Do complex pitch gestures induce syllable lengthening in Catalan and Spanish?*

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In both Spanish and Catalan, narrow contrastive focus and presentational broad focus in nuclear position have different pitch accent choices, namely a rising or a falling pitch accent, respectively. In words with final stress, narrow contrastive focus displays a rise-fall complex pitch gesture in the last syllable of the utterance. This article investigates the effects of the complexity of such a pitch pattern on the durational properties of the syllables in both languages when compared to the simpler falling pitch movement. The results of the production experiment reveal that, in general, the presence of a complex pitch pattern tends to have a lengthening effect on the target syllable. Yet we also find that some instances of this complex contour can be partially truncated, in which case it does *not* trigger lengthening. In sum, even though truncation and compression have been claimed to be language- and dialect-specific strategies (Ladd 1996; Grabe 1998; Grabe et al. 2000), in our data, truncation can be considered a speaker phonetic realization strategy that interacts with timing in such a way that there is a trade-off relationship between the two factors.

1. Introduction

In languages with a contrast between contour and non-contour tones, there are often restrictions on where those categories can occur. These restrictions vary from language to language, but there are some such patterns that recur independently

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and in unrelated languages. Contour tones tend to manifest themselves in contexts that are longer, while shorter contexts tend to produce neutralization. For example, it has long been noted that contour tones in Chinese languages such as Mandarin, Cantonese, and Fuzhou appear with fewer restrictions in language varieties that have coda contrasts, diphthongs, and longer rhyme durations, that is, in bimoraic syllables (Duanmu 1990, 1994a, b). Similarly, in Tokyo Japanese (unlike Kansai Japanese), a contour tone cannot be realized on a single mora (Maeda & Venditti 1998).[1] Nonetheless, the strictly moraic approach has been challenged by Zhang (2001, 2004), who points out that contour tones appear cross-linguistically in syllables which are long for independent reasons and which do not need to be bimoraic, e.g., syllables at the end of prosodic domains, syllables in shorter words, etc., and argues that the tone-bearing ability is rooted in phonetic behavior. In the realm of perception, experiments by Diehl & Kluender (1989) have revealed that high tones in Chinese may be misperceived as rising tones when syllables are longer.

In pitch-accent languages, it has also been observed that when complex pitch gestures appear as a result of two or three associated tones with a single syllable, either the contour is fully realized and 'compressed', or certain repair strategies appear, such as contour truncation (for examples of these different strategies, see Ladd 1996:132–136; Grabe 1998; and Grabe et al. 2000). Truncation and compression are two distinct phonetic realization strategies: while compression generally involves a speeding up of the pitch realization in order to produce a complete accent shape, truncation involves no pitch velocity change in the contour, which is only partially realized (see Grabe et al. 2000:162). In compressing languages, a few studies have observed that syllables bearing a complex pitch accent are longer than syllables bearing simpler pitch accents. For example, Gili-Fivela (2006) reports that syllables in contrastive focus (e.g., rise-fall gestures) are 7% to 10% longer than syllables in broad focus (e.g., rise gestures), regardless of their position within the word. Similarly, Ortega-Llebaria & Prieto (2006) recently investigated the durational properties of words with broad vs. narrow contrastive focus in Catalan and Spanish. They found that duration was amplified in narrow-focused words although only in final position. Since it is only in final position that we have a complex tonal gesture, the working hypothesis is that complex tonal gestures trigger lengthening. Crucially, durational differences only appeared between narrow vs. broad focus in words with final stress, a context where we find the pressure of realizing a complex rising-falling tonal gesture only in narrow focus. In contrast,

1. On the other hand, in Cantonese, contour tones have a lengthening effect: specifically, there is a statistically significant difference between the duration of a level tone and that of either a morphologically-derived or a sandhi-derived rising tone (Yu 2003).

the lack of duration effect in words with penultimate stress is attributed to the lack of realization of the complex pitch gesture.

The goal of this paper is to systematically investigate the effects of the presence of complex pitch movement on the durational properties of syllables in Catalan and Spanish and to test whether the abovementioned restrictions are rooted in phonetic behavior. Crucially, in both languages, narrow contrastive focus and presentational broad focus have different pitch accent choices (e.g., *She broke her neck, right? — No, she broke her LEG*) (see de la Mota 1995; Face 2002 for Spanish; Prieto 2002; Estebas-Vilaplana 2000; Astruc-Aguilera 2006 for Catalan). As Figure 1 shows, in Catalan narrow focus is realized as a rising accent and broad focus as a falling accent. Interestingly, when the accented syllable is in phrase-final position (*mamá*), the rising accent is realized as a complex rise-fall gesture, as follows.[2]

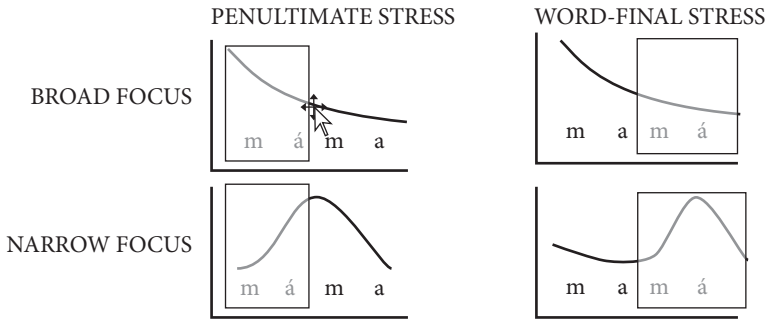

Figure 1. Schematic representation of the realization of the nuclear pitch accent in broad focus and in narrow contrastive focus utterances, in words with penultimate stress and final stress

This contrast will enable us to test the hypothesis that the presence of a complex pitch gesture in words with final stress in narrow focus will trigger an extra amount of lengthening in this syllable. The present article presents an analysis of 1280 utterances produced with the abovementioned contrasts. The analysis revealed the following: (a) in cases where the complex contour is fully realized, a clear difference is revealed between the duration properties of syllables carrying a narrow focus accent in final position vs. penultimate position; this is attributed to the pressure of realizing a complex tonal gesture only in final position (see Figure 1); (b) in cases of truncated (or partially truncated) contours, there is no clear lengthening effect. The potential implications of these results for cross-linguistic work on the constraints and strategies of contour compression and truncation will be discussed.

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2. Both in Spanish and Catalan we have two possible words meaning 'Mum', namely, *mamá* and *mama* in Spanish, and *mamà* and *mama* in Catalan.

The article is organized as follows. Section 2 presents the methodology of the production experiment. Section 3 presents the main results of pitch range and duration of the production experiment. Finally, Section 4 discusses the main implications of this work for cross-linguistic studies on the interaction between pitch realization and duration.

2. Experimental investigation

2.1 Method

2.1.1 *Materials.* In both Catalan and Spanish, broad focus has been described as having a different prosodic realization from narrow contrastive focus (e.g., *She broke her neck, right? — No, she broke her LEG*) (see de la Mota 1995 and Face 2002 for Spanish; Prieto 2002; Estebas-Vilaplana 2000; Astruc-Aguilera 2006 for Catalan; for Romanian, see Manolescu, Olson & Ortega-Llebaria (2009, this volume). In Spanish and Catalan, nuclear broad focus is typically realized with a falling nuclear pitch accent. In contrast, the nuclear narrow contrastive focus is realized with a non-downstepped rising pitch accent, as Figure 2 shows. While the narrow contrastive pitch accent is generally transcribed as L+H*, there is no consensus as to what is the phonological analysis of the falling nuclear pitch accent in both languages. Some analyses such as Astruc-Aguilera (2006) for Catalan and Beckman et al. (2002) for Spanish have proposed the H+L* nuclear pitch accent, identifying this pitch accent with the broad focus nuclear pitch accent of European Portuguese (Frota 2002) and of Italian (D'Imperio 2002). On the other hand, Sosa (1999) transcribes it as having an L* nuclear accent — see the discussion about this topic in Beckman et al. (2002). Yet the main contrast between the two accent types is upheld under any of the analyses that seem tenable.

In order to test the hypothesis that the presence of a complex pitch gesture in words with final stress with narrow-corrective focus will trigger an extra amount of lengthening, we planned a controlled production experiment comparing near-minimal-pair words bearing the two types of pitch accents. A previous study with similar speech materials for Catalan and Spanish (Ortega-Llebaria & Prieto 2006) found that durational differences between stressed syllables in narrow vs. broad focus were only found in words with final stress, and not in words with penultimate stress. This contrast was attributed to pressure on the speaker to realize a complex tonal gesture only in narrow focus. Yet these materials did not control segmental content, which is done in the present experiment. The sentences under study were the following: (1) a broad-focus utterance (e.g., *Catalina me desanimó* 'Catalina discouraged me'), and (2) a narrow-contrastive focus (e.g., *¿Catalina te animó?*

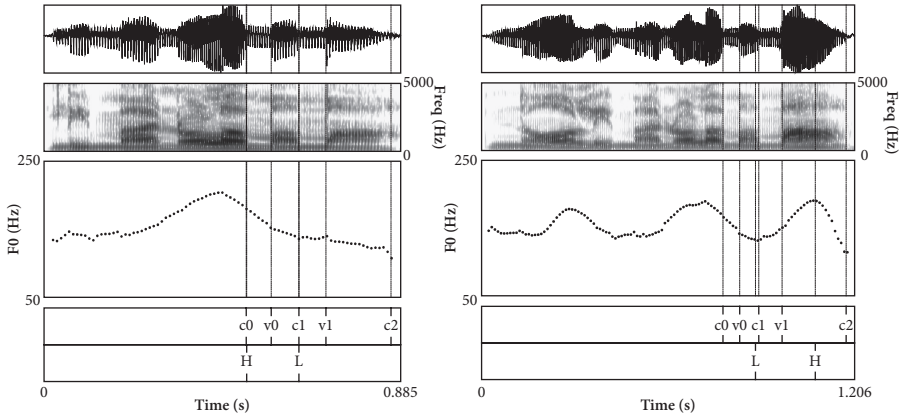

Figure 2. Waveforms, spectrograms, and F0 contours of the Catalan utterances L'hi mano a la mamà 'I am asking this to Mum' (broad focus, left panel) and No, l'hi mano a la MAMÀ 'No, I am asking this to MUM' (contrastive corrective focus, right panel)

'Did Catalina encourage you?' – *No, Catalina me DESANIMÓ* 'No, Catalina DISCOURAGED me').

To enhance the control for vowel and consonantal effects on duration (i.e., segmental effects), the target words selected are four two-syllable nouns that have the same segmental composition and that contrast only in the stress position in both languages: Spanish/Catalan *mamá* 'Mum' vs. *mama* 'Mum',[3] and *Mimí* 'proper noun' vs. *Mimi* 'proper noun'. Each target word was placed in: (1) a broad-focus utterance (e.g., Span. *¿Qué pasa? – Se lo dice a mama* '(S)he is telling Mum'); and (2) a narrow-contrastive focus, which is indicated in capital letters (e.g., Span. *¿Se lo dice a mamá? – No, se lo dice a MAMA* 'No, (s)he is telling MUM'), as follows:

Catalan

/a/	/i/
L'hi dono a la mama	*L'hi dono a la Mimi*
'I am giving it to Mum'	'I am giving it to Mimi'
L'hi dono a la MAMA	*L'hi dono a la MIMI*
'(No), I am giving it to MUM'	'(No), I am giving it to MIMI'
L'hi dono a la mamà	*L'hi dono a la Mimí*
'(No), I am giving it to Mum'	'I am giving it to Mimi'

3. As mentioned above, there are two possible words in Spanish and Catalan for 'Mum', each of which have two different stress patterns, namely, *mamá* and *mama* in Spanish, and *mamà* and *mama* in Catalan. Even though both forms are used, *mamá* is more common in Spanish, and *mama* in Catalan.

L'hi dono a la MAMÀ	*L'hi dono a la MIMÍ*
'(No), I am giving it to MUM'	'(No), I am giving it to MIMÍ
Spanish	
Se lo doy a mama	*Se lo doy a Mimi*
'I am giving it to Mum'	'I am giving it to Mimi'
Se lo doy a MAMA	*Se lo doy a MIMI*
'(No), I am giving it to MUM'	'(No), I am giving it to MIMI'
Se lo doy a mamà	*Se lo doy a Mimí*
'(No), I am giving it to Mum'	'I am giving it to Mimi'
Se lo doy a MAMÁ	*Se lo doy a MIMÍ*
'(No), I am giving it to MUM'	'(No), I am giving it to MIMÍ'

These nouns in two focus contexts were inserted in 20 frame sentences with different verb types (see Appendix) and placed in sentence-final position.

2.1.2 *Experimental procedure.* Subjects were asked to look at a Power Point presentation comprising 80 slides (20 utterances x 2 words x 2 focus types) which contained suitable contexts for triggering an utterance with either broad or narrow focus, together with the answers, as follows:

Broad focus

Context: — *¿Què passa?*
'What is going on?'
— *L'hi dono a la mamà*
'I am giving it to Mum'

Narrow-contrastive focus (with emphasis and assertiveness)

Context: — *¿L'hi dones a la mamà?*
'Will you give it to "mamà"?'
— *No, l'hi dono a la MAMA*
'No, I will give it to "mama"'

First, the experimenter read the context question aloud to the subject. The subject was supposed to read out the answer in the appropriate intonation. If the experimenter thought that the utterance had been mispronounced, the speaker was asked to repeat the sentence. This happened in only a handful of cases, and not for every speaker. The same process was repeated with each one of the slides.

Speakers were recorded individually in a quiet room, using a Sennheiser MKH20P48U3 omnidirectional condenser microphone and a Pioneer PDR609 digital CD-recorder. Speech samples were digitalized at 32000 Hz in 16-bit mono, double-checking that the target utterances were produced with the intended prosody.

2.1.3 *Subjects*. Four young female speakers of Central Catalan and four young speakers of Peninsular Spanish (between 23 and 40 years of age) participated in the experiment, giving a total of 160 utterances per speaker (20 verb types x 2 focus conditions (broad vs. narrow) * 4 target words stress conditions (*mama, mamá, mimi, mimí*) = 160 utterances per speaker. Thus, we obtained a total of 1280 utterances (160 utterances x 8 speakers = 1280 utterances).

2.2 Data analysis and measurements

The following measurements were made with *Praat* (Boersma & Weekink 2005; Wood 2005) on each of the 1280 target words. Figure 2 shows the labels that we used to segment the target words. In tier 1, we marked the beginning and end of the target segments, for example, 'm', 'a', 'm' and 'a'. In tier 2, we marked the valley (L) and the peak (H) of the pitch accent. In the cases where the pitch line was flat or descending, marks were placed at the beginning and end of the syllable. A Praat script extracted the F0 value in Hz at the marked points and calculated the pitch excursion size by subtracting the F0 values at L from the F0 values at H for each of the 1280 tokens.

2.3 Statistical analysis

In order to ensure that our data did indeed include two types of accents with different intonation properties, a Repeated Measures ANOVA with the within-subject factor of intonation (broad focus vs. narrow focus) and the between-subject factor of language (Catalan and Spanish) was performed on the pitch-range measurements. After this, we performed a Repeated Measures ANOVA on the duration of stressed vowels with three within-subject factors: stress position (([+word-final]/[-word-final])) and accent-type (broad focus vs. narrow focus) and vowel (i, a), and the between-subject factor of language (Catalan and Spanish). Since the vowel was not significant, we collapsed our data across vowels.

3. Results

The main research question posed by the study is whether syllable duration is amplified in contrastive narrow-focused words with respect to broad-focused words. That is, we investigate whether the presence of a complex F0 gesture is accompanied by an increase in duration.

3.1 Pitch excursion size differences

In this section, we check that the two types of focus (broad focus and narrow focus) in nuclear position were indeed realized using two different pitch accents, namely, a falling pitch accent and a rising pitch accent. The boxplots in Figure 3 show the mean pitch distance (in Hz) between LH values (in the case of a rising pitch movement) and between HL values (in the case of a falling pitch movement) of stressed syllables in broad-focused and narrow-focused conditions (striped boxes vs. dotted boxes, respectively) for all four Catalan speakers and all four Spanish speakers. It should be remembered that in cases in which the pitch was descending and no peak and valley could be visually identified, the pitch measures were taken at the beginning and at the end of the target accented syllable. As is clear from the graph, both Catalan and Spanish subjects consistently used a substantial pitch increase in narrow-focused sentences (a mean of 69.20 Hz, s.d. 28.47 in Spanish and 56.82 Hz, s.d. 45.04 in Catalan) and a negative increase in the broad-focus case (i.e., a mean of -33.65 Hz, s.d. 17.16 in Spanish and -28.36 Hz, s.d. 14.01 in Catalan).

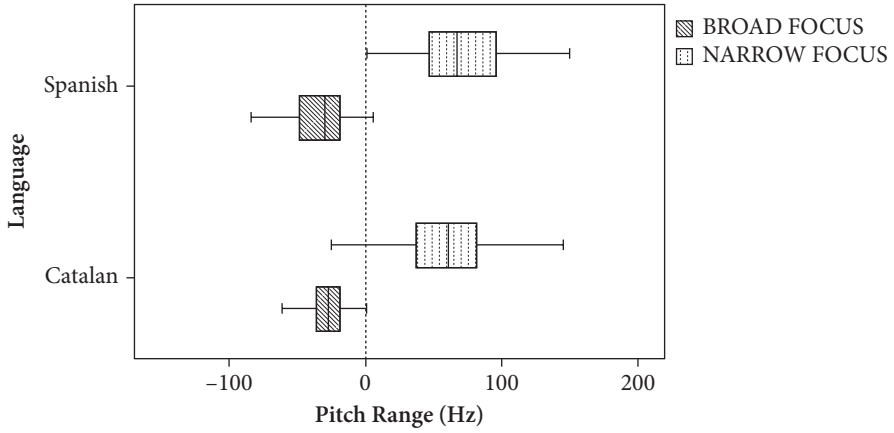

Figure 3. Mean values (in Hz) of the pitch distance between LH values (in the case of a rising pitch movement) and between HL values (in the case of a falling pitch movement) of the stressed syllables in broad focus (striped boxes) and narrow focus (dotted boxes) in Spanish and Catalan

If we plot the data separately by speaker (see Figure 4 below), the same pattern emerges for each one of the subjects, namely, speakers produce pitch accents with larger pitch ranges in narrow focus than in broad focus. While this difference is maintained, speakers also show some variation in the amount of pitch range values, especially in the narrow-focus case. For example, Spanish speaker (MB) has a mean pitch range of 34.93 Hz, while Spanish speaker (MN) has a much larger mean pitch range of 81.60 Hz.

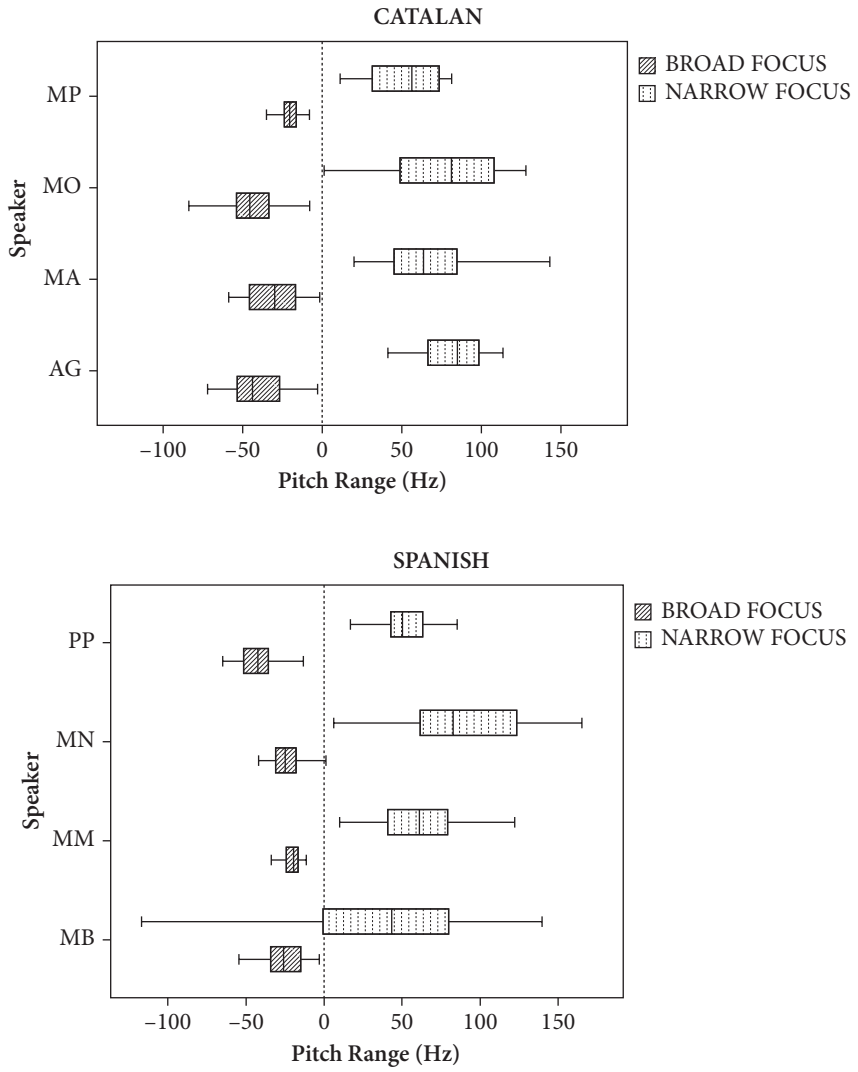

Figure 4. Mean values (in Hz) of the pitch range of the stressed syllables in broad focus (dashed boxes) and in narrow focus (dotted boxes) in Spanish and Catalan, plotted separately for all eight speakers

A Repeated Measures ANOVA on the pitch range of stressed syllables revealed highly significant effects of the accent factor on F0 variation (measured as pitch excursion size), at $F(1,587) = 989.798$; $p<.0001$ and no interaction between the accent*language factor, at $F(1,587) = 1.676$; $p = .196$. Hence, as expected, narrow focus was consistently cued by a rising pitch accent in the two languages. In contrast, broad focus in both languages was cued by a falling nuclear pitch accent.

3.2 Durational differences

Figure 5 below displays the mean duration (in ms) of the target syllable in penultimate (upper graph) and word-final (lower graph) position in Catalan and Spanish across vowels. In all four plots, the duration of the stressed syllables is compared between the narrow-focused (dotted boxes) and broad-focused (striped boxes) words. The graphs reveal that, in general, stressed syllables in narrow-focused words are longer than in broad-focused words in both languages, in both penultimate and word-final position (mean differences in penultimate and final position for Catalan: 39 ms and 55 ms; for Spanish: 69 ms and 207 ms). In general, the data works as expected: we find greater duration values in narrow-focused than

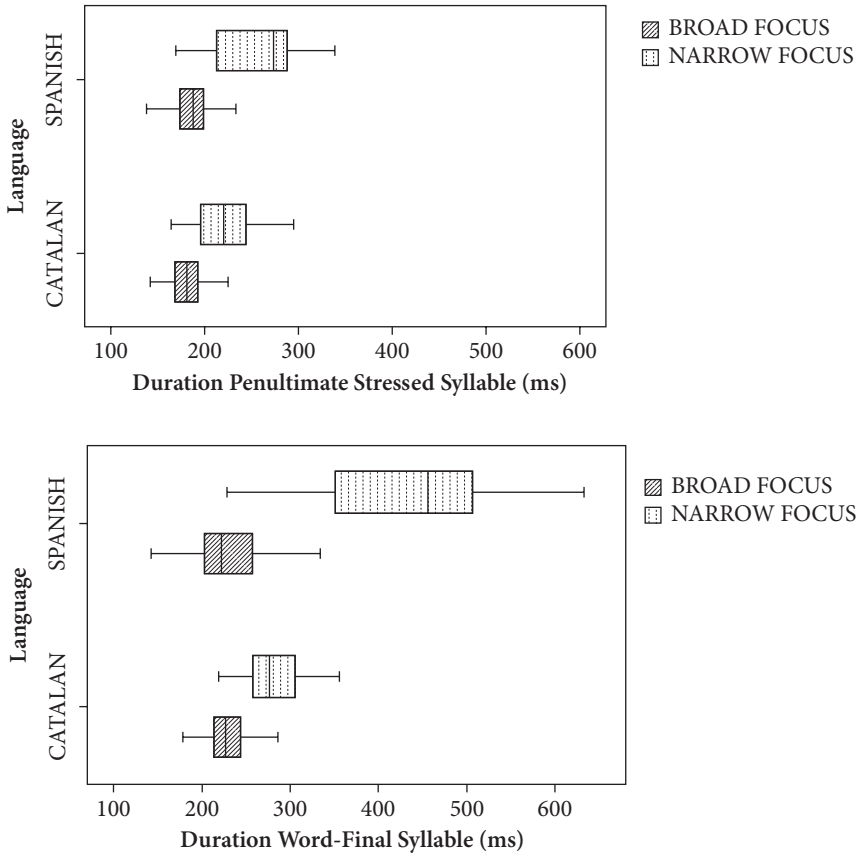

Figure 5. Mean duration values (in ms) of the target syllable in penultimate (upper graph) and word-final (lower graph) position in broad focus (dashed boxes) and narrow focus (dotted boxes), for both Spanish and Catalan

in broad-focused syllables both in final and penultimate positions and in both languages (that is, dotted boxes are always to the right of striped boxes). Yet the graphs also show that there is a contrast between Spanish and Catalan. While Spanish speakers produce an extra amount of lengthening in narrow-focused words in final position (see lower graph), this does not seem to be the case for Catalan speakers (mean and standard deviation for narrow focus in Spanish 437.5 ms (105.5) vs. 281.5 ms (33.7) in Catalan).

The boxplots in Figure 6 depict the same data for each one of the four Spanish subjects. In general, it is very clear that all Spanish speakers display substantial durational differences between narrow- and broad-focused syllables, both in penultimate

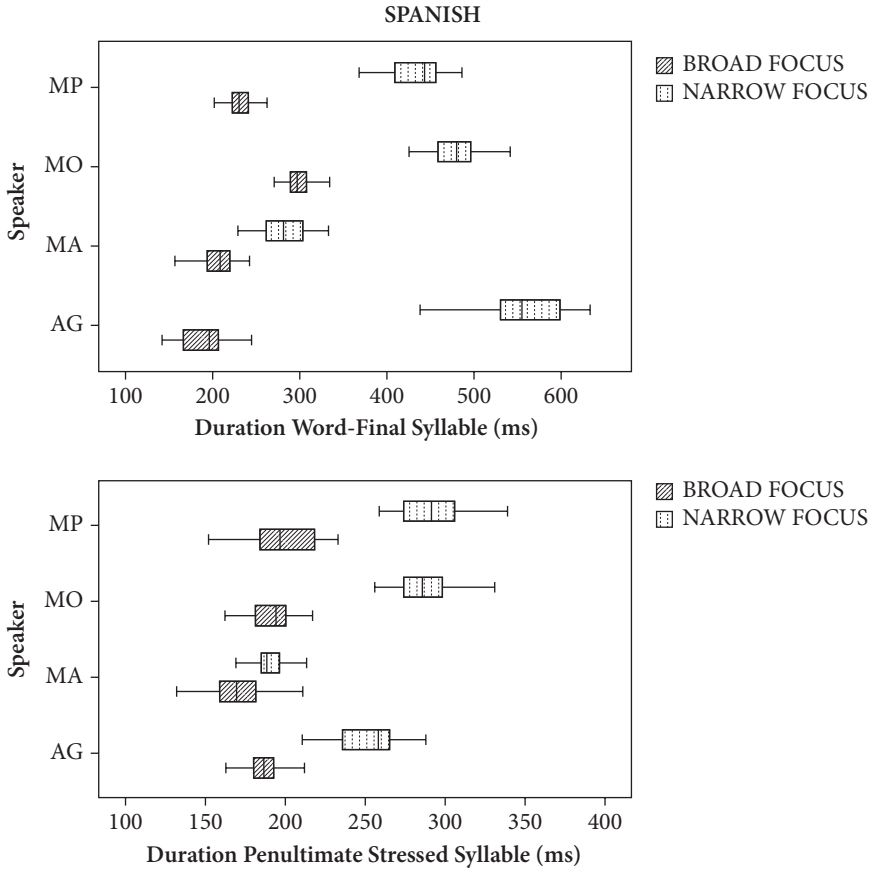

Figure 6. Mean duration values (in ms) of the target stressed syllables in broad focus (dashed boxes) and narrow focus (dotted boxes) in Spanish, plotted separately for all four speakers. Word-final syllables are plotted in the upper graph and penultimate syllables in the lower graph

and word-final position, and, importantly, there is a greater difference between the two when in word-final position, that is, when a complex tonal pattern is realized on the target syllable. For example, for speaker AG, the mean difference in duration between segments in broad focus and segments in narrow focus is 386 ms in words with final stress, while this difference falls to 67 ms in words with penultimate stress, thus showing that the lengthening effect of narrow focus with respect broad focus is 316 ms longer in words with final stress than in words with penultimate stress. For speaker MO these mean differences are 180 ms and 96 ms respectively, and for speaker MP they are 204 ms and 92 ms, showing that the lengthening effect of narrow focus in words with final stress is 84 ms longer than that of words with penultimate stress for speaker MO, and 112 ms for speaker MP. For speaker MA, the lengthening effect of narrow focus in words with final stress is only 56 ms longer than in words with final stress since mean differences between narrow and broad focus in both conditions are 76 ms and 20 ms respectively.

Yet for Catalan subjects, subject differences may be found (see boxplots in Figure 7): while subjects MN and PP have an extra lengthening effect in narrow-focused syllables only of words with final stress, speakers MB and MM do not display this difference. Thus, similarly to Spanish speakers, for Catalan speakers MN and PP, the lengthening effect of narrow focus in words with final stress is around 40 ms longer than that of narrow focus in words with penultimate stress (mean differences between narrow and broad focus for words with final and penultimate stress for MN: 87 ms and 44 ms, for PP: 40 ms and 2 ms). However, this lengthening effect decreases to less than 10 ms for speaker MM (40 ms in words with final stress and 31 ms in words with penultimate stress) and even shows the opposite direction for speaker MB (52 ms in words with final stress and 83 ms in words with final stress).

We performed a Repeated Measures ANOVA on the duration of stressed vowels with two main within-subject factors: Position (([+word-final]/[-word-final])) and Accent-type (narrow focus vs. broad focus) and vowel (i, a), and the between-subject factor of language (Catalan and Spanish). Both Accent type and Position have a significant effect on the duration of the target syllables (Accent type: $F(1,318) = 910.65$, $p<.0001$; Position: $F(1,318) = 793.22$, $p<.0001$) corroborating the hypothesis that narrow focus extends the duration of segments and that this lengthening effect is larger in words with final stress. There was no significant vowel effect, thus indicating that lengthening effects are similar in vowels [a] and [i]. Importantly, there is a significant interaction between Accent type*Language ($F(1,318) = 910.65$, $p<.0001$), meaning that the lengthening effect of narrow focus is larger in Spanish than in Catalan. In the next section, we investigate possible

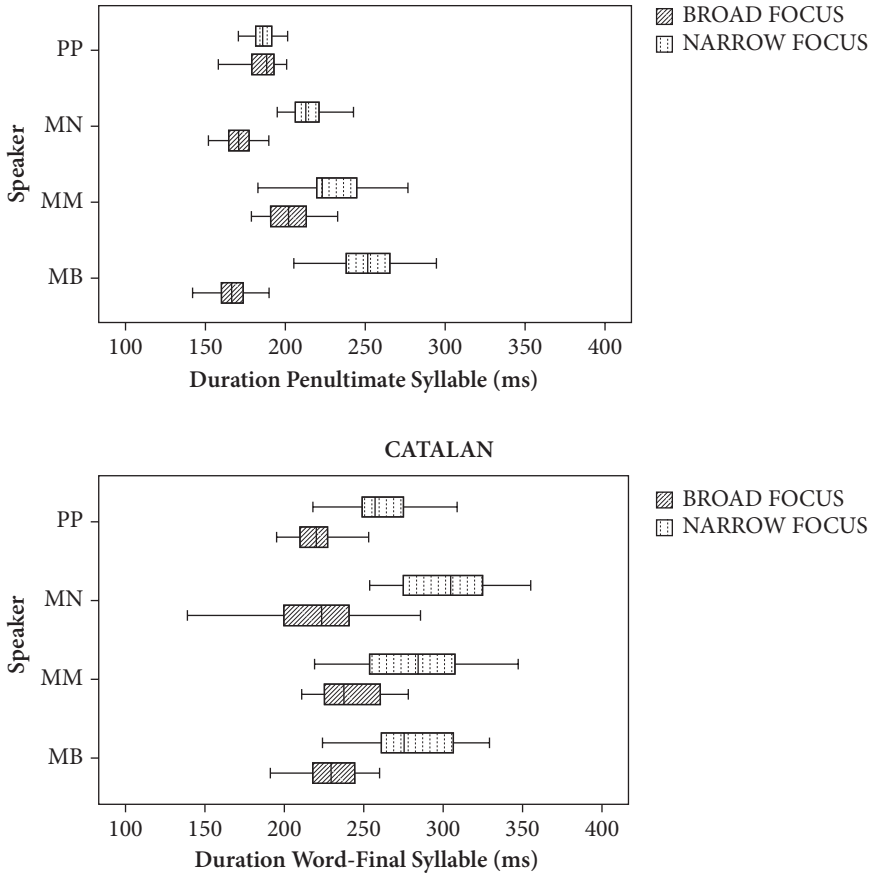

Figure 7. Mean duration values (in ms) of the target stressed syllables in broad focus (dashed boxes) and narrow focus (dotted boxes) in Catalan, plotted separately for all four speakers. Word-final syllables are plotted in the upper graph and penultimate syllables in the lower graph

sources of variation that can explain the distinctive and surprising behavior of these two Catalan speakers.

4. Discussion and conclusion: Sources of variation

When searching for sources of variation in the data, we noticed that several of the complex pitch accents that appear in narrow-focused words in utterance-final position were truncated. Figure 8 shows the waveforms, spectrograms, and F0

contours of the Catalan utterance *No, l'hi mano a la MAMÀ* 'I am asking this to MUM' as uttered by two different speakers. In the left panel we see a fully compressed contour while the right panel shows a truncated contour.

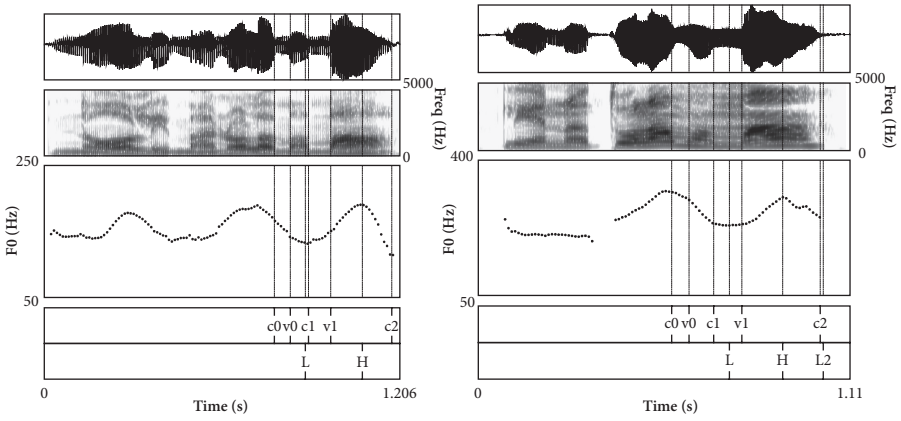

Figure 8. Waveforms, spectrograms and F0 contours of two possible prosodic realizations of the Catalan utterance No, l'hi mano a la MAMÀ 'No, I am asking this to MUM'. Left panel shows a fully compressed contour and right panel a truncated contour

We hypothesize that, in our data, unexpected subject differences in durational patterns might be attributed to the presence of truncated contours. Figure 9 shows the mean relative truncation of the final F0 value (in Hz) for the four Catalan speakers (upper panel) and the four Spanish speakers (lower panel). This value was calculated as the distance in Hz from the final F0 value in each of the narrow-focused contours to the reference baseline of the speaker (that is, the bottom of the speaker's pitch range, a value that is obtained at the end of broad focus statements) so that higher values correlate with truncation and lower values with fully realized pitch contours. The graphs show that speakers use different degrees of truncation and further support a view of truncation as a gradient acoustic effect. In general, Spanish speakers produce fewer truncated contours than Catalan speakers. Within the Spanish speakers, MA realizes full contours less often than the other speakers. And, among the Catalan speakers, MB and MM truncate contours more often. Interestingly, if we compare this data with the graphs in Figure 7, we can see that the Catalan subjects with more truncation (MB, MM, and MN) are exactly the ones who display less lengthening in narrow-focused words in final position. Similarly, the Spanish speaker who used full contours less often also showed the shortest lengthening effect of narrow focus in word-final position.

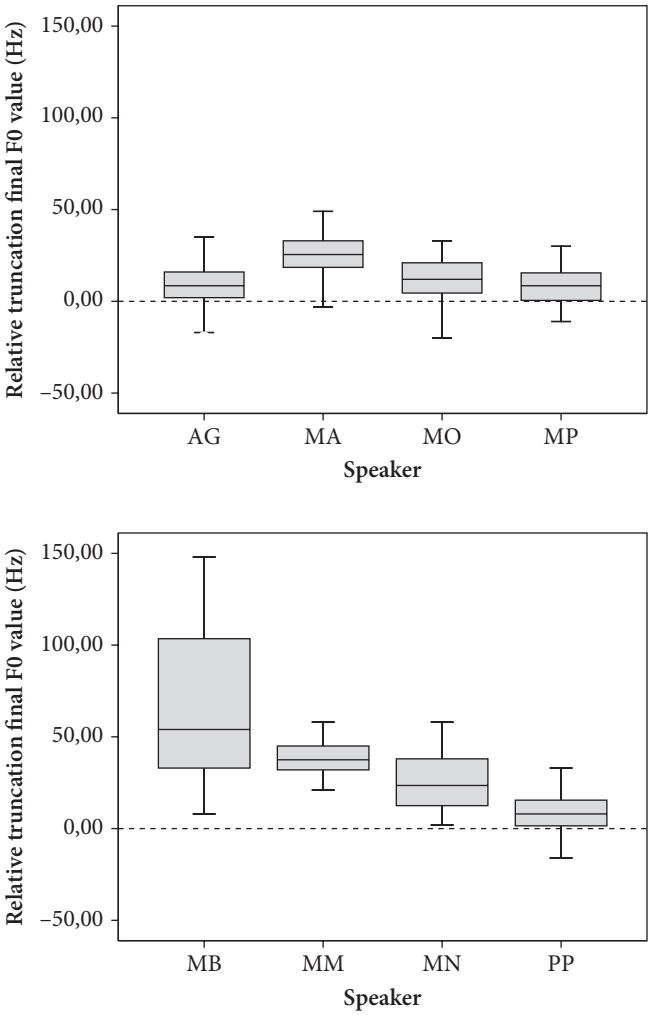

Figure 9. Mean truncation of the final F0 value (in Hz) in narrow-focus utterances relative to the baseline for all Spanish speakers (upper panel) and all Catalan speakers (lower panel)

The scatter plot in Figure 10 shows the duration of the final syllable (in ms) in narrow focus contexts as a function of the degree of truncation (in Hz). For each speaker, the 'degree of truncation' was calculated relative to the speaker's baseline. Results show that there is a slight negative correlation between the two factors: in general, the more truncated the contour is, the shorter the accented syllable. Yet, we should be cautious in interpreting these results because this effect is not very strong and the data seems to be grouped in three different data sets. Linear

regression analyses show that truncation alone explains 15% of the variation in the syllabic duration of oxytone words with complex tones.

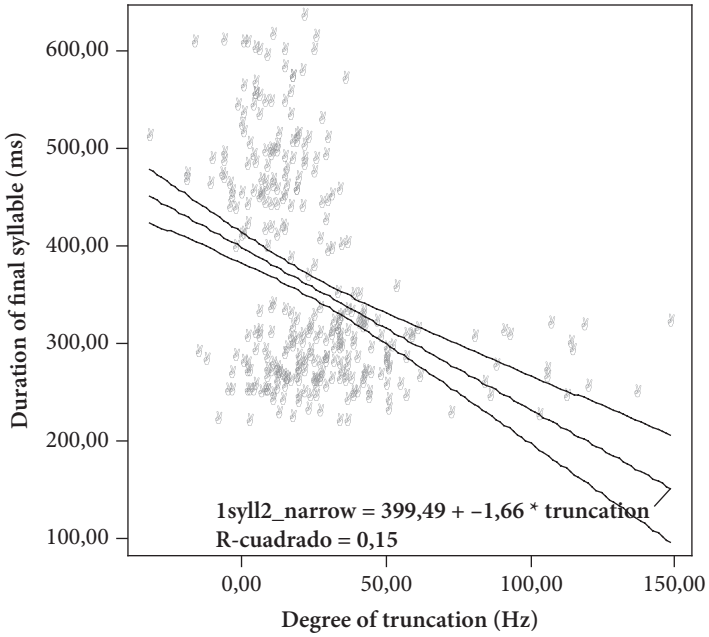

Figure 10. Duration of the final syllable (in ms) in narrow focus contexts as a function of the degree of truncation (in Hz), calculated relative to the baseline, for all speakers

In sum, the results of our production experiment reveal that in both Catalan and Spanish, duration is amplified in narrow-focused words, whether in penultimate or final position. In general, duration is also amplified in syllables with a complex tonal gesture. Figure 11 shows the mean duration of word-final target syllables in different conditions in our data for the two languages: [–stress, –complex pitch gesture], [+stress, –complex pitch gesture], and [+stress, + complex pitch gesture]. It is clear that once we control for final lengthening factors, we have to consider two factors that affect duration and that combine in an additive fashion: (a) stress; and (b) tonal complexity.

In our data, the presence of a complex pitch contour is the strongest lengthening factor. Multiple Comparisons with the Bonferroni adjustment show that the duration differences between these three types of syllables ([–stress, –complex pitch gesture], [+stress, –complex pitch gesture], and [+stress, + complex pitch gesture]) are statistically significant. The mean duration value and standard

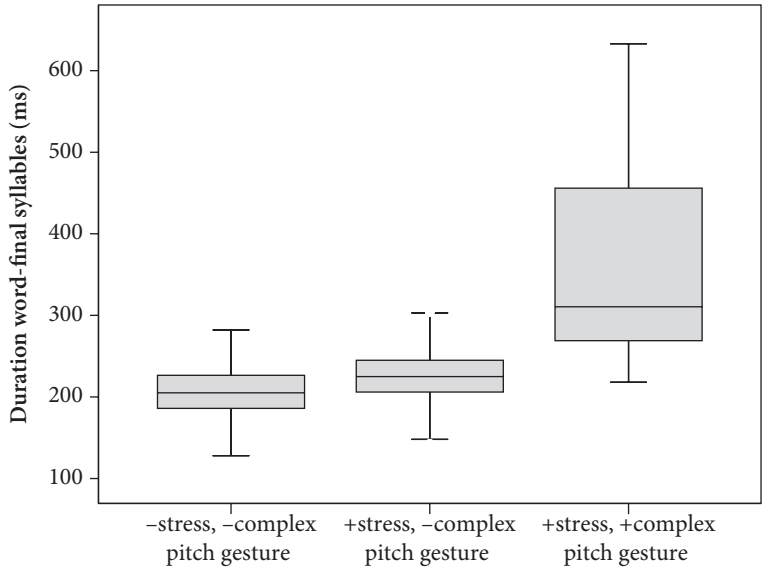

Figure 11. Mean duration of word-final target syllables in different conditions: [–stress, –complex pitch gesture], [+stress, –complex pitch gesture], and [+stress, +complex pitch gesture]

deviation are the following: [–stress, –complex] 206.5 ms (31.1), [+stress –complex] 228.6 ms (37.5), and [+stress, +complex] 359.5 ms (110.5).

In sum, truncation is used by some speakers as a phonetic realization strategy that interacts with timing. As we have just seen, some Catalan speakers truncate (or partially truncate) the complex contour: it is precisely these speakers who do *not* display the expected amount of extra lengthening in these syllables. Thus, in our data, the truncation of complex contours can be regarded as a phonetic realization strategy that interacts with timing in such a way that there is a trade-off relationship between the two factors. The observed phenomenon has consequences for cross-linguistic work on tonal realization strategies, namely, truncation and compression. Different studies have shown that there are cross-linguistic differences in the application of truncation and compression in standard varieties of English and German, and cross-dialectal differences within Swedish and Danish (see Ladd 1996; Grabe 2008; Grabe et al. 2000, among others). For example, while speakers of Cambridge English and Newcastle English compress rising and falling accents, speakers of Leeds English, in identical contexts, perform truncation. The data in this article challenge the view that truncation and compression are language and dialect-specific strategies (Ladd 1996, Grabe et al. 2000), and favor the view that they have to be regarded as phonetic realization strategies that interact in a dynamic way with timing.

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Appendix

TARGET VERBS (CATALAN)	TARGET VERBS (SPANISH)
L'hi mano a la mama	Se lo mando a mama
L'hi cuso a la mama	Se lo coso a mama
L'hi dono a la mama	Se lo vendo a mama
L'hi porto a la mama	Se lo debo a mama
L'hi torno a la mama	Se lo hago a mama
L'hi bullo a la mama	Se lo ruego a mama
L'hi bato a la mama	Se lo nombro a mama
L'hi poso a la mama	Se lo pongo a mama
L'hi dicto a la mama	Se lo dicto a mama
L'hi envio a la mama	Se lo envío a mama
L'hi pago a la mama	Se lo noto a mama
L'hi deixo a la mama	Se lo pago a mama
L'hi rento a la mama	Se lo pido a mama
L'hi cuino a la mama	Se lo leo a mama
L'hi busco a la mama	Se lo busco a mama
L'hi pinto a la mama	Se lo lavo a mama
L'hi brodo a la mama	Se lo llevo a mama
L'hi ballo a la mama	Se lo dejo a mama
L'hi tallo a la mama	Se lo presto a mama
L'hi baixo a la mama	Se lo guiso a mama