3

The intonational phonology of Catalan*

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3.1 Introduction

This chapter presents an analysis of the prosodic and intonational structure of Catalan within the Autosegmental-Metrical (AM) framework (Pierrehumbert 1980; Pierrehumbert & Beckman 1988; Ladd 1996; Gussenhoven 2004; Jun 2005; 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-Tamarit, & Vanrell 2009). This chapter will describe the main facts about 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 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. In the last decades, Catalan has been intensively analyzed from a prosodic point of view. The first comprehensive studies of Catalan intonation were

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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 (Recasens 1977; Virgili Blanquet 1971; Bonet 1986; Salcioli 1988; Prieto 1995, 2000, 2002b; Estebas-Vilaplana 2000, 2003; Font 2007, among others) and for other dialectal varieties (Mascaró i Pons 1986, 1987; Prieto 2001; Prieto & Pradilla 2004; Martínez Celdrán et al. 2005a, 2005b; Fernández Planas et al. 2006; Prieto & Rigau 2007; Vanrell 2007, 2008; Fernández Planas 2009, 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 (Prieto, D'Imperio, & Gili-Fivela 2006; Vanrell 2007; Prieto, Torres-Tamarit, & Vanrell 2008), as well as the details of alignment and scaling of Fo contours (Estebas-Vilaplana 2000, 2003; Astruc-Aguilera 2005, 2007; Prieto 2005a, 2006, 2009, among others). In the following sections, the main findings of previous work on intonational contours and categories are described and summarized where relevant.

The prosodic analysis presented here has been largely developed on the basis of a spoken corpus of Catalan which can be found on the web page of the *Interactive Atlas of Catalan Intonation*.[1] which includes data from speakers of different dialects. The data analyzed is circumscribed to the Central Catalan variety, which is considered to be the standard variety, and which includes data from the following localities: Banyoles (Pla de l'Estany), Barcelona (Barcelonès), Berga (el Berguedà), Girona (el Gironès), La Bisbal d'Empordà (el Baix Empordà), La Garriga (Vallès Oriental), Manresa (el Bages), Mataró (el Maresme), Reus (Baix Camp), Ripoll (el Ripollès), Santa Coloma de Farners (la Selva), Solsona (el Solsonès), Valls (l'Alt Camp), Vic (Osona) i Vilafranca del Penedès (l'Alt Penedès). Subjects surveyed were mostly educated women aged between 25 and 45 years and from 15 cities across the Central Catalan-speaking area. The corpus comprises three types of materials: a) sentences obtained through the administration of an *intonation survey* based on the discourse completion test technique and which consisted of approximately 49 situations, each intended to elicit a particular type of utterance and pragmatic meaning; b) dialogues

[1] *The Interactive Atlas of Catalan Intonation* <http://prosodia.upf.edu/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.

obtained by means of the *Map Task* technique; and c) videotaped fragment of spontaneous speech or informal conversation.

The main goal of this chapter is to present a full-fledged ToBI annotation proposal for Catalan, which is based on years of prosodic analysis of the Central Catalan variety and on a preliminary proposal based on Prieto et al. (2009). A complementary and useful website is the *Cat_ToBI Training Materials* (Aguilar et al. 2009–11), which contains examples of labeled utterances and labeling exercises. It is intended to be a practical tool for learning how to label Catalan prosodically diverse speech data. This site has the function of maintaining and consistently updating the Cat_ToBI proposal. A recent inter-transcriber consistency test was performed on the Cat_ToBI proposal as explained in this chapter, and results revealed comparable rates of consistency between our proposal and ToBI proposals for other languages (Escudero, Aguilar, Vanrell, & Prieto 2012).

The chapter is organized as follows. Section 3.2 presents an overview of the stress and rhythmic system, and also of prosodic phrasing. Section 3.3 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.

3.2 Catalan prosody and prosodic structure

3.2.1 *Stress and rhythmic structure*

In stress-accent languages like Catalan, syllables with primary stress generally serve as the landing site for pitch accents, which are signaled acoustically by a pitch movement (Bolinger 1958; Pierrehumbert 1980; Ladd 1996, among others). Generally, stressed syllables in a lexical item receive an accent, even though there are exceptions. For example, in some types of Catalan compounds only the last member receives a pitch accent (e.g. there is a contrast between a compound such as *netejaparabrises* "windshield wiper," pronounced with one pitch accent in the last stressed syllable and the corresponding homophonous verbal phrase *neteja parabrises* "(s)he cleans the windshield," pronounced with two pitch accents. (See Recasens 1993; Mascaró 2002; 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 pitch 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 2008). Prieto et al. (2001) proved with both a production and a perception experiment that Catalan speakers have a hard time distinguishing between stressed syllables in a clash environment and unstressed syllables in homophonous pairs of sequences such as *camí net* ("clean path") vs. *caminet* ("small path"), demonstrating that Catalan uses weakening or complete deaccenting as a general strategy of stress clash resolution. 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 classical 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 (Ortega-Llebaria, Vanrell, & Prieto, 2010).

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 (*maratóo* "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 that are consistently associated with stress-timed languages. Yet in a recent study, Prieto, Vanrell, Astruc, Payne, & Post (2012) 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. (In English stressed syllables are significantly longer than unstressed syllables, creating the sensation of the morse-type rhythmic effect, but this is not the case for Catalan and 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. 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.

3.2.2 *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 the most prominent stress within the prosodic unit in the last tonic syllable. In other words, by default, prominence within the prosodic phrase is rightmost.

In Cat_ToBI (Prieto et al. 2009), the Catalan data has been analyzed 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 in this section. As for the *prosodic word* level, we follow Vigário (2003) in taking primary word stress as one of the clearest 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 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 three break index in the Cat_ToBI system, while the strong disjuncture corresponds to a level four 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 3.3.2).

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 already, 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.

Several studies have pointed out that even though the construction of prosodic structure in Catalan is influenced by syntax, it cannot solely be determined on the basis of syntactic information alone but rather must also refer to prosodic markedness constraints that regulate the size and eurhythmicity of phrase constituents (Prieto 1997, 2005b; D'Imperio et al. 2005; 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 girl ask.3s the gifts of Epiphany
"The little girl asks for her Epiphany gifts"

b. (El periodista comunicà) (la notícia del dia)
the journalist reported.3s the news of-the day
"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 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)
buy.ms maps of the Barcelona old
"I/(s)he used to buy maps of old Barcelona"

b. (Menjaré pastissos) (de xocolata amarga)
eat.3s caked of chocolate bittersweet
"I will eat cakes of bittersweet chocolate"

An interesting fact about Catalan phrasing, initially noted by Oliva (1992), is that stress clash resolution also plays an important role in phrasing decisions in Catalan. In his study of Catalan phrasing, Oliva (1992:131) suggests that the presence of a clash can optionally trigger prestructuring in some cases. As is well known, 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*) 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 (2008) 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 in phrasing decisions in Catalan, suppressing effects of syntactic and other prosodic constraints.

(3) a. (La Maria) (beu aigua destil·lada)
the Mary drinks.3s water distilled
"Mary drinks distilled water"

b. (La Maria bevia)ϕ (aigua destil·lada)ϕ
the Mary drank.3s water distilled
'Mary used to drink distilled water'

3.3 Intonational phonology

As mentioned already, 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 Fo 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. 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 and intonation.

3.3.1 *The pitch accents*

Table 3.1 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). The following upstepped and downstepped pitch accents (i.e. scaled higher or lower than the previous pitch accent) have been attested in Catalan: !H*, ¡H*, L+!H*, L+¡H*, and !H+L*.[3] As criteria for starredness, I follow Prieto, D'Imperio, & Gili-Fivela's (2006) 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

[2] The diacritic, ">" (delayed Fo peak). is used when the Fo peak is realized after the syllable nucleus. This symbol has been used in other ToBI systems such as MAE_ToBI (Beckman et al. 2005) and Gr_ToBI (Arvaniti & Baltazani 2005).

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

Table 3.1 Schematic contours of seven types of pitch accent in Catalan

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; see section 3.3.3.3.1).
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; see section 3.3.3.3.1).

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.

3.3.2 *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 does not need to appear before IP boundaries (Sosa 1999 for Spanish; Frota 2002a, this volume, for Portuguese; Prieto & Frota, in preparation, for several Romance languages). Following this, the Cat_ToBI proposal does not posit the existence of IP phrase

accent category before the IP boundary tone. That means that boundary tonal movements before an IP will be signaled by either simple or complex boundary tones. Eight types of boundary tones have been attested before the IP level (see Table 3.2). On the other hand, five types of phrase accent tones have been attested at the end of IPs (marked with the - symbol after the tone), namely, three with one target (L-, !H-, and H-), and two with two targets (HH- and LH-).

Schematic contours of eight types of boundary tone combinations at the IP level are shown in Table 3.2. 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%, !H%, L!H%, 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. 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, in Catalan there is enough evidence to argue that boundary tones can have a phonologically contrastive mid boundary tone (see Prieto, Torres-Tamarit, & Vanrell 2008). Following proposals such as Greek, English, Portuguese, and German ToBI, we propose to represent it with a downstepped high tone boundary tone in the system !H% (Beckman & Ayers-Elam 1997 for English; Arvaniti & Baltazani 2005 for Greek; Grice, Baumann, & Benzmüller 2005 for German; this volume for Portuguese).

The domain of association of IP boundary tones in Catalan is the posttonic stretch. When the boundary tone is monotonal, the target is located at the end of the phrase and an interpolation movement connects the nuclear pitch accent with this target. When the boundary tone is bitonal, the two tones are realized in two posttonic syllables, if available. Finally, the tritonal boundary tone combination associates to the posttonic stretch, if available: if two syllables are available, the L target is realized in the posttonic and the HL in the phrase-final syllable. Finally, 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 2009).

Table 3.2 Schematic contours of eight types of boundary tone combinations at the IP level in Catalan

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.
	!H%	!H% is manifested phonetically as a rising movement to a target mid tone or as a mid stylized sustained tone, represented as a downstepped high tone. It is attested in hesitations, in obviousness and disapproval statements, and in vocative chants.
	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 Fo value. It is attested in anti-expectational and incredulity questions.
	L!H%	The L!H% is manifested phonetically as a dip and then a rise to a mid Fo value. It is attested in obviousness statements.
	HL%	The HL% is manifested phonetically as high plateau and then a fall to a low Fo value. It is attested after high or low pitch accents in requests and in obviousness statements.
	LHL%	The LHL% is manifested phonetically as a complex pitch movement consisting of a fall plus a rise and then a fall to a low Fo value. It is found in exhortative requests.

3.3.3 *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 appropriate, we will present near-minimal pairs which show relevant contrasts.

3.3.3.1 *Statements*

Broad focus statements The intonation of a broad focus statement is characterized by the presence of rising prenuclear pitch accents that are associated with the all stressed syllables of the utterance, followed by a low pitch accent that occurs on the phrase-final stressed syllable. Fig. 3.1 exemplifies the pitch contour of broad focus statements with the utterance *Volen melmelada* "They want some jam."[4] 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 Fo 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* as prenuclear pitch accent and L* as nuclear pitch accent.[6]

Even though the peak in prenuclear pitch accents is located in the posttonic syllable, this can vary depending on the rightwards prosodic structure. As mentioned already, tonal crowding phenomena (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 Fo gestures involved, resulting in early realization of the first peak H (which is realized within the accented syllable) and delay of the first L of the second.

Earlier work on Central Catalan statements has shown that declarative contours are characterized by downstepping of prenuclear accents (L+!H*) and extreme

[4] In all figures, the pitch accent labels are aligned around the middle of the accented syllable and the boundary tone labels with the end of the prosodic phrase.

[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 (2010) find 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.

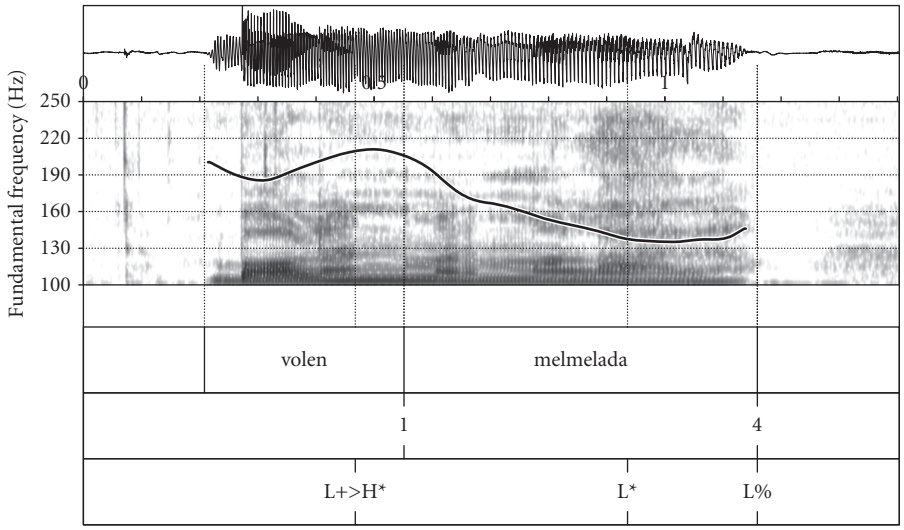

FIGURE 3.1 Waveform, spectrogram, and Fo pitch track of the broad focus statement *Volen melmelada* (want.3pl jam, "They want some jam"). This example illustrates the phonetic realization of the rising prenuclear pitch accent L+>H* and the low nuclear pitch accent L* in broad focus statements.

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 Fo 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 Fo 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 (2007) 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.

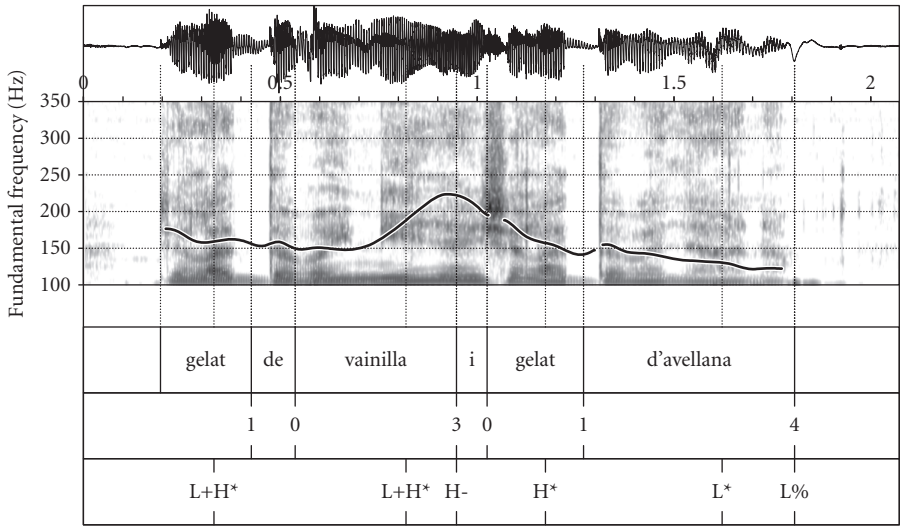

FIGURE 3.2 Waveform, spectrogram, and Fo pitch track of the broad focus statement *Gelat de vainilla i gelat d'avellana* (ice cream of vanilla and ice cream of hazelnut, "Vanilla ice cream and hazelnut ice cream"). This example illustrates the continuation rise H% that appears at the right edge of the first intermediate phrase.

In declarative utterances comprising several intermediate phrases, the right edge of each intermediate phrase is signaled 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). Fig. 3.2 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%.

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 3.3 for a summary of the nuclear tonal configurations in Catalan and their meanings). The pitch contour in Fig. 3.3 illustrates the narrow focus statement. 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).

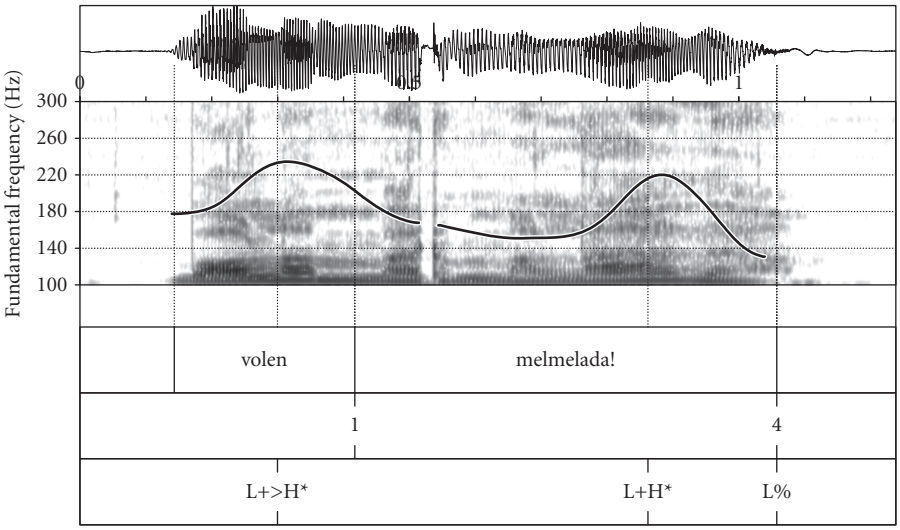

FIGURE 3.3 Waveform, spectrogram, and Fo pitch track of the narrow focus statement *Volen melmelada (i no pas mantega)* (want.3pl jam, "They want jam (not butter)"). This example illustrates the nuclear L+H* pitch accent with an aligned peak.

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 Fig. 3.4. 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).

It has been claimed that while in Germanic languages such as English the strategies used to focus an item involve a reorganization 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 can be achieved by prosodic as well as syntactic means.

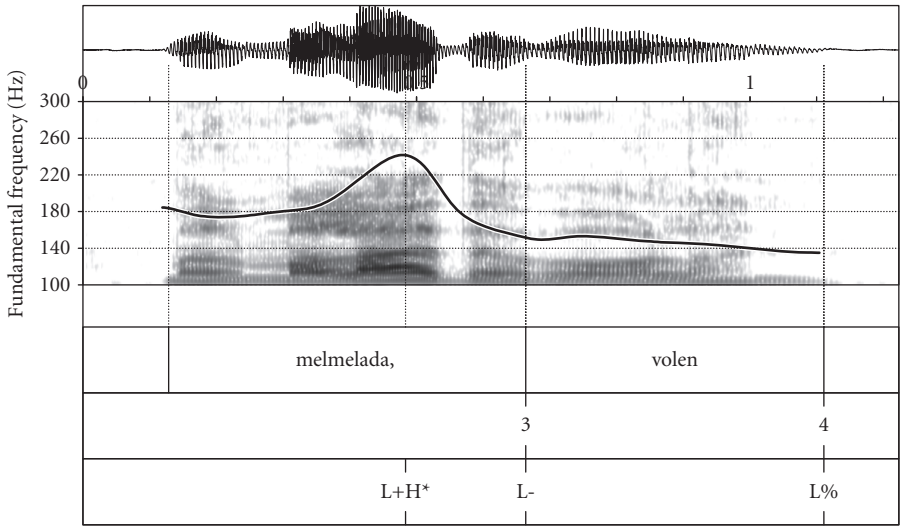

FIGURE **3.4** Waveform, spectrogram, and Fo pitch track of the contrastive focus utterance *MELMELADA volen* (i no pas mantega) (jam want.3pl, "JAM is what they want (and not butter)"). This example illustrates the L+H* nuclear pitch accent and the postnuclear deaccented stretch.

3.3.3.2 *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 Fig. 3.5 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!" (panel a), and *(Home), la Bàrbara!*, "Barbara (obviously)!" (panel b). The contour in (a) is characterized by a nuclear low tone followed by a complex boundary movement HL%. The contour in (b), 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 boundary tone L!H%—further evidence for the contrast between L!H% and LH% can be found in Prieto, Torres-Tamarit, & Vanrell (2008). The phonetic realization of these complex boundary tones HL% and L!H% 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.

With respect to the final !H% boundary tone, Prieto, Torres-Tamarit, & Vanrell (2008) have shown that Catalan speakers perceive a rise to a mid boundary tone, L!H%, as categorically distinct from a rise to a high boundary tone, LH%.

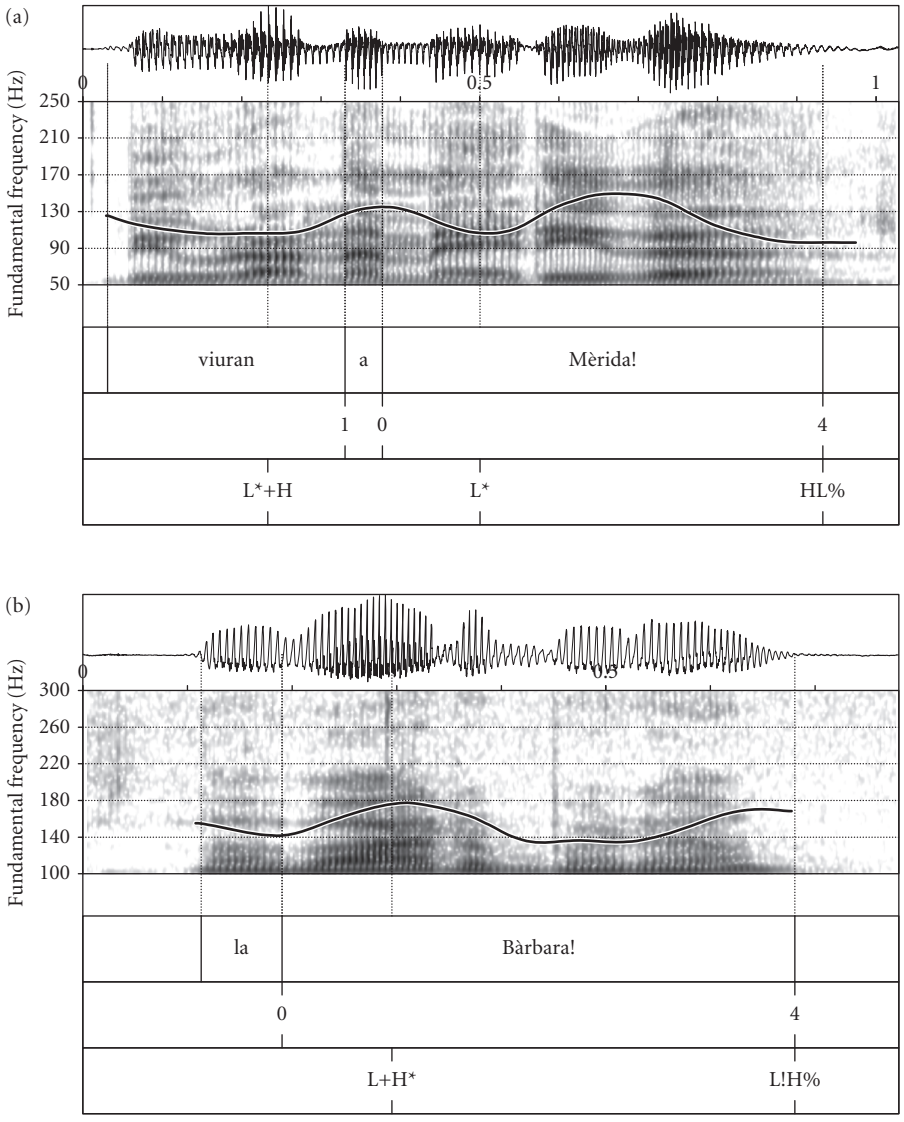

FIGURE 3.5 Waveform, spectrogram, and Fo pitch track of the two types of obviousness statements: *(Home), viuran a Mèrida!,* (live.3pl in Mèrida "They're going to live in Mèrida (of course)!") (panel a), and *(Home), la Bàrbara!,* "Barbara (obviously)!" (panel b). The contour in the right panel confers a more categorical meaning of obviousness.

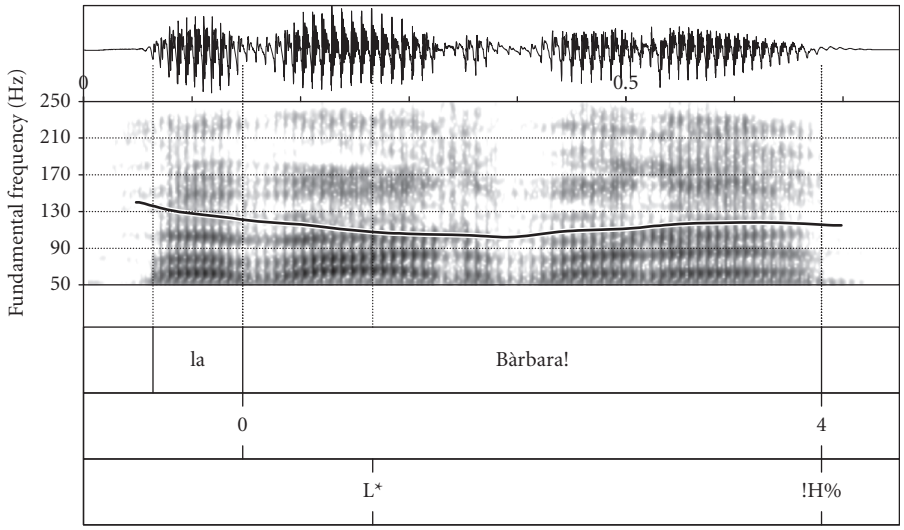

FIGURE 3.6 Waveform, spectrogram, and Fo pitch track of the disapproval statement *(No estic d'acord amb) la Bàrbara!* "(I disapprove of) Barbara!".

Disapproval statements Disapproval statements in Catalan are realized with a L* nuclear accent followed by a final rise to a !H% tone. Fig. 3.6 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 !H% target aligned with the end of the phrase-final syllable, and there is an interpolation between the nuclear L* pitch accent and the !H% target at the end of the utterance.

Hesitation statements Fig. 3.7 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 sustained tone.

3.3.3.3 *Questions*

3.3.3.3.1 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

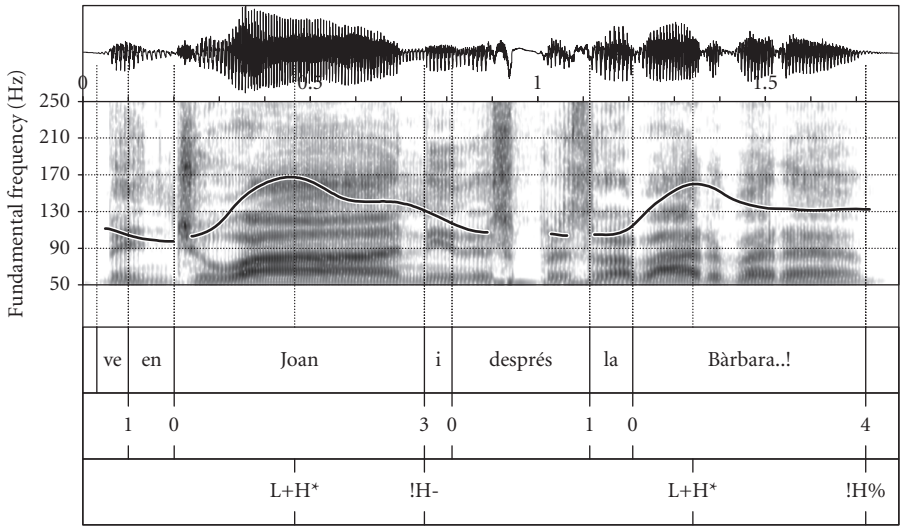

FIGURE 3.7 Waveform, spectrogram, and Fo pitch track of the hesitation contour *Ve en Joan . . . i després la Bàrbara.* (comes.3s the Joan . . . and after the Bàrbara "Joan is coming . . . and also Barbara."

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 (2009).

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, and differs from rising yes-no questions (see later in this section). 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 Fig. 3.8. 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 (2009). Basically, the accented syllable acts as the basic domain of phonetic realization for the H+L* nuclear pitch accent.

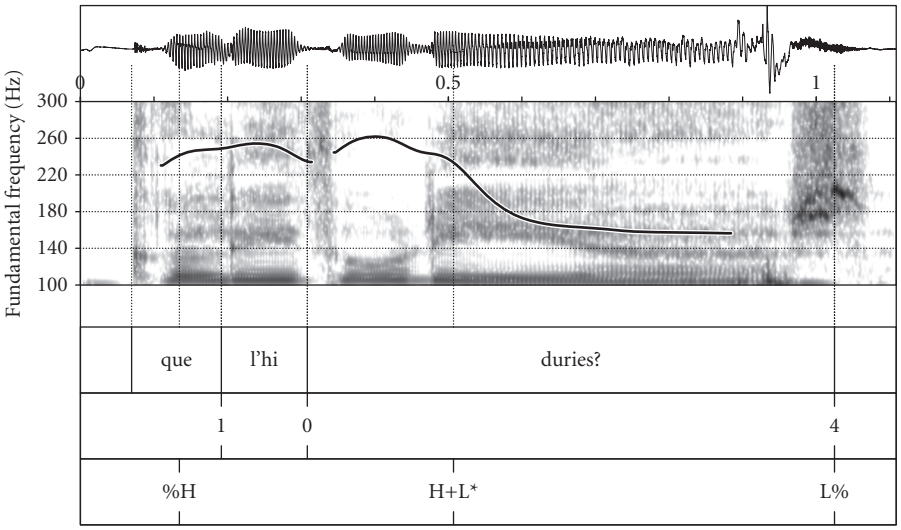

Figure 3.8 Waveform, spectrogram, and Fo pitch track of the falling yes-no question *Que l'hi duries?* (that him.it take.2s "Would you take it to him/her?") in Central Catalan.

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 2007 for 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 Fig. 3.8), 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 Fig. 3.9 show the pitch contours of the falling yes-no question *Que vindria la Marina?* "Would Marina come?" (panel a) and of the rising version of the same question *Vindria la Marina?* "Would Marina come?" produced by the same speaker of Central Catalan (panel b). The rising intonation pattern can be characterized 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.

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.

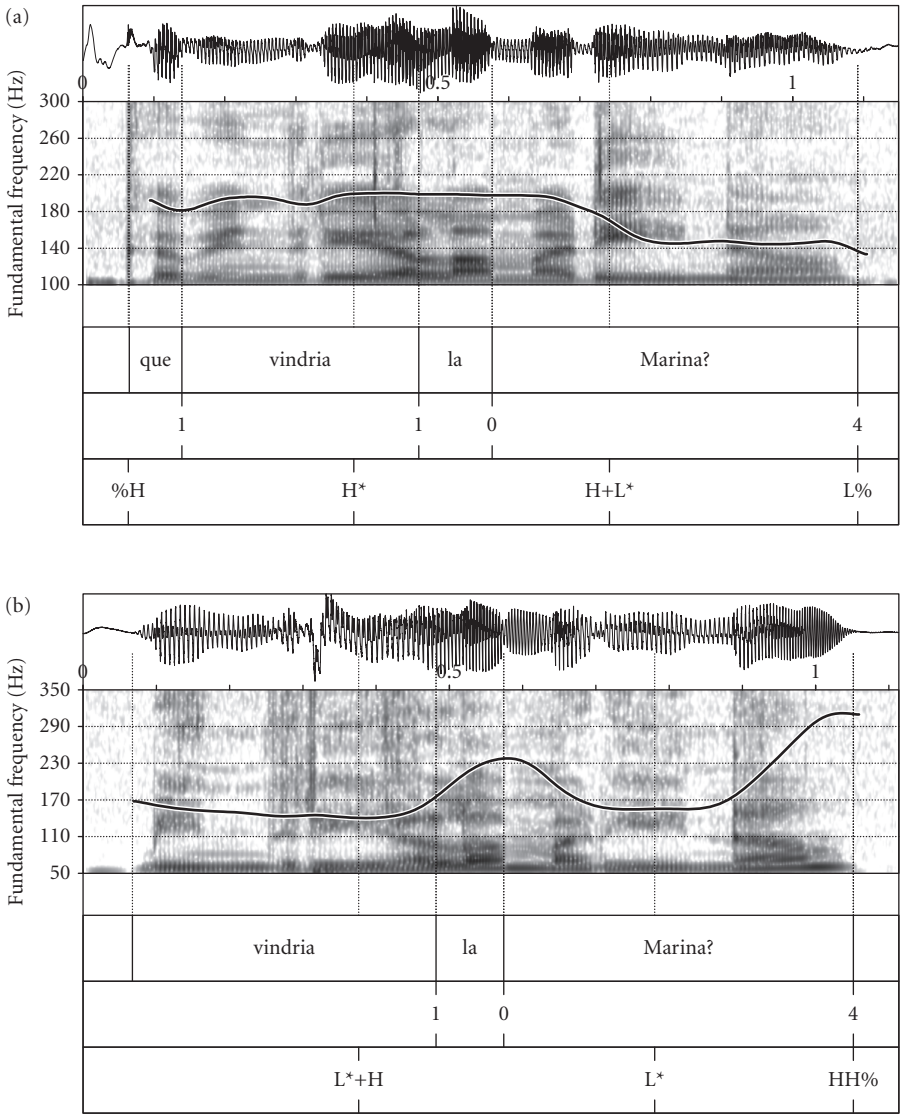

FIGURE **3.9** Waveforms, spectrograms, and Fo pitch tracks of the falling yes-no question *Que vindria la Marina*? (that come.cond.3s the.f Marina "Would Marina come?") (panel a) and of the rising contour of the same question *Vindria la Marina*? (come.cond.3s the Marina "Would Marina come?") produced by the same speaker of Central Catalan (panel b).

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-Sendra 2011).

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. Fig. 3.10 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 Fig. 3.2, and Aguilar et al. 2009).

3.3.3.3.2 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

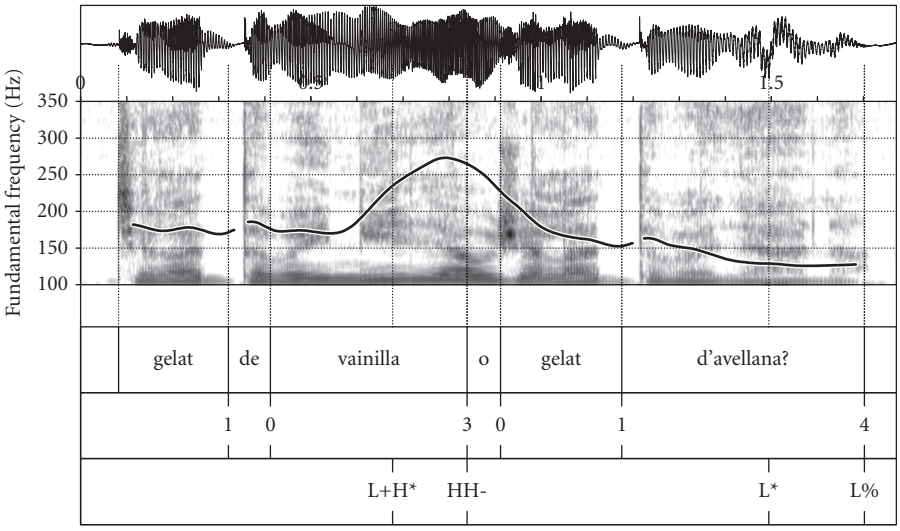

FIGURE 3.10 Waveform, spectrogram, and Fo pitch track of the alternative polar question *(Què vols?) Gelat de vainilla o gelat d'avellana?* (ice cream of vanilla or ice cream of hazelnut "(What would you like?) Vanilla ice cream or hazelnut ice cream?") This figure illustrates the realization of the HH- boundary tone at the end of the first intermediate phrase.

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 Fig. 3.11 (panel a), is characterized by a low nuclear accent L*. The second type of pitch accent (panel b), 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

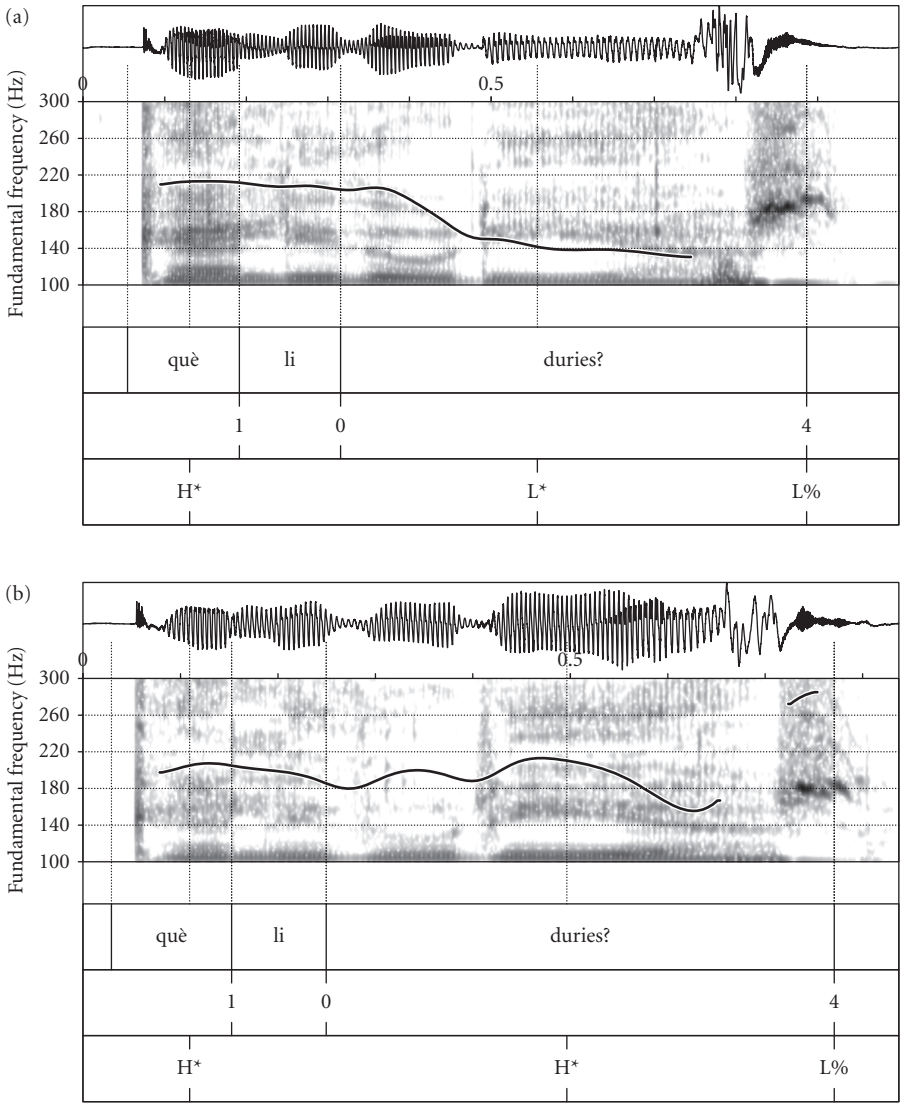

FIGURE 3.11 Waveforms, spectrograms, and Fo pitch tracks of two possible nuclear pitch contours of the wh-question *Què li duries?* (what him take.cond.2sing "What would you take him/her?"), namely, !H+L* and H*.

choice of nuclear pitch accent 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.

In focused wh-questions, a particular constituent can be focalized. An example of the focus wh-question contour is provided in Fig. 3.12. 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 3.3.3.3.3). The prenuclear stretch is produced with a compressed pitch range before the upstepped rising accent in nuclear positions, thus being the mirror image of the contrastive focus in statements (see Fig. 3.4).

3.3.3.3.3 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.

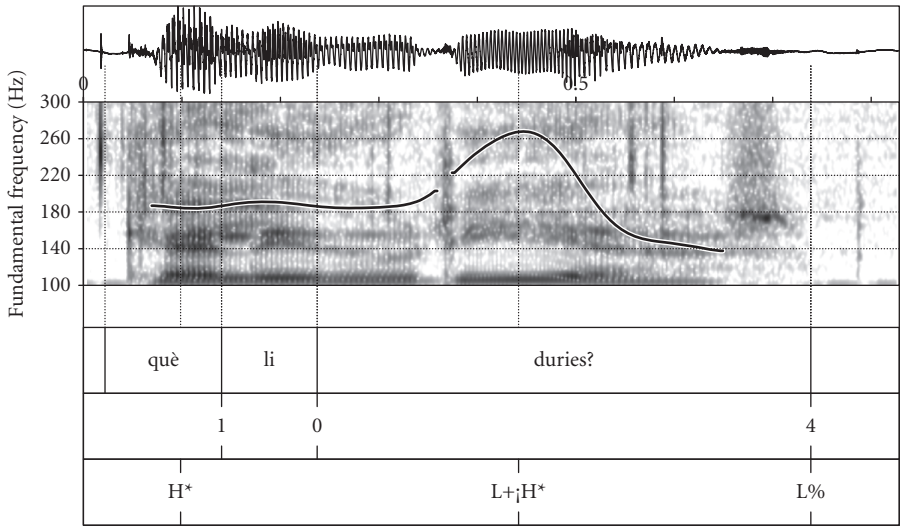

FIGURE 3.12 Waveforms, spectrograms, and Fo pitch tracks of the focus wh-question *Què li duries?* (what him take.cond.2sing "What would you take him/her?"), produced with an upstepped nuclear pitch accent L+¡H*.

Confirmatory Questions Confirmation-seeking questions are questions that ask for mutually shared information in which the speaker reveals an expectation or a clear hypothesis about the answer. Typically Catalan confirmatory questions are headed by a question marker followed by the conjunction *que* (e.g. *Que no vindràs?* "You will not be coming, right?"). Catalan dialects display a great linguistic variety of such markers (e.g. *Oi/no/eh que no vindràs?* "You're not coming, are you?"; see Prieto & Rigau 2007). In all these sentences, questions reveal the expectation of an affirmative or a negative answer.

The intonation of confirmatory questions lead by *que* is characterized by the nuclear falling pattern described in Fig. 3.9 for information-seeking questions (e.g. *Que vindràs?* "You will not be coming, right?"). Yet this falling pattern is used in almost all Catalan dialects (even those that have a rising question intonation) to express a confirmation meaning. Moreover, dialects that use a falling pattern for the information-seeking question also display an intonation difference in the realization of the leading tones or the boundary tones to mark this distinction (see Vanrell et al. 2012 for a production and perception study comparing information-seeking vs. confirmation-seeking questions in Majorcan Catalan).

Echo Questions and Incredulity 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). Fig. 3.13 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.

For an experimental investigation of the phonological contrast between L+H* (statement) and L+¡H* (echo question), see Borràs-Comes et al. (2010).

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 in Fig. 3.14 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)

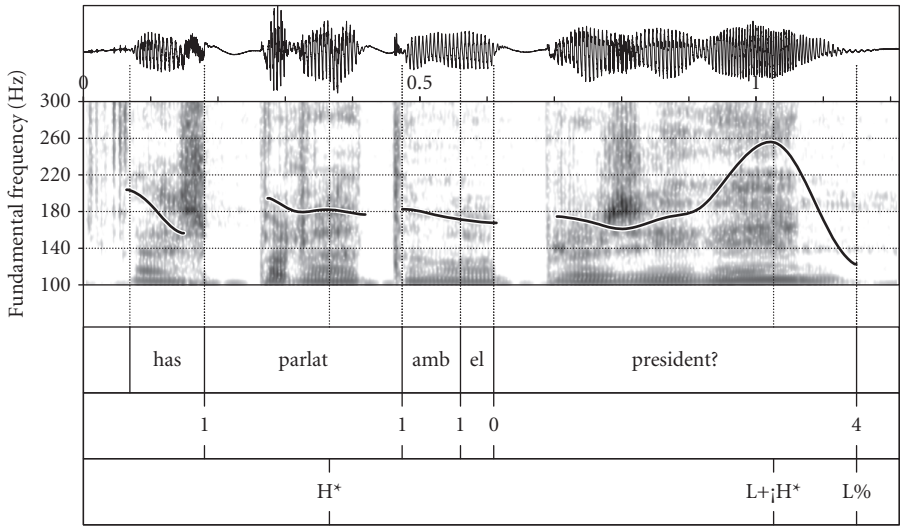

FIGURE 3.13 Waveform, spectrogram, and Fo pitch track of the echo question –*(Dius que) has parlat amb el president?* (Have.2sing spoken with the president? "(You say that) you have spoken with the president?").

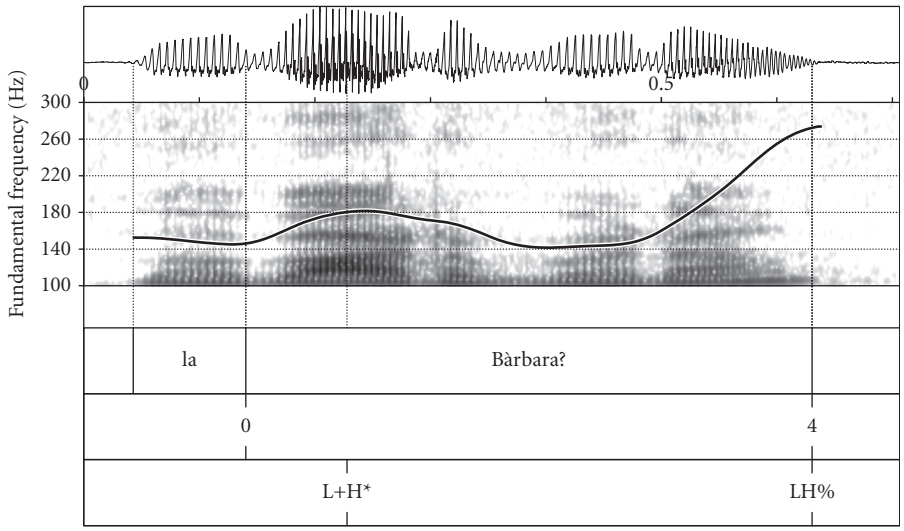

FIGURE 3.14 Waveform, spectrogram, and Fo pitch track of the incredulity question *(Has dit) la Bàrbara?* "(Did you say) Barbara?"

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.

The contour in Fig. 3.14 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). This tritonal boundary tone combination associates to the posttonic stretch, if available: if two syllables are available, as in the case of *Bàrbara*, the L target is realized in the posttonic and the HL in the phrase-final syllable.

Finally, there is a variant of the rising question intonation contour which conveys incredulity. It uses the basic canonical rising pitch contour, that is, it is characterized by a L* nuclear pitch accent followed by a sharper rise at the end. The difference between this question and the neutral rising contour is the pitch range of the final HH% boundary tone, and the duration of the postaccented syllable (see Crespo-Sendra et al. 2010).

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 toward 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 Fig. 3.15 show the contrast between high-rise and low-rise questions in Catalan.

3.3.3.4 *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

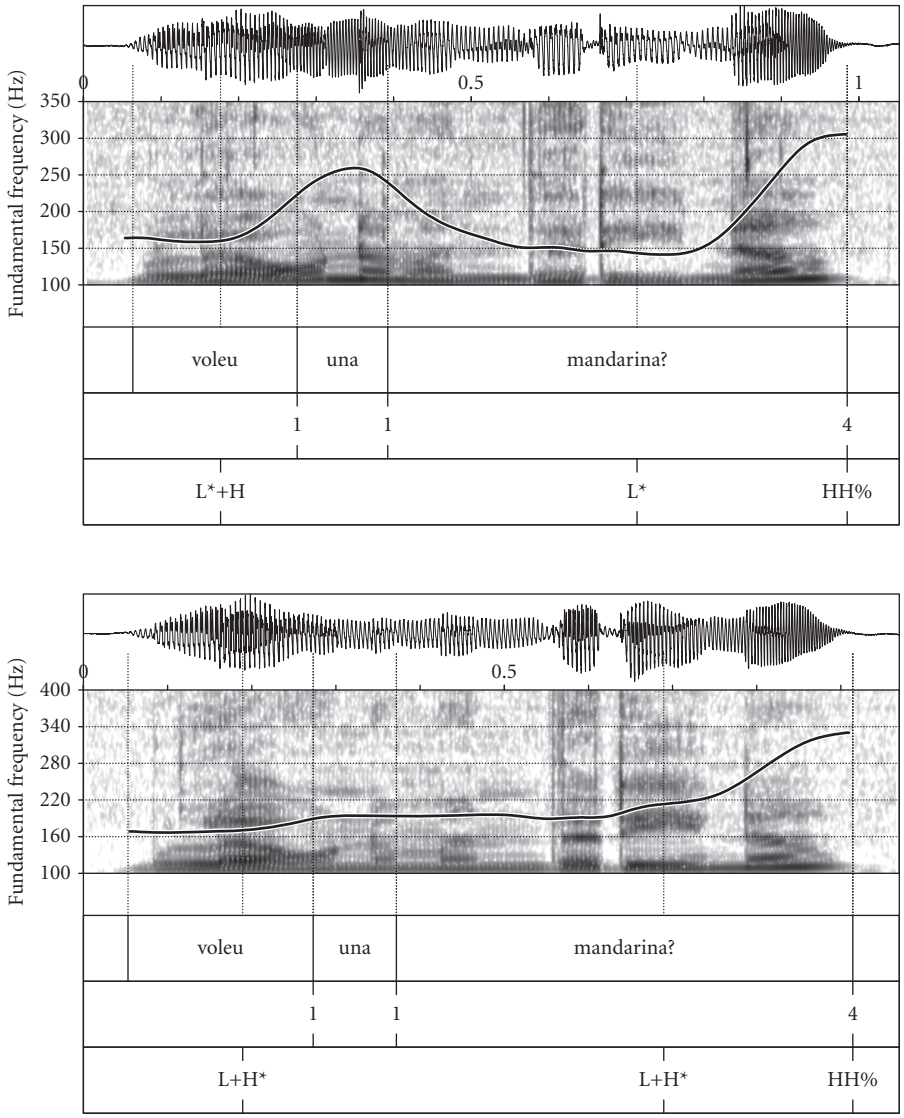

FIGURE 3.15 Waveforms, spectrograms, and Fo pitch tracks of the neutral rising yes-no question *Voleu una mandarina?* (want.2pl a tangerine? "Do you want a tangerine?") (top panel) and the same utterance with an invitation meaning (bottom panel). This figure illustrates the contrast between low-rise (neutral) questions and high-rise (offering) questions in Catalan.

utterances, as well as the prosodic realization of pragmatic nuances such as differences in degree of insistence in commands and requests.

Fig. 3.16 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, panel a) and then with a late focus *¡Demana-ho a la MARIA!* "Ask Mary!" (panel b). 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 postnuclear 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.

The example in Fig. 3.17 illustrates the most common way to express a soft command in Catalan, with early focus such as *DEMANA-HO a la Maria* "(Please) ask Mary." The exhortative tune is characterized by a low tone associated with the focused syllable ('ma' in DEMANA-HO) followed by a rise in the posttonic syllable (L*+H). After that, the pitch falls gradually in "morendo" fashion until the low postnuclear pitch accent (L*), which is associated with the last stressed syllable of the utterance ("ri" in Maria), and followed by a final low boundary tone (L%).

Fig. 3.18 illustrates the contrast between a soft request (L+H* L!H%) and an insistent request (L+H* LHL%) which ends in a rise-fall-rise pitch movement. Again, this is the Catalan utterance-final "insistence tune" mentioned elsewhere (Prieto 1995, 2001a).

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 of tunes over short sequences.[7]

[7] Yet in a recent experiment about the realization of narrow contrastive focus in Catalan and Spanish, Prieto & Ortega-Llebaria (2009) 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

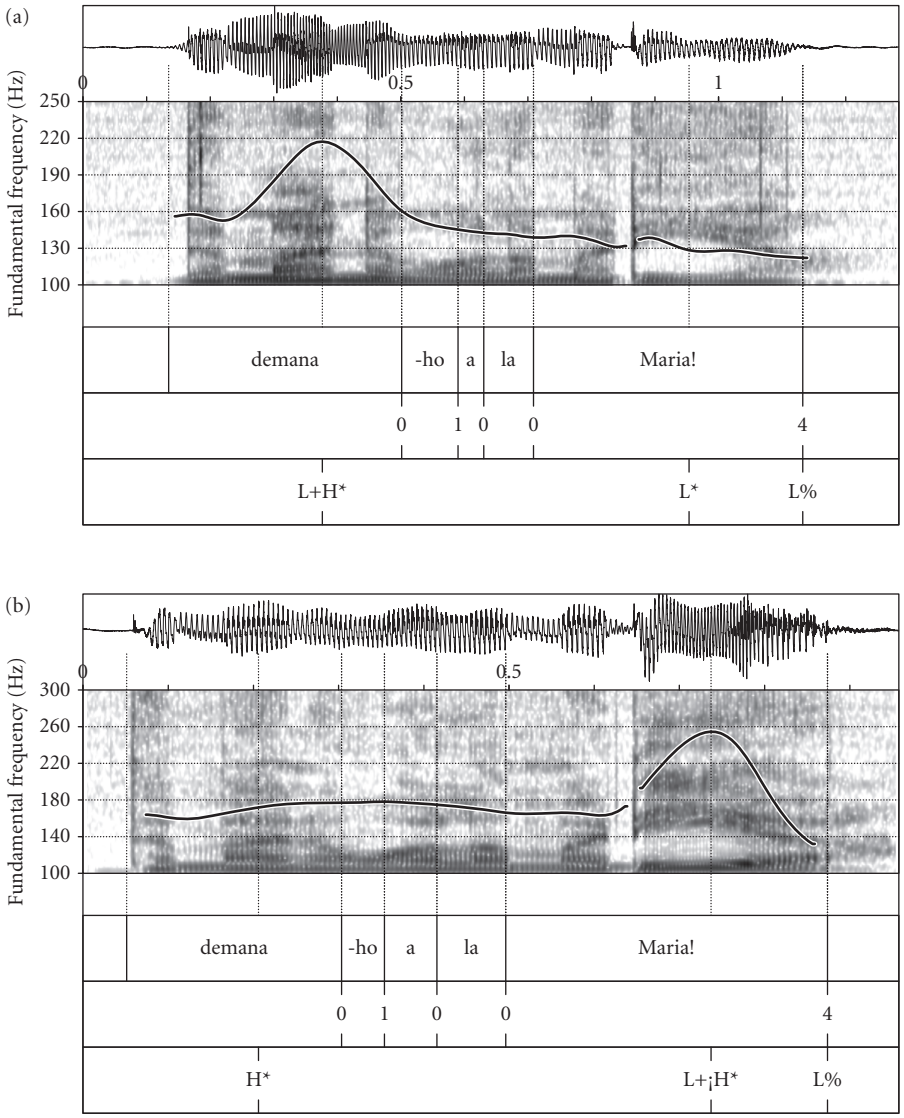

FIGURE **3.16** Waveform, spectrogram, and Fo pitch track of the strong command *Demana-ho a la Maria!* (ask.3s it to the Mary "Ask Mary!"). In panel (a) the focus is late, while in panel (b) the focus is early.

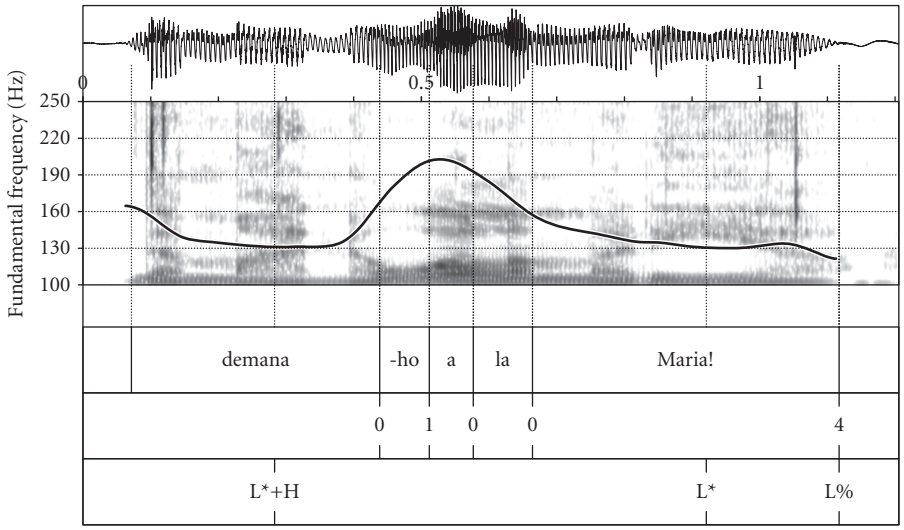

FIGURE 3.17 Waveform, spectrogram, and Fo pitch track of the soft command *Demana-ho a la Maria* (ask.3s it to the Mary "(Please) ask Mary!").

3.3.3.5 *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). Fig. 3.19 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 a !H% boundary tone, which in this particular contour spreads to the left in the posttonic stretch. That is, the spreading goes together with the lengthening that we also find in the calling contour.

Catalan has different variants of calling contours which are linked to particular pragmatic meanings. For example, a variety of imperative contours (section 3.3.3.4) can be used as vocatives to express commands and requests. Fig. 3.20 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 plateau and then a fall during the posttonic stretch. If the posttonic stretch has two syllables, the plateau 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.

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 (see section 3.3.2).

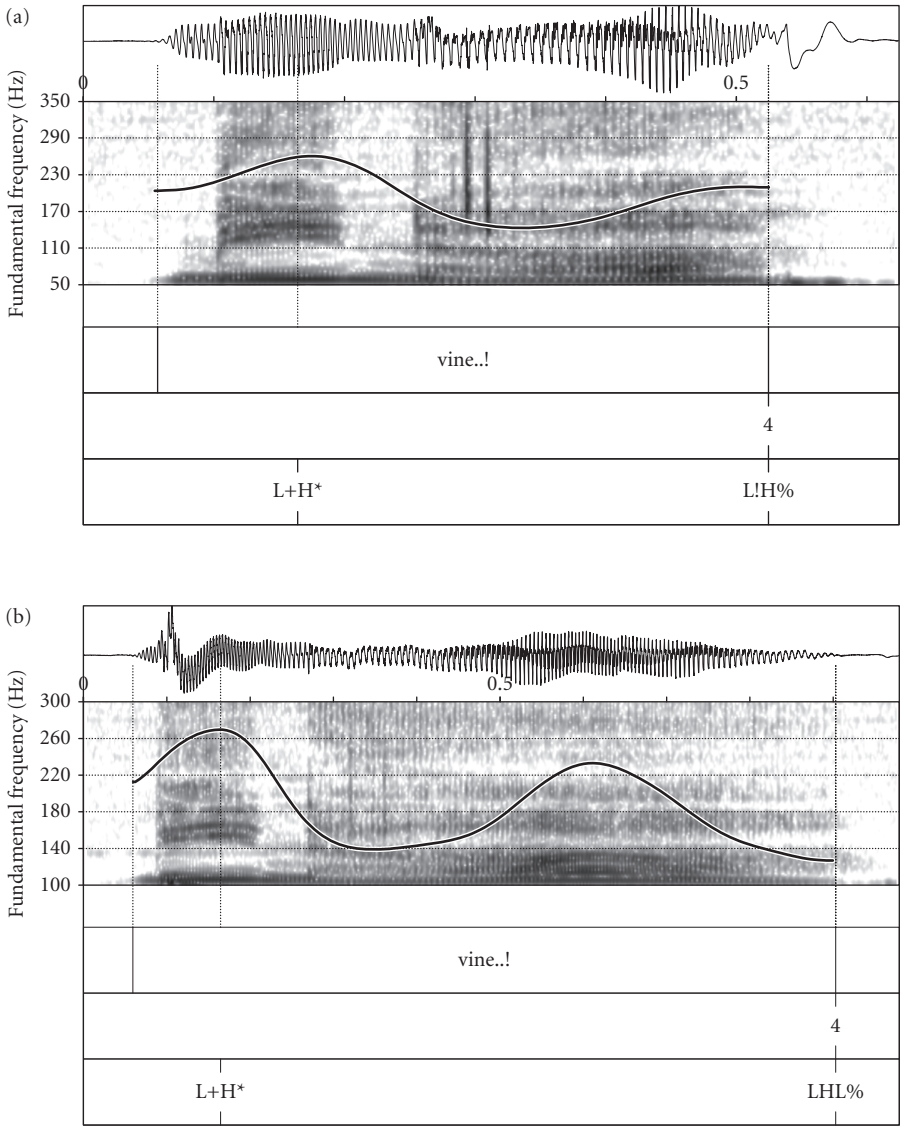

Figure 3.18 Waveform, spectrogram, and Fo pitch track of the same utterance *Vine* "Please come" produced first as a soft request (panel a) and then as a more insistent request (panel b).

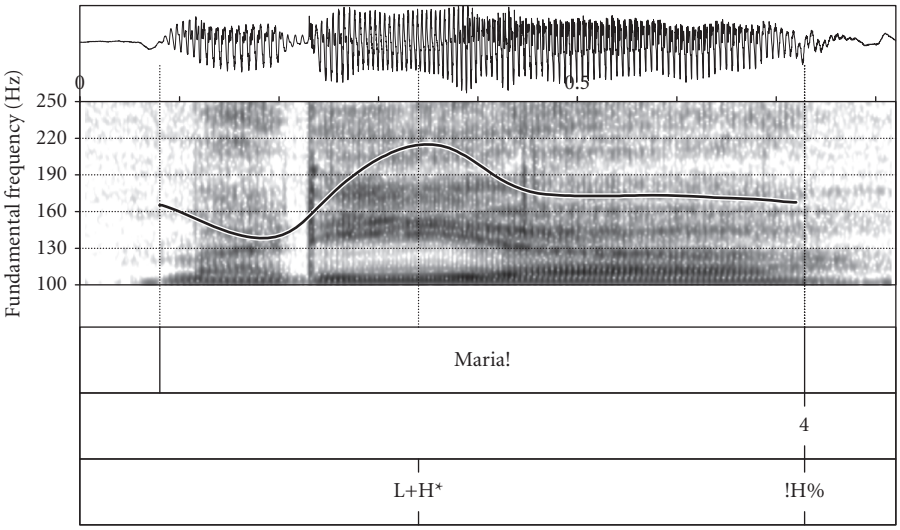

Figure 3.19 Waveform, spectrogram, and Fo pitch track of the vocative chant *Maria!* "Maria!". This figure illustrates the mid sustained boundary tone !H%.

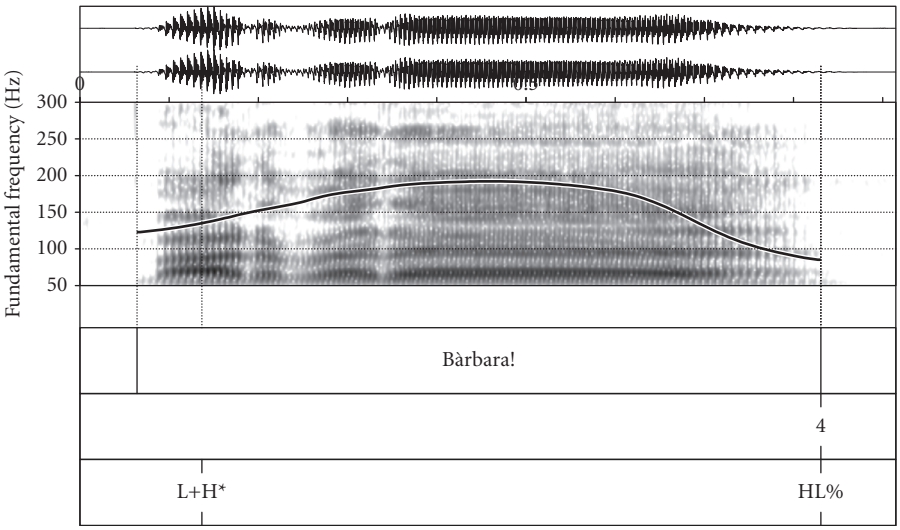

Figure 3.20 Waveform, spectrogram, and Fo pitch track of the insistent call *Bàrbara!* "Barbara!". This figure illustrates the boundary tone HL%.

3.4 Nuclear configurations

Table 3.3 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.

3.5 Discussion and 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 led 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*, 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, we find another type of alignment contrast related to degrees of insistence. There is a crosslinguistic tendency to express narrow focus through the use of retracted pitch peaks. As 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

TABLE 3.3 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

Schematic contour	Cat_ToBI label	Context	Examples (Fig.)
	L* L%	Broad focus statement Neutral wh-question	Fig. 3.1 Fig. 3.11
	H+L* L%	Information-seeking yes-no question (falling) Confirmation-seeking yes-no question	Figs.. 3.8, 3.9
	H* L%	Focused wh-question	Fig. 3.11
	L* HH%	Information-seeking yes-no question (rising)	Figs. 3.9, 3.10
	L+H* HH%	Inviting yes-no question	Fig. 3.15
	L+H* L%	Narrow focus statement, exclamative Imperative Echo question (L+¡H*)	Figs. 3.3, 3.4 Fig. 3.16 Fig. 3.13
	L* HL%	Obviousness statement Soft request	Fig. 3.5 Fig. 3.17
	L+H* !H%	Vocative chant Hesitation statement	Fig. 3.19 Fig. 3.7
	L+H* HL%	Insistent vocative (also insistent request)	Fig. 3.20
	L+H* LH%	Antiexpectational echo question	Fig. 3.14
	L+H* LHL%	Insistent request	Fig. 3.18
	L+H* L!H%	Emphatic obviousness statement	Fig. 3.5
	L* !H%	Disapproval statement	Fig. 3.6

narrow focus (Gili-Fivela 2004, 2008 for Pisa Italian; Smiljanic 2004 and Yu 2008 for Croatian; Ahn 2008 for English).

As for edge tones, 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 that 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%, !H%, and L% and bitonal combinations LH%, HH%, 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).

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. 3.9). 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 phonologically contrastive mid boundary tones. In Catalan, the crucial difference between echo questions and statements of the obvious 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 L!H%. In a recent experiment using the categorical perception paradigm, Prieto, Torres-Tamarit, & Vanrell (2008) show that Catalan listeners perceive the contrast between L+H* LH% and L+H* L!H% 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), the majority of systems 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. For Gr_ToBI, Arvaniti & Baltazani (2005) 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. In general, 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 nine 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 1993, 2005). 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 further refine the assessment of the pragmatic meanings conveyed by intonation. Finally, our knowledge about Catalan intonation will be further strengthened through the study of dialectal differences in intonation, the development and analysis of larger corpora of spoken data, as well as the acquisition and development of early intonation and phrasing.