The Intonational Phonology of Catalan*

Pilar Prieto

ICREA-UAB

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1. Introduction

This chapter presents an analysis of the prosodic and intonational structure of Catalan within the Autosegmental-Metrical (AM) framework (Pierrehumbert 1980, Pierrehumbert and Beckman 1988, Ladd 1996, Gussenhoven 2004, Jun 2005, and Beckman et al. 2005, among others). Based on this analysis, we have developed the Cat_ToBI system of prosodic annotation of Catalan corpora (Prieto, Aguilar, Mascaró, Torres & Vanrell 2009). This chapter will concentrate mainly on a description of the Catalan prosodic phrasing and intonation, by describing the basic intonational tunes found in the language and by exemplifying the intonational categories with utterances that provide evidence for minimal phonological contrasts.

The description of Catalan intonational phonology presented here is based on early work on Catalan intonation and on the examination of a speech corpus especially designed to obtain a variety of intonation contours with different pragmatic meanings. The first comprehensive studies of Catalan intonation were Bonet (1984) and later Prieto (2002a), who established the bases for a detailed description of the intonation contours found in a variety of sentence types in Central Catalan, the standard variety of Catalan. Also, several studies have analyzed a number of Catalan intonation contours (mostly declaratives and interrogatives), both for Central Catalan (Bonet 1986, Estebas-Vilaplana 2000, 2003, Font 2007, Prieto 1995, 2000, 2002b, Recasens 1977, Salcioli 1988, and Virgili Blanquet 1977, among others) and for other dialectal varieties (Fernández Planas et al. 2006, Fernández Planas 2007, Mascaró i Pons 1986, 1987, Martínez Celdrán et al. 2005a, 2005b, Prieto 2001, Prieto & Pradilla 2004, Prieto & Rigau 2007, and Vanrell 2006, 2008, among others). In the last decade, relevant research has been conducted within the Autosegmental-Metrical framework. This work has focused on a variety of issues related to the typology of pitch accents and boundary tones and tonal constrasts in Catalan (Vanrell 2006, Prieto, D'Imperio & Gili-Fivela 2006, Prieto, Torres & Vanrell 2008), as well as the details of alignment and scaling of F0 contours (Estebas-Vilaplana 2000, 2003, Astruc-

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Aguilera 2005, 2007, and Prieto 2005a, 2006, 2008a, among others). In the following sections, the main findings of previous work on intonational contours and categories are described and summarized where relevant.

The analysis presented here has been largely developed on the basis of the Cat_ToBI corpus of spoken Catalan, which includes data from speakers of different dialects. The corpus comprises three types of materials: a) sentences obtained through the administration of an *intonation survey* which consisted of approximately 49 situations, each intended to elicit a particular type of utterance; b) dialogues obtained by means of the *Map Task* technique; and c) videotaped fragment of spontaneous speech or informal conversation. Subjects surveyed were mostly women aged between 25 and 45 years and from 48 cities across the Catalan-speaking regions. The speech materials of the Cat_ToBI corpus can be found on the web page of the *Interactive Atlas of Catalan Intonation*.[1]

The chapter is organized as follows. Section 2 presents an overview of the stress and rhythmic system, and also of prosodic phrasing. Section 3 is devoted to intonational phonology. First, I briefly introduce the basics of the AM model, together with the basic inventory of pitch accents and boundary tones attested in Catalan, describing their phonetic realizations and distributional properties. After that, I describe the basic intonation patterns found in a variety of sentence types (statements, questions, commands and requests, vocatives), as well as the intonational realization of different pragmatic meanings such as insistence or incredulity, and the effects of the presence of focus on the default realizations of prosodic structure. Finally, I present a summary of the Cat_ToBI labels and the main nuclear configurations found in Catalan. In the conclusion I summarize the principal findings and point to areas for future research.

2. Catalan Prosody and Prosodic Structure

2.1. Stress and rhythmic structure

In stress-accent languages like Catalan, syllables with primary stress (a lexical property of a word which specifies which syllable will be ‘stronger’, i.e. more prominent than the others) generally serve as the landing site for pitch accents, which are signalled acoustically by a pitch movement (Bolinger 1958, Pierrehumbert 1980, and Ladd 1996, among others). Generally,

[1] *The Interactive Atlas of Catalan Intonation* (http://prosodia.uab.cat/atlesentonacio/) is intended as the first step in a comprehensive study of the dialectal diversity present in Catalan intonation. By means of interactive maps of the Catalan linguistic area, the user can conveniently access various audio and video materials exemplifying different kinds of intonation contours. Each file from the intonation survey includes a description and interpretation of the contour, an audio file, the fundamental frequency curve, and the Cat_ToBI labeling. The website also contains the *Cat_ToBI* annotation proposal (Prieto, Aguilar, Mascaró, Torres & Vanrell 2009) and a resource page with downloadable bibliography on Catalan intonation and information about the currently available corpora of spoken Catalan.

stressed lexical items receive an accent, even though there are exceptions: in some types of Catalan compounds only the last member receives stress (e.g., the prominence contrast between *netejaparabrises* 'windshield wiper' vs. *neteja parabrises* '(s)he cleans the windshield'; see Mascaró 2002, Recasens 1993, Prieto 2003). However, not all syllables with primary stress are accented in all discourse contexts: the presence or absence of a pitch accent (and its prominence) depends on the larger prosodic structure in which the lexical item is found. For example, the rightmost member of a prosodic phrase receives the nuclear accent, that is, the most prominent accent within the phrase. Likewise, Catalan typically resolves stress clash situations by destressing and/or deaccenting the first accent involved in the clash (*deu nens* > *deu nens* 'ten children' Oliva, 1992; Prieto et al., 2001; Prieto 2008a). Thus, in Catalan there exist at least three levels of syllabic prominence: unstressed, stressed and accented, and stressed but not accented.

Until recently, acoustic cues to stress prominence in Catalan had been studied only in words and sentences spoken in intonation patterns that exhibited covariation between stress and accent. In these studies, all stressed syllables also had a pitch accent, while unstressed syllables were deaccented (Barnils 1933, Recasens 1986). Results indicated that stressed syllables were phonetically realized with an increase in pitch and by longer durations and intensity levels. Lately, however, some experimental work on stressed but deaccented syllables has demonstrated that the stress contrast in Catalan is maintained in deaccented contexts by differences in duration, spectral tilt, and to a lesser extent, vowel quality, despite the absence of accent, and that a small difference in duration is the primary perceptual cue for the stress difference (Prieto & Ortega-Llebaria 2006, Ortega-Llebaria, Prieto & Vanrell, submitted).

It is also possible for unstressed syllables to become stressed and/or accented. The presence of postlexical rhythmic stresses has been a matter of disagreement among authors. While Coromines (1971) and Oliva (1992) claim that rhythmic stresses appear regularly in long stretches of unstressed syllables, following a binary or ternary pattern (*maratónó* 'marathon', *fàtalitat* 'fatality'), other authors do not find phonetic evidence for this rhythmic pattern (see Prieto 2001). It is possible that the appearance of rhythmic secondary stresses is conditioned by speech style, being more frequent in news broadcasts and public discourse (lectures, speeches, etc.), and in emphatic speech in general. This phenomenon, called 'emphatic stress', might also interfere with the perception of 'rhythmic stress'. Emphatic stress consists of the placement of a pitch accent prominence on the initial (and sometimes second) syllable of a word, with an emphatic function. It is characterized by the presence of a rising pitch accent through the stressed syllable, followed by a fall on the posttonic. The lexically stressed syllable in words with emphatic stress can also receive tonal prominence, and in this case we have a word with two prominent syllables and possibly two pitch accents (e.g., *és increïble* 'it is incredible'; *la manifestació* 'the rally').

With respect to rhythm, even though Catalan has been classified as an intermediate language between a syllable-timed language like Italian and Spanish and a stress-timed language like English or Dutch (Nespor 1990, Ramus et al. 1999), phonologists have not reached a firm agreement on its rhythmic status. Catalan has a greater complexity of syllable structure types than Spanish (Span. *caballo*, Cat. *cavall* 'horse'; Span. *arco*, Cat. *arc* 'arch') and it also presents vowel reduction phenomena, properties which are consistently associated with stress-timed languages. Yet in a recent study, Prieto, Vanrell, Astruc, Payne & Post (2008) show that when

syllable structure properties are controlled for in the experimental materials, no durational planning differences arise between Catalan and Spanish, while important differences arise between English vs. Catalan/Spanish. This calls into question the status of Catalan as an 'intermediate language' and demonstrates that even though the phonological properties of the language place Catalan as a mixed type of language regarding rhythmic class, duration measures reveal that Catalan behaves like Spanish in the relative duration of stressed and unstressed syllables. While in English stressed syllables are significantly longer than unstressed syllables (creating the sensation of the morse-type rhythmic effect), this is not the case for Catalan and Spanish. Further evidence for the syllable-timed status of Catalan is given in Gavaldà-Ferré (2007). Her data reveals a lack of rhythmic distinction between two types of Catalan dialects, Eastern Catalan with a full vowel reduction system, and Western Catalan with a 'partial' vowel reduction system.

2.2. Levels of phrasing

While we assume that prosodic groupings are perceptual categories, these have been found to be associated with certain physical characteristics of the speech signal. In addition to different tonal features, the end of phrases may be identified by one or more of the following phonetic correlates: pauses, reduction in amplitude, and lengthening of the final syllable in the phrase. In general, major phrase boundaries tend to be associated with longer pauses, greater and more complex tonal changes, and more final lengthening than minor boundaries. In Catalan, besides all these phonetic features, evidence for phrase groupings comes from stress/accent facts and intonation. Catalan speakers place a prominent stress and an accent on the last tonic syllable of the group. In other words, by default, prominence within the prosodic phrase is rightmost.

In Cat_ToBI (Prieto et al. 2009), the Catalan data has been analysed as having three levels of phrasing above the prosodic word level: the phonological phrase, the intermediate phrase, and the intonational phrase. The latter two are relevant to intonation. Evidence in support of these three prosodic constituents is described below. As for the *prosodic word* level, we follow Vigário (2003) in taking primary word stress as one of the most clear diagnostics for the prosodic word domain in Romance languages and in many other languages. It is generally accepted that the prosodic word must bear one and only one primary stress, and, in consequence, elements which cannot bear primary stress will not count as a prosodic word. In Catalan, clitics and first elements of compounds are incorporated in the prosodic word level (e.g., *la comprarà* '(s)he is going to buy it', *netejaparabrises* 'windshield wiper').

There is plenty of evidence for the level of the *intonational phrase* in Catalan. This is the domain of application of many sandhi rules such as vowel deletion, vowel coalescence, gliding, and fricative voicing (about the first of these, see Cabré & Prieto 2005). Similarly, it is the domain for pre-boundary lengthening, it defines the position for pauses, and it has a precise intonational definition. The intonational phrase is the domain of the minimal tune: it consists of one or more pitch accents plus the boundary tones. Nevertheless, there are several arguments in in favor of a second level of intonationally-defined constituent, the *intermediate phrase*. The first argument is a perceptual one. In Catalan prosodic transcriptions, transcribers clearly distinguish between two levels of degree of perceived disjuncture. The end of the weaker disjuncture corresponds to a

level 3 break index in the ToBI system, while the strong disjuncture corresponds to a level 4 break index. The second argument relates to intonational marking. Like the intonational phrase, the intermediate phrase is tonally marked after its final pitch accent (yet not as strongly as the intonational phrase), but the inventory of boundary tones that appear in this position is of a different (but partially overlapping) class. Typically, H% boundary tones, also called "continuation rises", mark the end of an intermediate phrase. Frota, D'Imperio, Elordieta, Prieto & Vigário (2007) examined the phonetics and phonology of prosodic boundaries in such positions in five Romance languages, among them Catalan. They found that the two dominant boundary tones in statements (located at the end of the first prosodic constituent) were either the continuation rise or the sustained pitch. By contrast, intonational phrase-final edges were generally signaled by a Low boundary tone (L%) and by a wider inventory of boundary tone combinations (see section 3.2).

As for the existence in Catalan of another possible level of phrasing below the intermediate phrase, the *phonological phrase*, this is an unresolved issue. This domain generally includes the lexical head, the elements on the head's nonrecursive side, and a following nonbranching phrase within its maximal projection (see Oliva 1992). In other Romance languages the phonological phrase is the domain of application for several phonological processes. For example, in Florence Italian, Radoppiamento Sintattico (or Syntactic Redoubling), Final Lengthening and Stress Retraction are phenomena that apply at the phonological phrase level (Nespor & Vogel 1986, 1989). And in French and in Brazilian Portuguese, Stress Retraction also applies within the phonological phrase domain (see Post 1999, and Sandalo & Truckenbrodt 2002, respectively). In Catalan, no conclusive evidence has been found thus far. Unlike other Romance languages, the phonological phrase is not the domain of sandhi processes in Catalan: for example, vowel deletion and vowel merging processes can even apply across two intermediate phrases (e.g., (*La nena de la Marina*) (*arribarà demà*) 'Marina's daughter will arrive tomorrow', pronounced with just one schwa across the two domains). Similarly, the edges of phonological phrases do not need to be tonally marked and need not be signaled by edge-tones. Though Nespor & Vogel (1989) argue that Catalan exhibits Stress Retraction in this domain, this is not the usual way to avoid stress clash in this language. As noted above, the default way to avoid stress clash in Catalan is the deletion or weakening of the first stress involved in the clash (Oliva 1992, Prieto et al. 2001). On the other hand, from a perceptual point of view, oftentimes transcribers perceive a clear phrasing break at the end of a domain which does not have a tonal marking. Thus, the phonological phrase level might have subtle manifestations in the prosody of Catalan, and we thus leave open the possibility of its existence.

With respect to the syntactic grounding of prosodic constituents in Catalan, several studies have pointed out that the construction of prosodic structure in this language cannot solely rely on syntactic information but rather must also refer to prosodic markedness constraints which regulate the size and eurhythmicity of phrase constituents (D'Imperio et al. 2005, Prieto 2005b, Prieto 1997, Feldhausen 2008). In some cases, the prosodic conditions that trigger the balancing of long phrases can create mismatches between the prosodic and syntactic constituencies. One of the most striking mismatches is the case of (SV)(O) phrasings, exemplified in (1), whereby a verbal head is phrased together with a preceding subject when the object is long. This fact is not predicted under the most common theories of syntax-phonology interface, as syntactic constraints of alignment and wrapping of syntactic constituents are violated.

(1) a. (La nena demana) (els regals de Reis)
'The little girl asks for her Epiphany gifts.'
b. (El periodista comunicà) (la notícia del dia)
'The journalist reported the news of the day

Similarly, when verbal heads are followed by a complex object containing three prosodic words, prosodic conditions trigger a redistribution of the phonological weight of the sequence in such a way that the resulting prosodic phrases phrases are more balanced for phonological weight (counted in number of prosodic words). The examples in (2) show that the first object noun is phrased together with the preceding verb due to the fact that the prepositional phrase internal to the object is longer.

(2) a. (Comprava mapes) (de la Barcelona antiga)
'I/(s)he used to buy maps of old Barcelona.'
b. (Menjaré pastissos) (de xocolata amarga)
'I will eat cakes of dark chocolate.'

An interesting fact about Catalan phrasing, initially noted by noted by Oliva (1992), is that stress clash resolution also plays an important role on phrasing decisions in Catalan. In his study of Catalan phrasing, Oliva (1992:131) suggests that the presence of a clash can optionally trigger p-restructuring in some cases. As it is well knowsn, the preferred option for resolving stress clashes in this language is the deletion (or weakening) of the first stress involved in the clash (see Prieto et al. 2001). The examples in (3) show how the stress clash situation present in sentence (3a) (that is, between *beu* and *aigua*s) is resolved by placing both words within the same prosodic phrase and thus allowing for the deletion of the first stress. By avoiding the stress clash situation, speakers state a clear preference for sentences with no clash, even though its resolution is not obligatory. In a recent production experiment, Prieto (2008b) confirms that Catalan speakers significantly produce prosodic groupings which lead to the presence of more evenly spaced stressed syllables and that the no-clash constraint plays a major role on phrasing decisions in Catalan suppressing effects of syntactic and other prosodic constraints

(3) a. (La Maria) (beu aigua destil·lada)
'Mary drinks distilled water'
b. (La Maria bevia)ϕ (aigua destil·lada)ϕ
'Mary used to drink distilled water'

3. Intonational Phonology

As mentioned above, the data presented here stems from the analysis of an *intonation survey* that was designed to evoke everyday situations (Prieto 2001). It is an inductive method in which the researcher presents the subject with a series of situations (such as "You go into a shop you have never been in before and ask the shop assistant if they sell tangerines") and then asks him or her to respond accordingly. This method is especially useful because it allows the researcher to obtain a wide range of intonation contours that are difficult to obtain with other methods. The sentence-types covered by the survey are the following: a) declaratives; b) yes-no questions; c) wh-questions; d) echo questions; e) requests and orders; and f) vocatives.

For the intonational analysis of Catalan utterances we recognize two types of tonal events: i) pitch accents, or local tonal events associated with metrically strong syllables and which confer accentual prominence to these syllables; and ii) boundary tones, or tonal events associated with the boundaries of prosodic domains. It is therefore assumed that the important parts of intonational contours are localized events in the F0 contour which are phonologically specified. In this framework, intonational contours are viewed as sequences of one or more pitch accents plus a combination of boundary tones.

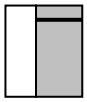
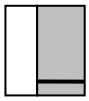
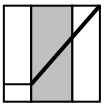
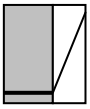
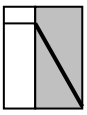
In the following sections we describe the inventory of pitch accents and boundary tones attested in Catalan, together with their Cat_ToBI labels and phonetic realizations. The current set of Cat_ToBI annotation conventions captures the relevant empirically observed patterns attested thus far, and will be exemplified with utterances that provide minimal phonological contrasts (see section 3.4). After a description of the main intonational units used in the analysis, we describe the intonation of the main sentence types (statements, questions, requests, commands, and vocatives). Different tonal events encoding different semantic/pragmatic information are described, as well as the ways in which focus affects phrasing patterns.

3.1. The pitch accents

Table 1 shows a summary of the monotonal, bitonal, and tritonal pitch accents in Catalan with a description of their default phonetic realization patterns and their main distributional properties. The shaded part of each contour shape indicates the stressed syllable. Catalan has six basic pitch accents: H*, L+H*, L+>H*[2], L*, L*+H, and H+L* (see the Cat_ToBI proposal in Prieto et al. 2009). Also, the tritonal pitch accent L+H*+L has been documented in Alguerese Catalan, the Catalan variety spoken in the city of L'Alguer (Sardinia). The following upstepped and downstepped pitch accents (i.e. scaled lower than the previous pitch accent) have been attested in

[2] If the maximum F0 peak does not actually occur within the syllable nucleus, we adopt the convention that the maximum F0 peak is late by using the symbol '>' before the H symbol, indicating a late F0 event. This convention is used in MAE-ToBI (Beckman et al 2005) and in Gr_ToBI (Arvaniti & Baltazani 2005).

Catalan: !H*, ¡H*, L+!H*, L+¡H*, and !H+L*.[3] As criteria for starredness, I follow Prieto, D'Imperio & Gili-Fivela (2006)'s analysis, as it offers a transparent analysis of the alignment contrasts found in various Romance languages. There are several H* pitch accents, which are perceived as (mainly) high accents, and other L* pitch accents, which are perceived as (mainly) low accents. In order for a syllable to be perceived as high, the pitch level needs to stay high or rise for a good portion of the accented syllable; conversely, in order for a syllable to be perceived as low the pitch level must stay low or fall for a good portion of the accented syllable. The bitonal representations capture the fact that the LH shape is aligned differently in the two contrastive pitch accents. For example, while L*+H has a low tone (L) on the stressed syllable and a high tone (H) trailing it, L+H* has a high tone on the stressed syllable with a low tone leading it. The tritonal pitch accent L+H*+L, documented in Alguerese Catalan narrow focus statements, is phonetically realized as a complex rise-fall within the accented syllable.

Monotonal pitch accents		
	H*	This pitch accent is phonetically realized as a high plateau, and no initial dip is observed. In our corpus, it is attested as one of the possible choices for nuclear position in wh-questions.
	L*	This pitch accent is phonetically realized as a low plateau. It is generally realized as a local pitch minimum in the speaker's range. It is attested in nuclear position in broad focus statements and in yes-no questions (rising type).
Bitonal pitch accents		
	L+H*	This pitch accent is phonetically realized as a rising pitch movement during the accented syllable. The rise starts at the onset of the accented syllable and ends at the end of that syllable. It is attested in nuclear position in broad and narrow focus, in anti-expectational questions, and in combination with a variety of boundary tones in calls, insistent requests, obviousness statements, etc.
	L+>H*	This pitch accent is also phonetically realized as a rising pitch movement. Typically, the L tone is aligned with the onset of the accented syllable, and the H tone is aligned with the postaccentual syllable. This is the predominant choice for prenuclear accents in broad focus statements.
	L*+H	This pitch accent is realized as a low tone on the accented syllable followed by a rise on the posttonic syllable. The peak is typically realized at the end of the posttonic syllable, and sometimes later. In our corpus, it is attested in prenuclear position in yes-no questions and requests.
	H+L*	This pitch accent is phonetically realized as a fall within the accented syllable. The start of the fall is aligned with the beginning of the accented syllable and the end of the fall is aligned (roughly) with the end of the stressed syllable. It is attested in nuclear position in yes-no questions (falling type) .

[3] Following standard AM assumptions, downstep is marked explicitly by a "!" (final exclamation mark) and upstep with a "¡" (initial exclamation mark) diacritic before the H target. Both are used to indicate a step down (downstep) or step up (upstep) within a sequence of H pitch accents.

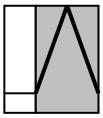
Tritonal pitch accent (Alguerese)		
	L+H*+L	The tritonal pitch accent L+H*+L, documented in Alguerese Catalan, is phonetically realized as a complex rise-fall within the accented syllable. It is attested in narrow focus statements.

TABLE 1. Schematic contours of seven types of pitch accent in Catalan.

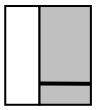
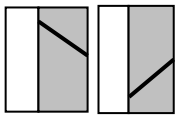
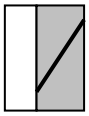
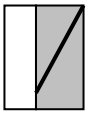
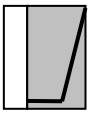
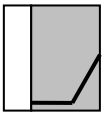
3.2. The boundary tones

Given that in Romance languages the nucleus is located at the end of prosodic phrases, several authors have argued that the phrase accent category is not needed and that one can dissociate the strict correspondence between the prosodic hierarchy (intonational vs. intermediate phrases) and the number and type of boundary tone combinations (Sosa 1999 for Spanish, Frota 2002a, this volume, for Portuguese, Prieto & Frota, in preparation, for several Romance languages). In accordance with this argumentation, the Cat_ToBI proposal has argued that the phrase accent category can be dispensed with, and that only one type of boundary tone is needed, which can appear at both the right edge of intermediate phrases and the right edge of intonational phrases. An argument in favor of having one type of boundary tone is the fact both types of prosodic levels in Catalan, i.e. the intermediate phrase and the intonational phrase, can be signaled by either simple or complex boundary tones: for example, complex boundary tone combinations of the type LH% are commonly attested at the end of intermediate phrase boundaries and intonational phrase boundaries (see Feldhausen 2008, Prieto et al 2009). Yet if one assumes that the intermediate phrase level should be obligatorily marked by a phrase accent, we should not expect having a complex phrase accent.

Schematic contours of eight types of boundary tone combinations are shown in Table 2. The shaded part of the contour indicates the posttonic syllable (or syllables) containing the boundary tones. In Catalan, there are a number of boundary pitch movements that convey different discourse meanings, namely, L%, H%, M%, MM%, LM%, HH%, LH%, HL%, and LHL%. The difference between boundary configurations with one, two, or three tones corresponds to the number of targets that are produced. For example, the LH% configuration is phonetically realized as a fall followed by a rise in the posttonic stretch. Alignment analyses of boundary configurations in words with antepenultimate, penultimate, and final stress provide evidence for the existence of monotonal, bitonal, and tritonal boundaries. The same applies to M% vs. MM%, as the latter is attested in stylized calling contours which end in a sustained plateau. Yet the difference between H% and HH%, following the standard AM analysis, is that of pitch height, HH% being significantly higher.

Though the Autosegmental-Metrical framework proposes that only two level tones (High H and Low L) are sufficient to represent intonational contrasts, there is enough evidence to argue that boundary tone is phonologically contrastive at a mid level in Catalan (see Prieto, Torres and Vanrell 2009). We propose the presence of a mid tone level in the system M%, as Beckman et al.

(2002) do for Spanish, rather than the use of the downstep feature !H% used in the Gr_ToBI and G_ToBI. The latter symbol !H% leads to an overuse of a mechanism used by the AM model to refer to the lowering of successive high tone targets within a prosodic phrase in downstepping contours.[4] The M% level has the advantage of directly encoding the final pitch height, which is independent of any syntagmatic reference to preceding pitch accents. Second, there is enough crosslinguistic evidence that reveals that the M% boundary tone level is active in other languages at the boundary level: mid level tones in utterance-final position have been documented in English (Beckman & Ayers-Elam 1997), Greek (Arvaniti & Baltazani 2005), in German (Grice et al. 2005), and in Korean (Jun 2005, Lee 2003). Moreover, regarding the difference between M% and MM%, other languages such as Greek also show a difference between a mid sustained level tone (transcribed as !H!H%) typical of vocatives and a mid non-sustained tone (transcribed as !H%) attested in wh-questions.

One target		
	L%	L% is manifested phonetically as a low sustained tone or a low descending tone that attains the baseline of the speaker. It is attested at the end of broad and narrow focus statements, imperatives, falling yes-no questions, etc.
	M%	M% is manifested phonetically as a falling movement to a mid tone, or as a rising movement to a target mid tone. It is attested in hesitations and in obviousness and disapproval statements.
	H%	H% is manifested phonetically as a rising pitch movement, coming from either a high or a low pitch accent. It is attested at the end of non-final constituents, inconclusive statements, etc.
Two targets		
	HH%	HH% is manifested phonetically as a very sharp rising pitch movement at the end of the phrase, often attaining a very high frequency in the speaker's range. It is attested at the end of rising yes-no questions and echo questions.
	LH%	The LH% is manifested phonetically as a dip and then a rise to a high F0 value. It is attested in anti-expectational and incredulity questions.
	LM%	The LM% is manifested phonetically as a dip and then a rise to a mid F0 value. It is attested in obviousness statements.

[4] In a similar vein, Ratchke & Harrington (in press) point out that "if we allow the system to contrast H+L* and H+!H* pitch-accents, then this means that the frequency scaling of the (starred) tones that are associated with the accented syllable is no longer phonetic as argued in e.g., Pierrehumbert (1980), but is implicitly phonological because there is now a paradigmatic contrast between three tonal levels: high-star in (L+)H*, low-star in H+L* and effectively a mid-star in H+!H*."

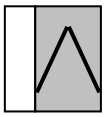
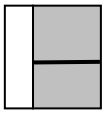
	HL%	The HL% is manifested phonetically as a rise and then a fall to a low F0 value. It is attested after high or low pitch accents in requests and in obviousness statements.
	MM%	MM% is realized as a mid stylized sustained tone, with a target M at the beginning of the posttonic stretch of syllables, and another target M at the end. It is typical of stylized calls.
Three targets		
	LHL%	The LHL% is manifested phonetically as a complex pitch movement consisting of a fall plus rise and then a fall to a low F0 value.

TABLE 2. Schematic contours of nine types of boundary tone combination in Catalan.

Generally, these tonal boundary targets are realized within the posttonic stretch. Yet when the nuclear word has final stress, both the pitch accent and the boundary tones have to be compressed and realized within the same syllable. In general, Catalan acts as a 'compressing language' and does not truncate the final configuration composed by the nuclear pitch accent followed by boundary tones (see Prieto 2002, but see the case of partial truncation described in Prieto & Ortega-Llebaria, in press).

3.3. Basic intonational patterns in Catalan

In the next sections we describe the basic intonational contours found in Catalan. Though the majority of examples used to exemplify the contours are based on the standard Catalan variety, Central Catalan (the examples were uttered by two native speakers of this variety), references will also made to the intonation of other geographical varieties. Where appropiate, we will present near-minimal pairs which show relevant contrasts in different dialects.

3.3.1. Statements

Broad focus statements

The intonation of a *broad focus statement* is characterized by the presence of *rising prenuclear pitch accent*s that are associated with the stressed syllables of the utterance, followed by a *falling pitch accent* that occurs on the nuclear stressed syllable. Figure 1 exemplifies the pitch contour

of broad focus statements with the utterance *Volen melmelada* 'They want some jam'. The location of the start of the rise in prenuclear accents is generally at the onset of the accented syllable. After this, there is a rise during the accented syllable, and finally the peak is generally located on the posttonic syllable (for a detailed study of the temporal alignment of F0 prenuclear rises in Central Catalan declaratives, see Estebas-Vilaplana 2000, 2003).[5] After the rise of the last prenuclear pitch accent, the pitch falls, and the nuclear syllable is typically realized with a falling pitch accent. Like other Romance languages, Catalan differentiates nuclear position from other less prominent positions by the choice of pitch accent type (see Frota 2002b for Portuguese and D'Imperio 2002 for Italian), with L+>H* on non-final words and a L* accent for the word in nuclear position.[6]

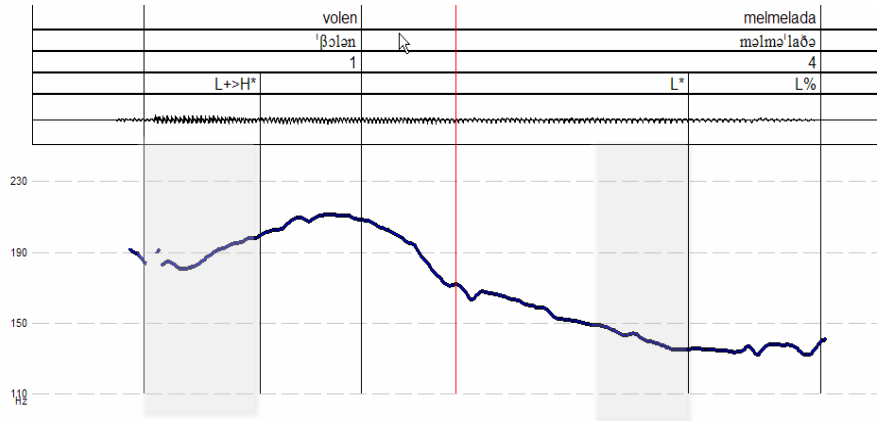


FIGURE 1. Waveform and F0 pitch track of the broad focus statement *Volen melmelada* 'They want some jam'. This example illustrates the phonetic realization of the rising prenuclear pitch accent L+>H* and the falling nuclear pitch accent in broad focus statements.

Even though the peak in prenuclear pitch accents is located in the posttonic syllable, this can vary depending on the rightwards prosodic structure. As it is well known, pitch pressure environments (namely, proximity to a boundary tone or to an upcoming pitch accent) can drastically affect the surface H alignment patterns (Silverman & Pierrehumbert 1990 for English; Prieto, van Santen & Hirschberg 1995 for Spanish; Estebas-Vilaplana 2000, 2003, and Prieto 2005a for Catalan). For example, Prieto (2005a) discusses the effects of tonal clash (or strict adjacency between two accents) on the phonetic realization of rising prenuclear accents in Catalan. Analysis of the data shows that the adjacency of two rising accents triggers a drastic temporal reorganization of the F0 gestures involved, resulting in anticipation of the first peak H (which is realized within the accented syllable) and delay of the first L of the second.

[5] Estebas-Vilaplana (2000) argued that the H target aligns with the word-boundary and thus proposed to characterize Catalan prenuclear accents as the sequence of a monotonal L* tone associated with the stressed syllable and a word-edge tone associated with the end of the word. Yet in more recent studies, Prieto (2007) and Prieto, Estebas-Vilaplana & Vanrell (2007) found that the H peaks in prenuclear rises were not strictly 'anchored' to word-edges. Thus it can be claimed that H word-edge tones are not present after prenuclear pitch accents in this language.

[6] Even though some analyses of the Catalan nuclear accent such as Astruc-Aguilera (2005) 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 Italian (D'Imperio 2002), they have phonetically distinct properties.

Earlier work on Central Catalan statements has shown that declarative contours are characterized by downstepping of prenuclear accents (L+!H*) and extreme downstepping and final lowering of the nuclear accent (see Estebas-Vilaplana 2000, 2003, for an analysis of the patterns of downstep found in Catalan declarative utterances). Regarding the scaling of the first peak of the utterance, there is still a question about the possible effects of 'preplanning', that is, whether the height of the initial F0 values and peaks is governed by a look-ahead or preplanning mechanism. In a recent study, Prieto, D'Imperio, Elordieta, Frota & Vigário (2006) examined the frequency scaling of utterance-initial F0 values and H initial peaks in several Romance languages (Catalan, Italian, Standard and Northern European Portuguese, and Spanish) as a function of phrasal length. The authors suggest that the failure to find a correlation between phrase length and initial scaling for all speakers within languages shows that we are dealing with a 'soft' preplanning mechanism (in Liberman & Pierrehumbert's 1984 terms), that is, an optional production mechanism that may be overridden by other tonal features. Vanrell (2006) also analyzes the effect of utterance length on the height of the first peak in both yes-no question and wh-questions in Majorcan Catalan: she finds a statistically significant effect of utterance length on the initial H, and especially in wh-questions, which is taken as evidence for preplanning. Furthermore, the fact that wh-questions display a greater effect of preplanning is interpreted as an indication that the presence of obligatory downstep can act as a trigger for preplanning effects.

In declarative utterances comprising several intermediate phrases, the right edge of each intermediate phrase is signalled by a boundary tone which is generally a high boundary (H%) tone, also called 'continuation rise', or a sustained pitch (see Frota, D'Imperio, Elordieta, Prieto & Vigário 2007). This boundary tone also appears at the end of sentence-initial topic phrases (see Feldhausen 2008). Figure 2 illustrates the typical continuation rise contour found in non-final intermediate phrases with the utterance *Gelat de vainilla* i *gelat d'avellana* 'Vanilla ice-cream and hazelnut ice-cream'. In this case, the nuclear pitch accent is of a rising type L+H* followed by a high boundary tone H%.

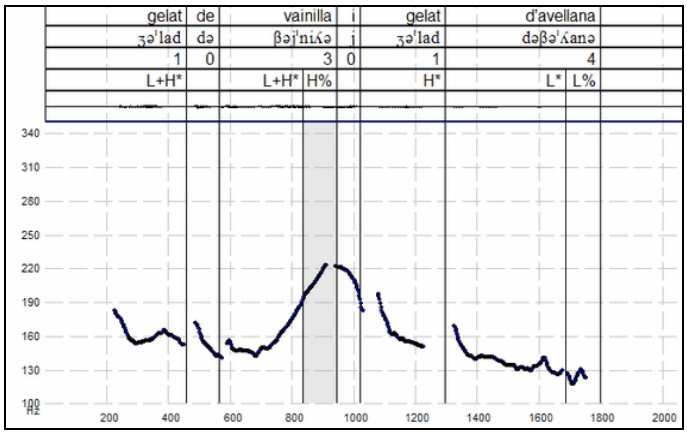


FIGURE 2. Waveform and F0 pitch track of the broad focus statement *Gelat de vainilla i gelat d'avellana* 'Vanilla ice-cream and hazelnut ice-cream'. This example illustrates the continuation rise H% that appears at the right edge of the first intermediate phrase.

Narrow focus statements

In the nuclear position of declaratives, a L+H* can also be found. From a pragmatic point of view, while L* signals narrow focus, L+H* signals *narrow contrastive focus* (and sometimes emphasis) in the same contexts. In our corpus, this pitch accent was frequently attested in nuclear position in imperatives and anti-expectational wh-questions, and also combined with other boundary tones in calling contours, imperatives, wh-questions, and obviousness statements (see Table 3 for a summary of the nuclear tonal configurations in Catalan and their meanings). The pitch contour in Figure 3 illustrates the narrow focus statement (right panel). Instrumental inspection of the nuclear pitch accent shows that the peak of the rising pitch accent is typically aligned with the end of the accented syllable (see Estebas-Vilaplana 2000 and Prieto 2002a, 2002b).

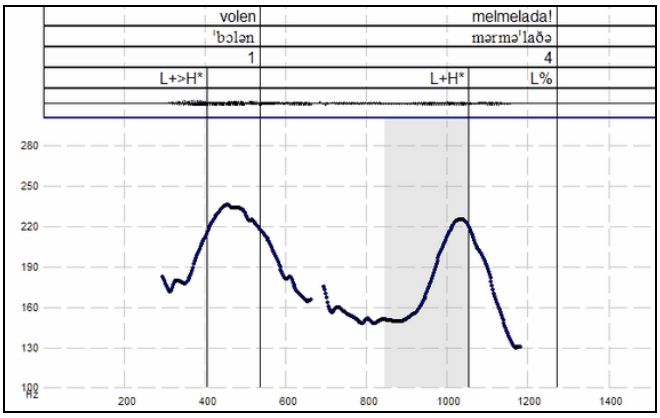


FIGURE 3. Waveform and F0 pitch track of the narrow focus statement *Volen melmelada (i no pas mantega)* 'They want jam (not butter)'. This example illustrates the nuclear L+H* pitch accent with an aligned peak.

Thus the presence of a contrastive focus does have an effect on phrasal prominence and intonation: contrastive focus is tonally expressed by means of a particular pitch accent, L+H*. It is also characterized by a high frequency scaling of the peak. Another strategy of attaining contrastive focus is the initial preposing of the contrastive element, which gets focus/nuclear prominence and also triggers postnuclear pitch accent deaccentuation and/or subordination. This is shown in Figure 4. The postnuclear stretch is either deaccented or a very reduced series of L+!H* accents (for the intonation of sentence-external elements and postnuclear elements, see Astruc-Aguilera 2005, 2007;see also Feldhausen 2008).

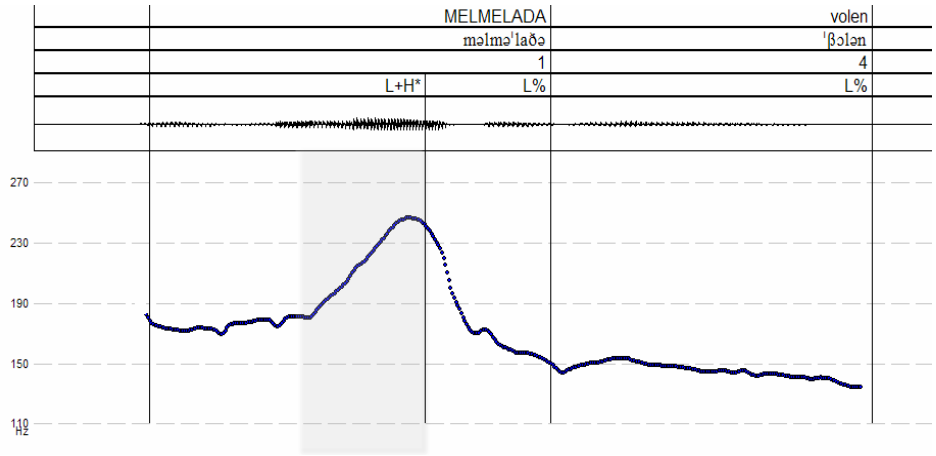


FIGURE 4. Waveform and F0 pitch track of the contrastive focus utterance *MELMELADA volen* (i no pas mantega) 'JAM is what they want (and not butter)'. This example illustrates the L+H* nuclear pitch accent and the postnuclear stretch.

It has been claimed that while in Germanic languages such as English the strategies used to focus an item involve a reorganisation of the intonational pattern of the sentence, in Catalan, a syntactic shift rather than an accentual alteration tends to occur (see the plastic vs. non-plastic language classes in Vallduví 1992). Estebas-Vilaplana (2001) argues that in Central Catalan focal elements must be placed at the end of a prosodic phrase. However, this does not necessarily need to be achieved by a syntactic shift. A prosodic shift, such as the introduction of a phrase boundary, can locate the focused item on an accent-bearing position and hence no word order alteration is needed. Thus the strategies used to locate the focal item at phrase-final position need not be syntactic.

The variety of Catalan spoken in L'Alguer (Sardinia) shows a contrast between two types of rising pitch accents characterized by a high tone associated to the accented syllable. In both cases, the start of the rise aligns with the beginning of the accented syllable, but while in the narrow focus pitch accent the peak is reached in the first half of the vowel, in the broad focus pitch accent it is reached by the end of the open syllable. The example in Figure 4b shows the waveform and F0 track of the sentence *Verament bona, aqueixa paella, no l'he mai volguda assajar* 'It is very good, this paella, and I NEVER wanted to taste it before' The pitch accent on the word *mai* 'never' expresses a narrow (contrastive) interpretation. We propose to analyze the broad focus pitch accent as an instance of L+H* and the narrow focus pitch accent as a tritonal pitch accent L+H*+L involving a low trailing tone. One of the main arguments in favor of such analysis is the observation that the presence of the trailing tone is enough to phonologically distinguish the two pitch accents. This option also allows for a phonetically transparent labeling, that is, the tritonal pitch accent is composed of three tones of equal strength. For more arguments in favor of this analysis, see section 4.

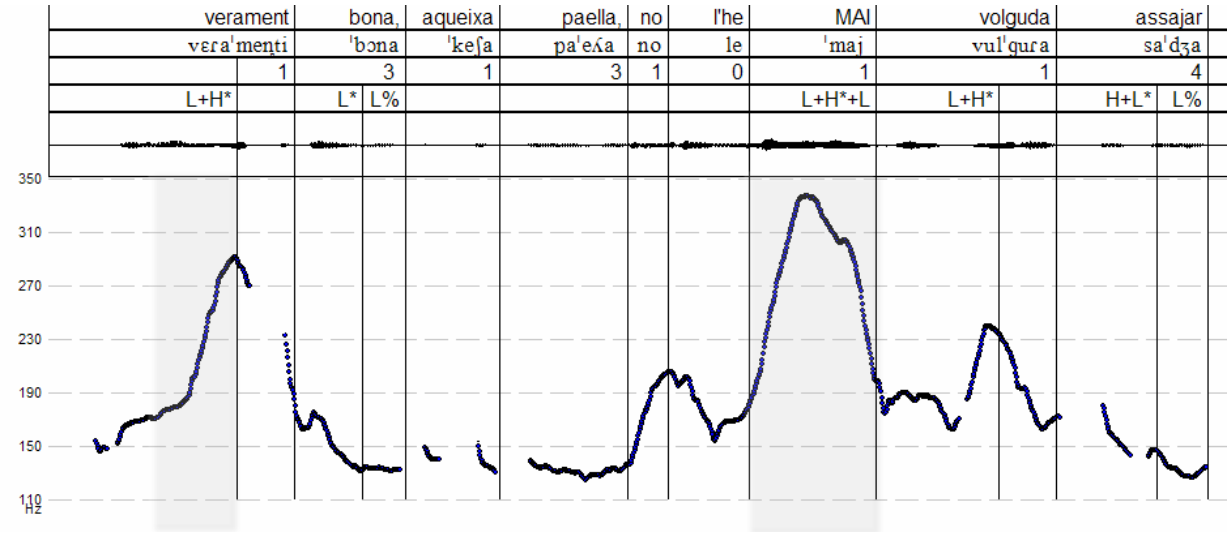


FIGURE 4b. Waveform and F0 pitch track of the contrastive focus utterance *Verament bona, aqueixa paella, no l'he mai volguda assajar* 'It is very good, this paella, and I NEVER wanted to taste it before'. This example illustrates the contrast between the L+H* pitch accent and the L+H*+L pitch accent.

3.3.2. Biased statements

Statements of the obvious

There are special tonal configurations which confer a meaning of obviousness and strong belief of certainty on the part of the speaker. The intonation contours in Figure 5 illustrate two possible intonation contours that express a statement with an obvious meaning: *(Home), viuran a Mèrida!*, 'They're going to live in Mérida, of course!' (left panel), and *(Home), la Bàrbara!*, 'Barbara (obviously)!' (right panel). The contour on the left is characterized by a nuclear low tone followed by a complex boundary movement HL%. The contour on the right, which confers a more emphatic obviousness meaning, is characterized by a rising nuclear L+H* pitch accent produced on the syllable *bàr-* and followed by a complex falling and rising movement to a mid tone LM% —further evidence for the contrast between LM% an LH% can be found in Prieto, Torres & Vanrell (2008); see also section 3.4. The phonetic realization of these complex boundary tones HL% and LM% over words with antepenultimate stress (*Mérida* and *Bàrbara* respectively) reveals that each target is associated with a posttonic syllable. While the first target (either H or L) is aligned at the end of the first posttonic syllable, the last target (either L or M) is aligned with the end of the utterance-final syllable.

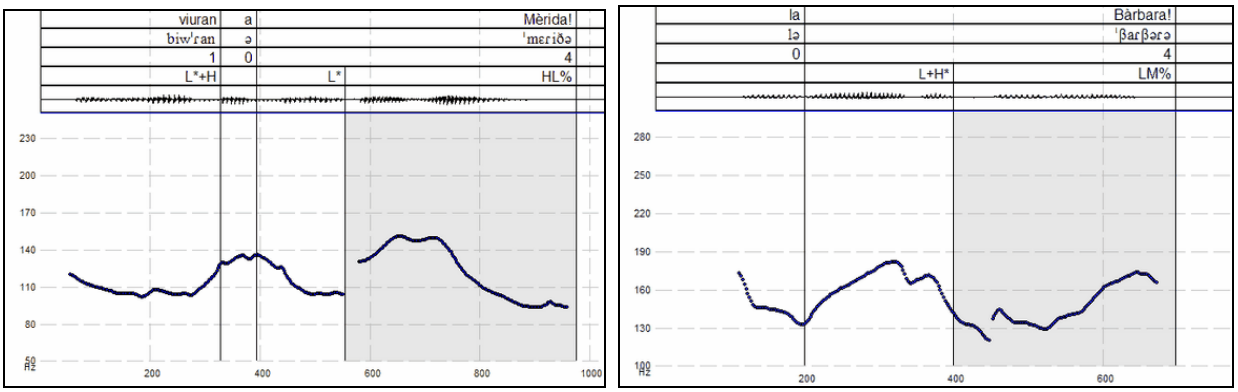


FIGURE 5. Waveform and F0 pitch track of the two types of obviousness statements: *(Home), viuran a Mèrida!*, 'They're going to live in Mérida (of course)!' (left panel), *and (Home), la Bàrbara!*, 'Barbara (obviously)!' (right panel). The second (right panel) confers a more categorical meaning of obviousness.

With respect to the final M% boundary tone, Prieto, Torres & Vanrell (2008) have shown that Catalan speakers perceive a rise to a mid boundary tone, LM%, as categorically distinct from a rise to a high boundary tone, LH% (see also section 3.4).

Disapproval statements

Disapproval statements in Catalan are realized with a L* nuclear accent followed by a final rise to an M% mid tone. Figure 6 illustrates a typical disapproval contour with the utterance *(No estic d'acord amb la) Bàrbara!* '(I disapprove of) Barbara'). In this case, we have only one M% target aligned with the end of the phrase-final syllable, and there is an interpolation between the nuclear L* pitch accent and the M% target at the end of the utterance.

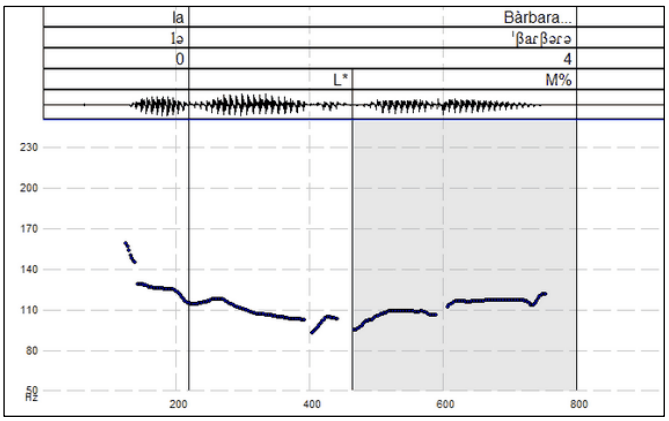


FIGURE 6. Waveform and F0 pitch track of the disapproval statement *(No estic d'acord amb) la Bàrbara! '(I disapprove of) Barbara!'*.

Hesitation statements

Figure 7 exemplifies the Catalan hesitation contour, which is another intonation contour involving a mid boundary tone configuration. The utterance *(Potser) ve en Joan, i després la Bàrbara* 'Joan is coming.. and also Barbara' is produced with a rising L+H* nuclear accent followed by a falling movement to a final mid tone.

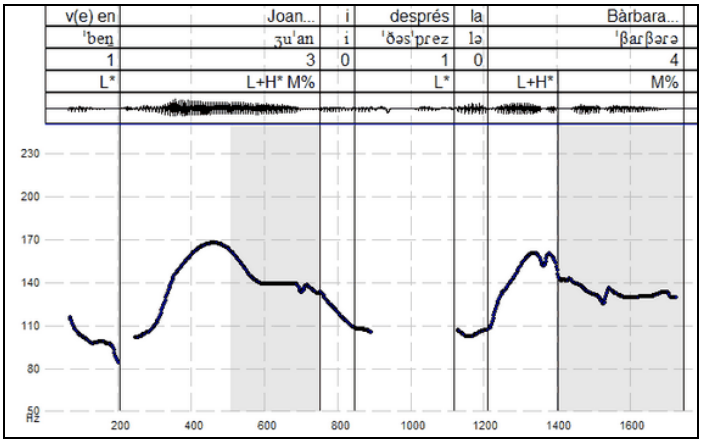


FIGURE 7. Waveform and F0 pitch track of the categorical obvious statement *Ve en Joan... i després la Bàrbara..* 'Joan is coming.. and also Barbara'.

3.3.3. Questions

3.3.3.1. Yes-no questions

Catalan yes-no questions display a substantially rich intra- and interdialectal variation which relates to the type of intonation contour, the presence of the particle *que*, and its semantic/pragmatic properties. Catalan has various particles, such as the conjunction *que* 'that' which can head neutral (i.e., non-expectational or non-presuppositional) polar questions under certain conditions (e.g., *Que plou?* 'Is it raining?', *Que vindran a Ciutadella?* 'Are they coming to Ciutadella?'). In this respect, Catalan behaves differently from some neighboring Romance languages such as Spanish, French, Italian and Portuguese, which do not allow for the presence of such particles. Yet other Romance languages such as Sardinian and (Aranese) Occitan have been reported to display similar types of interrogative particles such as *a* or *e* (e.g., Sardinian *A bi venit Juanne?* 'Is John coming?'; Occitan *E vies tu?* 'Are you coming?'). For a fuller discussion of the prosodic and semantic characteristics of yes-no questions headed by *que* in the different dialects, see Prieto & Rigau (2007), Martínez-Celdrán et al. (2005), and Fernández Planas (2007).

Yes-no questions headed optionally by the particle *que* have a predominantly falling intonation pattern in Catalan, which is one of the most common intonation contours across dialects. Thus, contrary to the dominant crosslinguistic pattern, most Catalan dialects have a falling yes-no

question with a low boundary tone. Still, questions differ from statements in that the former have a high plateau during the prenuclear part of the contour that is absent in the latter. The falling pattern is exemplified in Figure 8. The contour is characterized by a steady high pitch which spans from the beginning of the sentence up until the onset of the last stressed syllable. Then the pitch falls during the last accented syllable in the prosodic phrase (H+L*) and is followed by a low boundary tone (L%) which reaches the bottom range of the speaker. The alignment patterns of H+L* of Catalan nuclear falls in yes-no questions have been analyzed in detail by Prieto (2008a). Basically, the accented syllable acts as the basic domain of phonetic realization for the H+L* nuclear pitch accent.

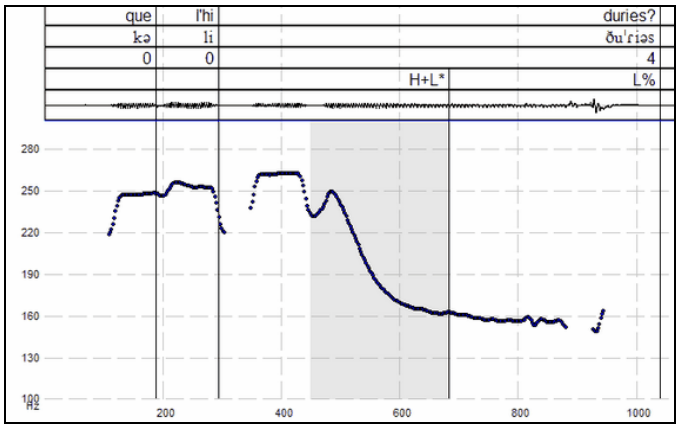


FIGURE 8. Waveform and F0 pitch track of the falling yes-no question *Que l'hi duries?* 'Would you take it to him/her?' in Central Catalan.

There is some dialectal variation in the phonetic implementation of the falling question intonation pattern. In Majorcan Catalan, and in some areas of Central Catalan and Northwestern Catalan, the pretonic syllable is significantly higher than in other dialects (see Vanrell 2006 for Majorcan Catalan). Figure 9 exemplifies the yes-no question *Que l'hi duries?* 'Would you take it to him/her?' in Majorcan Catalan. By comparing this utterance with the one exemplified in Figure 8 from Central Catalan, one can see that the last pretonic syllable *du* contains an extra rise in pitch height before the fall during the accented syllable.

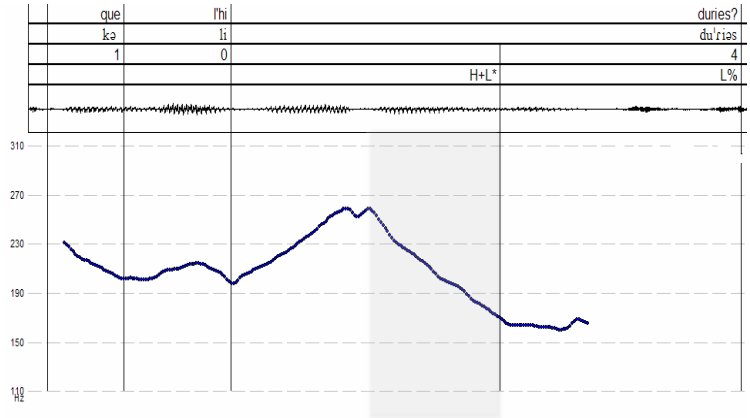


FIGURE 9. Waveform and F0 pitch track of the falling yes-no question *Que l'hi duries?* 'Would you take it to him/her?' in Majorcan Catalan.

Other Catalan dialects, such as Central Catalan, allow for two possible types of neutral (or non-presuppositional) polar questions. The first type is the *falling question intonation pattern* (see Figures 8 and 9), and the second type is the *rising question intonation pattern*, which is characterized by a sharp intonation rise at the end. The two graphs in Figure 10 show the pitch contours of the falling yes-no question *Que vindria la Marina?* 'Would Marina come?' (left panel) and of the rising version of the same question *Vindria la Marina?* 'Would Marina come?' produced by the same speaker of Central Catalan (right panel). The rising intonation pattern can be characterised as follows: the first stressed syllable of the utterance is pronounced with a low tone followed by a rise in the posttonic syllable (L*+H), and the last stressed syllable is pronounced with a low tone followed by a sharp rise.

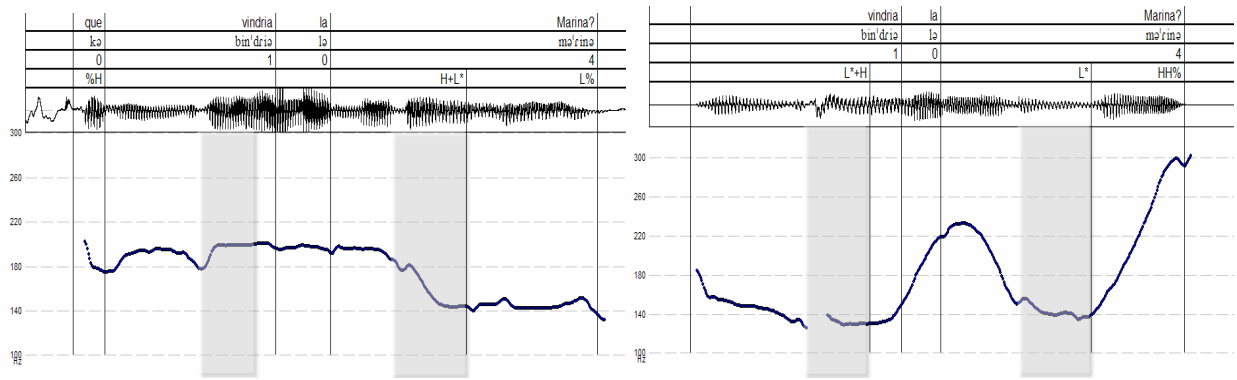


FIGURE 10. Waveforms and F0 pitch tracks of the falling yes-no question *Que vindria la Marina?* 'Would Marina come?' (left panel) and of the rising version of the same question *Vindria la Marina?* 'Would Marina come?' produced by the same speaker of Central Catalan (right panel).

Recent work on the pragmatic value of *que* together with a falling intonation pattern in Central Catalan has proposed that sentences with the falling pattern (and which are optionally headed by *que*) are characterized as being polite in general. Payrató (2002) claims that the selection of neutral polar questions with the falling intonation pattern (and optionally headed by *que*) in Central Catalan is sensitive to the pragmatic cost-benefit scale on which the cost or benefit of the proposed action to the hearer is estimated, and which is related to politeness.

In other dialects such as Rossellonese, Northern Central Catalan, and Central and Southern Valencian, the rising intonation pattern in (b) is used exclusively for neutral questions. Like in the case of the falling intonation pattern, there is dialectal variation in the implementation of the rising pattern. In Valencian, the yes-no question is characterized by a LH% boundary tone, with a L target which is realized well past the end of the nuclear syllable (see Prieto 2001, Crespo 2008). The two graphs in Figure 11 show the contrast between the phonetic realization of the rising yes-no question in Central Catalan (left panel) and Valencian (right panel).

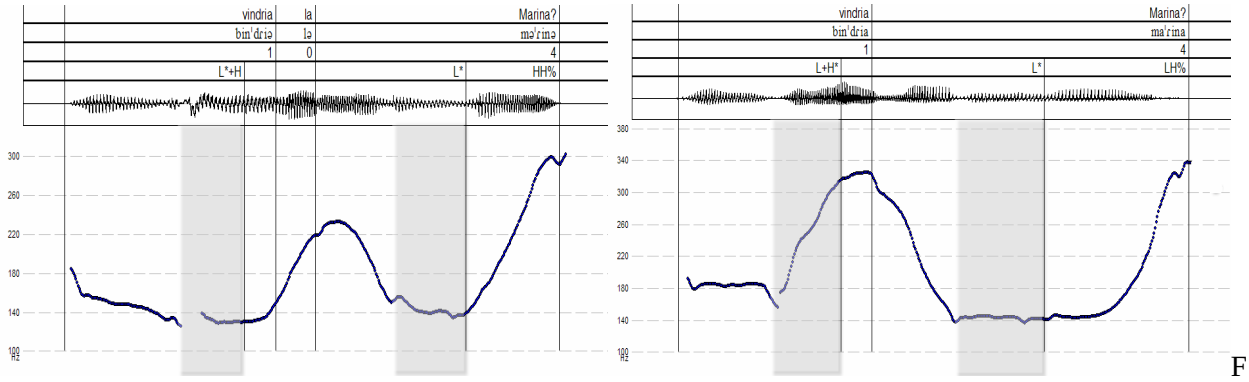


FIGURE 11. Waveforms and F0 pitch tracks of the rising yes-no questions of *Vindria la Marina?* 'Would Marina come?' produced by a Central Catalan speaker (left panel) and *Vindria Marina?* 'Would Marina come?' produced by a speaker of Southern Valencian.

Vanrell (2006) has examined the downstep patterns in falling yes-no questions and wh-questions and has found that the H tone of the nuclear pitch accent is progressively lower as sentence length increases, especially in wh-questions. There is a need to investigate in more detail the difference between the two downstep patterns and the potential effects of declination and downstep in interrogative utterances.

When yes-no questions are produced with more than one prosodic constituent, as in alternative polar questions, an extra high HH% boundary tone typically marks the end of the first intermediate phrase. Figure 12 illustrates the intonation contour of the alternative polar question *Gelat de vainilla o gelat d'avellana?* 'Vanilla ice-cream or hazelnut ice-cream?' Perceptually, there is a clear phonological contrast between H% and HH%, as the second utterance is immediately perceived as having an interrogative meaning (for a comparison between the two, see section 3.4).

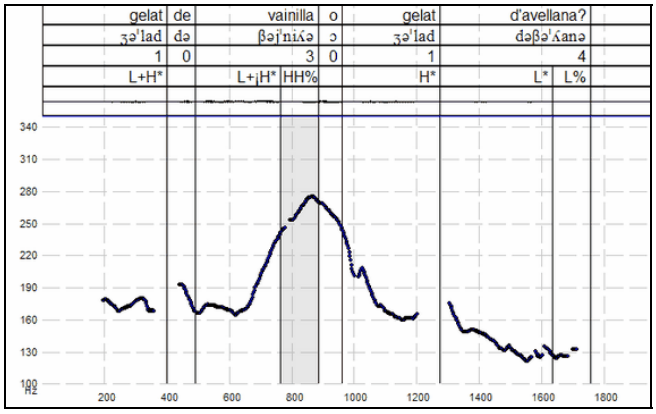


FIGURE 12. Waveform and F0 pitch track of the alternative polar question *(Què vols?) Gelat de vainilla o gelat d'avellana?* 'What would you like? Vanilla ice-cream or hazelnut ice-cream?' This figure illustrates the realization of the HH% boundary tone at the end of the first intermediate phrase.

3.3.3.2. Wh-questions

The most common contour used for wh-questions in Catalan points to similarities between wh-questions and broad focus statements. Generally, the wh-word is accented with a high tone H* and continues with a descending pattern until the last pitch accent in the utterance. In Catalan, neutral wh-questions can contain two possible types of nuclear pitch accent which are associated with the last stressed syllable of the utterance, a H* and a downstepped falling accent !H+L*. The first type of pitch accent, illustrated in Figure 13 (left panel), is characterized by a downstepped falling pitch movement !H+L*. The second type of pitch accent (right panel), is a non-downstepped high pitch accent H*. Both are followed by a L% boundary tone. Based on an analysis of the Map Task dialogue corpus, Vanrell (2008) shows that the nuclear pitch accent choice in wh-questions might be related to a difference in the function of focus. The high nuclear pitch accent H*, which is the more marked pattern, serves as a way of reactivating an idea that is already part of the listener's background so that it is part of the listener's awareness. With a rising pitch accent, the speaker would succeed in activating the topic by bringing it into focus.

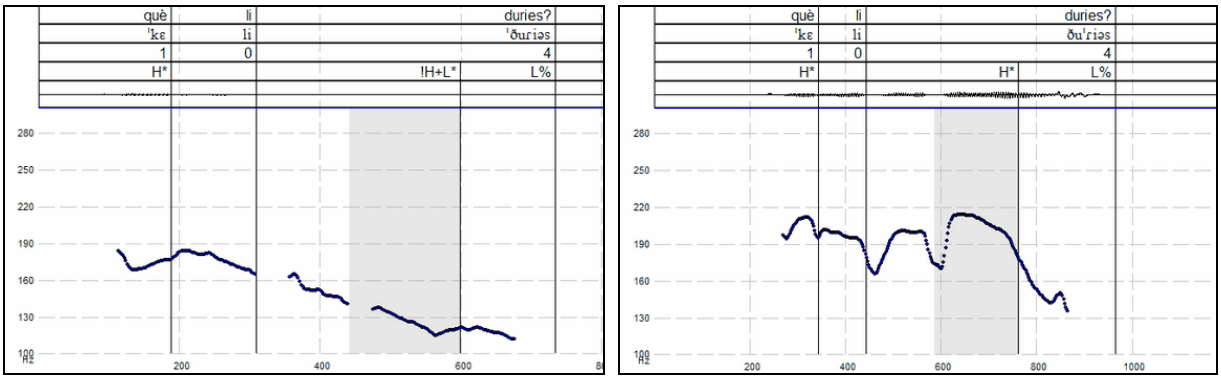


FIGURE 13. Waveforms and F0 pitch tracks of two possible pitch contours of the wh-question *Què li duries?* 'What would you take him/her?' This figure illustrates two possible nuclear pitch accent types in neutral wh-questions, namely, !H+L* and H*.

In focused wh-questions, a particular constituent can be focalized. An example of the focus wh-question contour is provided in Figure 14. In such focused wh-questions, the nuclear syllable is realized as an upstepped L+¡H* pitch accent, followed by a boundary fall. Speakers can have different reasons for bringing a particular constituent into focus: they might disapprove of what is being stated by the listener, they might want to contradict the speaker's assumptions, etc. Thus these can also be examples of biased questions (see section 3.3.3.3). The prenuclear stretch is deaccented before the upstepped rising accent in nuclear positions, thus being the mirror image of the contrastive focus in statements (see Figure 4).

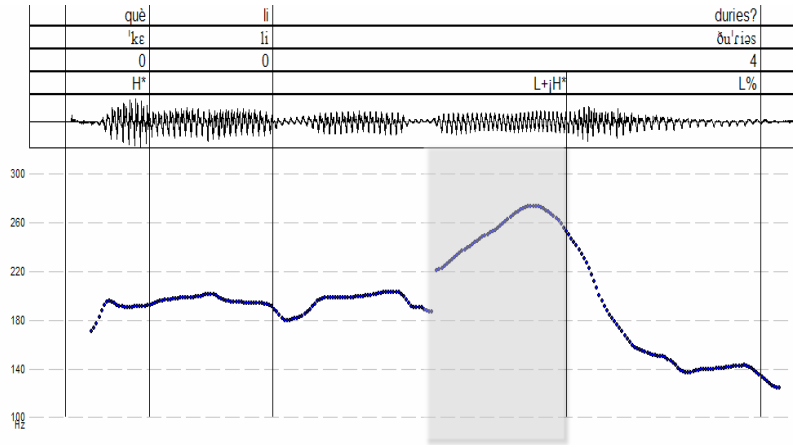


FIGURE 14. Waveforms and F0 pitch tracks of two possible pitch contours of the focus wh-question *Què li duries?* 'What would you take him/her?' This figure illustrates the upstepped nuclear pitch accent L+¡H*.

3.3.3.3. Biased questions

In this section, we will describe the intonation patterns of several types of biased questions. Biased questions, as opposed to neutral questions, express the speaker's assumptions or biases in favor of a given interpretation of the discourse. Among biased questions, we find confirmatory questions, anti-expectational questions, rhetorical questions, or exhortative questions. In these cases, the main aim of the interrogative is not to elicit unknown information, but to express a variety of illocutionary meanings related to the speaker's attitude.

Echo questions and anti-expectational questions

Echo questions, also known as reprise questions, are questions that are used to signal a failure to understand the previous move in a conversation (e.g., Speaker A. *–He parlat amb el president* 'I have spoken to the president'; Speaker B. *–(Dius que) has parlat amb el president*? '(You say that) you have spoken with the president?'). Echo questions can express a genuine failure to understand the utterance, but typically they convey some type of anti-expectational meaning such as surprise, incredulity, disapproval, and even outrage (all meanings that indicate that the situation contradicts the speaker's expectations). Echo questions usually have the same syntactic form as yes-no questions, but they are characterized by a distinct intonational pattern in many languages (for Catalan, see Prieto 2002a). Figure 15 illustrates the typical pitch contour of echo questions in Catalan. Typically, the contour starts with a low pitch that continues until the last stressed syllable in the utterance, which is pronounced with an upstepped L+¡H* pitch accent. After that, the contour ends in a final falling tone. Thus final focus prominence triggers prenuclear deaccentuation.

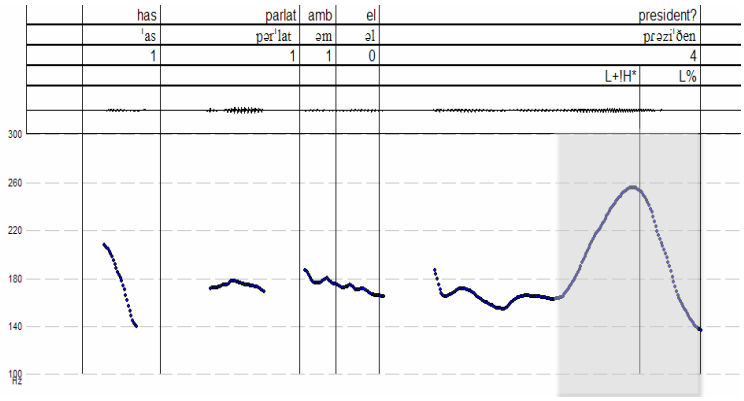


FIGURE 15. Waveform and F0 pitch track of the echo question *–(Dius que) has parlat amb el president?* '(You say that) you have spoken with the president?'.

When producing an echo question, speakers can convey different degrees of surprise and astonishment, and even incredulity. This is generally reflected in the height of the nuclear pitch accent, but it can also be achieved through the use of a different intonation contour. The intonation pattern illustrated below corresponds to an echo-type question which conveys a stronger meaning of surprise and insistence on the part of the speaker (e.g., *(Has dit) la Bàrbara?* '(Did you say) Barbara?'). In autosegmental terms, this pitch pattern can be described as a nuclear sequence consisting of a rising L+H* pitch accent associated with the accented syllable (*Bàr-*), followed by an L tone associated with the first posttonic syllable, *-ba-*, and an H boundary tone associated with the last unstressed syllable.

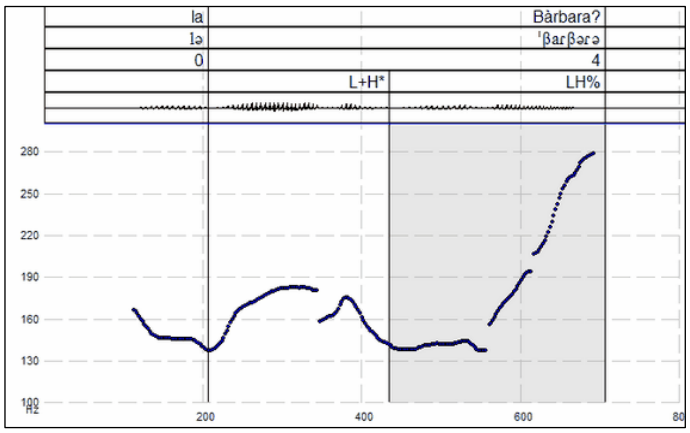


FIGURE 16. Waveform and F0 pitch track of the anti-expectational question *(Has dit) la Bàrbara?* '(Did you say) Barbara?'

The contour in Figure 16 can be produced with an even higher degree of insistence, which is expressed through the complex boundary tone LHL%. Elsewhere this special tune has been called the "insistence tune" (Prieto 2002a).

Finally, there is a variant of the question intonation contour which conveys tentativeness, uncertainty, and incredulity. It uses the basic canonical rising pitch contour illustrated in Figure 10, that is, it is characterized by a L* nuclear pitch accent followed by sharp rise at the end. Yet the alignment of the low-rising final tune is different: in the incredulity question, the low stretch goes well into the posttonic materials, that is, we have a bitonal LH% configuration. The two graphs in Figure 17 illustrate the of the incredulity question *(Has dit) la Bàrbara?* '(Did you say) Barbara?'. The difference between this question and the neutral rising contour (Figure 10) is the alignment of the H% boundary tone, which in the neutral question starts rising after the accented syllable.

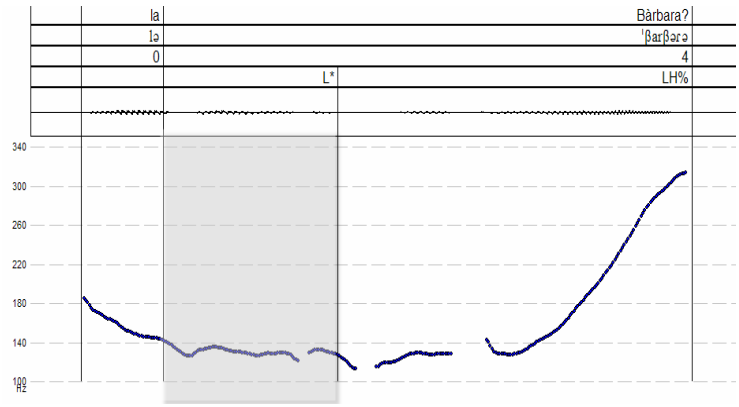


FIGURE 17. Waveform and F0 pitch track of the incredulity question *(Has dit) la Bàrbara?* '(Did you say) Barbara?'

Exhortative or imperative questions

Questions can also be used as imperative utterances, that is, as directive speech acts, as the speaker's attempt to advise the hearer or even force him or her towards a given response. Questions can have the illocutionary force of a strong command, as in utterances such as *Voleu callar d'una vegada?* 'Would you please be quiet once and for all?' or even a soft request. The intonation of imperative questions will depend on the illocutionary force of the utterance, and range from the use of the canonical rising and falling question intonation pattern to a series of distinctive intonation patterns (for a review, see Prieto 2002). For example, invitations and offers can be expressed through the use of a particular type of rising intonation pattern which uses a rising pitch accent in nuclear position, L+H* HH%. Thus the difference in pitch accent choice is what distinguishes a 'low-rise question' (L* HH% the neutral yes-no question, which is used when the aim of the interrogative is simply to elicit unknown information.) from a 'high-rise question' (L+H* HH%, which is used in situations where the speaker does not have an informational goal, like in offering questions). The two panels in Figure 18 show the contrast between high-rise and low-rise questions in Catalan.

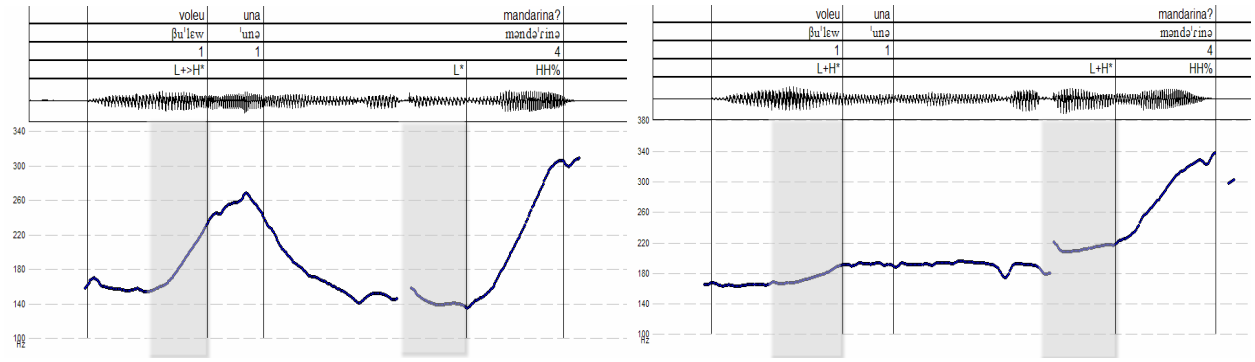


FIGURE 18. Waveforms and F0 pitch tracks of the neutral rising yes-no question *Voleu una mandarina?* 'Do you want a tangerine?' (left panel) and the same utterance with an invitation meaning (right panel). This figure illustrates the contrast between low-rise (neutral) questions and high-rise (offering) questions in Catalan.

3.3.4. Imperatives: commands and requests

Imperative utterances (being commands or requests) are interpreted as directive speech acts, i.e., as the speaker's attempt to get the hearer to perform the action described by the proposition. The illocutionary strength with which the speaker conveys this speech act can go from a strong command to a gentle request. In Catalan, imperative utterances are usually characterized by being verb-initial and by the use of the imperative mood. In this section we describe the intonation patterns that characterize these types of utterances, as well as the prosodic realization of pragmatic nuances such as differences in degree of insistence in commands and requests.

Figure 19 illustrates the typical pitch pattern of strong commands in Catalan by means of the same utterance first with an early focus *¡DEMANA-ho a la Maria!* 'Ask Mary!' (that is, focus on the verb, left panel) and then with a late focus *¡Demana-ho a la MARIA!* 'Ask Mary!' (right panel). In both cases, the stressed syllable is pronounced with a very prominent rising pitch accent (L+H*) followed by a fall on the posttonic syllables. We assume that in commands with an early focus there exists a post-nuclear accent (L*), though this is a question that requires further research. Another feature of imperative utterances is the expanded pitch range of focus accents and the fast speech rate of the whole utterance, which expresses the urgency of this speech act.

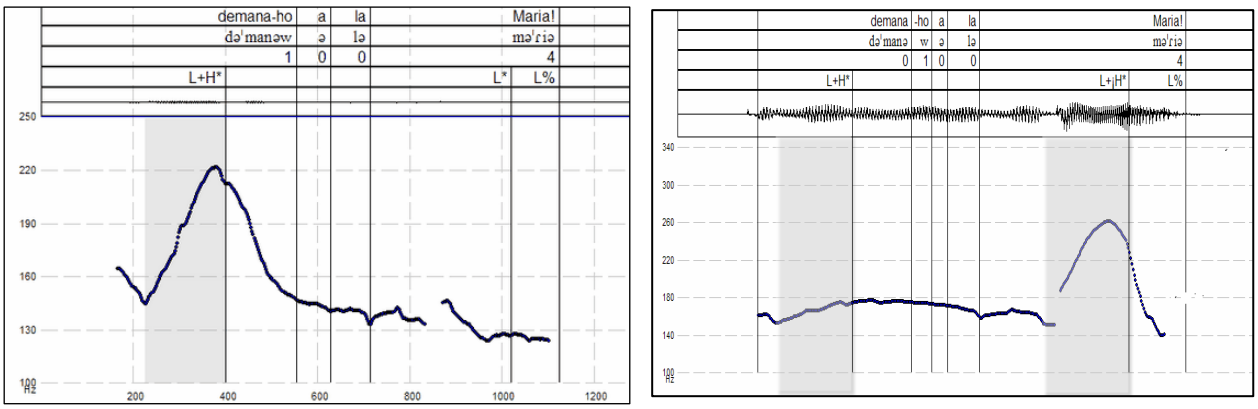


FIGURE 19. Waveforms and F0 pitch tracks of the strong command *Demana-ho a la Maria!* 'Ask Mary!'. In the left panel the focus is late, while in the right panel the focus is early.

The examples in Figure 20 illustrate the most common way to express a soft command in Catalan, either with early focus such as *DEMANA-HO a la Maria* '(Please) ask Mary' (left panel) or with a late focus *Demana-ho a la MARIA* '(Please) ask Mary' (right panel). In the early-focus utterance, the exhortative tune is characterized by a low tone associated with the accented syllable followed by a rise in the posttonic syllable (L*+H). After that, the pitch falls gradually in 'morendo' fashion until the postnuclear pitch accent (L*) and the end of the sentence (L%). In the late focus case, the last syllable is (L*+H). After that, the high pitch is maintained until the last stressed syllable of the utterance, where the pitch falls rapidly (HL*). Finally, the pitch gradually falls over the posttonic syllables (L%).

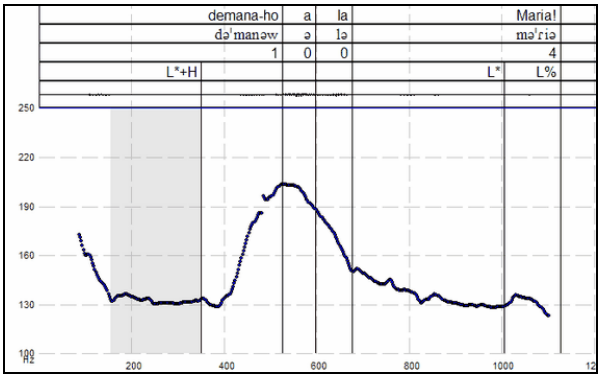


FIGURE 20. Waveform and F0 pitch track of the soft command *Demana-ho a la Maria* '(Please) ask Mary!'

Figure 21 illustrates the contrast between a soft request (L* HL%) and an insistent request (H* LHL%) which ends in a rise-fall-rise pitch movement. Again, this is the "insistence tune" mentioned elsewhere (Prieto 1995, 2001a).

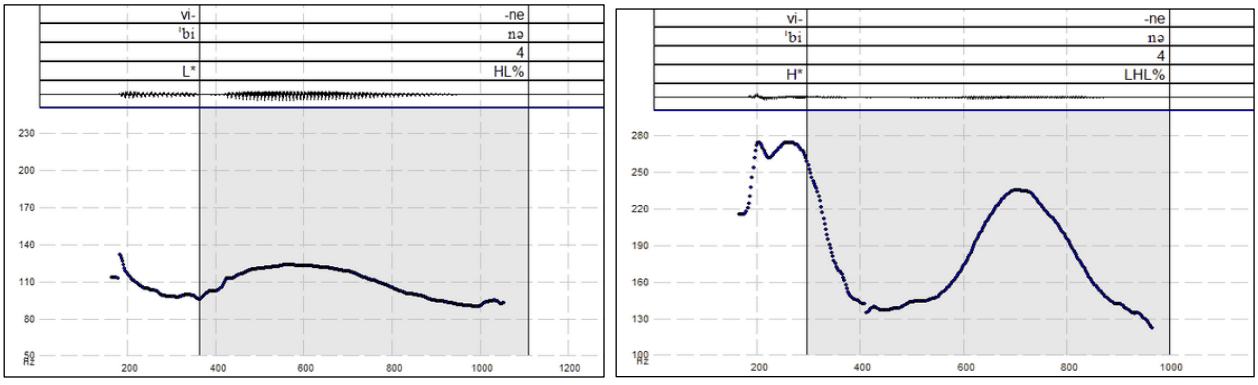


FIGURE 21. Waveform and F0 pitch track of the same utterance *Vine* 'Please come' produced first as a soft request (left panel) and then as a more insistent request (right panel).

Thus, in Catalan the distinction between basic requests and commands can be conveyed by pitch accent choice (L+H* in commands and L* in requests) and by final boundary marking (L% vs. HL%). Furthermore, differences in boundary tones can express a variety of illocutionary meanings like degree of insistence (e.g., HL% vs. LHL%). Similarly, prosodic features such as duration can signal subtle pragmatic differences and are an important feature in the expression of different degrees of insistence (the stronger the insistence, the longer the duration of the sentence). Thus the illocutionary strength of imperative utterances is expressed through the use of intonation and other prosodic features such as duration.

Finally, imperative intonation clearly shows that Catalan is not a truncating language. In general, when a complex sequence of tones is linked to a single syllable, the tonal sequence is compressed and the segmental string is lengthened to cope with complex tonal realization —for more evidence, see Prieto (2002), who describes a variety of intonation patterns in Central Catalan and examines the process of tonal realization of a variety tunes over short sequences.[7]

3.3.5. Vocatives

In Catalan, like in other European languages, the typical vocative chant is realized with a sustained mid boundary tone (see Ladd 1996 for English, Arvaniti & Baltazani 2005 for Greek, Grice et al. 2005 for German, Frota this volume for Portuguese). Figure 22 illustrates the typical vocative chant in Catalan, which is characterized by rising pitch accent on the nuclear syllable and an immediate fall to sustained pitch until the end of the contour. Sustained pitch has been analyzed in Cat_ToBI as having an MM% boundary tone, which is responsible for the final sustained level.

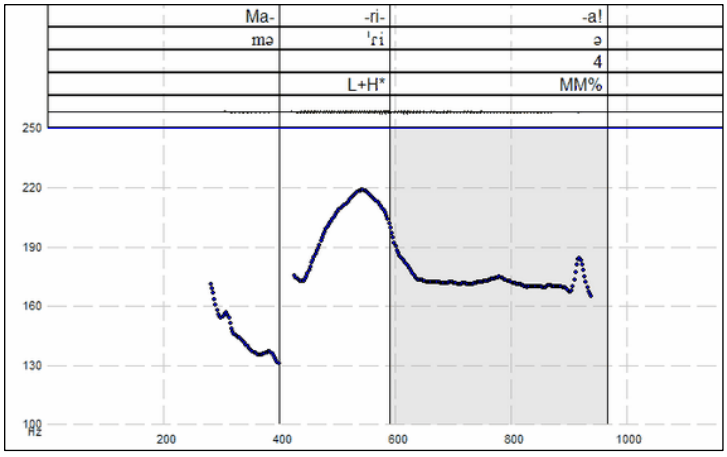


FIGURE 22. Waveform and F0 pitch track of the vocative chant *Maria!* 'Maria!' This figure illustrates the mid sustained boundary tone MM%.

[7] Yet in a recent experiment about the realization of narrow contrastive focus in Catalan and Spanish, Prieto & Ortega-Llebaria (in press) found that, even though truncation and compression have been claimed to be language- and dialect-specific strategies (Ladd 1996, Grabe et al. 2000), in both languages partial 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. These results further support a view of truncation as a gradient acoustic effect.

Catalan has different variants of calling contours which are linked to particular pragmatic meanings. For example, a variety of imperative contours (section 3.3.4) can be used as vocatives to express commands and requests. Figure 23 illustrates a type of calling contour which expresses an insistent call. It is characterized by a rising pitch accent on the nuclear syllable, immediately followed by a gradual and slow rise and then a fall during the posttonic syllable. If the posttonic stretch has two syllable, the rise is phonetically realized during the first posttonic syllable and the fall during the final syllable. This vocative contour expresses an insistent call that would be pragmatically infelicitous if used as an instance of a greeting or first call.

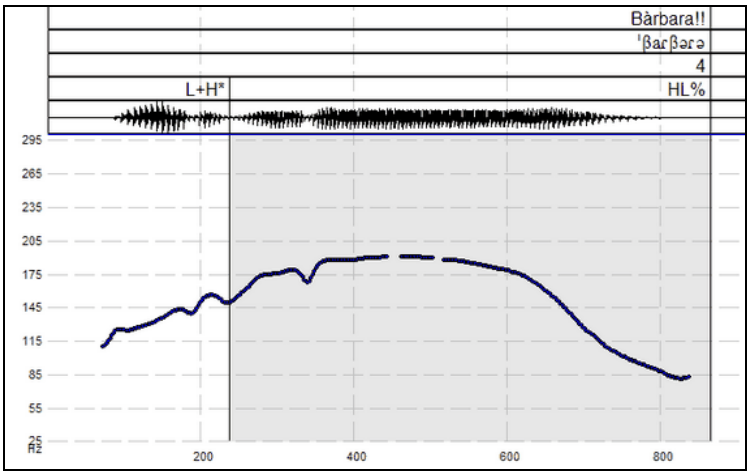


FIGURE 23. Waveform and F0 pitch track of the insistent call *Bàrbara!* 'Barbara!' This figure illustrates the boundary tone HL%.

3.4. Summary of intonational analysis

3.4.1. Minimal pair contrasts

In this section, the current set of Cat_ToBI categories (pitch accents and boundary tones) is exemplified with utterances that provide side-by-side minimal phonological contrasts. Most of the examples have been used in previous sections to illustrate the intonation of a variety of sentence types. Figure 24 shows the contrast between a rise with a delayed peak L+>H* (typical of prenuclear pitch accents in broad focus statements), and a rise with a non-delayed peak L+H* (typical of imperative utterances) –for more arguments in favor of the analysis of this pitch accent as L+>H*, see Prieto, D'Imperio & Gili-Fivela (2006).

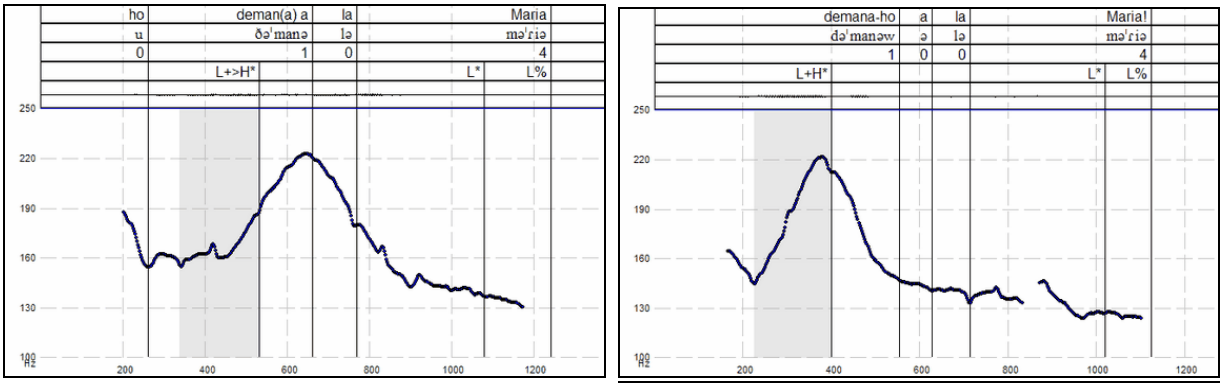


FIGURE 24. Waveforms and F0 pitch tracks of the broad focus statement *Ho demana a la Maria* '(S)he is asking Mary' (left) and the strong command *Demana-ho a la Maria!* 'Ask Mary!' (right). This figure illustrates the contrast between the L+>H* and L+H* prenuclear pitch accents.

Figure 25 illustrates the phonological contrast in alignment between the L*+H and L+H* pitch accents: the former appears in nuclear accents in soft requests (left panel) and the latter in nuclear accents in strong commands. Thus, the basic distinction between commands and soft requests in Catalan is the relative alignment of the rising melody with the accented syllable: while the nuclear accent in imperative sentences is phonetically realized with a peak aligned with the end of the stressed syllable, the nuclear accent in requests is realized as a post-tonic rise (i.e., a rise that starts at the end of the stressed syllable).

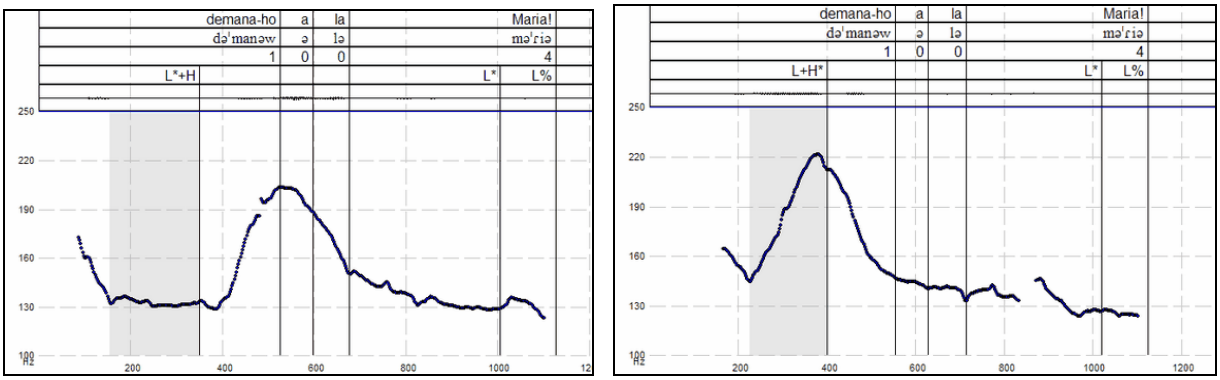


FIGURE 25. Waveforms and F0 pitch tracks of the soft request *Demana-ho a la Maria* 'Ask Mary' (left) and the strong command *Demana-ho a la Maria!* 'Ask Mary!' (right). This figure illustrates the contrast between the L+>H* and L+H* prenuclear pitch accents.

Figure 26 illustrates the contrast between a falling yes-no question (left panel) and a focused wh-question (right panel). The main difference between the two is the alignment of the falling tune towards the end of the utterance: while yes-no questions are characterized by a fall during the accented syllable (H+L*), focused wh-questions have a high tone H* in the nuclear syllable.

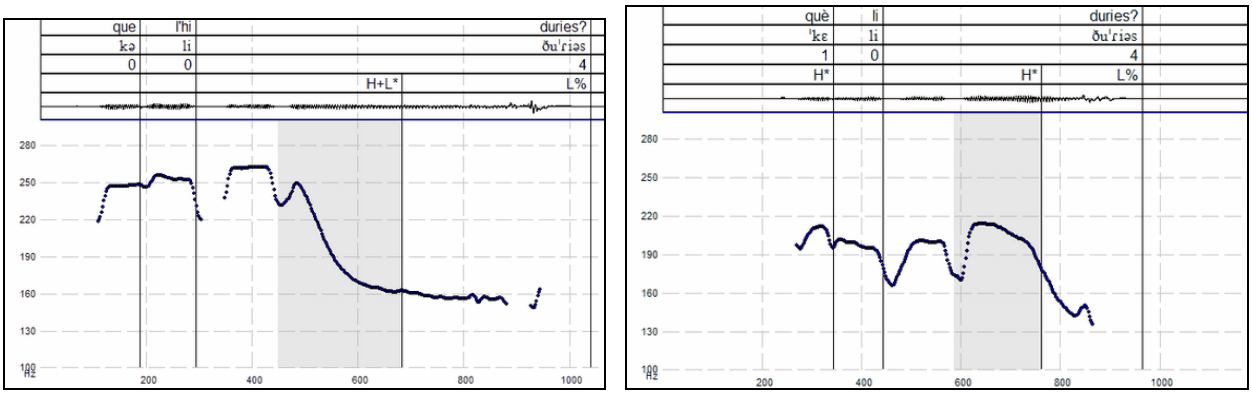


FIGURE 26. Waveforms and F0 pitch tracks of the falling yes-no question *Que l'hi duries?* 'Would you take it to him/her? (left) and the focused wh-question *Què li duries?* 'What would you take to him/her?' (right). This figure illustrates the contrast between the H+L* and H* nuclear pitch accents.

Figure 27 illustrates the contrast between a falling yes-no questions (left panel) and a neutral wh-question (right panel). The main difference between the two is the height of the falling tune towards the end of the utterance: while yes-no questions are characterized by a fall during the accented syllable (H+L*), focused wh-questions have a high tone H* in the nuclear syllable.

Results from identification and discrimination experiments have shown that the height of the leading tone is the primary perceptual cue in distinguishing yes-no questions from wh-questions in Majorcan Catalan (Vanrell 2006). In this dialect, yes-no questions headed by the particle *que* (as in *Que l'hi duries?* 'Would you take it to him/her?') can be homophonous with wh-questions headed with the question word *què* 'what' (as in *Què li duries?* 'What would you take him/her?'). Even though in Majorcan Catalan the H+L* pitch accent is phonetically produced with a clear upstepped leading tone, we hypothesize that regardless of the way each dialect manifests that difference, the crucial difference between yes-no questions and wh-questions is the height of the leading H.

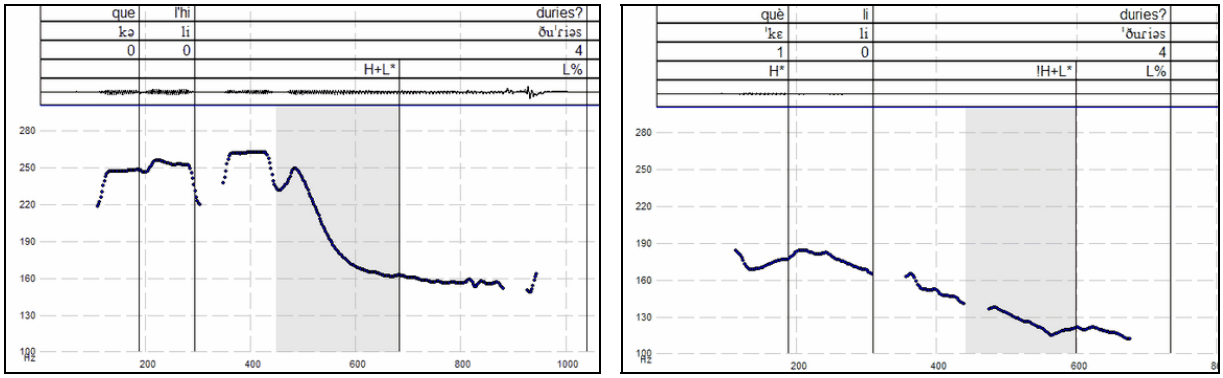


FIGURE 27. Waveform and F0 pitch track of the falling yes-no question *Que l'hi duries?* 'Would you take it to him/her? (left) and the neutral wh-question *Què li duries?* 'What would you take to him/her?' (right). This figure illustrates the contrast between the H+L* and H* nuclear pitch accents.

With respect to boundary tones, Figure 28 illustrates the contrast between an obvious statement (left panel) and an echo question (right panel). The difference between the two lies in the height of the utterance-final boundary tone: while a final rise to a mid boundary tone is characteristic of

categorical-obvious statements (LM%), a final rise to a high boundary tone, LH%, is typical of echo questions. Prieto, Torres & Vanrell (2008) undertook an identification and discrimination experiment using these sentences and demonstrated that the change from a high boundary tone to a mid boundary tone is categorically perceived by Catalan listeners.

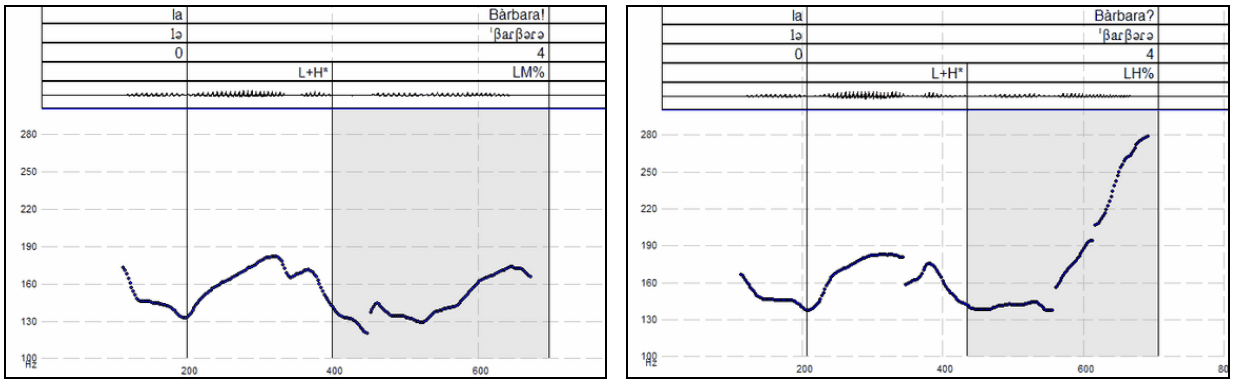


FIGURE 28. Waveforms and F0 pitch tracks of a categorical obviousness statement *La Bàrbara!*, 'Barbara (obviously)!' and an echo question *La Bàrbara?* '(Did you say) Barbara?' This figure illustrates the contrast between the H% and M% boundary tones.

Figure 29 illustrates the difference between H% and HH%, which, following the standard AM analysis, is that of pitch height, HH% being significantly higher. In the graphs below, the scaling difference between H% and HH% is that of 45 Hz.

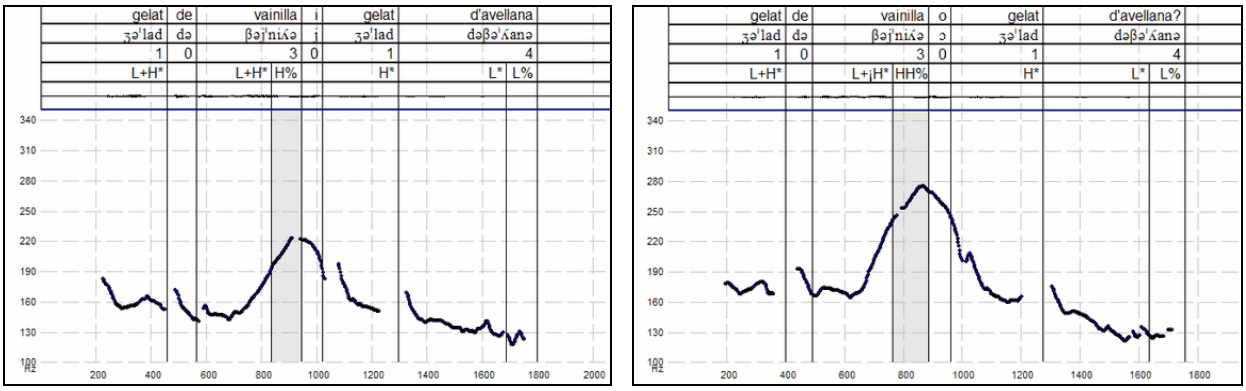


FIGURE 29. Waveforms and F0 pitch tracks of a coordinate structure *Gelat de vainilla i gelat d'avellana* 'Vanilla ice-cream and hazelnut ice-cream?' (left) and the alternative question *Gelat de vainilla o gelat d'avellana?* 'Vanilla ice-cream or hazelnut ice-cream?' (right). This figure illustrates the contrast between the H% and HH% boundary tones.

Figure 30 illustrates the difference between the MM% sustained boundary tone typical of the vocative chant, and the M% tone that is typical of disapproval statements. While MM% has two targets (one at the beginning of the posttonic stretch of syllables and another at the end), M% has just one target at the end. That is why in the first case we get a sustained M tone throughout

while in the second case there is a pitch interpolation between the pitch accent and the final M tone.

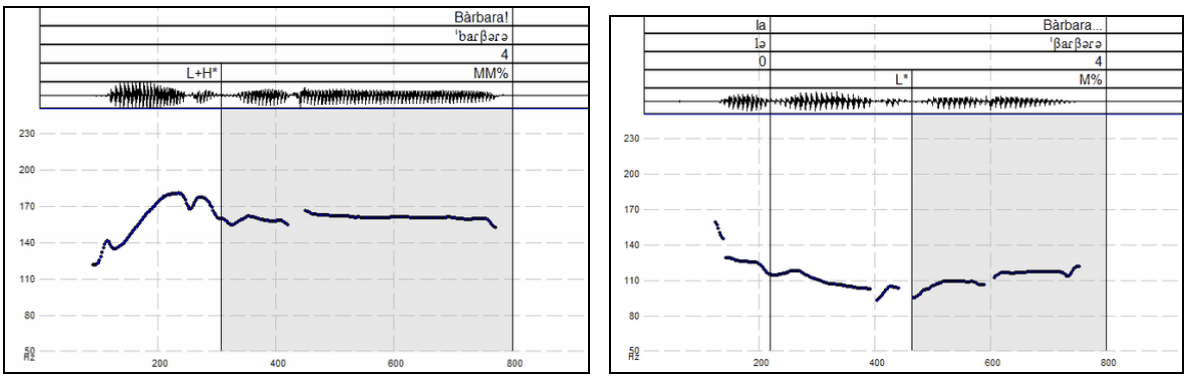


FIGURE 30. Waveforms and F0 pitch tracks of the vocative chant *Bàrbara!* 'Barbara' (left) and the disapproval statement *La Bàrbara* '(I disapprove of) Bàrbara' (right). This figure illustrates the contrast between an MM% sustained tone and an M% boundary tone.

3.4.2. Nuclear configurations

Table 3 presents a summary of the commonly occurring nuclear configurations in Catalan: each tune is represented by a schematic contour, the Cat_ToBI label, and the context where it is found. For ease of reference, in the last column we refer the reader to specific examples and figures within the chapter. As usual, the shaded box represents the stressed syllable.

Schematic contour	*Cat_ToBI label*	*Context*	*Examples (Fig.)*
	L* L%	Broad focus statement	Figure 1
	H+L* L%	Neutral yes-no question (falling)	Figures 8, 9
	H* L%	Wh-question	Figure 13
	L* HH%	Neutral yes-no question (rising)	Figures 10, 12
	L+H* HH%	Inviting yes-no question	Figure 18
	L+H* L%	Narrow focus statement, exclamative Imperative	Figures 3, 4 Figure 19
	L* HL%	Obviousness statement Soft request	Figure 5 Figure 20, 21

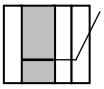
	L+H* MM%	Vocative chant	Figure 22
	L+H* HL%	Insistent vocative (also insistent request)	Figure 23
	L+H* LH%	Antiexpectational echo question	Figure 16
	L+H* LHL%	Insistent request	Figure 21
	L+H* LM%	Emphatic obviousness statement	Figure 5
	L* M%	Disapproval statement	Figure 6
	L+H* M%	Hesitation statement	Figure 7
	L* LH%	Anti-expectational question	Figure 17

TABLE 3. Commonly occurring Catalan nuclear configurations. The table contains the schematic representation of the contour, the Cat_ToBI label, the context, and reference to an example.

4. Conclusion

This chapter has offered an analysis of the prosodic phrasing and intonational structure of Catalan. The properties of the phonological phrase, the intermediate phrase, and the intonational phrase have been presented. The intonation system of the language has been exemplified through the main intonation contours found for different types of speech acts and also through the examination of minimal phonological contrasts found between pitch accent and boundary tone types. The study of Catalan intonation and its proposed tonal inventory has lead to the discussion of certain assumptions of the AM model, some of which will need further research. Among them are: (1) the contrastive use of tonal alignment and the potential presence of tritonal pitch accents; (2) the phonological status of the phase accent category; (3) the role of the syllable in the alignment of leading and trailing tones, and the association of boundary tones; and (4) the phonological status of mid level boundary tones. Even though the last few decades have witnessed considerable progress in the understanding of the intonational phonology of Catalan, several of these issues need further investigation.

One of the first issues that emerges from the Catalan data is the contrastive use of tonal alignment for the expression of different discourse meanings. In the tone tier, Catalan

distinguishes among the following accent types: H*, L*, L+H*, L+>H*, L*+H, H+L*, the tritonal L+H*+L (documented in Alguerese Catalan), and the downstepped and upstepped variants of H (¡H* and !H*). First, there is a three-way contrast in rising pitch accents in Catalan: (a) rises with nondelayed peak (L+H*), (b) rises with delayed peak (L+>H*), and (c) post-tonic rises (L*+H). As we have seen throughout the chapter, the three surface patterns are clearly contrastive and used in a productive way in different intonation contours found in the language. Importantly, in Alguerese Catalan we find another type of alignment contrast related to focus. In this variety, there is a contrast between two types of rising pitch accents. In both cases, the start of the rise aligns with the beginning of the accented syllable, but while the peak of the broad focus pitch accent is reached by the end of the open syllable (and then the pitch gradually falls during the posttonic), in the narrow focus pitch accent the peak is reached in the first half of the vowel and then the pitch falls abruptly until it gets to the end of the syllable (see Figure 4a). We proposed to analyze the broad focus pitch accent as an instance of L+H* and the narrow focus pitch accent as a tritonal pitch accent L+H*+L involving a low trailing tone. A first argument in favor of such analysis is that the presence of the trailing tone observed in one of the two patterns is enough to phonologically distinguish the two pitch accents and that this allows for a phonetically transparent labeling of the two pitch accents. The tritonal pitch accent, characterized with a sharp rise and a fall within the accented syllable, is thus composed of three tones or targets with equal strength. Second, this type of pitch accent contrast is attested in other languages such as Pisa Italian (for an analysis, see Gili Fivela 2004, and Prieto et al. 2006), Croatian (Smiljanic 2004, Yu 2008), and English (Ahn 2008, Jun p.c.). Furthermore, there is a crosslinguistic tendency to express narrow focus through the use of retracted pitch peaks. As it is well known, some languages use the pitch accent L+>H* for broad focus vs. L+H* for narrow focus (e.g. Estebas-Vilaplana 2000 for Central Catalan; Beckman et al 2002 for Spanish). Other languages express this distinction through the use of L+H* for broad focus and a more retracted pitch accent followed by a low tonal target (some kind of L+H*+L) for narrow focus (Gili Fivela 2004, 2008 for Pisa Italian, Smiljanic 2004 and Yu 2008 for Croatian, Ahn 2008 for English). Even though some authors have suggested that the retracted pitch accent is either due to the presence of a phrase accent L- introduced by narrow focus or to the presence of a word boundary tone (Smiljanic 2004), in Alguerese Catalan this pitch accent is not necessarily followed by a prosodic break. In short, we believe that through the use of a tritonal pitch accent L+H*+L that cues narrow focus we can account in a transparent way for the phonetic realization of this pitch accent. In order to clarify the effects of pitch retraction and the presence of an L trailing tone, we need controlled experiments that can assess in detail the contribution of intonation to the expression of different focus meanings. It should be further clarified the relationship between categorical and gradient effects within the expression of focus (see Gili Fivela 2008).

As for edge tones, it has been claimed that the phrase-accent category can be dispensed with in the intonational analysis of Catalan. As it is well known, given that in Romance languages the nucleus is located at the end of prosodic phrases, several authors have argued that the phrase accent category can be dispensed with (Sosa 1999 for Spanish, Frota 2002a, this volume, for Portuguese, Prieto & Frota, in preparation, for several Romance languages). In many cases, there is only one tonal target after the nuclear pitch accent. In accordance with this, the Cat_ToBI proposal has argued that the phrase accent category can be dispensed with, and that only one type of boundary tone is needed, which can appear at both the right edge of intermediate phrases and the right edge of intonational phrases. Thus the model differs from the English ToBI model in that there is no phrase-accent category and only one type of boundary tone occurs to the right

of intermediate and intonational phrase boundaries. Importantly, the Catalan data shows that the model should dissociate the strict correspondence between the prosodic hierarchy (intonational vs. intermediate phrases) and the number and type of boundary tone combinations. A clear argument in favor of having one type of boundary tone is the fact both types of prosodic levels in Catalan, i.e. the intermediate phrase and the intonational phrase, can be signaled by both simple or complex boundary tones. Thus phrase edges can be marked by monotonal H%, M%, and L% and bitonal combinations LH%, HH%, MM% and, HL%. Crucially, complex boundary tone combinations such as LH% are commonly attested at the end of intermediate phrase boundaries (see Feldhausen 2008, Prieto et al 2009). Yet if one assumes that the intermediate phrase level should be obligatorily marked by a phrase accent, we should not expect having a complex phrase accent.

Another issue that arises concerns the phonetic implementation and alignment of tonal categories, especially leading and trailing tones, and well as boundary tones. Standard AM assumptions propose that leading and trailing tones are aligned at a given time interval from the starred tone (Pierrehumbert 1980). In the case of Catalan, leading tones tend to be bound to the pretonic syllable: in the case of the H leading tone of the H+L* pitch accent, it is associated with the pretonic syllable, that is, the pitch starts to rise at the onset of the pretonic syllable (see Fig. 9). By contrast, the H trailing tone in the L*+H pitch accent is not associated to the end of the posttonic syllable. In general, the Catalan data provides evidence that the fixed tonal alignment in the standard definition of bitonal pitch accents does not correspond with the empirical facts.In the case of edge tones, throughout the chapter, we have shown that intonational structure can convey essential grammatical distinctions such as question/statement or question/command, as well as degrees of illocutionary force (HL% vs. LHL% to express a larger degree of insistence, or HH% vs. LH% to express degrees of uncertainty in questions). With respect to alignment, bitonal boundary combinations such as LH% and HL% are associated with the posttonic syllables so that in words with antepenultimate stress the first target is aligned at the end of the posttonic syllable and the second target is aligned with the end of the utterance-final syllable. There is a need for detailed empirical studies of how pitch targets in bitonal pitch accents and in boundary tone combinations are aligned with the text.

Finally, another issue that emerges from the Catalan data is the need for a phonologically contrastive mid boundary tones. In Catalan, the crucial difference between echo questions and categorical-obvious statements lies in the height of the sentence-final boundary tone: whereas echo questions are produced with a sentence-final low-high boundary tone LH%, obvious statements are produced with a low-mid boundary tone LM%. In a recent experiment using the categorical perception paradigm, Prieto, Torres & Vanrell (2008) show that Catalan listeners perceive the contrast between L+H* LH% and L+H* LM% configurations in a categorical way. Other languages such as Spanish, English, Greek or German have also documented a mid level tone in utterance-final position (see Beckman & Ayers-Elam 1997 for English, Arvaniti & Baltazani 2005 for Greek, Grice et al. 2005 for German, Beckman et al. 2002 for Spanish, Lee 2003 for Korean). While some of these systems have adopted the M% level tone (e.g., Beckman et al. 2002 for Spanish), others have analyzed it as the result of effects of upstep and downstep. For example, Grice, Baumann & Benzmüller (2005) analyze an utterance-final mid-level tone in German as a H% that is downstepped by a preceding L- phrase accent, while Beckman & Ayers-Elam (1997) analyze a similarly scaled tone in English as a L% boundary tone that is upstepped by a preceding H- phrase accent. Yet Catalan has a tune containing the LH% sequence in which

H% is scaled as high as other H targets, which means that the mid-level scaling of H% in the Catalan data cannot be regarded as the automatic consequence of the sequence of L and H edge tones. In all these cases there is a phonological paradigmatic contrast between the H, M, and L levels, and the presence of the mid level is independent of the phonological process of successive lowering of H tones. For Gr_ToBI, Arvaniti & Baltazani suggest that there is a phonological distinction in Greek –that is, a meaningful intonational choice– between downstepped (!H%) and non-downstepped (H%) final high boundary tone. For Catalan, we proposed the presence of a mid tone level in the system M%, as Beckman et al. (2002) do for Spanish, rather than the use of the downstep feature !H%. The latter symbol !H% leads to an overuse of a mechanism used by the AM model to refer to the lowering of successive high tone targets within a prosodic phrase in downstepping contours. The M% level has the advantage of directly encoding the final pitch height, which is independent of any syntagmatic reference to preceding pitch accents. Finally, crosslinguistic evidence reveals that *at an edge of prosodic unit*, languages use more tonal contrasts to represent different pragmatic meanings. This is supported by Korean, which has more than 9 boundary tone combinations with their own pragmatic meaning (all possible by L and H but differ by a number of tonal changes: L, H, LH, HL, LHL, HLH, LHLH, HLHL, LHLHL (Jun p.c.). And, as Lee's (2003) data shows, there are arguments to add a mid level to the Korean boundary tone inventory (like LM% or ML%). Thus, even though there is a need for more experimental work to further describe the scaling contrasts found in boundary position and to determine whether those contrasts are categorical or gradient in nature, evidence is accumulating that edges can be marked by (at least) three levels of tonal height.

In conclusion, it is hoped that the study of Catalan prosody presented here will serve as a stimulus for further research in this area. This study, thanks to the development of Cat_ToBI, has identified some areas for further research within the Autosegmental-Metrical model. We hope to be able to provide evidence for the contrastiveness of the different intonational units through further empirical investigations that can refine the assessment of the pragmatic effects. Finally, our knowledge about Catalan intonation will be further strengthened through the study of dialectal differences and the development of larger corpora of spoken data.

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