

# DOWNSTEPPING SEQUENCES IN CENTRAL CATALAN BROAD AND NARROW FOCUS DECLARATIVES

EVA ESTEBAS VILLAPLANA

UNED

## Abstract

The aim of this paper is to explore the relationship between focus and downstep in Central Catalan declaratives produced with two peaks. In particular, we examine the hypothesis that broad focus is associated to a downstepped second peak whereas narrow focus blocks the downstep movement. In utterances produced with narrow focus two variables were taken into account: 1) the position of the focused material within the sentence (medial or final) and 2) the type of focus (contrast vs. new information). The results indicate that in Central Catalan broad focus is always associated with downstep but the link between narrow focus and non-downstep is not so categorical, but shows a continuum of downstep degrees. This seems to indicate that downstep is not a phonological property of an accent but a realizational option. These results are relevant for the implementation of intonation to systems of speech synthesis and speech recognition.

**Keywords:** *downstep, focus, contrast, new information, Autosegmental-Metrical framework.*

## 1. Introduction

In this study we analyze the relationship between focus and downstep in Central Catalan declaratives within the Autosegmental-Metrical (AM) approach of intonational analysis (Pierrehumbert 1980, Beckman and Pierrehumbert 1986, Beckman and Hirschberg 1994, Ladd 1996, Gussenhoven 2004, among many others). The AM approach describes pitch patterns as a sequence of categorically distinctive entities, associated to stressed syllables (*pitch accents*) and to the edges of prosodic domains (*boundary tones*). The tonal properties of pitch accents and boundary tones are transcribed as H and L, which stand for relatively high and relatively low F0 targets. The rhythmic properties are indicated by assigning an asterisk [\*] following the tone that marks a pitch accent and [%] after the tone for the boundary tone. In earlier versions of the AM model, boundary tones were monotonal (H%, L%) and pitch accents could be both monotonal (H\*, L\*) and bitonal (L\*+H, L+H\*, H\*+L, H+L\*). Bitonal accents are left-headed or right-headed depending on whether the first or the second element of the accent is associated to the metrically strong syllable. The AM framework of intonational modelling has been used to describe the intonation of several languages including Catalan (Prieto 1995, Estebas-Vilaplana 2000, Astruch 2005). The latest studies on Catalan intonation within the AM model (Prieto, Aguilar, Mascaró, Torres-Tamarit and Vanrell 2008 and Prieto in press) have proposed a system of intonational notation for Catalan (Cat\_ToBI) which includes new descriptive units in the inventory of tones, such as the presence of bitonal and even tritonal boundary tones (LH%, HL%, LHL%) as well as an M (mid) boundary tone.

The possibility of analysing pitch traces by means of only two tones (H and L) in the AM framework derives from the fact that the model assumes that tonal targets are not scaled

*Revista Electrónica de Lingüística Aplicada* (ISSN 1885-9089)

2009, Número 8, páginas 45-62

Recibido: 27/07/2009

Aceptación comunicada: 04/10/2009

at the same pitch level. For example, in English the intonational pattern of a neutral declarative tends to involve a sequence of high accents (H\*), each of them scaled at a much lower level than the preceding one. This is due to the gradual declination of pitch (or F0) over the course of an utterance. This downward trajectory is illustrated in Figure 1 for the English sentence *Jenny prefers to live in London* containing four H\* pitch accents. Each H\* is lower than the preceding one. The convention to mark a lowered or downstepped accent in the AM model is to add the symbol ! before H\* (Beckman and Hirschberg 1994, Ladd 1996, among many others). Thus, !H\* stands for a downstepped peak.

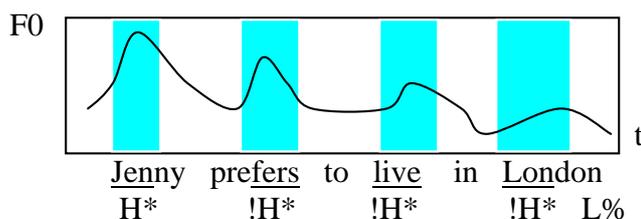


Figure 1. Schematised F0 contour for the sentence *Jenny prefers to live in London*. Stressed syllables are underlined. The shaded areas show the limits of the accented syllables.

The gradual declination of F0 over the course of a sentence has been reported in various languages (Ladd 1984). However, the interpretation of such a downtrend varies in the literature. Two major views have been proposed for the description of F0 downtrends, referred to by among others Ladd (1983) and Nolan (1995) as the *Contour Interaction* model and the *Tone Sequence* model (henceforth CI and TS respectively). Within the CI model, the downward trend of pitch has been analysed as a global effect, conceived as a component of the overall contour. Thus, F0 downtrends were believed to be triggered by an automatic physiological mechanism. This was attested in Japanese (Fujisaki 1983, 1988), Danish (Thorsen 1980), Swedish (Bruce 1977) and English (Lieberman 1967; Liberman 1975; Cooper and Sorensen 1981; Lieberman and Blumstein 1990), among other languages. Followers of the TS model, however, treated this F0 downtrend as a local, phonologically controlled mechanism, which affects accents individually and in relation to previous accents. Pierrehumbert (1980) and Liberman and Pierrehumbert (1984) discovered that the value of each F0 peak in a descending contour could be expressed as a constant proportion of the previous peak. They found that time-dependent lowering was almost absent in their data and that pitch descent could be characterised as an accent-by-accent decay, which they termed *downstep* (or *catathesis* in Pierrehumbert and Beckman 1988), eliminating the need for a global declination component. Additionally, they found out that the final pitch accent in a sentence undergoes a more drastic lowering in F0 than expected by the application of the downstep rule and proposed to account for it by using a lowering constant. The existence of downstep and *final lowering* has been observed in many other languages apart from American English such as Japanese (Beckman and Pierrehumbert 1986; Poser 1984), Mexican Spanish (Prieto, Shih and Nibert 1996), German (Grabe 1998) and Central Catalan (Estebas-Vilaplana 2000). Additionally, some studies on intonation (Fujisaki 1983, 1988; Poser 1984; Pierrehumbert and Beckman 1988) propose that the analysis of pitch downtrends as a sequence of localised phonological events does not exclude the existence of a global declination effect and suggest that both phenomena, declination and downstep, can coexist in the same utterance.

In this study we will examine the relationship between downstep and focus in sentences produced with two consecutive high pitch accents (H\*) in Central Catalan. In languages such as English (Ladd 1996) the ordinary intonation of a declarative with two peaks can have two realizations: 1) the second peak (p2) can be equal to or higher than the first peak (p1) as in (1a), and 2) p2 can be much lower than p1, as in (1b). In pattern (1b) p2 is downstepped with respect to p1, that is, p2 is scaled at a much lower frequency than p1. These two patterns can be found both in *broad focus* (i.e. focus on the whole utterance) as in “my uncle’s notebooks” (possible response to “what’s this?”), and in *narrow focus* (i.e. focus on a particular constituent) as in “my uncle’s NOTEBOOKS” (possible response to “your uncle’s pencils?”). Thus, both a downstepped and a non-downstepped p2 can be used in English declaratives regardless of whether there is a narrow focus intended in the last word or not. The notational conventions used within the AM framework for the description of these two patterns is H\* H\* L% for (1a) and H\* !H\* L% for (1b). As previously mentioned, in this analysis downstep is accounted for by a particular item (!H\*) in the phonological system.



However, in other languages, such as Portuguese (Frota 1995) a much closer relationship has been observed between the presence or absence of downstep and the conveyance of broad or narrow focus. In Portuguese, a downstepped p2 seems to be associated to broad focus, whereas the non-downstepped accent is related to narrow focus. The same has been observed for Spanish. Prieto et al. (1996) analysed the pitch downtrends of neutral declaratives in Mexican Spanish as a series of H\* downstepped accents and showed that the last !H\* accent undergoes a more drastic lowering than the previous !H\*s. Recent studies on the intonation of Peninsular Spanish (Beckman, Díaz Campos, McGory and Morgan 2002 and Estebas-Vilaplana and Prieto 2008) and other Spanish varieties (Sosa 1999) have even described the last pitch accent of neutral declaratives as a low tone (L\*) as opposed to the accent used for contrast (L+H\*) which stands for a non-downstepped peak preceded by a low F0 on the pretonic syllable.

Since most studies on Central Catalan intonation (Bonet 1984, Prieto 1995, Estebas-Vilaplana 2000, Prieto et al. 2008) agree with Portuguese and Spanish in that the ordinary intonation of broad focus declaratives involves a much lower (downstepped) p2 (sometimes even described as a low tone, as in the case of Spanish), one of our aims here is to investigate whether in Catalan the association between broad focus and downstep, on the one hand, and narrow focus and lack of downstep, on the other, also applies. In this study several Central Catalan declaratives produced with broad and narrow focus are examined following the tenets of the AM model.

## 2. Methodology

### 2.1. Materials

The data analyzed in this study consisted of S(ubject) V(erb) O(bject) Central Catalan declaratives produced with broad focus, that is, focus on the whole sentence, (e.g. *els homes llimaven l'armari*, “the men planed the cupboard”), and the same structures with narrow focus on the verb (e.g. *els homes LLIMAVEN l'armari*) and on the object (e.g. *els homes llimaven L'ARMARI*). Narrow focus on the subject was not examined because these structures only consist of one peak. All sentences had three lexical stresses but were produced with two pitch accents.

Both for broad and narrow focus, structures were elicited in a reading task, which allowed us to control the segmental string and the distribution of the stresses. Sentences were designed with as many voiced sounds as possible so as to avoid interrupted F0 contours and with at least two unstressed syllables between stresses so as to avoid contexts with a potential tone clash. Narrow focus structures were elicited as responses to two kinds of questions: 1) questions that prompted the correction or *contrast* of a previously mentioned item, and 2) questions that involved the eliciting of a piece of *new information*. Broad focus structures were elicited as answers to the question *Què passa?* (What happens?). This is illustrated in (2) which shows the prompts for the three types of readings: 1) broad focus (2a), 2) contrastive narrow focus (2b) and 3) narrow focus as a response to a question asking for new information (2c). The list of sentences recorded in this study is included in the Appendix at the end of the paper.

(2) a. *Broad focus triggering question*

Speaker A -*Què passa?*  
 ‘What happens?’  
 Speaker B -*Els homes llimaven l'armari.*  
 ‘The men planed the cupboard.’

b. *Contrast triggering question*

Speaker A -*Els homes netejaven l'armari?*  
 ‘Did the men clean the cupboard?’  
 Speaker B -*Els homes LLIMAVEN l'armari.*  
 ‘The men PLANED the cupboard.’

c. *Question that asks for new information*

Speaker A -*Què feien els homes amb l'armari?*  
 ‘What did the men do with the cupboard?’  
 Speaker B -*Els homes LLIMAVEN l'armari.*  
 ‘The men PLANED the cupboard.’

## 2.2. Data recording

The informants were 6 female Central Catalan speakers (identified as DV, ER, NM, NG, MC and CP) who read a total of 100 sentences each (20 for broad focus, 20 for contrastive narrow focus in medial position, 20 for contrastive narrow focus in final position, 20 for new

information narrow focus in medial position, and 20 for new information narrow focus in final position). They were between 30 and 35 years old at the time of the recording. Catalan was the language they always used with their family, friends and at work, even though all of them knew Spanish.

The speakers received instructions to read the sentences as responses to the questions posed by the researcher which prompted the three types of readings illustrated in (2) above. The sentences were presented to the speakers by means of a computer program with sufficient time between each utterance for the researcher to ask the following question and the speaker to provide the answer. Sentences with the three types of focal structures (broad focus, contrastive focus and new information) were presented in a randomized order. Both speech and F0 signals were recorded for each sentence. Overall, 600 sentences were gathered.

### 2.3. Data analysis

The sentences were analysed by means of the *Praat* software (Boersma and Weenik 1992-2001) which allows for a time-aligned inspection of the speech waveform and the F0 trace. For each sentence the following pitch labels were placed: 1) maximum F0 point for the first peak (p1) and 2) maximum F0 point for the second peak (p2). The pitch measurements were recorded in a script. The results were subsequently transferred to a statistics program for further analysis.

An example of the data analysis is provided in Figures 2, 3 and 4 for the sentences *Els homes llimaven l'armari* (with a broad focus reading), *Els homes LLIMAVEN l'armari* (with contrastive focus in medial position) and *Els homes llimaven L'ARMARI* (with contrastive focus in final position). The four panels displayed in each graph show 1) the speech waveform, 2) a spectrogram with an overlapped F0 trace, 3) the syllable boundaries marked at the end of each syllable and 4) the labels corresponding to the maximum F0 values of p1 and p2. Note that even though sentences contained three lexical stresses (underlined), they were only produced with two pitch accents. In the utterances with broad focus (Figure 2) and with final narrow focus (Figure 4) the middle stressed syllable did not become accented. Sentences produced with medial narrow focus showed no accent on the final word which was deaccented (Figure 3).

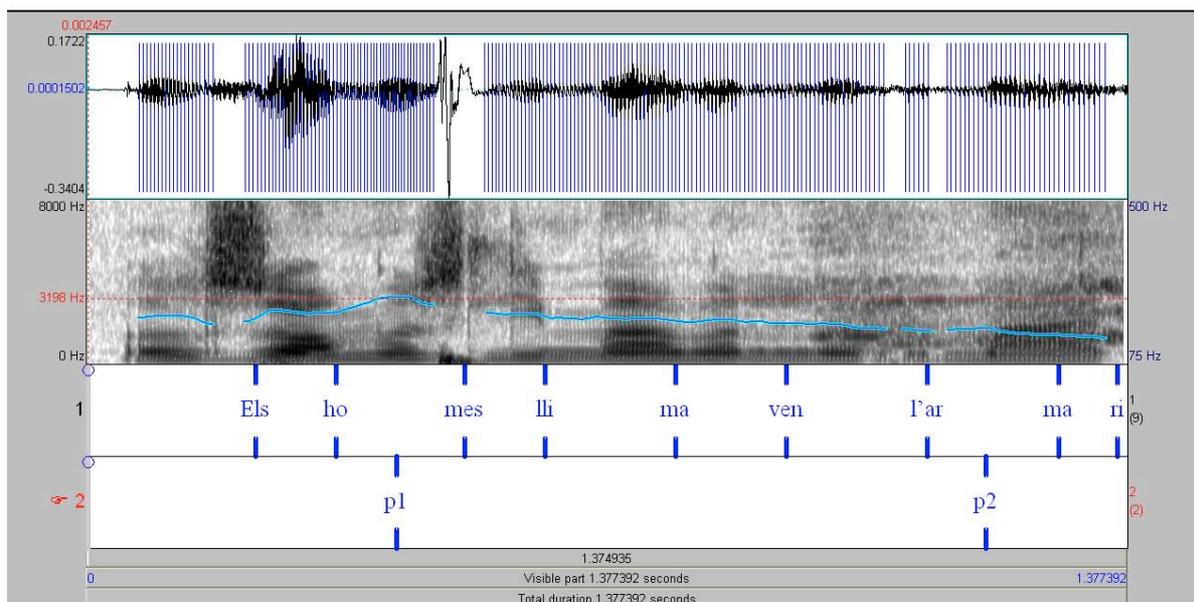


Figure 2. Display of speech waveform, spectrogram and F0 trace, syllable boundaries and F0 landmarks for the sentence *Els homes llimaven l'armari* (with a broad focus reading) produced by speaker CP.

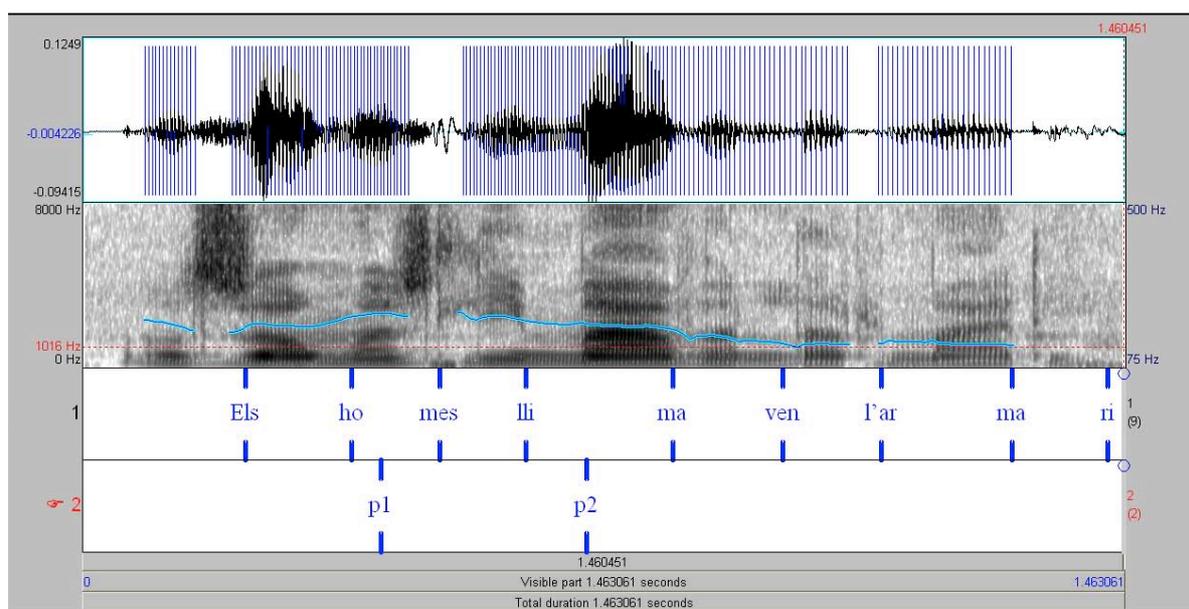


Figure 3. Display of speech waveform, spectrogram and F0 trace, syllable boundaries and F0 landmarks for the sentence *Els homes LLIMAVEN l'armari* (with contrastive focus in medial position) produced by speaker CP.

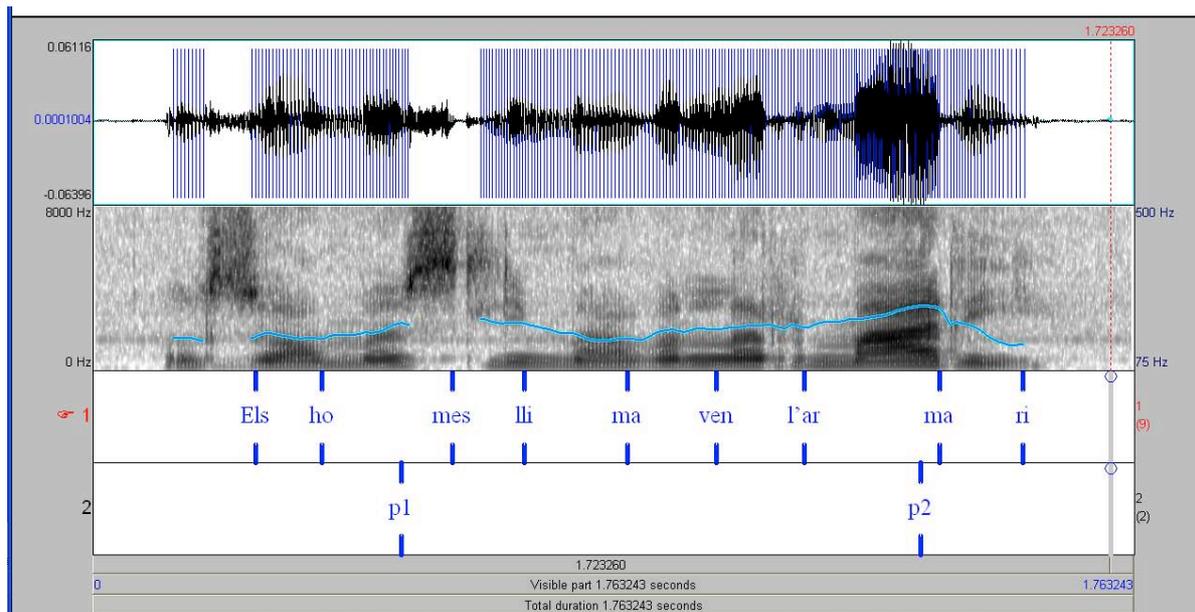


Figure 4. Display of speech waveform, spectrogram and F0 trace, syllable boundaries and F0 landmarks for the sentence *Els homes llimaven l'ARMARI* (with contrastive focus in final position) produced by speaker CP.

### 3. Results

#### 3.1. Broad focus

As expected, sentences with a broad focus intonation were produced with two H pitch accents, associated to the first and last stressed/accented syllables. For all speakers the second H was downstepped with respect to the first H. This can be observed in Figure 5, which displays the mean values of p1 and p2 in Hz for all broad focus declaratives produced by each speaker. All speakers uttered p2 as a steadily falling slope, rather than a clear peak. This phenomenon has been observed in other languages, such as Spanish (Prieto, Shih and Nibert 1996, Sosa 1999, Estebas-Vilaplana and Prieto 2008, among others). Here we analyze the falling slope as a possible realization of a downstepped H\* that takes place when there is a considerable distance between p1 and p2 (Grice 1995). For each speaker, t-tests comparing the maximum height of the two peaks were performed in order to confirm the lowering of p2. For p2 the F0 maximum was considered to be the onset of the accented syllable. The results of the t-tests are presented in Table 1. The t-tests showed that for all speakers p2 was significantly lower than p1 ( $p < 0.001$ ). Thus, double accented broad focus declaratives in Central Catalan are consistently produced with a markedly downstepped second peak, which seems to indicate that the relationship between downstep and broad focus is applicable in this language.

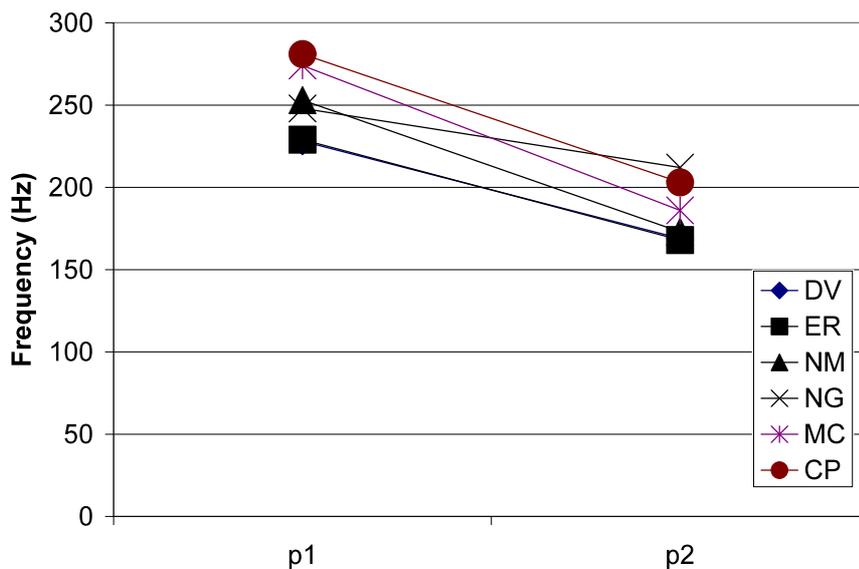


Figure 5. Mean p1 and p2 for broad focus declaratives produced by each speaker.

DV	ER	NM	NG	MC	CP
D	D	D	D	D	D

Table 1. Results of the t-tests comparing the height of p1 and p2 in broad focus declaratives for each speaker. D stands for a downstepped p2 at  $p < 0.001$ .

### 3.2. Narrow focus

#### 3.2.1. Medial position

Utterances with narrow focus in medial position (i.e. on the verb) were also produced with two pitch accents. The first pitch accent is still associated to the first stressed/accented syllable. The second pitch accent is now associated to the accented syllable of the verb. In this case, the last stressed syllable does not become accented since the word it belongs to is old information. As before, the second pitch accent is analyzed as a H tone. However, in contrast to broad focus declaratives, now the second H shows a clear peak in the F0 contour. As with broad focus utterances, t-tests comparing the height of p1 and p2 were performed so as to see whether p2 was downstepped or not with respect to p1. The results of the t-tests are presented in Table 2. Figures 6 and 7 display the mean values of p1 and p2 for narrow focus triggered by contrast and by new information respectively.

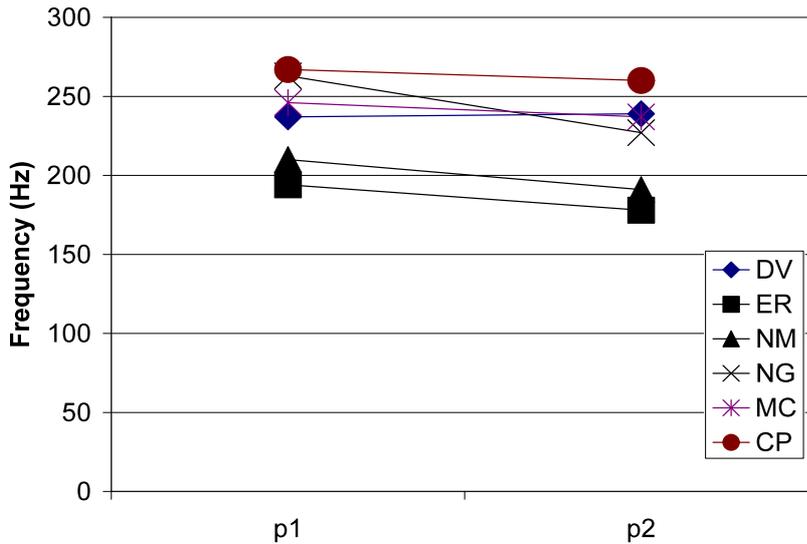


Figure 6. Mean p1 and p2 for medial narrow focus declaratives triggered by contrast.

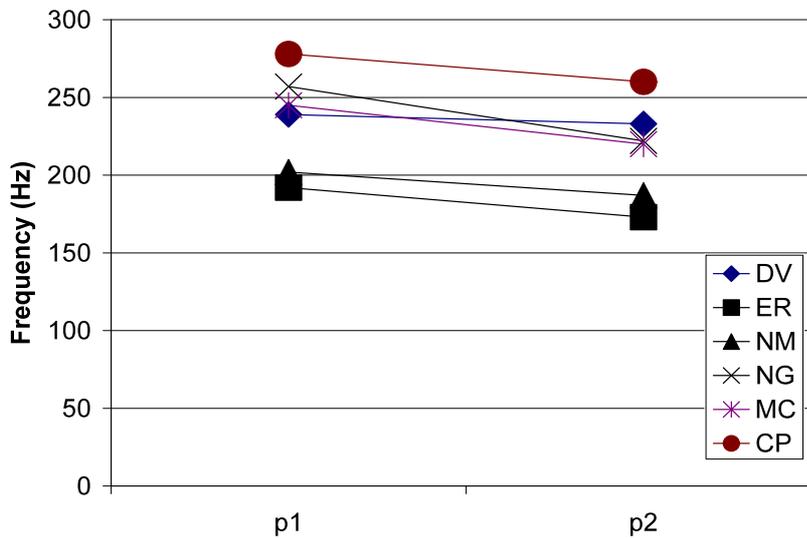


Figure 7. Mean p1 and p2 for medial narrow focus declaratives triggered by new information.

	DV	ER	NM	NG	MC	CP
Contrast	ND	D	D	D	ND	ND
New	ND	D	D	D	D	D

Table 2. Results of the t-tests comparing the height of p1 and p2 in medial position for narrow focus triggered by contrast and by new information. D stands for a downstepped p2 ( $p < 0.001$ ) and ND stands for a non-downstepped p2 ( $p > 0.001$ ).

Figure 6 shows that in contrastive narrow focus in medial position p2 is produced at a lower frequency than p1 for three speakers (ER, NM and NG). On the other hand, speakers DV, MC and CP show a similar scaling for p1 and p2. The results of the statistical analysis displayed in Table 2 confirmed these observations. Differences in the scaling between p1 and

p2 proved to be significant ( $p < 0.001$ ) for speakers ER, NM and NG indicating that p2 is significantly lower than p1 and thus it can be interpreted as a downstepped high accent. For speakers DV, MC and CP differences in the scaling of p1 and p2 are not significant ( $p > 0.001$ ) demonstrating that the second peak is not downstepped. Figure 7 shows that in new information narrow focus in medial position p2 tends to be produced at a lower frequency than p1 for most speakers except for DV which exhibits a similar scaling for the two peaks. The results of the t-tests presented in Table 2 confirm these observations since differences in the scaling between p1 and p2 are significant for all speakers ( $p < 0.001$ ) except for DV. Thus, sentences involving new information narrow focus in medial position tend to be produced with a downstepped p2 in almost all cases.

Overall, the results of our data showed that both a downstepped and a non-downstepped p2 are used in Central Catalan declaratives to convey narrow focus in medial position. Three speakers (ER, NM and NG) produced a downstepped p2 both in new information and in contrast. One speaker (DV) produced a non-downstepped p2 in both cases, and finally two speakers (MC and CP) uttered a downstepped p2 in new information and a non-downstepped p2 in contrast. These results seem to show that Central Catalan declaratives with narrow focus in medial position do not display the expected link between non-downstep and narrow focus, since both a downstepped and non-downstepped p2 can be observed. Overall, our data shows that utterances where narrow focus is triggered by a contrast prompt are more likely to have a non-downstepped p2 than utterances where narrow focus is elicited by a new information question.

### *3.2.2. Final position*

Utterances with narrow focus in final position (i.e. on the object) are also produced with two high pitch accents associated to the first and last accented syllables. In this position, very clear differences were observed between focus triggered by contrast and focus triggered by new information. As displayed in Figure 8 all speakers uttered p2 at the same level as or even higher than p1 in focus triggered by contrast. The results of the t-tests (Table 3) showed that differences in the scaling of p1 and p2 are not significant ( $p > 0.001$ ) for speakers DV, ER, NM and MC indicating a non-downstepped p2. As it can be observed in Figure 8, speakers NG and CP also produced a non-downstepped p2. The main difference between these two speakers and the other four is that in the productions of NG and CP the scaling of p2 was even higher than that of p1. In these cases, the statistical results (Table 3) showed that the scaling of p2 was significantly different ( $p < 0.001$ ) from that of p1, corroborating the higher frequency of p2. According to these findings, we can conclude that in sentences uttered with a contrastive narrow focus in final position p2 is not downstepped with respect to p1 for any speaker. Thus, in this case, the relationship between narrow focus and a non-downstepped p2 seems to be accomplished.

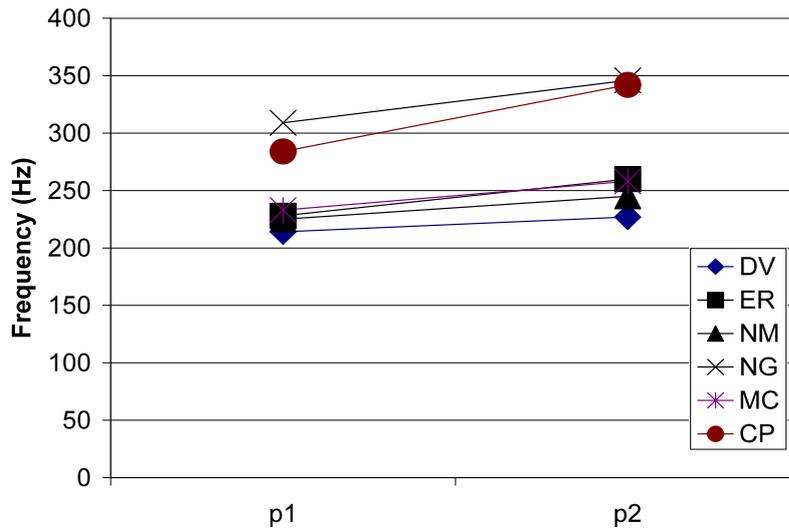


Figure 8. Mean p1 and p2 for final narrow focus declaratives triggered by contrast.

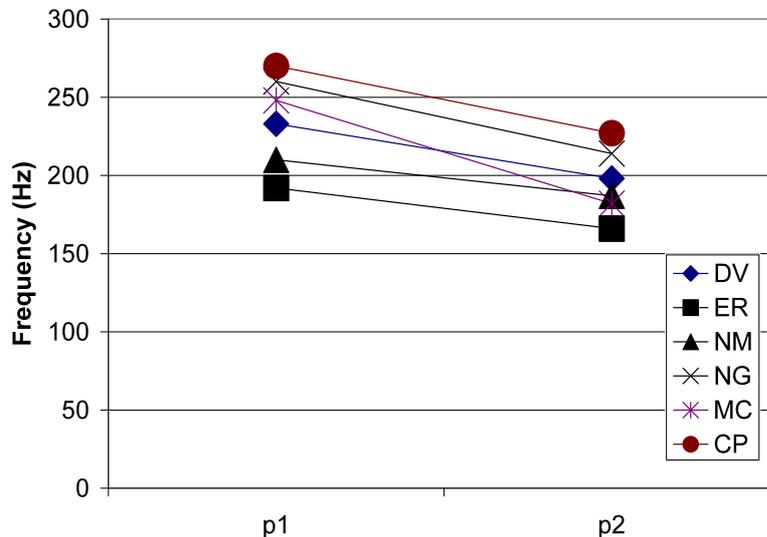


Figure 9. Mean p1 and p2 for final narrow focus declaratives triggered by new information.

	DV	ER	NM	NG	MC	CP
Contrast	ND	ND	ND	ND!	ND	ND!
New	D	D	D	D	D	D

Table 3. Results of the t-tests comparing the height of p1 and p2 in final position for narrow focus triggered by contrast and by new information. D stands for a downstepped p2 ( $p < 0.001$ ) and ND stands for a non-downstepped p2 ( $p > 0.001$ ). ND! stands for a non-downstepped p2 higher than p1 ( $p < 0.001$ ).

Finally, the results of narrow focus in final position triggered by new information are very different from those observed in contrast. In new information utterances, the second pitch accent is always scaled at a much lower frequency than p1. This can be observed in Figure 9 which shows a consistently lowered p2 for all speakers. The results of the t-tests (Table 3) confirmed the behavior of a downstepped p2 for all speakers in final narrow focus

elicited by a new information prompt. These results seem to coincide with the behaviour observed in broad focus structures where a downstepped p2 was consistently produced. In order to see whether there are any differences between the scaling of p2 in broad focus utterances and in final narrow focus structures triggered by new information, we compared the mean difference between p1 and p2 in both kinds of structures. The values of the mean peak difference and the results of the t-test comparing the two values for each speaker are presented in Table 4. Although for most speakers (except for NG) the mean peak difference is higher in broad focus than in narrow focus, the results of the t-tests comparing the two mean differences happened to be non-significant ( $p > 0.001$ ). This indicates that narrow focus structures triggered by a new information prompt in final position are very similar to broad focus sentences. This confirms the idea observed in narrow focus on medial position that in Central Catalan declaratives the relationship between narrow focus and non-downstep is not categorical.

	DV	ER	NM	NG	MC	CP
Broad Focus	59 Hz	52 Hz	49 Hz	36 Hz	87 Hz	78 Hz
Final new information narrow focus	34 Hz	26 Hz	23 Hz	45 Hz	66 Hz	42 Hz
T-test results	*	*	*	*	*	*

Table 4. Mean absolute peak difference in Hz between p1 and p2 for broad focus and narrow focus in final position triggered by new information and results of the t-tests comparing the two mean differences. (\*) indicates that differences between the two measurements are not significant  $p > 0.001$ .

#### 4. Discussion

Overall, the data analyzed in this study showed that the neutral intonation of double accented Central Catalan declaratives produced with broad focus involves a downstepped p2. The possibility of using a non-downstepped p2 in this position, as in English, is not encountered in our data. This seems to indicate that the association between broad focus and downstep is true for Central Catalan declaratives. Narrow focus declaratives, on the other hand, present a more variable behavior since both a downstepped and a non-downstepped p2 is observed in our data. Considerable differences are found in relation to the kind of question that triggers narrow focus. When narrow focus is triggered by new information, p2 tends to be downstepped both in medial and in final position. There is a possibility of using a non-downstepped p2 as well (as observed for one speaker in medial position) but the resulting intonation seems to be less natural. A perception test is expected to be carried out to confirm or discard this idea. When narrow focus is triggered by contrast, there is a much greater tendency of using non-downstepped tones. In final position this is observed for all speakers. In medial position there is more fluctuation between a downstepped and a non-downstepped p2. This might be due to the fact that in medial position, other factors such as deaccenting of old material, also contribute to highlight the contrastive item(s), whereas in final position the focusing effect mainly depends on the last pitch accent. Thus, our data show that the association between narrow focus and non-downstep is not so categorical in Central Catalan. Different degrees of downstep can be observed in narrow focus depending on the position of the focused material within the sentence and the triggering question. This is summarized in Figure 10.

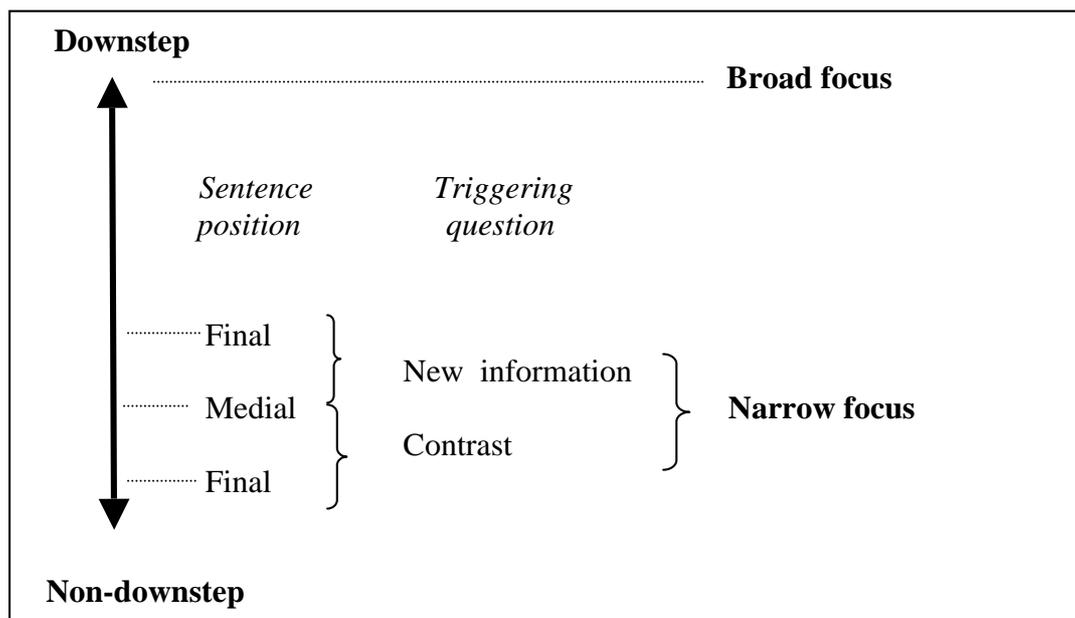


Figure 10. Schematization of the relationship between focus and downstep in Central Catalan, taking into account the position of the focal element within the sentence and the triggering question in narrow focus structures.

One of the questions that arises from these results is whether downstep or non-downstep accents should be incorporated in the phonological system of Central Catalan. In other words, shall we interpret downstep as an intrinsic feature of the accent or as a realizational option? The answer to that question is not clear-cut according to our data. On the one hand, the consistent downstepped p2 in broad focus sentences seems to indicate that the phonological unit that better accounts for such tonal target is !H\*. However, the problem emerges when we look at the narrow focus data. If narrow focus structures had shown a consistent lack of downstep on the second peak, we could have distinguished between non-downstepped accents (H\*) for narrow focus and downstepped accents (!H\*) for broad focus. However, since narrow focus sentences can also be produced with downstepped peaks, the distinction between H\* for narrow focus and !H\* for broad focus is no longer applicable.

Studies on Catalan intonation within the AM approach and the Cat\_ToBI system (Prieto 1995, 2002; Prieto et al. 2008 and Prieto in press) describe the last peak of a multi-accented broad focus declarative as a low target (L\*). As pointed out in Estebas-Vilaplana (2003), this description poses a phonological problem since the interpretation of the nuclear accent in broad focus declaratives in Catalan varies depending on the presence or absence of prenuclear accents within the sentence. According to the Cat\_ToBI system, if the declarative consists of only one accent, the tonal element to describe this final accent is H\* since a slight F0 peak is observed in the F0 contour. If the sentence has prenuclear accents, the last configuration is interpreted as L\* given the lack of a clear peak in most of the utterances. This interpretation is problematic since two phonological entities (L\* and H\*) are used to describe two intonation patterns which do not trigger a contrastive opposition since in both cases the meaning conveyed is that of a neutral, unmarked declarative.

Estebas-Vilaplana (2003) carried out a perceptual test which showed that speakers found no auditory differences between the non-lowered pitch accent of single-stressed

utterances and the lowered accent of multi-stressed sentences, where the prenuclear portion was removed. The auditory impression of the informants was that when heard in isolation lowered H\* accents sounded very similar to non-lowered H\* accents (produced with a low register). What seems evident from these results is that the nuclear accent of single and multi-stressed declaratives has to have the same tonal interpretation. In Estebas-Vilaplana (2003) it was suggested to use H\* for both types of utterances with different realizations (i.e. with a clear peak in single-stressed utterances [H\*] and with a strongly lowered or downstepped accent in multi-stressed utterances [!H\*]). According to this proposal, downstep is interpreted as a realizational option rather than an intrinsic feature of the tone.

The results obtained in this study also point out towards the non-categorical interpretation of downstep since in narrow focus structures downstepped peaks showed a gradient behaviour, with a continuum of degrees depending on the position of the focal element within the sentence (medial or final) and on the triggering question (contrast vs. new information). Thus, the H\* nuclear accent of narrow focus declaratives exhibited a continuum of downstepping degrees which seems to indicate that the presence or absence of a downstepped peak may vary depending on the emphasis the speaker intends to convey.

Thus, the analysis we propose in this study for the nuclear accent of both broad and narrow focus structures is H\*. /H\*/ has to be understood as a phonological unit which can sometimes be realized without downstep [H\*] and some other times with downstep [!H\*]. In broad focus declaratives [H\*] and [!H\*] are in *complementary distribution*. [H\*] appears in the nuclear position of single-stressed structures and [!H\*] in the nuclear position of multi-stressed structures. This behaviour is similar to allophonic variation at the segmental level. For example, in English, /p/ is realized with aspiration at the beginning of a stressed syllable and without aspiration if the syllable is unstressed. Thus, the presence or absence of aspiration in English (and the presence or absence of downstep in Catalan) is conditioned by the context and therefore the two features [+ aspiration] and [+ downstep] are mutually exclusive. In narrow focus declaratives [H\*] and [!H\*] are in *free variation*, that is, they may be downstepped or not mainly depending on the speaker's choice. This is similar to the possible realizations of aspirated and unaspirated /p/ in word-final position in English. In other words, in certain contexts the presence or absence of aspiration in English and the presence or absence of downstepped accents in Catalan is optional. Thus, the interpretation of downstep suggested in this study involves an allotonic realization of a high accent. Sometimes downstepped and non-downstepped accents are in complementary distribution (as in the nuclear position of single and multi-accented broad focus structures) and other times are in free variation (as in narrow focus declaratives).

These findings are important for the implementation of Catalan intonation to speech synthesis and speech recognition systems where broad focus nuclear accents have to show a strongly lowered peak as opposed to narrow focus nuclear accents which may show a variety of F0 levels depending on the emphatic nuance of the sentence.

## 5. Conclusions

In this paper we analyzed the relationship between focus and downstep in Central Catalan double accented declaratives. We expected to find that a downstepped peak was mainly associated to broad focus and a non-downstepped peak to narrow focus as it has been argued for other Romance languages such as Portuguese. The results on the Catalan data are true for

broad focus structures where a consistently downstepped p2 is observed. However, the association between narrow focus and non-downstep is not fulfilled in our data, since both a downstepped and a non-downstepped p2 can occur in narrow focus structures. A continuum of downstep degrees is attested in narrow focus utterances depending on the position of the focal material within the sentence (medial vs. final) and the triggering context (contrast vs. new information). The results of the utterances produced with narrow focus have shown the following tendencies: 1) in contrastive narrow focus in medial position there was an optional usage of downstep (50% of the speakers produced a downstepped p2 and the other 50% a non-downstepped p2), 2) in contrastive narrow focus in final position a non-downstepped p2 appeared in the data of all speakers, 3) in new information narrow focus in medial position a downstepped p2 was observed for all speakers except for one, and 4) in new information narrow focus in final position all speakers produced a downstepped p2. Thus, narrow focus triggered by contrast is more likely to show a non-downstepped p2 than narrow focus triggered by new information. In narrow focus triggered by contrast the blockage of downstep is more consistent when the focal material is in final rather than in medial position. When narrow focus is triggered by new information a downstepped p2 tends to occur both in medial and in final positions. These results suggest that downstep is not categorical in Central Catalan and therefore the association of a downstepped H pitch accent (!H\*) to broad focus and a non-downstepped one (H\*) to narrow focus is not completely true. Alternatively, downstepped and non-downstepped accents seem to be allotonic variations of a /H\*/ tone with various degrees of lowering depending on the sentence type (broad focus vs. narrow focus reading) and on the context in which the accent is located (medial vs. final sentence position). The immediate implications of such findings is that a downstepped H (!H\*) must not be interpreted as a discrete phonological category in Catalan intonation but an optional realization of /H\*/.

## Acknowledgements

This research has been funded by the grants HUM 2006-01758/FILO (Ministerio de Ciencia e Innovación) and FFI 2008-04982-C03-03 (Ministerio de Educación y Ciencia). The author is member of Grup d'Estudis de Prosòdia (Pla de Recerca de Catalunya: 2009 SGR-701).

## References

- Astruc, L. 2005. *The intonation of extra-sentential elements in Catalan and English*. PhD dissertation, University of Cambridge.
- Beckman, M., M. Díaz Campos, J. T. McGory and T. A. Morgan. 2002. Intonation across Spanish, in the Tones and Break Indices framework. *Probus* 14: 9-36.
- Beckman, M.E. and J. Hirschberg. 1994. The ToBI annotation conventions. Ohio State University. [Available at <http://www.ling.ohio-state.edu/ToBI.6.html>].
- Beckman, M. and J. Pierrehumbert. 1986. Intonational Structure in Japanese and English, *Phonology Yearbook* 3: 255-310.
- Bonet, E. 1984. *Aproximació a l'entonació del català*. BA dissertation, Universitat Autònoma de Barcelona.
- Boersma, P. and D. Weenink. 1992-2001. Praat: a system for doing phonetics by computer. [Available at <http://www.praat.org>].
- Revista Electrónica de Lingüística Aplicada* (ISSN 1885-9089)  
2009, Número 8, páginas 45-62  
Recibido: 27/07/2009  
Aceptación comunicada: 04/10/2009

- Bruce, G. 1977. *Swedish Word Accents in Sentence Perspective*. Lund: Gleerup.
- Cooper, W. F. and J. M. Sorensen. 1981. *Fundamental Frequency in Sentence Production*. Heidelberg: Springer.
- Estebas-Vilaplana, E. 2000. *The use and realization of accentual focus in Central Catalan with a comparison to English*. PhD dissertation, University College London. Published by Lincom Europa (2009).
- Estebas-Vilaplana, E. 2003. Phonetic and phonological properties of the final pitch accent in Catalan declaratives. *Proceedings of the International Conference on Prosodic Interfaces*. 35-40. Université de Nantes.
- Estebas-Vilaplana, E. and P. Prieto. 2008. La notación prosódica del español: una revisión del Sp\_ToBI. *Estudios de Fonética Experimental* 17: 265-283.
- Frota, S. 1995. *On the prosody of intonation of focus in European Portuguese*. PhD dissertation, University of Lisbon.
- Fujisaki, H. 1983. Dynamic characteristics of voice fundamental frequency of speech and singing. In P. F. MacNeilage (ed.), *The production of speech*. 39-55. New York and Berlin: Springer-Verlag.
- Fujisaki, H. 1988. A note on the Physiological and Physical Basis for the Phrase and Accent Components in the Voice Fundamental Frequency Contour. In O. Fujimura (ed.), *Vocal Physiology: Voice Production, Mechanisms and Functions*. 347-355. New York: Raven.
- Grabe, E. 1998. *Comparative Intonational Phonology: English and German*. Wageningen: Ponsen and Looijen bv.
- Grice, M. 1995. *The intonation of interrogation in Palermo Italian*. Tübingen: Niemeyer.
- Gussenhoven, C. 2004. *The Phonology of Tone and Intonation*. Cambridge: Cambridge University Press.
- Ladd, D. R. 1983. Peak Features and Overall Slope. In A. Cutler and D. R. Ladd (eds.), *Prosody: Models and Measurements*. 39-52. Berlin: Springer.
- Ladd, D. R. 1984. Declination: a Review and Some Hypotheses. *Phonology Yearbook* 1: 53-74.
- Ladd, D. R. 1996. *Intonational Phonology*. Cambridge: Cambridge University Press.
- Lieberman, P. 1967. *Intonation, Perception, and Language*. Cambridge MA: MIT Press.
- Lieberman, M. 1975. *The intonational system of English*. PhD dissertation, MIT.
- Lieberman, M. and J. Pierrehumbert. 1984. Intonational Invariance under Changes in Pitch Range and Length. In M. Aronoff and R. Oerhle (eds.), *Language Sound Structure*. 157-233. Cambridge MA: MIT Press.
- Lieberman, P. and S. Blumstein. 1990. *Speech Physiology, Speech Perception and Acoustic Phonetics*. Cambridge MA: Cambridge University Press.
- Nolan, F. 1995. The Effect of Emphasis on Declination in English Intonation. In J. Windsor-Lewis (ed.), *Studies in General and English Phonetics. Essays in Honour of Professor J. D. O'Connor*. 241-254. London: Routledge.
- Pierrehumbert, J. 1980. *The phonology and phonetics of English intonation*. PhD dissertation, MIT.
- Pierrehumbert, J. and M. Beckman. 1988. *Japanese Tone Structure*. Cambridge MA: MIT Press.
- Poser, W. 1984. *The Phonetics and Phonology of Tone and Intonation in Japanese*. PhD dissertation, MIT.
- Prieto, P. 1995. Aproximació als contorns tonals del català. *Caplletra* 19: 161-186.

- Prieto, P. 2002. Entonació. In J. Solà (ed.), *Gramàtica del català contemporani*. 95-462. Barcelona: Edicions 62.
- Prieto, P. In press. The Intonational Phonology of Catalan. In S. A. Jun (ed.), *Prosodic Typology 2*. Oxford: Oxford University Press.
- Prieto, P., L. Aguilar, I. Mascaró, F. Torres-Tamarit and M. M. Vanrell. 2008. L'etiquetatge prosòdic Cat\_ToBI. *Estudios de Fonética Experimental* 18: 287-309.
- Prieto, P., C. Shih and H. Nibert. 1996. Pitch Downtrend in Spanish. *Journal of Phonetics* 24: 445-473.
- Sosa, J. M. 1999. *La entonación del español*. Madrid: Cátedra.
- Thorsen, N. 1980. Intonation Contours and Stress Group Patterns in Declarative Sentences of Varying Length in ASC Danish. *Annual Report of the Institute of Phonetics* 15: 13-47. University of Copenhagen.

## Appendix

This appendix includes all the sentences recorded in the production test. Even though each structure is only listed once, each sentence was recorded five times with the following readings: 1) broad focus (e.g. *La Rosa llegia novel.les*), 2) narrow focus in medial position triggered by contrast and by new information (e.g. *La Rosa LLEGIA novel.les*) and 3) narrow focus in final position triggered by contrast and by new information (e.g. *La Rosa llegia NOVEL.LES*).

1. *La Rosa llegia novel.les*.  
'Rosa read novels.'

2. *En Juli vivia a Màlaga*.  
'Juli lived in Malaga.'

3. *La Mireia volia verdura*.  
'Mireia wanted vegetables.'

4. *En Ramon olora benzina*.  
'Ramon smells the oil.'

5. *L'Emília volia amanida*.  
'Emilia wanted salad.'

6. *La Glòria venia de Mòdena*.  
'Gloria comes from Modena.'

7. *La Marina beu llimonada*.  
'Marina drinks lemonade.'

8. *Els homes llimaven l'armari.*  
'The men planed the cupboard.'
9. *La nena venia joguines.*  
'The girls sold toys.'
10. *La Remei mimava les nenes.*  
'Remei pampered the girls.'
11. *En Joan domina les llengües.*  
'Joan masters languages.'
12. *La Rosa regava els geranis.*  
'Rosa watered the geraniums.'
13. *En Jaume anava al museu.*  
'Jaume went to the museum.'
14. *La minyona negava la maionesa.*  
'The maid spoilt the mayonnaise.'
15. *L'home volia mandarines.*  
'The man wanted tangerines.'
16. *La Marina cantava balades.*  
'Marina sang ballads.'
17. *La Lola guardava monedes.*  
'Lola kept coins.'
18. *La Núria vol una amiga.*  
'Nuria wants a friend.'
19. *La Ramona mirava la roba.*  
'Ramona looked at the clothes.'
20. *La mare menjava mongetes.*  
'The mother ate beans.'