) those with a clear effect of length (significant or not), that is, European Portuguese and Italian; (ii) those with no clear effect of length, that is, Spanish and Catalan. Moreover, within groups, some further differences were found: (i) the first group shows lower ratios with increasing length, but in SEP this is due to higher scaling of UttIni, while in Italian there is no effect on UttIni, and in NEP there is a strong effect on HBT (that becomes lower with increasing length) combined with a tendency for higher scaling of UttIni; (ii) in the second group there is no clear effect of length, but a slight tendency to higher ratios in longer phrases appears in Catalan, whereas in Spanish this is not consistent across speakers or nuclear accent types. The question arises whether the effect of length patent in the first group is a function of a whole phrase implementation effect or rather of a more local effect, such as the scaling of the previous accent. In the case of SEP, the available evidence points to a whole phrase effect, as it is the beginning of the phrase that is affected by the size of the phrase in a way similar to that described in Rialland (2001) for Dagara. In the case of NEP, evidence suggests a combined effect of local and global factors, as a main influence on HBT scaling was found together with a slight influence on UttIni. In Italian, only an influence on HBT scaling was found. How this *local* influence of phrase length on HBT should be obtained in both NEP and Italian is a matter for future research. The best place to look at seems to be the nuclear pitch accent, that is, the accent immediately preceding the boundary. We will thus explore this issue in the near future.

Like the phrase length factor, the influence of the first peak on the scaling of HBT is also not consistent across languages. The analysis of this factor has divided the languages observed in the same two groups: European Portuguese and Italian, on the one hand, with no significant correlation between HBT and the first peak of the phrase (H1), and Catalan and Spanish, on the other hand, with significant correlations between H1 and HBT. This interdependence between the scaling of HBT and of the first peak in the latter group suggests that locally iterated changes in peak scaling within a phrase may apply in these languages. Indeed, in the Catalan data the number of accents in a phrase seems to affect the scaling of HBT, with HBT scaling higher in phrases with more accents. This may be taken as an indication that a local iterated computation between accents within a phrase (as shown by Prieto, Shih & Nibert 1996 for Mexican Spanish) and between the last accent and the boundary peak is an important factor to take into account both in Catalan and Spanish. This is a topic to explore in further research.

Finally, the impact of the two last factors examined – phrase length and first peak scaling – on the height of the boundary peak clusters languages in exactly the same way: European Portuguese and Italian show an effect of length, but not an effect of the first peak; conversely, Catalan and Spanish show an effect of the first peak, but not a length effect. Another question to be addressed in future research within the Romance languages intonational phrasing project is whether this variation corresponds to different ways of implementing tone scaling across languages, as it has been suggested in the literature (namely, via localized changes between adjacent peaks within a phrase as described in Liberman & Pirrehumbert 1984, inter alia, or via global phrasal implementation as described in Rialland 2001, among others).

6. *Conclusion*

This paper describes the phonetics and phonology of intonational boundaries in Catalan, in two varieties of European Portuguese, in Italian, and in Spanish. A typology of the boundary cues used was put forward and their relative frequency was established. Due to the dominant use of the H boundary tone across languages and its contribution to the two main types of boundary configurations found - continuation rise and sustained pitch -, this paper has focused on the phonology and phonetics of the whole tonal gesture that signals phrasing boundaries in Romance.

It was shown that the phonology of intonational boundaries in Romance is characterized by two main traits: the presence of the H boundary tone is the common feature, whereas nuclear pitch accent choice and the possible combinations of nuclear accent with the continuation rise/sustained pitch configurations set languages apart in two different groups. The phonetics of intonational boundaries offers a similar picture: nuclear pitch accent choice plays a major role on HBT scaling in all languages, with HBT being upstepped after an accentual H, whereas the other factors inspected set languages apart in exactly the same two groups. Overall, the variation found is between the Catalan-Spanish group on the one hand, and the European Portuguese-Italian group on the other. Within the latter, the Northern variety of European Portuguese is consistently closer to Italian than the Standard variety.

It is hoped that the present findings may add to recent work on variation in intonation (inter alia, Grabe 2002; Chen 2003; Grice et al. 2005), and contribute to our understanding of the dimensions of variation in intonational phrasing in Romance languages.

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