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Tune-text accommodation in Optimality Theory: an account of Southern Valencian Catalan yes-no questions

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Abstract: This paper aims at contributing to ascertain the principles of intonational grammar that lie behind the realization of nuclear contours and at presenting them in terms of Optimality Theory constraints. In order to do so, we analyse the prosody of the nuclear configuration of Southern Valencian Catalan yes-no questions, with special emphasis on situations where text-tune accommodation phenomena take place. The empirical data, which are analysed according to the principles of the autosegmental-metrical model, show a complex interplay of different phenomena at the text-tune interface, like vowel lengthening, tonal spreading, tonal retraction and intonation-driven schwa epenthesis. We argue that the variation detected in the data can be accounted for by the interaction of nine constraints (i.e., MAX-IO(μ^{P}), DEP-IO(μ^{S}), ANCHOR(T%,Rt,IP,Rt), ANCHOR(L*,Rt,ˈσ,Rt), *ANCHOR(T,C), *ANCHOR(T,-voice), SHARE(T*,NC), DEP-IO(ASSOCIATE), MAX-IO(ASSOCIATE)), whose ranking is established by means of a Stochastic Optimality Theory analysis.

Keywords: Catalan; intonation; Optimality Theory; schwa epenthesis; tonal retraction; tonal spreading

1 Introduction

Studies on prosody – understood as the area of suprasegmental phonetics and phonology that includes, among other aspects, intonation and duration – have flourished in the last few decades. This has resulted in an abundance of scientific research on different aspects of prosody itself: the relationship between prosody and pragmatics, the sociolectal and dialectal prosodic variation, the prosody-syntax

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interface, the role of prosody in encoding focus, etc. (see Prieto and Roseano [2020] for a review).

However, not all facets of prosody have been explored in equal depth. An issue that has been dealt with only in part is the so-called text-tune interface. The importance of this aspect of prosody was highlighted in Pierrehumbert (1980), which is considered the foundational work of the autosegmental-metrical (AM) approach to intonation. To put it in her own words,

> the phonological characterization of intonation [includes] rules for lining up the tune with the text. The complete phonological representation for intonation is thus a metrical representation of the text with tones lined up in accordance with the rules. (Pierrehumbert 1980: 10–11)

In spite of the fact that the rules that line up the tune with the text are part of the intonational grammar of a language, they have been paid relatively little attention. One of the reasons for this is to be found, once again, in Pierrehumbert's dissertation:

> In other languages [as opposed to English], rules that alter tonal values or delete tones can apply to such a representation. English appears to lack such rules, with the result that the underlying and derived phonological representations of intonation are identical. (Pierrehumbert 1980: 11)

The fact that English was considered to lack any remarkable phenomenon related to the text-tune interface has probably also set back the development of studies of this kind in other languages (for a comprehensive review of the literature on this topic see Roettger and Grice [2019] and Vigário et al. [2019]).

The scarcity of descriptions of the text-tune interface is particularly evident in Romance languages, where such studies are not common.[1] The fact that such phenomena are not often described has an obvious consequence: the theoretical reflection and formalization that can be built on the data are incomplete. As we will see in more detail in Section 1.4, this shortage is particularly evident within Optimality Theory (OT), despite the fact that it is currently one of the most common models in phonology (see, among others, Holt 2018).

The objective of this paper is, thus, twofold. On one hand, it aims to provide a description of a number of intonational phenomena in Southern Valencian Catalan

1 Among the noteworthy studies specifically dedicated to this topic are Prieto et al. (1995, 2005), Frota (2002), Prieto (2002, 2006a, 2006b, 2008, 2011), Welby (2006), Moraes and Colamarco (2008), Prieto and Ortega-Llebaria (2009), Vigário (2016), Frota et al. (2016), Grice et al. (2018), Roseano and Fernández-Planas (2018), Martínez-Celdrán and Roseano (2019), Rodriquez (2020), and Rodriquez et al. (2022). In addition, a few other publications hint at this subject although they do not focus on it (e.g., Cruz 2013; D'Imperio 2002; Dorta 2013; Grice 1995; Rodriquez et al. 2020; Roseano et al. 2015; Vanrell et al. 2015, among others).

that can shed light on the text-tune interface; on the other, it seeks to contribute to offer a deeper understanding of intonation within the OT model.

In order to achieve these objectives, we begin by presenting the theoretical background of our work. We first summarize how the AM model deals with intonation in Section 1.1 and durational phenomena in Section 1.2. In Section 1.3, we define the concept of text-tune accommodation, which is central for our analysis. We conclude the introduction in Section 1.4 with an overview of the efforts that have been made to analyse intonation within OT. Following this, Section 2 describes the methods of data collection and analysis. Section 3 contains an exhaustive descriptive generalization of the data, which represents the necessary basis for the OT analysis developed in Section 4. As we will see, the dataset shows a significant number of different phonetic realizations of the phonological inputs, making the OT analysis challenging. It is thanks to its challenging nature that this case study can lead us to a deeper understanding of the text-tune interface. Section 5 critically assesses the OT analysis, focussing on the constraints used in this paper. Finally, Section 6 raises some issues that need to be addressed in future research.

1.1 The autosegmental-metrical model of intonation

Intonation "refers to the use of suprasegmental phonetic features to convey 'postlexical' or sentence-level pragmatic meanings in a linguistically structured way" (Ladd 2008: 4). The dominant theory for the phonological analysis of intonation is the autosegmental-metrical (AM) model, whose core idea is that intonation is the result of the interplay between elements belonging to different planes. According to Pierrehumbert and Beckman (1988: 117), there are three planes:

1) The first of them is the plane where the prosodic hierarchy lies, which includes all relevant levels[2] from the IP down to the μ.
2) The second plane contains a tier where the segmental phonemes lie. We will call this tier the 'segmental phonemes tier'.
3) The third plane is where the tones are. We will name this tier the 'tonal phonemes tier'. A basic postulation of the AM model is that tones are of different discrete phonological heights. For our analysis, it is enough to remember that in Catalan tones may be of at least two levels: high (H) or low (L). In the same language, there are two main types of tones: (a) pitch accents or PA, that correspond to stressed syllables and are transcribed with a star (for example, L* is a low pitch accent), and (b) boundary tones or BT, that mark the edges of major

2 In the representations of the prosodic hierarchy we use in this paper we have not included the foot because it does not seem to play any role in Valencian Catalan intonation.

prosodic constituents and are transcribed with a percent sign (for example, H% is a high tone at the end of an intonational phrase).[3] In an utterance, the final element of the intonation contour (i.e., the one that contains the final pitch accent and the final boundary tone) is called the nuclear configuration (NC), a concept that can be traced back to the British school of the analysis of intonation (see García-Lecumberri [2003] and Estebas-Vilaplana [2017] for a review). The NC usually contains the most important pragmatic information (i.e., it allows the identification of the sentence type, see Face 2007).

The left part of Figure 1 (which expands on a similar illustration by Ladd 2008: 177), contains a representation of the interaction between the three planes that allow us to account for the intonation of a rising yes-no question in Central Catalan. The three planes are represented with different colours and, like in Pierrehumbert and

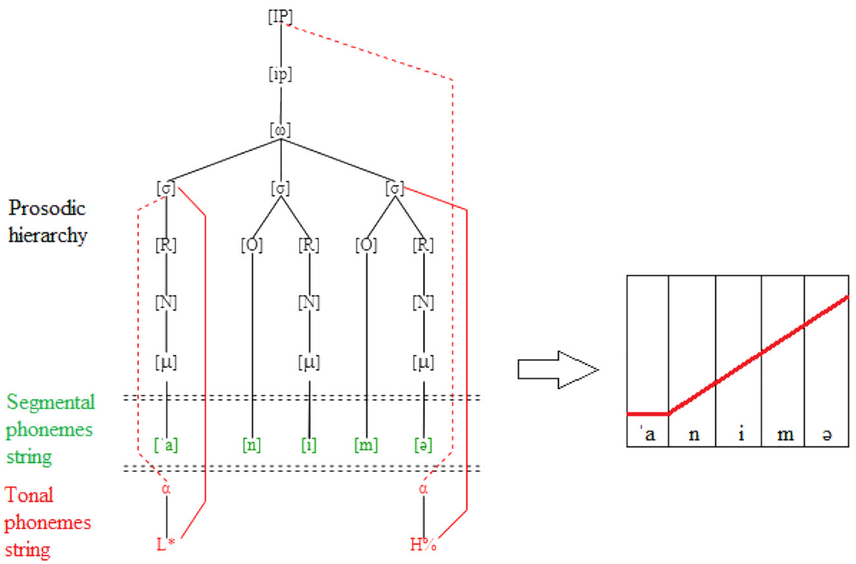


Figure 1: Phonological representation of the three planes that allow for the mapping of the intonation of the NC of the Central Catalan rising yes-no question ‘Ánima?’ (left panel) and schematic phonetic representation of the contour (right panel). Whereas the left panel corresponds to a phonological representation of the utterance including the tune, the right panel can be thought of as a broad phonetic representation of the same contour.

3 For the analysis we put forward in this paper only two pitch events are needed: the L* pitch accent and the H% boundary tone. A description of the rest of pitch accents and boundary tones documented in Catalan can be found in Prieto et al. (2015).

Beckman (1988) and in Prieto et al. (2005), double black dashed lines separate the planes.

In the prosodic hierarchy, drawn in black, IP represents the intonational phrase, ip is the intermediate phrase, ω is the prosodic word, and σ is the syllable. Below the level of the syllable and above the level that contains the moras, following Roseano and Rodriquez (2021), we include the information about the syllable structure, which we will need in Section 1.2 when we discuss the issue of the representation of duration. In the part of the tree representing the syllable structure, O is the onset, R is the rhyme, N is the nucleus and C is the coda. The square brackets indicate the edges of the constituents that, as we will see in the following paragraph, play a relevant role.

According to the AM model, tones are not directly associated with segments on the segmental phonemes tier where they are phonetically realized but with positions within the metrical structure. The association of the tones with the prosodic structure is double. On the one hand, the tone is associated as a whole (as an α-node, following Ladd 2008) with the *node* of a prosodic constituent of a higher level. (This association is represented in Figure 1 with continuous red lines). On the other hand, the constituent tones (e.g., the L and the H tones that constitute a L+H* tone) can have an additional association with the *edges* (Prieto et al. 2005) of one prosodic constituent of a lower level. For example, the L* pitch accent has an association with the stressed syllable as a node, and its sole constituent tone L has another association with the right edge[4] of the stressed syllable. In the same way, the H% BT has an association with the IP as a node, and its sole constituent tone H has an additional association with the right edge of the last syllable of the IP. This second kind of association is represented with dashed red lines in Figure 1.

Most phonologists today agree that there is a dual association of tones but, unfortunately, there is not much agreement among the authors as to what these two different associations have to be called. The association with the node of a higher-level constituent has been called primary association, affiliation, α-association, or alignment. The association with the lower-level constituent has been called secondary association, alignment, β-association or phonological anchoring. In this paper, in order to avoid confusions, we will use 'affiliation' to designate the association with a constituent as a node, and 'alignment' to designate the association with the edge of a constituent located on a lower level of the hierarchy.

4 In Catalan the association of a L* is with the right edge of the syllable both for monotonal accents (L*) and for bitonal accents (L*+H). If the association were not with the right edge but, e.g., with the left edge, the L*+H PA would be confused with the L+<H*, and the L* in nuclear position before H% could be confused with L+H* H%.

Nevertheless, affiliation and alignment are not enough in order for a tone to surface. In order to do so, a tone needs to coordinate temporally with a segment that carries F0. In other words, after a tone has been affiliated and aligned in the prosodic hierarchy, it needs to percolate down the prosodic tree till it reaches the segmental phonemes string. In doing so, it follows, in principle, the dominance relations within the tree; for example the H% tone in Figure 1 gets aligned with the right edge of the final syllable σ], percolates down to the right edge of the subordinated R], then to the right edge of the subordinated N], then to the right edge of the corresponding μ], till it reaches the right edge of the segment ə], where it is phonetically realized.[5] In order to describe this phenomenon we will use the term 'anchoring'. In sum, after having been affiliated and aligned, a tone needs to end up anchored to an element in the segmental string. Regarding anchoring, it has to be remembered that not all segments are equally suitable for the phonetic realization of tones: voiced vowels are always capable of allowing for the surfacing of tones, while unvoiced consonants are generally not (see, among others, Durand 1990: 249–250; Steriade 1991; Yip 2002: 73; Zec 1988).

Before moving on to the description of the intonational phenomena of Southern Valencian Catalan, we need to introduce another concept: the Tone Bearing Unit (TBU). Like in the case of the dual association of tones discussed above, the idea of TBU is characterized by the coexistence of different terminological traditions, which might cause misunderstandings. In most of the literature about Romance Languages, the TBU is thought of as the prosodic constituent that represents the docking site of the phonological association of tones. In this sense, the TBU is the syllable. For example, in Catalan the stressed syllable is the constituent where the PA has its affiliation and, in this sense, it is the TBU (cf. Figure 1).

On the other hand, the term TBU has been used with a different meaning in a range of studies about languages of other families and, more limitedly, also about Romance. In this second connotation – which is the connotation we use in this article – the TBU is not the docking site of the phonological association of tones but the timing unit for the realization of tones, as well as the domain for processes like tonal spreading or tonal-crowding-solving processes. Studies about typologically different languages (and especially the analyses of tonal crowding) argue that the timing unit for the realizations of tones is the mora, as discussed by Watkins (1984),

5 To put it in Ladd's (2008: 14) words, a "complete phonological description [of intonation] does not consist of abstract formulas alone, but must also specify how the abstract formulas are realised; that is, it must describe the mapping from the categorical phonological elements to the continuous acoustic parameters". For this reason, we think that our model needs to explain the mapping of phonological tones down to the position where they get anchored in the segmental phoneme tier. However, we do not think a phonological model needs to account for minor phonetic details like microprosodic variations in the timing of F0 movements and segments.

Zhang (2002) or Gordon (2004) for tonal languages, or by Roseano and Fernández Planas (2018) for some Romance varieties, among them Catalan.

Finally, for our analysis we need to recall the concepts of interpolation and spreading. Interpolation means that, when we look at how the tune is implemented phonetically, in intonational languages the F0 contour between two points where a tone is anchored continues smoothly from the first tonal value to the second, across all intermediate elements where no tone is anchored (see Féry [2016] for a review). If we look at scheme (a) in Figure 2, we see that the L* and H% points are joined by a straight line with no intermediate turning point or target.

Spreading is a concept frequently used in the description of tonal languages and less often when describing intonational languages. In spite of being comparatively less common in Romance, its presence is not as rare as it might seem, since it has been documented in French, Occitan, Portuguese, Italian, Friulian and Ladin (Frota et al. 2015; Jun and Fougeron 2000, 2002; Prieto et al. 2015; Roseano and Rodriquez, 2021; Sichel-Bazin et al. 2015). Importantly for this paper, it has also been described for Southern Valencian Catalan yes-no questions (Crespo Sendra 2011: 25–26, 143), as we will see in more detail below (Section 3). By tonal spreading, we mean the process by which a tone that is associated with one TBU becomes associated with adjacent TBUs (that is, in our case, with adjacent moras) thus expanding its temporal span. For example, in diagram (b) of Figure 2 the L* that is phonologically aligned with the right edge of the stressed syllable spreads to the following unstressed TBU, where we mark the phonetic inflection point of the F0 contour with L^S. In diagram (a) of the same figure, on the other hand, there is no tonal spreading.

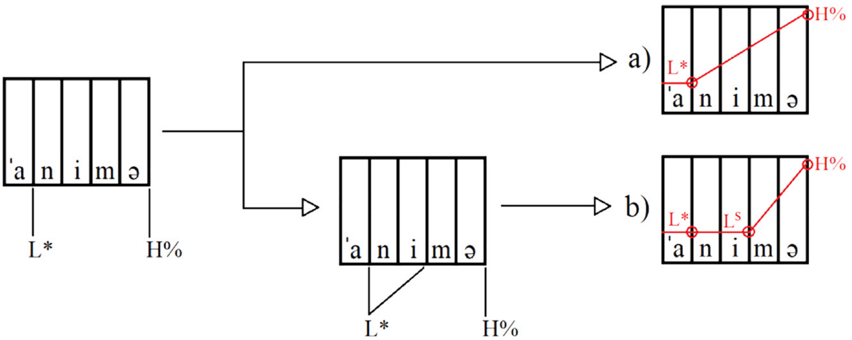


Figure 2: Schematic representations of the F0 contours resulting from (a) the interpolation between a L* target and a H% target, and (b) right-spreading of the L* tone. The panel on the right is a very simplified representation of the left panel (although in the following pages we will use again, for the sake of brevity, this simplified kind of phonological representation, we maintain that the appropriate phonological representation is the one in the left panel of Figure 1); the right panel is a broad phonetic representation; the panel in between represents the spreading process.

1.2 The autosegmental-metrical model and duration

In intonational languages, the AM model has been used very often to account for intonation but not equally often to deal with another part of prosody: duration. This is due largely to the fact that in most non-tonal languages F0 modulation is one of the main strategies used to encode information about sentence type. Nevertheless, several studies show that duration can play a similar role insofar as it can transmit pragmatic information about the sentence type (although not in all languages and often to a minor extent in comparison with intonation).

It has been known for some time that duration plays a role in expressing sentence type in some non-Indo-European languages (see, among others, Rischel's [1974] seminal account of West-Greenlandic Eskimo). The Romance languages of the Iberian Peninsula provide some examples of how duration can encode information about the sentence type. In Mieres Asturian (Díaz Gómez et al. 2007; López Bobo et al. 2005) and in Don Benito Extremaduran Spanish (Congosto Martín 2007a, 2007b; Congosto Martín et al. 2010), the prosodic difference between a broad focus statement and a yes-no question does not lie in the F0 contour (which is the same in both sentence types) but in duration: while statements contain only short vowels, the final vowel of a question is considerably longer. Something similar has been reported for Central Catalan (Prieto et al. 2009, 2015), where uncertainty statements and vocatives display a similar rise-fall in the F0 contour, and the difference between the two lies in the lengthening of the final vowel in vocatives.

The fact that in these cases duration is distinctive at the sentence level (as opposed to well-known cases in which duration is distinctive at the lexical level) leads us to conclude that it must be represented phonologically. The question is "what kind of formal representation should be attributed to durationally-specified contours to distinguish them from ordinary intonation contours?" (Hayes and Lahiri 1991: 78). To the best of our knowledge, there have been very few attempts to provide such a phonological representation (for a review see Muñiz Cachón and Roseano [2022]). The basic idea they all share is that, in AM terms, prosody is not the result of the interplay between the prosodic hierarchy and *two* tiers, but with *three* tiers: a segmental phonemes tier that contains vowels and consonants and *two* suprasegmental strings (one that contains tones, and another that contains what we could tentatively call 'durational phonemes'). Following Prieto et al. (2005: 391) and Roseano and Rodriquez (2021), we suggest that such durational phonemes can be thought of as prosodic moras that must be associated to the final vowel of the IP. In the following pages prosodic moras will be represented with μ^p in order to distinguish them from moras defined at the segmental level, which we represent with μ^s.

Figure 3 exemplifies the association of segments, tones and durational phonemes for the NC of a yes-no question in Don Benito Extremaduran Spanish. In contrast to Figure 1, three strings are represented in the lower levels: the segmental string (in green), the tonal string (in red) and the durational string (in blue). We assume that also durational phonemes, as tonal phonemes, have a dual association: the solid blue line in Figure 3 represents the affiliation of the prosodic mora with the IP, while the dotted blue line represents the secondary association of the mora with the vocalic nucleus of the last syllable of the IP.

The width of the last rectangle in the right panel of Figure 3 reflects the increased phonetic duration of the vowel – which is due to the presence of two moras (the segmental mora and the prosodic mora) – and the dotted line that divides the last rectangle symbolizes the border between the two moras in the long vowel.

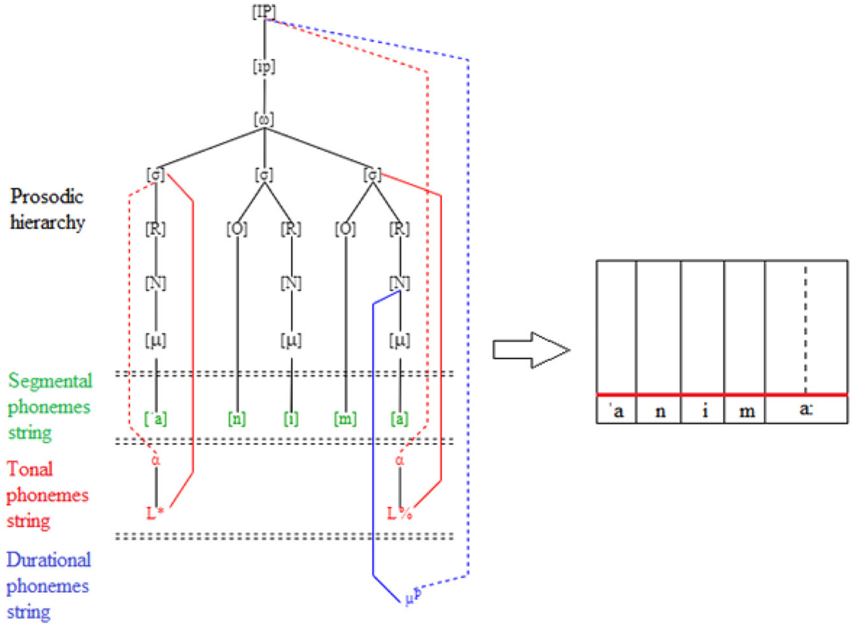


Figure 3: Phonological representation of the four planes that allow for the mapping of the prosody of the NC of the Extremaduran Spanish yes-no question 'Ánima?' (left panel) and schematic phonetic representation of the contour (right panel). Whereas the left panel corresponds to a phonological representation of the NC of the utterance including the tune and the durational phonemes, the right panel can be thought of as a broad phonetic representation of the same contour.

1.3 Tonal crowding and its effects on text and tune

Although the AM model "represents the tune and the text on separate tiers, such that the tiers cannot influence each other, there are situations in which they do in fact appear to do so. This is when there are conflicts between tune and text, for instance when there is not enough segmental material to bear a complex sequence of tones" (Roettger and Grice 2019: 266). The situation in which there are too many tones for the number of available TBUs is usually known as 'tonal crowding', and is observed especially at domain edges (Bennett 2015: 341). An example of tonal crowding in Catalan is the situation where a complex nuclear configuration with five tones like L+H* LHL% (which is used in insistent requests and insistent vocatives, see Prieto et al. [2015: 38, 46]) has to be realized on a monosyllabic imperative like *Ves!* ['bes] 'Go!' or on a monosyllabic vocative like *Ot!* ['ot] 'Otto!'.

When tonal crowding occurs, different types of phonological adjustment may arise in the process that leads to the underlying form being realized as the superficial form. As an example, we can consider a situation where a BT – which is phonologically aligned with the right edge of the IP – should be realized at the right edge of the final segment of an IP, but the segment in question is unvoiced (and therefore cannot bear a tone). The most likely possible outcomes are the following: (1) the BT gets anchored to the unvoiced segment (in this case the adjustment consists in not realizing the BT due to the fact that the TBU has no F0); (2) the BT gets anchored to the first voiced segment to the left of the unvoiced segment (in this case the adjustment consists in anchoring the BT in a location different from the one corresponding to the site it is phonologically aligned with); (3) an epenthetic vowel is added at the end of the phrase so that the BT can get anchored to a voiced segment in IP-final position; (4) the final segment of the IP is realized as voiced, allowing the BT to surface in the expected position. In the following paragraph, we will see how each of these outcomes is an example of a different kind of adjustment strategy.

Building on Gussenhoven (2004 [2009]: 145), Hanssen (2017: 34), Vigário et al. (2019), and Roettger and Grice (2019), we suggest that it is possible to distinguish between five different categories of adjustment. In general terms, some types of adjustments favour fidelity to the text, while others favour fidelity to the tune. In the first cases, it could be said, metaphorically, that the text drives the tune, while in the second the tune drives the text.

a) *Deletion of a suprasegment.* This adjustment, which has been described in intonation studies as 'tonal truncation', 'tonal deletion' or 'tonal undershooting', consists of the failure to realize an underlying tone. The outcome of (1) presented in the previous paragraph of this section is an example of this adjustment.

b) *Change in the anchoring of a suprasegment.* This adjustment may occur in situations such as the examples provided in the previous paragraph of this section (2). It entails realizing the tone at a point that does not correspond to the position within the prosodic constituent where it is aligned phonologically. Existing studies in intonation use various labels (among them 'tonal shifting', 'tone retraction', 'peak retraction', 'valley retraction' and 'tonal displacement') to describe changes of this kind.
c) *Change in the identity of a suprasegment.* Tonal crowding can be solved also by means of a change in the identity of the tones although this strategy seems to be very rare. In some varieties of Japanese, for example, if there is not enough segmental material for a complex a LH% sequence to be realized, tonal coalescence (Kubozono 2021) takes place and the tone surfaces as a mid tone (labelled M%).
d) *Insertion of a segment.* In cases of tonal crowding, some languages may insert vocalic moras to increase the number of available TBUs. This phenomenon has been reported in non-Romance languages (Hellmuth 2018) as well as in some Romance languages (as reported by Prieto and Ortega-Llebaria [2009]; Cruz [2013]; Grice et al. [2018]; Vigário et al. [2019], among others) and has been called 'vowel lengthening' (if an existing vowel is lengthened) or 'vowel epenthesis' (if a new vowel is added, as in [3] above).
e) *Change in the identity of a segment.* This is the case in outcome (4) above. To the best of our knowledge, it has not been described so far, at least in Romance languages.

1.4 Intonation in OT

OT (Prince and Smolensky 1993 [2004]) is a linguistic model that explains the relation between an underlying form (called input) and the corresponding surface representation (called output) by assuming that the latter satisfies a ranked series of conflicting constraints more adequately than other potential surface representations (called candidates). Constraints may be of three kinds: faithfulness constraints, markedness constraints, and alignment constraints.

The set of constraints (Con) is considered universal (McCarthy 2008: 31), meaning that differences between languages (and, crucially for this paper, also alternations and variation within the same language or within the same speaker) are attributed to differences in constraint rankings. The universality of constraints holds true also for the constraints that are at play at the text-tune interface. This means that OT studies devoted to a single case study like the prosody of Southern Valencian Catalan questions can contribute to a better understanding of the principles of intonational grammar in general, and not only of a specific language.

Different forms of OT have been put forward in the last decades, like the so-called classic OT (Prince and Smolensky 1993), the stochastic OT (Boersma and Hayes 2001) and Harmonic Serialism (McCarthy 2010). In this paper, which represents a first approach to text-tune interface in Southern Valencian Catalan, we first (Section 4.2) discuss the ranking of the different constraints in a classic OT perspective, and next (Section 4.3) we provide an overall analysis with Stochastic OT (Boersma 1997, 1998; Boersma and Hayes 2001).

In her influential handbook on tone, Yip (2002: 65–104) laid out the guidelines of how tone should be analysed in OT and in addition summarized earlier work. The OT research on tone represents a solid base for an OT approach to intonation since several constraints proposed for tonal languages can be easily adapted to intonational languages. Shortly after Yip published her handbook, Gussenhoven issued his well-known manual *The Phonology of Tone and Intonation*, which contained a chapter on intonation in OT (2004 [2009]: 143–169). In spite of his intention to inspire more OT analyses of intonation, studies of this kind remain more limited in number than might be expected considering the abundance of OT literature on tone. The aspects of intonation that have been dealt with from an OT approach are the following:

1) *Intonation and syntax (especially phrasing).* As Gussenhoven pointed out more than a decade ago (2004 [2009]: 144), the intonation-syntax interface (with special attention to phrasing) is unquestionably the aspect of prosody on which most work in OT has been carried out. Among the most recent or most influential studies of this kind on non-Romance languages are Truckenbrodt (1995, 1999, 2005), Selkirk (2000), Samek-Lodovici (2006), Hellmuth (2006), Myrberg (2010), Kisseberth (2010), Smith (2011), Henderson (2012) or Schubö (2020). Several studies deal with the same type of phenomena in Romance varieties, such as Post (2002, 2011), Gutiérrez-Bravo (2003), Féry (2004, 2006), Prieto (2005, 2006a, 2006b), Elordieta et al. (2005), Rao (2007), and Feldhausen (2010, 2011, 2016).
2) *Intonation and focus.* Another prosodic aspect that has been the object of some attention within OT is the relation between intonation and focus. In addition to well-known studies on non-Romance languages (like Elordieta 2007 and Selkirk 2008), some recent studies have been published on Romance varieties (Feldhausen and Vanrell 2014, 2015; Gabriel 2006, 2010; Samek-Lodovici 2019).
3) *Intonation and lexical tone.* Some attention has also been given to the interplay between intonation and lexical tone. The best-known contributions in the

framework of OT on this subject are those by Gussenhoven and van der Vliet (1999), Gussenhoven (2000) and de Lacy (2002).

4) *Text-tune interface.* As was mentioned in the introduction, the text-tune interface is one of the aspects of prosody that has received less attention within OT. To the best of our knowledge, there are only seven OT analyses entirely or partly dedicated to this subject (Cabré et al. 2015; Gussenhoven 2000; Gussenhoven 2004 [2009]; Levi 2002; Roseano and Fernández-Planas 2018; Rodriquez 2020; Rodriquez et al. 2022), with only the four most recent ones dealing with Romance languages.

Gussenhoven (2000, 2004 [2009]) puts forward a substantial set of constraints on intonation, which are often borrowed from previous studies on tonal languages. Among the fidelity constraints, the most noteworthy are those belonging to the Max(T) family, which prevent underlying tones from being elided. Markedness constraints are more heterogeneous and include NoRise (which penalizes rising contours), *Spread (which acts against tonal spreading), *Crowd (which states that a TBU should not be associated with more than one tone), *Contour (which acts against complex tones) and OCP (which states that consecutive identical tones are prohibited). Nevertheless, perhaps the most relevant contribution of Gussenhoven's analysis is the emphasis on the need for two types of constraints, which he names 'alignment constraints' and 'association constraints'. Alignment (Align) constraints determine the location of a tone relative to the constituents of the prosodic hierarchy. They do so by stipulating that the right/left edge of a tone should coincide with the right/left edge of a prosodic constituent (for example in Gussenhoven's [2000] account of Roermond Dutch, Align-T* requires the starred tone of the pitch accent to be aligned with the head of the foot). Association constraints (Assoc), on the other hand, set preference rules for the anchoring of a tone with a segment. Later in our paper, in order to avoid the terminological confusions mentioned in Section 1.1, we prefer to use 'anchoring constraints' instead of association constraints; such change only affects the label and not the nature of the constraints.

Levi's (2002) account of text-tune accommodation in Turkish shows a clear preference for markedness constraints. In addition to *Contour, the author postulates four well-formedness constraints that require prosodic constituents on upper levels to have at least one PA and one BT. Specifically, IP=T* and AP=T* require each Intonational Phrase and each Accentual Phrase to have at least one T* pitch accent, while IP=T% and AP=T- stipulate that each Intonational Phrase must have at least one T%, and each Accentual Phrase must have at least one T- boundary tone.

In their analysis of Spanish, Catalan and Friulian, Roseano and Fernández Planas (2018), in addition to Max(T) and *Crowd, use a variant of Dep(μ), which prohibits the insertion of moras that are not present in the underlying representation.

More recently, Rodriquez's (2020) account of text-tune accommodation in Sicilian introduced Align(T*,ˈσ), an alignment constraint that requires the stressed tone of a PA to be aligned with a stressed syllable.

The studies mentioned above provide an OT account of some – though not all – of the text-tune adjustments presented in Section 1.3. Tonal truncation has been dealt with by Levi (2002), Gussenhoven (2004 [2009]), Roseano and Fernández-Planas (2018), and Rodriquez (2020). Changes in the alignment or association of tones have been analysed by Gussenhoven (2000, 2004 [2009]) and Rodriquez (2020). Of the two possible forms of insertion of segments, vowel lengthening, is discussed by Roseano and Fernández-Planas (2018), while vowel insertion has been described in OT terms by Rodriquez et al. (2022).

2 Materials

The data we analyse in this paper are recordings of 74 yes-no questions that form part of the *Interactive Atlas of Valencian Intonation* (Prieto and Crespo-Sendra 2011). We specifically focus on seven localities (Sueca, Xàtiva, Gandia, Dénia, Gata, Tàrbena and Muro d'Alcoi) where the NC of this sentence type is the same one we describe in Section 3 below. The utterances were recorded by means of a Discourse Completion Task (Vanrell et al. 2018), which is a technique that consists of presenting the speakers with an everyday situation and asking them to utter the sentence they would use in a context. Example (A) below shows one of the 11 contexts to which, in the recordings of the *Interactive Atlas of Valencian Intonation*, the informants reacted by producing the tune we analyse in this paper.[6]

(A) Interviewer: You enter a store that you have never been in before and ask if they have tangerines.
Speaker A: Do you have any tangerines?
Speaker B: Do you sell any tangerines here?

6 The tune we analyse in this article has been used in four contexts that had been designed to elicit information-seeking yes-no questions (*Tenen mandarines?* 'Do you have any tangerines?'; *Pots portar-lo?* 'Can you bring him?'; *Ja ha arribat, Maria?* 'Has Maria arrived already?'; *Has vist a Maria?* 'Have you seen Maria?'), two contexts designed for incredulity yes-no questions (*Encara tens fam?* 'Are you still hungry?'; *Encara no ha vingut?* 'Hasn't he arrived yet?'), two contexts created to obtain confirmation yes-no questions (*Tens fam?* 'Are you hungry?'; *Vindràs a dinar, no?* 'You'll be here for dinner, won't you?'), two contexts conceived for neutral echo questions (*És la una?* 'It's one o'clock?'; *És Maria la que ve?* 'It's Maria who's coming?), and one context for incredulity echo questions (*Jaume es presenta per a alcalde?* 'Jaume's running for mayor?').

Table 1: Number of utterances per type of nuclear word in the dataset.

Stressed syllable	Last segment of the nuclear word	*n*	Examples
Penultimate	Vowel	34	*una* 'one o'clock', *portar-lo* 'bring him'…
	Unvoiced consonant	13	*mandarines* 'tangerines', *Carlos* 'Charles'…
Final	Vowel	8	*no* 'won't you?', *ve* 'coming'…
	Unvoiced consonant	13	*vingut* 'arrived', *veritat* 'really'…
	Voiced consonant	6	*fam* 'hunger', *dinar* 'lunch'…
Total		**74**	

The speakers are relatively free to choose the words they use (e.g., Speaker A uses 'tangerines' in nuclear position, while Speaker B uses 'here'). This implies that the yes-no questions we analyse have nuclear words with different characteristics in terms of accentual position (the stressed syllable is either the final or the penultimate syllable) and structure of the final syllable of the utterance (it may have a voiced coda, an unvoiced coda, or no coda at all). Table 1 describes the most important features of the final words of utterances in terms of accent position and last segment. For each kind of word, we provide the number of times it appears in the corpus. In addition, the table also contains some examples. As we will see in Section 3, the characteristics of the nuclear word contribute to determining how suprasegments surface.

The intonation of the utterances was annotated in Praat textgrids (Boersma and Weenink 2021) following the conventions of the Cat_ToBI system (Prieto et al. 2009, 2015). In addition to symbols commonly used by Cat_ToBI for tones, on a separate tier we recorded the presence of vowel lengthening due to prosodic mora (see Section 1.1).

3 Descriptive generalization

According to the descriptions provided by Prieto and Cabré (2007–2012, 2013), in most continental varieties of Catalan the default intonational pattern of yes-no questions is characterized by a NC with a L* tone aligned with the right edge of the stressed syllable and a H% tone aligned with the right edge of the intonational phrase. This pattern may be found in information-seeking yes-no questions, as well as in yes-no questions with other pragmatic functions (such as confirmation-seeking questions and echo questions). Figure 5 provides an example of this kind of nuclear configuration: we can observe that the L* nuclear pitch accent, which is phonologically aligned with the right edge of the stressed syllable, gets anchored at the end of the vowel [ˈu]). The H% boundary tone, which is phonologically aligned with the right edge of the last syllable of the IP, is accordingly anchored at the end of the vowel [ə]. This configuration is the same as that presented schematically in the right panel of Figure 1.

The intonation pattern of Southern Valencian yes-no questions, which has been described in previous research (Prieto 2001; Martorell et al. 2007; Crespo-Sendra 2010, 2011, 2013), is similar to the configuration described above but with some differences. The phonological representation of the tune of the NC is the same as in Central Catalan (i.e., L* H%) (Crespo Sendra 2011: 25–26, 87, 92, 144). Nevertheless, the contour of Southern Valencian differs from Central Catalan in two aspects:

a) On the one side, there is a lengthening of the last syllable of the utterance (Crespo Sendra 2011: 56, 2013: 54) and, specifically, of its vocalic nucleus. As we will see later, we argue that such lengthening is due the presence of a prosodic mora.
b) On the other side, the final rise begins later in Valencian. Specifically, while in Central Catalan the final rise begins at the end of the stressed syllable, "in Valencian, the L* tone of the nuclear accent spreads to the last syllable of the utterance and, therefore, the final inflection begins in the central part of the last syllable of paroxytone and proparoxytone words, and in the second part of the stressed syllable in the case of the oxyton words" (Crespo Sendra 2011: 65). The idea of L* right-spreading is consistently presented in other passages about the NC of Southern Valencian Catalan (Crespo Sendra 2011: 61, 81, 88; Crespo Sendra 2013: 549).

In other words, the final vowel of the utterance is lengthened and the rise from L to H takes place during the second half of the vowel in question. In the example provided in Figure 5, one can observe that the L* target has already been reached at the end of the stressed syllable (which means, as in the previous example, at the end of the vowel [ˈu]), and the H% boundary tone is realized at the right edge of the last segment of the IP (i.e., at the end of the vowel [a], exactly as we saw in Figure 4). The first difference between this example and the previous example from Central Catalan is that, as described in the studies mentioned above, the final vowel /a/ is realized as long. As we have argued in Section 1.2, this vowel lengthening can be thought of, in phonological terms, as the result of the existence of an underlying prosodic mora (μ^p). The fact that the extra length is due to the prosodic mora is represented on the bottom tier of Figure 5, and on the IPA tier of the same figure we use two vowels (i.e., [a a]), each of which represents a vocalic mora. Since in Catalan

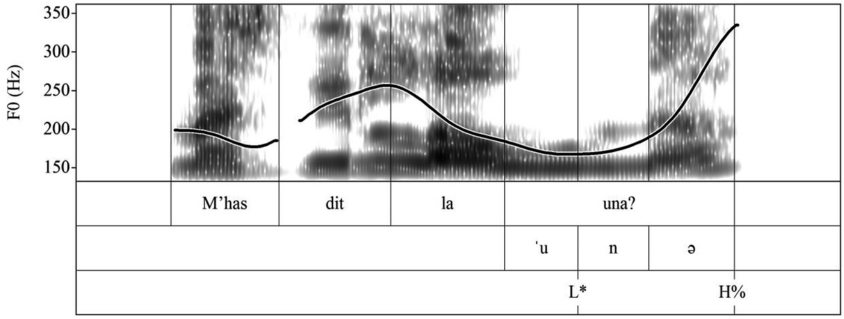


Figure 4: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the NC of the echo yes-no question *M'has dit la una?* 'You said it's one o'clock?' uttered by a speaker of Central Catalan from Vilafranca del Penedès.

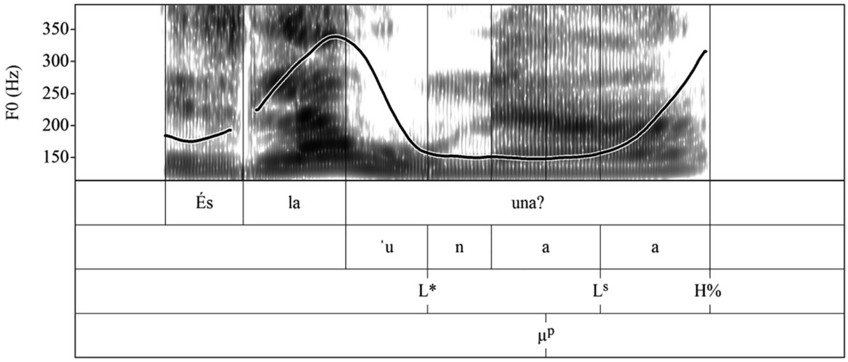


Figure 5: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the NC of the yes-no question *És la una?* 'Is it one o'clock?' uttered by a speaker of Southern Valencian Catalan from Xàtiva.

phonologically bimoraic vowels do not exist, we assume that the second vocalic mora constitutes the nucleus of a separate syllable [ˈu.na.a].[7]

The second relevant difference between the example in Figure 5 and the previous example from Central Catalan is that, after the L* is reached, the F0 contour remains low until the end of the first mora of the final vowel, instead of rising directly towards the final H% target as one would expect as a consequence of interpolation. This means that the L* spreads to its right and associates with all TBUs (i.e., moras) that do not bear a tone.

7 As we will see later (Figures 13, 14b, 18 and 19d), this assumption is also needed to correctly represent some of the cases in our dataset.

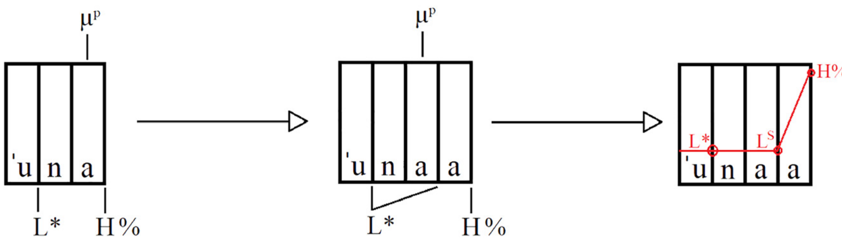


Figure 6: Simplified phonological (left) and broad phonetic (right) schematic representations of the nuclear word *una* ‘one o’clock’ of a yes-no question in Southern Valencian Catalan.

If we want to represent this configuration with a diagram similar to those in Figures 1–3, we can do so as in Figure 6 (in this case, for typographical clarity, we have placed the tonal tier below the segmental tier and the durational tier above). Once again, we see that the L* tone is aligned with the right edge of the stressed syllable and that it spreads to the right edge of the following TBU (i.e., [na]). After remaining low until the right edge of this syllable, the F0 rises towards the H% tone that is phonologically aligned with the right edge of the IP (and anchored to the right edge of the last vowel).

When – like in Figures 5 and 6 – the nuclear word bears the stress on the penultimate syllable and ends with a vowel (which occurs 34 times in our dataset), all underlying elements – both segments (i.e., /ˈuna/) and suprasegments (i.e., the tones L* and H%, as well as the vocalic prosodic mora μ^p) – are mapped in a faithful and straightforward way, in the sense that (a) all segments and suprasegments surface, (b) there is no epenthetic element, and (c) suprasegments are anchored to the expected elements of the segmental string. For this reason, we will refer to this mapping as canonical. In the following subsections, which are organized according to the accentual and syllabic characteristics of the nuclear words, we will present cases where the mapping is not so simple.

3.1 Nuclear words with stress on the penultimate syllable and a final unvoiced consonant

When the nuclear word bears its stress on the penultimate syllable and the final segment of the utterance is an unvoiced consonant (such as [mandaˈrines] ‘tangerines’), all of the items (13) in our dataset show the same solution, which is exemplified in Figure 7. The main way this differs from the example in Figure 6 is that the H% tone does not surface at the right edge of the final segment of the IP

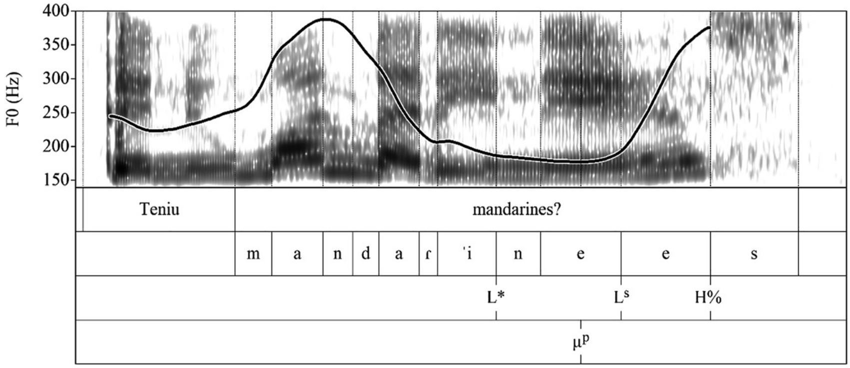


Figure 7: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the NC of the yes-no question *Teniu mandarines?* 'Do you have any tangerines?' uttered by a speaker of Southern Valencian Catalan from Gandia.

(which is an unvoiced consonant and, therefore, cannot bear tone) but at the right edge of the penultimate segment, which is a vowel.

Figure 8 provides a schematic representation of this nuclear configuration. Once again, we see that the L* tone is phonologically aligned with the right edge of the stressed syllable and that it spreads to the right edge of the following TBU. On the other hand, the H% tone that is phonologically aligned with the right edge of the IP becomes disassociated from the unvoiced consonant in IP-final position and reassociates with the preceding vowel so that it gets anchored to a voiced segment allowing it to surface. As a result, phonetically the F0 contour remains low up until the end of the first TBU after the stressed syllable, where it rises and continues towards the H% tone that surfaces at the right edge of the last vowel of the IP.

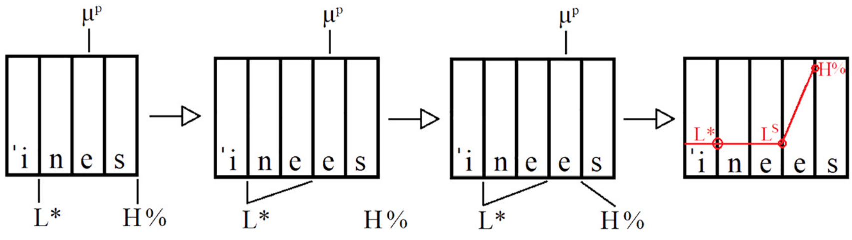


Figure 8: Simplified phonological (left) and broad phonetic (right) schematic representations of the nuclear word *[mandar]ines* '[tanger]ines' of a yes-no question in Southern Valencian Catalan.

3.2 Nuclear words with stress on the final syllable and no coda

When the nuclear word bears its stress on the penultimate syllable and the final syllable has no coda (like ['βe] 'comes' or ['no] 'won't you?'), we find two patterns in our dataset, which are exemplified in Figures 9 and 10. The first appears six times in our data and the second twice. The first model (Figure 9) differs from the canonical realization in only one respect: the L* tone aligned with the right edge of the stressed syllable does not right-spread (because the right edge of the following TBU is already occupied by the H% tone). The second pattern (Figure 10), on the other hand, differs from the canonical realization in three respects. The first, and possibly the most

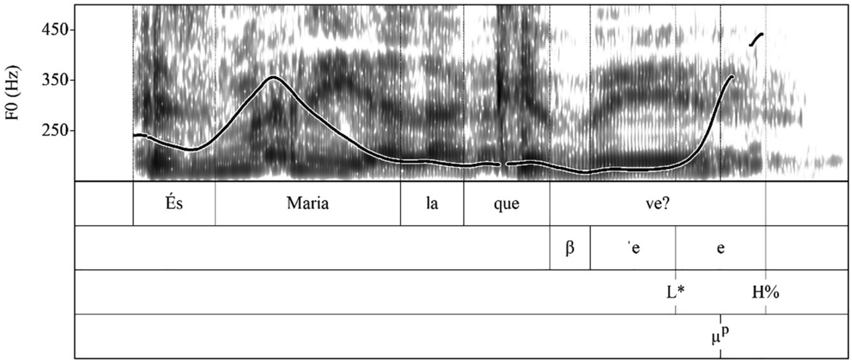


Figure 9: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *És Maria la que ve?* 'Is it Maria who's coming?' uttered by a speaker of Southern Valencian Catalan from Sueca.

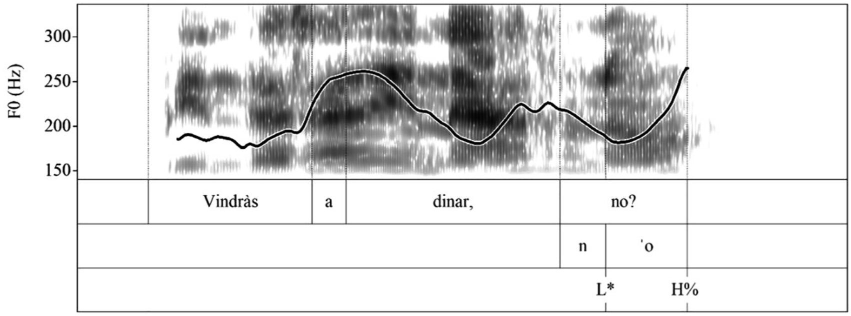


Figure 10: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Vindràs a dinar, no?* 'You'll be back for lunch, won't you?' uttered by a speaker of Southern Valencian Catalan from Muro d'Alcoi.

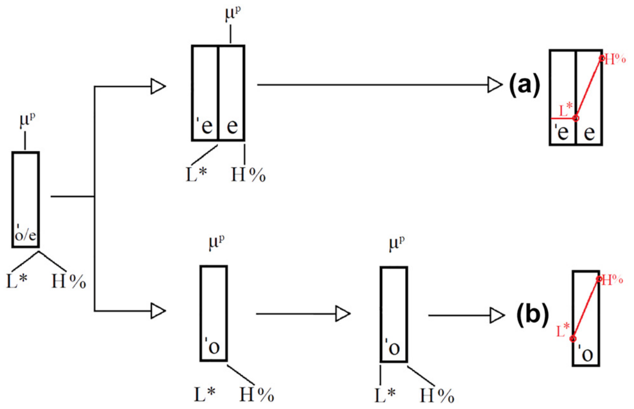


Figure 11: Simplified phonological (left) and broad phonetic (right) schematic representations of the nuclear words *[v]e* 'come' and *[n]o* 'won't you' of a yes-no question in Southern Valencian Catalan.

relevant, difference is that there is no vowel lengthening, i.e., the prosodic mora (μ^p) does not become associated with any element of the segmental tier and does not surface. The second difference lies in the phonetic position of the L* tone, which surfaces at the left edge of the stressed vowel. The third difference is that the L* tone does not spread.

A schematical representation of the nuclear configurations of Figures 9 and 10 is shown in Figure 11. Observe that in the first mapping (a) the L* tone does not spread, and the H% tone gets anchored to the right edge of the last segment of the IP. In the second one (b) not only does spreading not take place, but the L* disassociates from the right edge of the stressed vowel and reassociates with its left edge. In addition, the prosodic mora (μ^p) disassociates and remains floating.

3.3 Nuclear words with stress on the final syllable and unvoiced coda

When the nuclear word bears its stress on the final syllable and the final consonant is expected to surface as unvoiced (such as in [βiŋ'gut] 'arrived'), our data show two different patterns. The most common pattern, which is found four times, is exemplified in Figure 12, while the other (Figure 13) only appears twice. The contour in Figure 12 differs in some ways from the canonical realization of the nuclear configuration. Firstly, we observe that the H% tone does not get anchored to the right edge of the final segment of the IP (which is an unvoiced consonant and, thus, cannot bear a tone) but to the right edge of the penultimate segment, which is a vowel. In

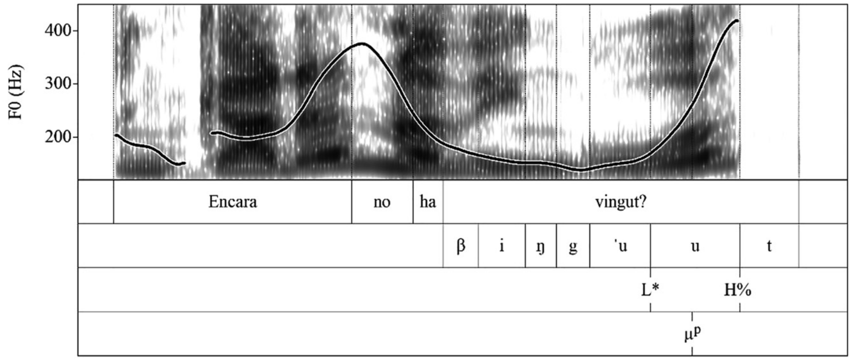


Figure 12: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Encara no ha vingut?* 'Hasn't he/ she arrived yet?' uttered by a speaker of Southern Valencian Catalan from Gata.

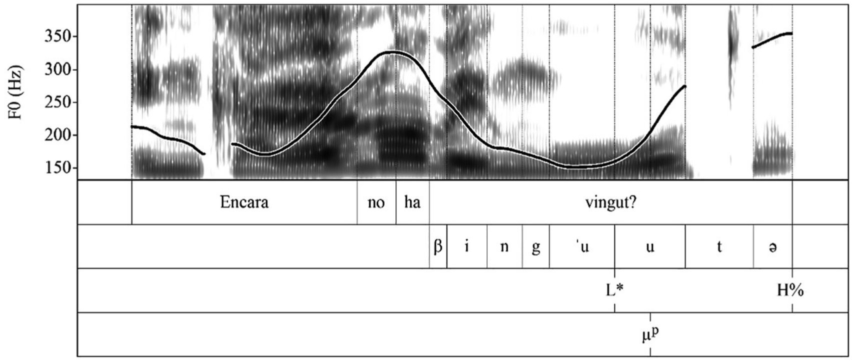


Figure 13: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Encara no ha vingut?* 'Hasn't he/ she arrived yet?' uttered by a speaker of Southern Valencian Catalan from Xàtiva.

addition, the L* tone aligned with the right edge of the stressed syllable does not right-spread because the right edge of the following TBU is associated with the H% tone.

The second pattern we find in our data (Figure 13) is characterized by the absence of spreading of the L* tone. In addition, it displays a feature we have not seen so far and which will emerge again in Section 3.4: an epenthetic schwa is inserted at the end of the utterance, and the H% tone is anchored to its right edge. The insertion of this [ə] is not documented in other contexts in Southern Valencian Catalan, therefore we deem it to be a case of intonationally triggered schwa insertion similar – although, as we will see in Section 5, not identical – to what happens in

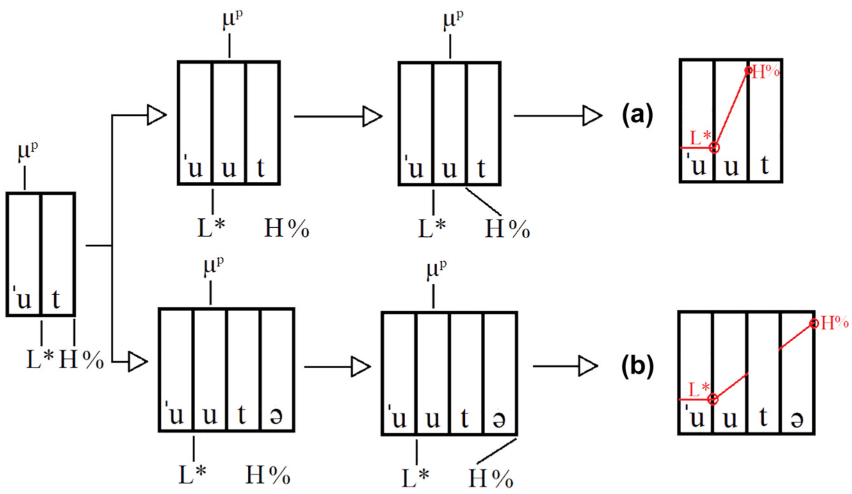


Figure 14: Simplified phonological (left) and broad phonetic (right) schematic representations of the nuclear word *[ving]ut* 'arrived' of a yes-no question in Southern Valencian Catalan.

Lisbon Portuguese (Frota et al. 2016) and Bari Italian (Grice et al. 2018). In Southern Valencian Catalan the schwa is inserted to avoid having an unvoiced segment in IP-final position so that the H% tone can appear at the right edge of the IP. In sum, we observe that the L* tone is anchored at the right edge of the stressed syllable ['gu], there is no spreading of L* to the following [u], and H% is anchored to the final epenthetic [ə].

Figure 14 presents the schematic representations of the realizations of the NC we have observed in this section. In each diagram, all suprasegments surface (both the L* and H% tones, as well as the prosodic mora μ^p). In the second mapping (b) there is an intonation-driven epenthetic schwa, which allows the H% tone to become disassociated from the unvoiced consonant and to be reassociated with the right edge of the schwa so that it is aligned with the right edge of the final segment of the IP. As mentioned above, the L* tone is anchored at the right edge of the stressed syllable ['gu] and there is no spreading of L* to the following [u].

3.4 Nuclear words with stress on the final syllable and voiced coda

Utterances ending with a word that bears its stress on the final syllable and has a voiced coda (like ['fam] 'hunger' and [di'naɾ] 'to have lunch') display an even higher degree of variability. In fact, four patterns are found in our data. The most common, which appears nine times, is the pattern exemplified in Figure 15, while the remaining three are less frequent: the pattern shown in Figure 16 is observed twice, and the other two (Figures 17 and 18) only once.

In the most frequent pattern (Figure 15) all suprasegments surface and the L* tone spreads to the right edge of the following vowel, as in the canonical realization. The most remarkable feature of this pattern is the presence of an IP-final epenthetic schwa, whose right edge the H% tone gets anchored to. The final schwa is added in order to have a better (i.e., higher in the sonority scale) anchoring element than the subjacent final /m/.

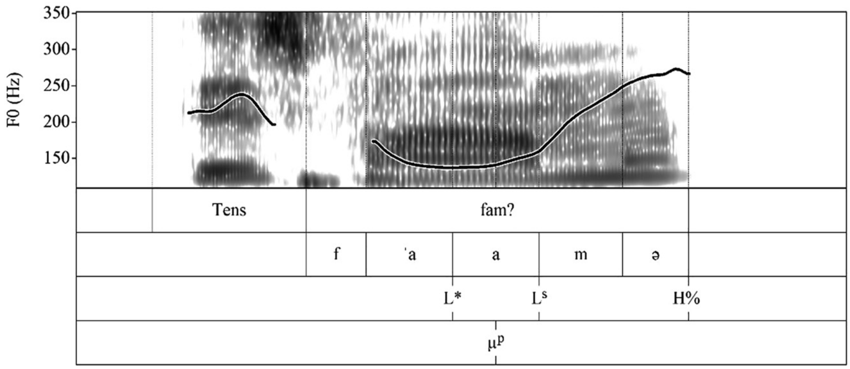


Figure 15: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Tens fam?* 'Are you hungry?' uttered by a speaker of Southern Valencian Catalan from Xàtiva.

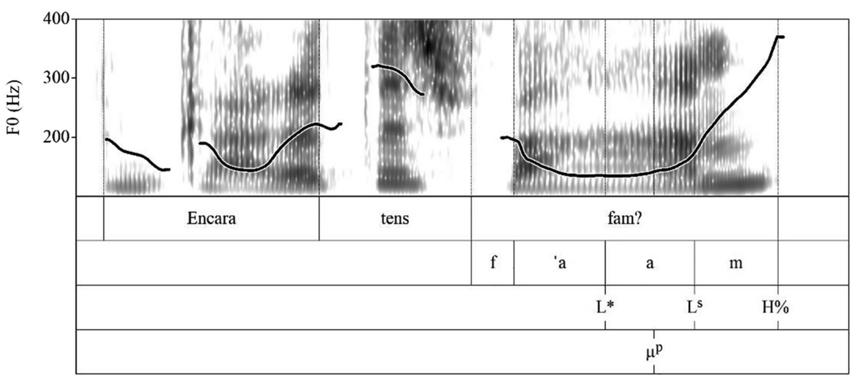


Figure 16: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Encara tens fam?* 'Are you still hungry?' uttered by a speaker of Southern Valencian Catalan from Gata.

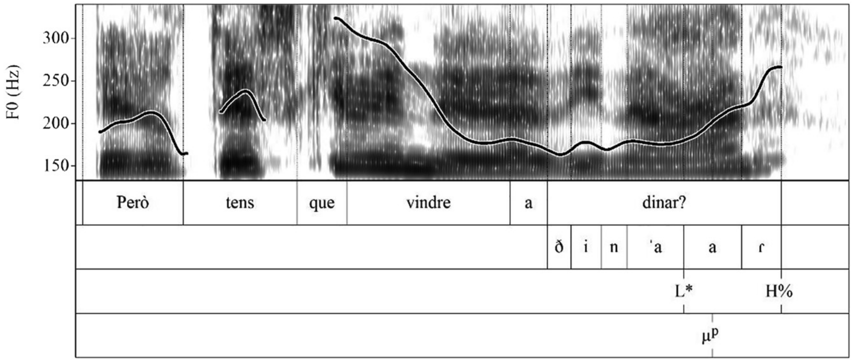


Figure 17: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Però tens que vindre a dinar?* 'Do you have to come for lunch?' uttered by a speaker of Southern Valencian Catalan from Gata.

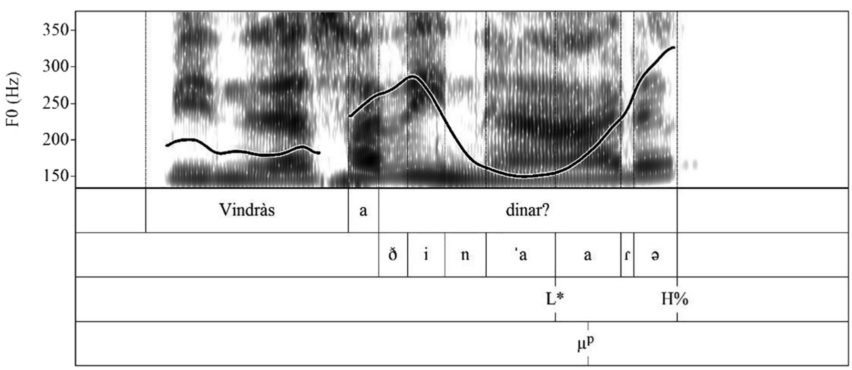


Figure 18: Spectrogram, F0 contour, orthographic transcription by word, broad phonetic transcription and prosodic transcription of the nuclear word of the yes-no question *Vindràs a dinar?* 'Will you come for lunch?' uttered by a speaker of Southern Valencian Catalan from Xàtiva.

The second pattern we observed (Figure 16) displays right-spreading of the L* tone up to the right edge of the following vowel, as in canonical realizations. The most interesting feature of this mapping is the fact that – since there is no epenthetic schwa – the final tone is anchored to the right edge of a voiced consonant (the final /m/).

The third pattern (Figure 17) is similar to the one described in Figure 16, with a singular, important difference: the L* tone does not spread, meaning that the F0 contour starts rising from the end of the stressed syllable (as in Figure 13) and reaches the H% target at the end of the final consonant (which, as in the previous case, acts as a TBU).

The fourth and final pattern found (Figure 18) is similar to the previous realization (Figure 17) insofar as the L* tone does not spread and the F0 contour begins to rise at the end of the stressed syllable and continues towards the H% target, which in this case, unlike in the previous pattern, does not get anchored to the realization of the subjacently final consonant /ɾ/ but to an IP-final epenthetic schwa.

Figure 19 shows the schematic representations of the four different realizations of the NC described in this section. In each case, all suprasegments (the L* and H%

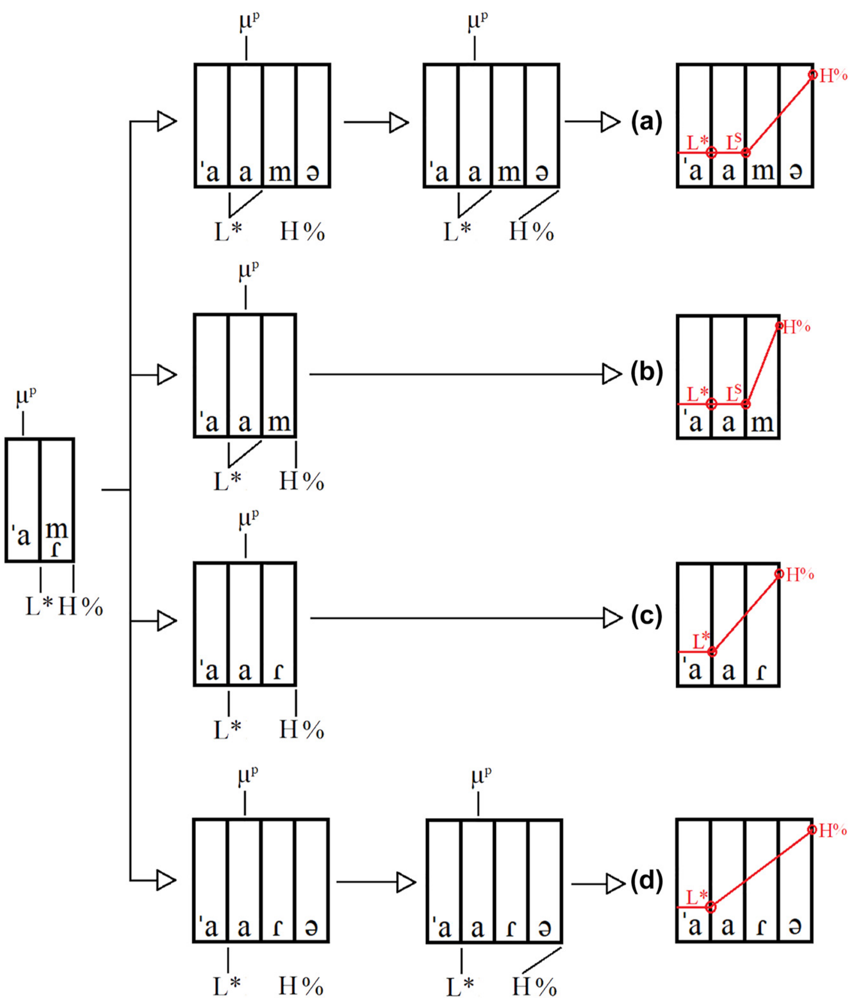


Figure 19: Simplified phonological (left) and broad phonetic (right) schematic representations of the nuclear words *[f]am* ‘hunger’ and *[din]ar* ‘have lunch’ of a yes-no question in Southern Valencian Catalan.

tones, as well as the prosodic mora) surface. Nevertheless, in the first two realizations, i.e. (a) and (b), the L* spreads to the following vowel, while in the second two, (c) and (d), it does not. The realizations represented in (a) and (d) also display a very remarkable feature: a prosodically driven epenthetic schwa, which allows the H% tone to be anchored to the right edge of a vowel in IP-final position (this implies that the H% tone first has to disassociate from the nasal consonant /m/ and then reassociate with the epenthetic schwa in IP-final position). In (b) and (c) on the other hand, H% is anchored to an IP-final voiced consonant.

4 OT analysis

In this section we develop the OT account of the data presented in Section 3. Firstly, we present the constraints needed for our analysis (Section 4.1). When doing this, we endeavour to use general constraints rather than those that target language-specific structures. In the second subsection (Section 4.2), we discuss the ranking arguments in a classic OT perspective. Finally, (Section 4.3), we put forward a Stochastic OT analysis that summarizes the results and provides a general view of the part of the intonational grammar of Southern Valencian Catalan that emerges from our data.

4.1 Constraints

Since the data we have described in Section 3 show a considerable amount of variation, it is not surprising that the number of constraints needed to account for it is relatively high (nine it total). The first two constraints deal with vowel length.

For our analysis we need a constraint (1) that requires all prosodic moras to surface, which is a specification of the more general Max-IO(μ) found in Hoshi (1998). In addition, we need a constraint (2) that discourages the insertion of moras that are not present in the segmental string, which is a variant of Dep-IO(μ) found in Hume et al. (1997).

(1) Max-IO(μ^{p}): assign a violation mark for every μ of the durational string in the input that does not have a corresponding μ in the output.

(2) Dep-IO(μ^{s}): assign a violation mark for every μ in the output that does not have a corresponding μ in the segmental string of the input.

To account for intonational phenomena, our subset of Con has to include two constraints that deal with tonal anchoring, both inspired in Myer's (1997) Align-R. Specifically, constraint (3) requires that an IP-final boundary tone (T%), which is phonologically aligned with the right edge of the IP, is also phonetically anchored to the right edge of the IP. To the best of our knowledge, this constraint is not language-specific in that it can apply to all intonational languages. Constraint (4), on the other hand, requires that the starred tone (L*) of a pitch accent, which is phonologically aligned with the right edge of the stressed syllable, is also phonetically anchored to the right edge of the same syllable. (4) is more language-specific, insofar as it is active in all varieties of Catalan and Spanish spoken in the Iberian Peninsula but not necessarily in other Romance varieties.

(3) Anchor(T%,Rt,IP,Rt): assign a violation mark for each TBU (μ) that intervenes between the anchoring point of the BT and the right edge of the IP.

(4) Anchor(L*,Rt,'σ,Rt): assign a violation mark for each TBU (μ) that intervenes between the anchoring point of the L* and the right edge of the stressed syllable.

As suggested by Gussenhoven (2004 [2009]) we also need constraints that set preference rules for the anchoring of a tone with a type of segment (cf. Section 1.4). In connection with this, one has to bear in mind that not all segments are equally capable of being the anchoring point for tones: voiced vowels are always capable of bearing tones, while voiced consonants are less suitable (cf. Section 1.1). We believe that the constraints which best capture the different tone-bearing capabilities of segments are those presented in (5) and (6). Constraint (5) states that vowels are better anchoring points than consonants, while (6) sets a preference for voiced segments over unvoiced segments. For this paper, these two restrictions are sufficient, but future research may show that we need to be more specific and distinguish between sonorant and non-sonorant consonants as argued by Yip (2002: 73) and Gussenhoven (2000: 19).

(5) *Anchor(T,C): assign a violation mark for every tone that gets anchored to a consonant.

(6) *Anchor(T,-voice): assign a violation mark for every tone that gets anchored to an unvoiced segment.

Three more constraints are needed to account for the instances of tonal movement, i.e., cases of spreading and of tone retraction. Regarding the constraint that favours spreading, we follow McCarthy (2011), who argued that Share(F) is the family of markedness constraints that accounts best for this kind of phenomena. We simply need to modify this very general formulation of the constraint so that it can account for the type of spreading we have observed in Valencian Catalan, i.e., spreading of the starred tone within the NC (7). On the other hand, the very general restriction that acts against spreading (but also against other types of tonal movement like tonal retraction) is DEP-IO(ASSOCIATE) (labelled as *ASSOCIATE (8) in Yip [2002]). The same author also put forward another constraint that disfavours tonal movements and the presence of floating suprasegments: MAX-IO(ASSOCIATE) (which appears as *DISASSOCIATE in Yip [2002] (9), which prohibits the deletion of association lines.

(7) SHARE(T*,NC): assign a violation mark for every toneless[8] TBU (μ) that lies in the nuclear configuration and that is not linked to T*.

(8) DEP-IO(ASSOCIATE): assign a violation mark for every association line in the output that is not present in the input.

(9) MAX-IO(ASSOCIATE): assign a violation mark for every association line in the input that is not present in the output.

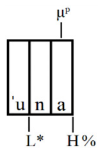
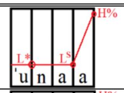
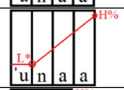
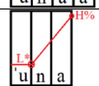
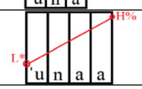
4.2 Ranking arguments

4.2.1 Nuclear words with stress on the penultimate syllable and final vowel

In Section 3 (Figures 5 and 6) we saw that the canonical realization of the NC is found in words that bear the stress on the penultimate syllable and end with a vowel, such as [ˈuna] 'one o'clock'. Tableau (10) shows that the winning candidate (a) violates DEP-IO(μ^s) (because the final vowel is lengthened) and DEP-IO(ASSOCIATE) (because tonal spreading adds an association line that was not present in the input). This allows us to conclude that DEP-IO(μ^s) and DEP-IO(ASSOCIATE) are ranked below the other constraints. Other possible outcomes of constraint interaction – not found in our data – are characterized by the lack of spreading of the starred tone (which means violating SHARE(T*,NC), like candidate (b) or by failing to realize the prosodic mora like candidate (c) (which means violating MAX-IO(μ^p), but also MAX-IO(ASSOCIATE) because the association line of the prosodic mora is deleted) or by valley retraction (a solution that violates, among other constraints, ANCHOR(L*,Rt,ˈσ,Rt), as in the case of candidate (d).

8 By toneless we mean that the TBU does not bear any *phonological* tonal target, and not that it does not *phonetically* have F0. In other words, if F0 is the result of interpolation, the TBU is considered toneless for the purposes of this constraint.

(10)

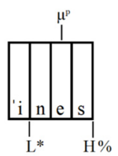
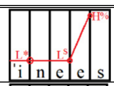
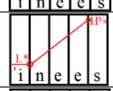
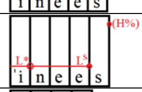
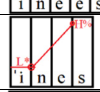
	Anchor (T%,Rt,IP,Rt)	*Anchor(T,C)	*Anchor(T,-voice)	Anchor(L*,Rt,'σ,Rt)	Max-IO(Associate)	Max-IO(μP)	Share(T*,NC)	Dep-IO(μS)	Dep-IO(Associate)
									
a. ☞ 								*	*
b. 							*	*	
c. 					*	*			
d. 				*	*		*	*	*

4.2.2 Nuclear words with stress on the penultimate syllable and a final unvoiced consonant

In Section 3.1 we described the only realization of the NC that we found in our data in cases where the nuclear word bears its stress on the penultimate syllable and ends with an unvoiced consonant as in [manda'rines] 'tangerines' (Figures 7 and 8). Tableau (11) shows that the winning candidate (a) violates Dep-IO(μ^S) (because the last vowel is lengthened), Anchor(T%,Rt,IP,Rt) (because there is a μ that intervenes between the boundary tone and the right edge of the IP), Max-IO(Associate) (because, as we have seen in Figure 8, the H% tone is disassociated from the IP-final unvoiced consonant before being reassociated with the preceding vowel), and Dep-IO(Associate) (for two reasons: because the H% tone is reassociated with a new association line to the preceding vowel, and because tonal spreading adds an association line that was not present in the input). This allows us to conclude that these four constraints are dominated by the remaining six.

Other possible outcomes are represented by candidates (b), (c), (d), and (e). Candidate (b) shows a lack of spreading (thus Share(T*,NC) is violated). In (c) the H% tone is anchored to the unvoiced consonant in IP-final position (i.e., *Anchor(T,-voice) and *Anchor(T,C) are violated), which causes it not to be realized phonetically. Candidate (d), where the last vowel of the nuclear word is not lengthened, violates constraint Max-IO(μ^p) that requires all prosodic moras to surface, but also Max-IO(Associate) because the association line of the prosodic mora is deleted. The instance of valley retraction, which corresponds to (e), violates, in addition to other constraints, Anchor(L*,Rt,'σ,Rt) because the L* tone does not surface at the end of the stressed syllable but at the beginning.

(11)

	Anchor(L*,Rt,'σ,Rt)	Max-IO(μ^P)	*Anchor(T,-voice)	*Anchor(T,C)	Share(T*,NC)	Anchor(T%,Rt,IP,Rt)	Dep-IO(μ^S)	Max-IO(Associate)	Dep-IO(Associate)
a. ☞ 						*	*	*	**
b. 					*	*	*	*	*
c. 			*	*			*		*
d. 		*						**	*
e. 	*				*	*	*	*	**

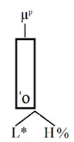
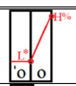
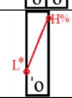
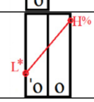
4.2.3 Nuclear words with stress on the final syllable and no coda

The cases we have discussed above in Sections 4.4.1 and 4.4.2 were relatively simple as only one output was found in our data. From this section onwards, we will deal with situations where our data show variation. In order to do so, we will present one tableau for every winning candidate observed in our data.

The most common realization of the NC in which the nuclear word bears its stress on the final syllable, which has no coda (like the tag-question ['no] 'won't you?'), is the pattern displayed in Figure 9 and in Figure 11(a). Tableau (12) shows that this winning candidate, i.e. (a), only violates Dep-IO(μ^s) because its vowel is lengthened.

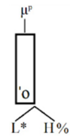
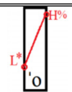
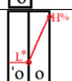
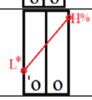
The losing candidate (b), however, is characterized by the absence of lengthening (violation of Max-IO(μ^P) but also of Max-IO(Associate) because the association line of the prosodic mora is deleted), in addition to other violations that will be discussed later. Candidate (c), which is harmonically bounded by the winner, displays vowel lengthening and valley retraction but also incurs a violation of Share(T*,NC) because it does not display tone spreading.

(12)

		Anchor(T%,Rt,IP,Rt)	*Anchor(T,-voice)	*Anchor(T,C)	Share(T*,NC)	Max-IO(μ^P)	Anchor(L*,Rt,'σ,Rt)	Dep-IO(Associate)	Max-IO(Associate)	Dep-IO(μ^S)
a. ☞										*
b.						*	*	*	**	
c.					*		*	*	*	*

The least common realization of the NC is displayed in Figures 10 and 11(b). Tableau (13) shows that the winning candidate, i.e. (a), is characterized by the absence of lengthening (which implies a violation of Max-IO(μ^P) because the prosodic mora does not surface, as well as a violation of Max-IO(Associate) because the prosodic mora becomes disassociated by valley retraction (which implies the violation of Anchor(L*,Rt,'σ,Rt) because there is a mora between the right edge of the stressed syllable and the point where the L* is anchored, as well as of Max-IO(Associate) because L* is disassociated from the right edge of the stressed syllable, and Dep-IO(Associate) because L* is reassociated with the left edge of the stressed vowel). In order for (a) to be the winner, constraints Max-IO(μ^P), Anchor(L*,Rt,'σ,Rt), Max-IO(Associate) and Dep-IO(Associate) need to be ranked below the others. Candidates (b) and (c), which show vowel lengthening, are ruled out by the violation of Dep-IO(μ^S), which prohibits mora insertion. In addition, (c) – which is harmonically bounded by (b) – also incurs the other violations discussed in the tableau (12).

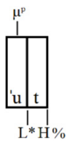
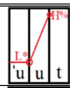
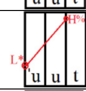
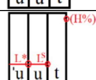
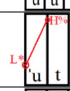
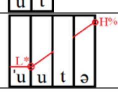
(13)

	ANCHOR(T%,Rt,IP,Rt)	*ANCHOR(T,-voice)	*ANCHOR(T,C)	DEP-IO(μS)	SHARE(T*,NC)	MAX-IO(μP)	ANCHOR(L*,Rt,'σ,Rt)	DEP-IO(ASSOCIATE)	MAX-IO(ASSOCIATE)
a. ☞ 						*	*	*	**
b. 				*					
c. 				*	*		*	*	*

4.2.4 Nuclear words with stress on the final syllable and unvoiced coda

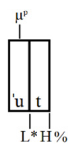
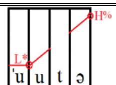
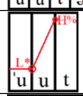
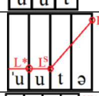
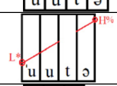
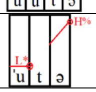
In Section 3.3 we saw that when the nuclear word bears its stress on the final syllable and has an unvoiced coda (like [βiŋ'gut] 'arrived') there are three different mappings. The most common, which can be seen in Figures 12 and 14(a), corresponds to candidate (a) in the tableau (14), which displays vowel lengthening and thus incurs a violation of DEP-IO(μ^S). In addition, the H% boundary tone moves from the IP-final edge to the right edge of the penultimate segment of the utterance, which involves violating three constraints: ANCHOR(T%,Rt,IP,Rt) (because there is a TBU (μ) that intervenes between the boundary tone and the right edge of the IP), MAX-IO(ASSOCIATE) (because H% is disassociated from the right edge of the IP) and DEP-IO(ASSOCIATE) (because H% is reassociated with the right edge of the final vowel of the IP). This tableau therefore allows us to conclude that, in order for (a) to be the winner, these four constraints must be ranked below the others. Candidate (b), which is harmonically bounded by the winner and is not found in our data, shows, in addition to the displacement of the H% tone, valley retraction without spreading (violating ANCHOR(L*,Rt,'σ,Rt) and SHARE(T*,NC)). The most relevant feature of (c) is that the H% boundary tone is associated with an unvoiced consonant (violating *ANCHOR(T,-voice)), which would prevent it from surfacing phonetically. (d) does not show vowel lengthening, which means that it violates MAX-IO(μ^P) and MAX-IO(ASSOCIATE) (in addition, like [b], to other constraints related to valley retraction). Finally, (e) which will be dealt with again in tableau (15), does not display spreading, which means it violates SHARE(T*,NC).

(14)

		MAX-IO(μ^P)	*ANCHOR(T,-voice)	*ANCHOR(T,C)	ANCHOR(L*,Rt,'σ,Rt)	SHARE(T*,NC)	ANCHOR(T%,Rt,IP,Rt)	MAX-IO(ASSOCIATE)	DEP-IO(ASSOCIATE)	DEP-IO(μ^S)
a. ☞							*	*	*	*
b.					*	*	*	**	**	*
c.			*	*					*	*
d.		*			*		*	***	**	
e.						*		*	*	**

In addition to the winning candidate in tableau (14), a second winner is present in our data, which can be seen in Figures 13 and 14(b). Candidate (a) in tableau (15) violates the constraint DEP-IO(μ^S) twice (once when the vowel /u/ is lengthened and once when the IP-final schwa is inserted) and SHARE(T*,NC) (because there is no spreading), as well as MAX-IO(ASSOCIATE) (because H% is disassociated from the right edge of the consonant, which is underlyingly in IP-final position) and DEP-IO(ASSOCIATE) (because H% is reassociated with the right edge of the epenthetic vowel). For this reason, we have to conclude that in order for (a) to be the winner, these four constraints must be ranked below the others. The most noteworthy aspect of this ranking is that the IP-final schwa is inserted in order to associate the BT with a vowel; in other terms, the crucial part of the ranking is that *ANCHOR(T,C) outranks DEP-IO(μ^S). Candidate (b), which was the winner in the preceding tableau, in this case is ruled out by ANCHOR(T%,Rt,IP,Rt), which requires BTs to surface in IP-final position. Candidate (c), unlike the winner (a) does not violate SHARE(T*,NC), but violates DEP-IO(ASSOCIATE) twice (the first time, like the winner, because the H% boundary tone is reassociated with the right edge of the epenthetic schwa, and the second time because there is spreading of the L*); the second violation of DEP-IO(ASSOCIATE) turns out to be fatal for this candidate. (d) Is less optimal than the winner in several aspects, among which is the notable presence of valley retraction (which implies a violation of Anchor(L*,Rt,'σ,Rt)). Candidate (e) is eliminated by the violation of Max-IO(μ^P) and Max-IO(Associate), in that it does not show vowel lengthening.

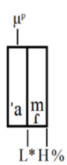
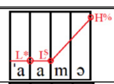
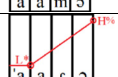
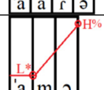
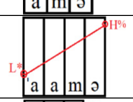
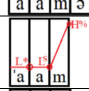
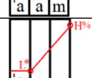
(15)

		*Anchor(T,-voice)	*Anchor(T,C)	Max-IO(μ^P)	Anchor(L*,Rt,'σ,Rt)	Anchor(T%,Rt,IP,Rt)	Dep-IO(Associate)	Max-IO(Associate)	Share(T*,NC)	Dep-IO(μ^S)
a. ☞							*	*	*	**
b.						*	*	*		*
c.							**	*		**
d.					*		**	**	**	**
e.				*			*	**		

4.2.5 Nuclear words with stress on the final syllable and voiced coda

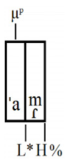
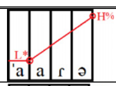
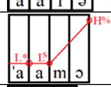
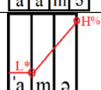
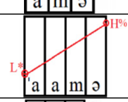
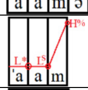
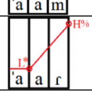
As we have seen in Section 3.4, yes-no questions ending in a word with the stress on the final syllable and a voiced coda (like ['fam] 'hunger' and [di'naɾ] 'to have lunch') display the highest degree of variability: four different mappings are found in our dataset. The most common is the pattern presented in Figures 15 and 19(a). Tableau (16) presents the ranking argument that accounts for this mapping. In order to avoid overgeneration of candidates, the tableau includes only the four different mappings found in our dataset (a, b, e, f) and two additional ones (c, d), which are useful as they give a clearer image of constraint interaction. The winner (a) violates Dep-IO(μ^S) twice (as there is both vowel lengthening and schwa epenthesis), Max-IO(Associate) once (because the H% boundary tone is disassociated form the underlying IP-final consonant before being reassociated with the schwa), and Dep-IO(Associate) twice (because there is both spreading of the L* pitch accent and reassociation of the H% boundary tone). For (a) to be more harmonic, these three constraints must be outranked by the others. As in tableau (15), the most notable aspect of the ranking is that the IP-final schwa is inserted in order to associate the BT with a vowel (i.e., *Anchor(T,C) outranks Dep-IO(μ^S)). Candidate (b) violates Share(T*,NC) because it does not show spreading of the starred tone. The mapping in (c) does not show vowel lengthening, and therefore violates Max-IO(μ^P) and Max-IO(Associate). The valley retraction in (d), which implies the violation of Anchor(L*,Rt,'σ,Rt) as well as Max-IO(Associate) and Dep-IO(Associate), explains the exclusion of this candidate, which also fails to display spreading (which implies a violation of Share(T*,NC)). Finally, the most noteworthy feature of (e) and (f) is that they violate *Anchor(T,C), since the boundary tone is anchored to a consonant.

(16)

		Anchor(T%,Rt,IP,Rt)	*Anchor(T,-voice)	*Anchor(T,C)	Anchor(L*,Rt,'σ,Rt)	Max-IO(μ^P)	Share(T*,NC)	Dep-IO(Associate)	Max-IO(Associate)	Dep-IO(μ^S)
a. ☞								**	*	**
b.							*	*	*	**
c.						*		*	*	*
d.					*		*	**	**	**
e.				*				*		*
f.				*			*			*

The mapping presented in Figures 18 and 19(d) is less common. This mapping is similar to the winning candidate in tableau (16), but it differs in one respect: the L* tone does not spread (which means that Share(T*,NC) is violated). In tableau (17) we present the ranking argument that favours this mapping, with (a) as the winner. In order for (a) to be the optimal candidate, Dep-IO(μ^S), Max-IO(Associate), Dep-IO(Associate) and Share(T*,NC) must be ranked below the rest of the constraints. Candidate (b) is eliminated by the second violation of Dep-IO(Associate) (i.e., the violation due to L* spreading), while the first violation (due to re-association of the BT) is shared with the winner and, thus, cannot be fatal for (b). The remaining candidates (c, d, e, f) are excluded for the same reasons discussed in the previous tableau.

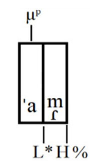
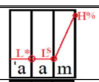
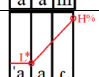
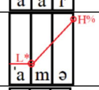
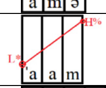
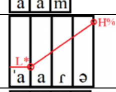
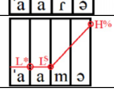
(17)

	Anchor(T%,Rt,IP,Rt)	*Anchor(T,-voice)	*Anchor(T,C)	Anchor(L*,Rt,'σ,Rt)	Max-IO(μ^P)	Share(T*,NC)	Dep-IO(Associate)	Max-IO(Associate)	Dep-IO(μ^S)
a. ☞ 						*	*	*	**
b. 							**	*	**
c. 					*		*	*	*
d. 				*		*	**	**	**
e. 			*				*		*
f. 			*			*			*

Another less frequent mapping found in our data is the pattern displayed in Figures 16 and 19(b). In this case, there is no schwa epenthesis and the BT is anchored to the IP-final consonant. Once again, in order to avoid overgeneration of candidates, tableau (18) contains only the four mappings found in our dataset (a, b, e, f) and two additional candidates (c, d), which help to illustrate the constraint interaction. The winner (a) violates *Anchor(T,C) (because the H% boundary tone is anchored to a consonant), Dep-IO(Associate) (because the L* pitch accent spreads), and Dep-IO(μ^S) (because there is vowel lengthening). We can thus infer that, in this case, *Anchor(T,C), Dep-IO(μ^S) and Dep-IO(μ^S) are ranked below the rest of the constraints. Candidate (b), which does not exhibit spreading, is ruled out as it violates

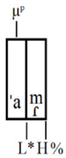
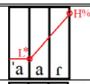
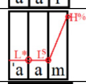
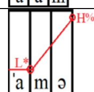
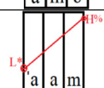
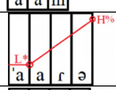
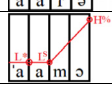
Share(T*,NC), which favours spreading and is ranked above Dep-IO(Associate), which disfavours spreading. The most salient characteristic of (c) is that the prosodic mora does not surface, which represents a violation of Max-IO(μ^{P}). Valley retraction characterizes (d) and implies a violation of Anchor(L*,Rt,'σ,Rt). Candidates (e) and (f) are ruled out due to the fact that they violate Max-IO(Associate) (which requires the H% boundary tone to be disassociated from the underlying final consonant in order to be later reassociated with the epenthetic schwa).

(18)

		Anchor(T%,Rt,IP,Rt)	*Anchor(T,-voice)	Anchor(L*,Rt,'σ,Rt)	Max-IO(μ^{P})	Max-IO(Associate)	Share(T*,NC)	Dep-IO(Associate)	*Anchor(T,C)	Dep-IO(μ^{S})
a. ☞								*	*	*
b.							*		*	*
c.					*	*		*		*
d.				*		*	*	*		
e.						*	*	*		**
f.						*		**		**

The final mapping found in our data is the pattern pictured in Figures 17 and 19(c). Contrary to the mapping discussed in tableau (18), the winning candidate (a) of tableau (19) does not show spreading. This means that, unlike the previous winner, it violates the constraint that favours spreading (i.e., Share(T*,NC)). In order for (a) to prevail over the others, Dep-IO(μ^{S}), *Anchor(T,C) and Share(T*,NC) must be outranked by all other constraints. Candidate (b), where spreading is present, is ruled out by the constraint that penalizes spreading (Dep-IO(Associate)). The remaining candidates (c), (d), (e) and (f) are excluded as a result of the same constraints discussed in the previous tableau.

(19)

	ANCHOR(T%,Rt,IP,Rt)	*ANCHOR(T,-voice)	ANCHOR(L*,Rt,'σ,Rt)	MAX-IO(μ^P)	MAX-IO(ASSOCIATE)	DEP-IO(ASSOCIATE)	SHARE(T*,NC)	*ANCHOR(T,C)	DEP-IO(μ^S)
a. ☞ 							*	*	*
b. 						*		*	*
c. 				*	*	*			*
d. 			*		*	*	*		*
e. 					*	*	*		**
f. 					*	**			**

4.3 Stochastic OT analysis

4.3.1 Basic notions of Stochastic OT[9]

In the traditional model of OT, as proposed by Prince and Smolensky (1993 [2004]), linguistic differences are explained by language-specific rankings of universal constraints. These constraint rankings are taken to be fixed, i.e., on an ordinal scale, where each dominance relationship between any constraint C_n and C_m (e.g., $C_n >> C_m$) is unchanging in the grammar. Consequentially, classic OT is a deterministic system that, given an input form *i* and a constraint hierarchy Con_x, will always return the same optimal candidate *o*.

The modifications that Boersma and Hayes (2001) have made to this classic model in their 'Stochastic Optimality Theory' (SOT hereafter) are twofold: they introduce (1) a continuous ranking scale and (2) a stochastic candidate evaluation mechanism.

9 This subsection was inspired by the concise explanation of SOT provided in Section 4.1 of Feldhausen (2016).

In SOT, constraints are not ordered on an ordinal scale, but rather on a continuous scale ranging from lax (low-ranked constraints) to strict (high-ranked constraints) (Figure 20). This allows for graduality in the representation of dominance relations between two constraints. For instance, in Figure 20 constraint C_1 dominates C_2 more strictly than C_2 dominates C_3 because the distance between C_1 and C_2 is larger on the continuous ranking scale than the distance between C_2 and C_3.

During each 'evaluation time' *t*, which refers to an instance of matching an input form with an optimal output candidate, each constraint is subjected to 'evaluation noise' (σ) that is represented as a Gaussian/normal distribution (Figure 21). In this distribution, the mean μ is what we previously thought of as a constraint's constant ranking value, and the standard deviation σ is the distribution's breadth that applies to all constraints.[10] During evaluation time a point on the continuous ranking scale is randomly selected for each constraint (a so-called 'selection point'), the likelihood of which is determined by the function's y-values.

This can lead to a constraint reranking during certain evaluation times as we will demonstrate with an example. In Figure 22 there are two constraint functions C_1 and C_2. The most frequent ranking of these constraints is $C_1 >> C_2$ because C_1's mean value is higher up the strictness scale than C_2's. Nevertheless, C_1 and C_2 visibly

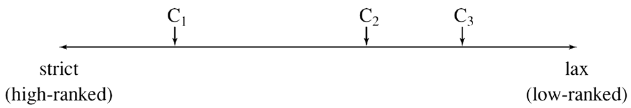


Figure 20: Categorical ranking of constraints (*C*) along a continuous scale (Boersma and Hayes 2001: 47).

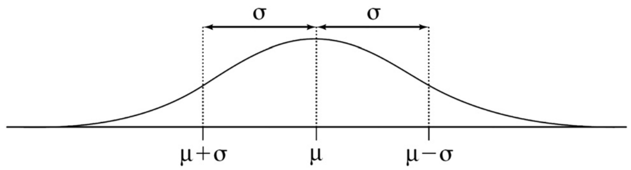


Figure 21: Gaussian distribution (Boersma and Hayes 2001: 49). About 68% of the values are within the μ+σ and μ−σ range, where μ is the mean and σ is the standard deviation.

10 For clarity's sake, we want to stress again that in the context of this section μ and σ do not refer to the mora or syllable.

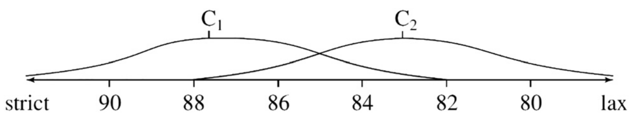


Figure 22: Overlapping constraints (Boersma and Hayes 2001: 49).

overlap in the [82, 88] range. This means that there will be certain evaluation times, during which C_2's random selection point, e.g., $s_t(C_2) = 86$, is higher than C_1's selection point, e.g., $s_t(C_1) = 84$. This would lead to the ranking $C_2 >> C_1$, which in turn can lead to an input-output mapping deemed 'suboptimal' in most other cases.

4.3.2 Results: an underlying ranking

Using the concepts of SOT as described in Section 4.3.1, we are going to present a hypothesis for a constraint ranking that underlies the individual rankings given in Section 4.2. To this aim, we used the 'Gradual Learning Algorithm' (GLA) (Boersma and Hayes 2001): a data-driven, frequentist method of approximating the distances of normally distributed constraint functions on the continuous evaluation scale. Given the limited amount of data, the output of the GLA should not be considered a full-fledged statistical model of Southern Valencian Catalan's intonational constraint grammar. Rather, we used the GLA to extract a statistical underlying ranking hypothesis to be discussed in this section.

The underlying constraint ranking that we propose for the examined mappings of Southern Valencian Catalan is: ANCHOR(T,-VOICE) >> {*ANCHOR(T,C) >> MAX-IO(ASSOCIATE) >> *SHARE(T*,NC) >> ANCHOR(T%,Rt,IP,Rt) >> DEP-IO(ASSOC)} >> DEP-IO(μ_s)

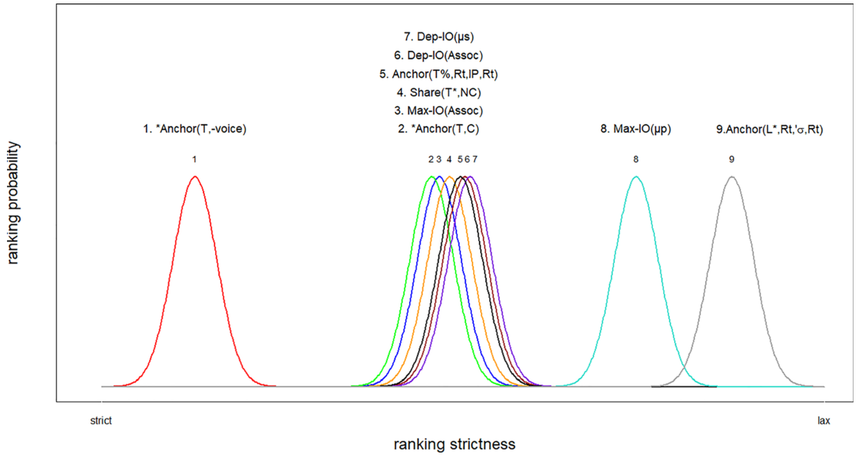


Figure 23: Proposed underlying constraint ranking for the intonational grammar of Southern Valencian Catalan.

>>MAX-IO($μ_p$) >> ANCHOR(L*,Rt,‘σ,Rt). The corresponding constraint distributions are shown in Figure 23.

First of all, we can see that in general there are three constraints that are very unlikely to swap ranking positions during evaluation time due to a lack of overlap with other constraints. These are *ANCHOR(T,-voice) on the strict end of the hierarchy and MAX-IO($μ_p$) and ANCHOR(L*,Rt,ˈσ,Rt) on the lax end. The remaining constraints DEP-IO($μ_s$), DEP-IO(ASSOCIATE), ANCHOR(T%,Rt,IP,Rt), *SHARE(T*,NC), MAX-IO(ASSOCIATE) and *ANCHOR(T,C) form the centre in this hierarchy and are all characterized by a substantial amount of overlap with one another. These constraints are thus the main source of variation in our data.

Let us examine each constraint’s ranking position within these three groups (strict end, centre, lax end) more closely. *ANCHOR(T,-voice) is by far the highest-ranking constraint because its violation favours candidates that are physically unrealizable since voicing is a requirement for any intonation to occur. Therefore, one could assume *ANCHOR(T,-voice) to actually be an inter-linguistically high-ranking constraint. *ANCHOR(T,C) also ensures a phonetically suitable environment for the realization of intonation since vowels are more fit than consonants when it comes to pitch transmission (Ladd 2008). Yet, a violation of this constraint does not lead to an unrealizable output candidate and can thus safely change ranking positions with other lower-ranking constraints, as is the case in Tableau (19).

A substantial amount of the other constraints that form the variable hierarchy centre are faithfulness constraints: DEP-IO($μ_s$), MAX-IO(ASSOCIATE), and DEP-IO(ASSOCIATE). That DEP-IO($μ_s$) is on the lower end of this subhierarchy is not surprising since a high-ranking would rule out those optimal candidates that use mora insertion in order to allow underlying durational phonemes to surface (Tableaux 11, 12, 14, 15, 16, 17, 18, 19). The reason for DEP-IO($μ_s$) not being on the lax end then is that it still needs to be able to move up the constraint hierarchy in cases like in tableau (13), where mora insertion does not occur, i.e., where lengthening does not occur. MAX-IO(ASSOCIATE) – besides its function as a preserver of tonal associations in the input – also preserves durational associations (i.e., those of $μ_p$) of the input, which is important to keep in mind when we will discuss the lax end of the hierarchy. The remaining two constraints in the hierarchy’s centre are *SHARE(T*,NC) and ANCHOR(T%,Rt,IP,Rt). A higher ranking of SHARE(T*,NC) enables spreading of the prominent tone in the nuclear configuration as is the case in (11, 16, 18), and can thus said to act as one of DEP-IO(ASSOCIATE)’s antagonist constraints because a higher ranking of DEP-IO(ASSOCIATE) blocks spreading and can thus be hypothesised to be the case in (12–15, 17, 19). The remaining constraint of the variable hierarchy centre is ANCHOR(T%,Rt,IP,Rt), which ensures the anchoring of boundary tones at the edge of the IP domain in the majority of our data (12–19). However, in examples like (11), strictly abiding by ANCHOR(T%,Rt,IP,Rt) would lead to the boundary tone being anchored to an unvoiced fricative [s], which in turn would constitute a fatal violation of the universally high-ranked *Anchor(T,-voice) as well as a violation of *Anchor(T,C). Since switching ranking positions with *Anchor(T,-voice) is virtually impossible in our proposed hierarchy, Anchor(T%,Rt,IP,Rt) needs to occasionally switch rankings with *Anchor(T,C), with which it has a sufficient amount of distribution overlap. This justifies Anchor(T%,Rt,IP,Rt)'s position in the variable hierarchy centre.

On the lax end of the hierarchy we have Max-IO(μ_p) as second lowest-ranking and Anchor(L*,Rt,'σ,Rt) as lowest-ranking. The position of both constraints at the low-end of the hierarchy is surprising at first glance since almost all optimal candidates abide by them except for (13), where the optimal candidate (a) violates both Anchor(L*,Rt,ˈσ,Rt) and Max-IO(μ_p). For both constraints it is probably the case that the higher-ranked more generic constraint Max-IO(Associate) located in the variable hierarchy centre 'gets the job done' for them. Given the way the constraints (Section 4.1) and input-output mappings (Section 3) are defined, a violation of Max-IO(μ_p) always entails a violation of Max-IO(Associate) because prosodic moras are also connected to the phonetic string by means of association lines. In the case of peak retraction, a violation of Anchor(L*, Rt, 'σ, Rt) (13a) always entails a violation of Max-IO(Associate) and Dep-IO(Associate) since we defined L* peak retraction as L* disassociating from its phonological position and associating to an earlier position (Figure 11b). Thus, it looks as if the relative specificity of Max-IO(μ_p) and Anchor(L*,Rt,ˈσ,Rt) compared to Max-IO(Associate) and Dep-IO(Associate) is redundant in the context of the OT model we present here. Most likely this is an effect of the data set on the one hand and the set of competing candidates on the other (i.e., the consequences of 'candidate omission' (Bane and Riggle [2012]). Nevertheless, we hypothesize that especially Max-IO(μ_p) is not simply rendered obsolete by Max-IO(Associate) and that in reality it has a generally higher-ranking position within the constraint hierarchy such that it can occasionally switch positions with a lower-ranking constraint – as in (13) – to allow for candidates that do not display lengthening. Though collecting more data and examining a larger candidate set will be required to test this hypothesis in future research.

5 Discussion

As we have pointed out in Section 1.4, intonation is an area of phonology that has not received much attention within OT. This implies that relatively few of the OT universal constraints dealing with intonation are known with certainty. Since "research in OT is primarily focused on developing and improving hypotheses about the constraints" (McCarthy 2008: 27), we have endeavoured in this paper to improve our knowledge of the constraints that are active in intonational languages and, specifically, of those that can account for the text-tune interface, which is one of the aspects of intonation that has received less attention within OT.

In order to account for the various mappings we have observed in our data, we have used a set of nine constraints. We have made an effort to use constraints that are as general as possible, i.e., to avoid language-specific constraints. We believe that Max-IO(μ^p), Dep-IO(μ^s), Anchor(T%,Rt,IP,Rt), Dep-IO(Associate) and Max-IO(Associate) meet this requirement. In addition, we deem the combination of Dep-IO(Associate) and Max-IO(Associate) to be more effective than the constraint *Spread (Gussenhoven 2000) to prohibit spreading, as Dep-IO(Associate) and Max-IO(Associate) are less specific than *Spread, since they do not only intervene in cases of spreading but also in cases where the anchoring point of the tones is not the one we would expect phonologically, and in cases where a prosodic mora remains floating.

On the other hand, as we have mentioned in Section 4.1, Anchor(L*,Rt,ˈσ,Rt), which requires the L* tone of a pitch accent to be anchored to the right edge of the stressed syllable, holds true for all varieties of Catalan and Spanish spoken in the Iberian Peninsula but possibly not for varieties of the same languages spoken elsewhere nor for other Romance languages. This means that future research might need to improve this constraint for starred tones in order to account for interlinguistic differences.

Another constraint that will likely need to be reanalysed in future research is Share(T*,NC), which has both advantages and limitations in comparison with constraints that favour spreading, proposed in previous analyses. We agree with McCarthy's (2011) argument that Share(F) is the family of markedness constraints which best accounts for spreading. Nevertheless, we are aware of the fact that our constraint is specifically designed to account for the spreading of the starred tone in the nuclear configuration but does not help us to understand the spreading of other types of tones (for example of boundary tones) nor does it apply in other contexts (i.e., in the prenuclear or postnuclear stretch of utterances). Future research on intonational languages that show different types of tonal spreading should be able to contribute to overcoming this limitation.

As recommended by Gussenhoven (2004 [2009]), for our analysis we have used what we have called 'anchoring constraints': *Anchor(T,C) and *Anchor(T,-voice). We believe that these two constraints represent an improvement in comparison to the constraint TBU (Gussenhoven 2000), which stipulates that tones should be anchored to a sonorant element, because they also allow for cases where the tone is anchored to a consonant which is not a sonorant. Nevertheless, these two restrictions might not be sufficient. Previous research on tonal languages (see, among others, Durand 1990: 249–250; Steriade 1991; Yip 2002: 73; Zec 1988) has shown that different segment types can be arranged on a scale according to their tone-bearing capability, therefore future research might need to introduce new constraints to distinguish, for example, between sonorants and voiced obstruents (in this case, the appropriate additional constraint might be *Anchor(T,-son)).

Last but not least, we have to bear in mind that aside from the constraints we have used in this paper there are other constraints which are relevant to the text-tune interface. In order to avoid using too many in our analysis, we have deliberately omitted the constraints mentioned in Section 1.4 that are never violated in our data (such as Max(T), *Crowd, IP=T*, AP=T*, AP=T-, IP=T%) or that do not add any substantial improvement to our analysis (such as *Contour).

In addition to making hypotheses about some of the constraints whose interaction gives way to intonational grammars, in this paper we describe two phenomena related to duration that are crosslinguistically rare: phonological postlexical duration and intonation-driven schwa epenthesis. We have seen that Southern Valencian Catalan yes-no questions display what Hayes and Lahiri (1991: 78) call a "durationally-specified contour", that is, a set of postlexical elements that includes both tonal phonemes and durational phonemes. We have represented tonal phonemes by means of the existing Cat_ToBI labelling system, which constitutes the implementation for Catalan of the autosegmental-metrical model. For the durational phoneme that is included in the representation of the contour, building on Prieto et al. (2005: 391) and Roseano and Rodriquez (2021), we have suggested that it can be thought of as a prosodic mora (μ^{P}) that has a primary association with the IP as a node and a secondary association with the last vowel of the IP.

Crosslinguistically, the existence of durationally-specified contours is less uncommon than one might think at first. In fact, the same durationally specified contour that Hayes and Lahiri (1991) describe for English chanted vocatives exists, sometimes with some differences, in several other languages (among them Hungarian, Greek, Dutch, German, Arabic, and all Romance languages; for a review, see Arvaniti et al. [2016]; Frota and Prieto [2015]). In addition to the widespread chanted call, other kinds of durationally specified contours are also documented in West-Greenlandic Eskimo (Rischel 1974), Mieres Asturian (Díaz Gómez et al. 2007; López Bobo et al. 2005), Don Benito Extremaduran Spanish (Congosto Martín 2007a, 2007b, 2010), Central Peninsular Spanish (Escandell Vidal 2011), Central Catalan (Escandell Vidal 2011: 199) and Neapolitan (Crocco et al. 2022: 143).

It is worth pointing out that this kind of postlexical lengthening is not triggered by tonal crowding but is already present in the underlying representation of the contour. In contrast, the literature describes several cases where lengthening is not underlying and is used as a strategy to solve tonal crowding (see Roettger and Grice [2019] for a review, as well as Roseano and Fernández Planas [2018] for an OT analysis).

Intonation-driven schwa epenthesis is far less common than underlying post-lexical lengthening. According to Vigário et al. (2019), only Bari Italian and some varieties of European Portuguese display this phenomenon. Nevertheless, as the authors point out, the nature of the process is different in Bari Italian and in Portuguese. In Bari Italian the schwa is not primarily inserted to solve tonal crowding but to repair syllable structure in loanwords that end with a consonant (as is well-known, Italian content words can only end with a vowel). In other words, in Bari Italian the final schwa is inserted both when there is and when there isn't tonal crowding, although it is statistically more frequent when tonal crowding is there. On the other hand, in the varieties of European Portuguese mentioned by Vigário et al. (2019), the final schwa is added *only* to solve tonal crowding. Specifically, it appears when there are not enough TBUs to realize all the underlying tones.

The schwa epenthesis of Southern Valencian Catalan is more similar to the Portuguese one, insofar as it is driven only by intonation. Nevertheless, there is a difference between the two languages. The schwa epenthesis in Southern Valencian Catalan is not motivated by the need to have enough TBUs to realize all the tones as in Portuguese, but by a more specific need to have an *ideal* TBU exactly et the *right edge* of the IP, so that the BT can surface exactly in the position where it is phonologically aligned. In fact, if one goes back to the examples in Figures 14(b) [βiŋ'guutə] and 15(a) ['faamə], one sees that even without the schwa there are enough TBUs to realize all tones. What was missing in these cases was an *ideal* TBU (i.e., a vowel) at the right edge of the IP. In OT terms, one can tentatively hypothesise that the schwa of Southern Valencian Catalan has to do with a high ranking of Anchor(T%,Rt,IP,Rt) and *Anchor(T,C), while the schwa in European Portuguese varieties is the result of a high ranking of Max(T).

Last but not least, the discussion of the results of this paper needs to include also some considerations about its limitations. As we mentioned in Section 2, we have analysed the recordings of 74 yes-no questions of Southern Valencian Catalan, which is not a very extensive dataset. The analysis we put forward in this paper, thus, has to be considered a pilot in some aspects, especially for outputs like the ones in Figure 17 or 18, where the number of observed cases is low. Further research about Southern Valencian Catalan should widen the empirical bases of the model and it should also include cases of proparoxytone nuclear configurations, which might shed further light on the intonational grammar of this variety.

6 Conclusions

In this paper we have analysed the prosody of the nuclear configuration of Southern Valencian Catalan yes-no questions within the framework of OT and according to the principles of the autosegmental-metrical model. This case study contributes to the development of theory in three main ways. Firstly, interrogativity is expressed by means of both intonation and durational phonemes (μ^p); the use of duration to convey information about sentence type is typologically uncommon and, to the best of our knowledge, had not previously been examined within the framework of OT. Secondly, this Romance variety displays a prosodically driven epenthetic schwa, a strategy of text-tune accommodation that has seldom been described before and which has not yet been analysed in OT. Last but not least, in the yes-no questions of Southern Valencian Catalan we observe tonal spreading, which is not very common in intonational languages, especially in Romance. These unusual features, along with the noteworthy variation observed in our data, make this case study challenging and, at the same time, valuable for the understanding of the text-tune interface.

Furthermore, studying the text-tune interface can promote the progress of OT, as we discussed in Section 4, and can also contribute to the refinement of some facets of the AM model. Specifically, it sheds light on the "rules for lining up the tune with the text" that, according to Pierrehumbert (1980: 10–11), are part of the phonological representation of intonation, as mentioned in Section 1. Nevertheless, more data and comparative research would be needed in order to account for language-specific constraint rankings, which in the case of Valencian we could provide only partially. In addition, our data have allowed us to put forward an AM representation of durational phonemes in terms of prosodic moras (μ^p), a representation that has enabled us to account for vowel lengthening in OT terms.

In order to achieve a unified OT account of the text-tune interface, future research will need to rely on a larger number of analyses of different languages, since "theorizing about Con [i.e., the set of universal constraints] is most successful when it's informed by the study of a phenomenon or some related phenomena in multiple languages" (McCarthy 2008: 31). Only by comparing the outcomes of the text-tune interface in different languages, will it be possible to test the adequacy of the constraints proposed in this paper and in others, with the ultimate goal of achieving a better understanding of the phonological representation of intonation.

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References

Arvaniti, Amalia, Marzena Żygis & Marek Jaskuła. 2016. The phonetics and phonology of the Polish Calling melodies. *Phonetica* 73(3–4). 338–361.

Bane, Max & Jason Riggle. 2012. Consequences of candidate omission. *Linguistic Inquiry* 43(4). 695–706.

Bennett, Ryan. 2015. Review of *Prosodic typology II: The phonology of intonation and phrasing*, by Sun-Ah Jun (ed.). *Phonology* 32(3). 337–350.

Boersma, Paul. 1997. How we learn variation, optionality, and probability. *Institute of Phonetic Sciences of the University of Amsterdam (IFA) Proceedings* 21. 43–58.

Boersma, Paul. 1998. *Functional phonology: Formalizing the interaction between articulatory and perceptual drives*. Amsterdam: University of Amsterdam dissertation.

Boersma, Paul & Bruce Hayes. 2001. Empirical tests of the Gradual Learning Algorithm. *Linguistic Inquiry* 32. 45–86.

Boersma, Paul & David Weenink. 2021. *Praat: Doing phonetics by computer* [Computer program]. Version 6.1.38. http://www.praat.org/ (accessed 2 January 2021).

Cabré, Teresa, Francesc Torres-Tamarit & Maria del Mar Vanrell. 2015. Templatic versus apparently non-templatic truncation in Sardinian. Paper presented at Phonetics and Phonology in Europe, University of Cambridge, 29–30 June.

Congosto Martín, Yolanda. 2007a. Primeras aportaciones a la descripción prosódica del extremeño: Interrogativas absolutas sin expansión en el habla de Don Benito (Badajoz). In Manuel González González, Elisa Fernández Rei & Begoña González Rei (eds.), *III Congreso Internacional de Fonética Experimental (CFE)*, 205–221. Santiago de Compostela: Xunta de Galicia.

Congosto Martín, Yolanda. 2007b. Interrogativas absolutas/declarativas en las hablas extremeñas: Estudio entonativo contrastivo. In Josefa Dorta (ed.), *La prosodia en el ámbito lingüístico románico*, 271–297. Santa Cruz de Tenerife: La Página ediciones.

Congosto Martín, Yolanda, Liliana Gómez, María Lucio-Villegas & Ruth Rodríguez. 2010. Estudio contrastivo de la entonación del castellano de Don Benito y del asturiano de Mieres en el marco del Proyecto AMPER. In *Actes du XXVe CILPR Congrès International de Linguistique et de Philologie Romanes*, vol. 2, 53–66. Berlin: De Gruyter Mouton.

Crespo-Sendra, Verònica. 2010. L'entonació de les oracions interrogatives absolutes: Un estudi de contrast dialectal [The intonation of absolute interrogative sentences: A study of dialect constrast]. *Llengua & Literatura* 21. 199–226.

Crespo-Sendra, Verònica. 2011. *Aspectes de l'entonació del valencià* [Aspects of Valencian intonation]. Barcelona: Universitat Pompeu Fabra dissertation.

Crespo-Sendra, Verònica. 2013. Valencià [Valencian]. In Pilar Prieto & Teresa Cabré (eds.), *L'entonació dels dialectes catalans* [Intonation of Catalan dialects], 43–73. Barcelona: Publicacions de l'Abadia de Montserrat.

Crocco, Claudia, Barbara Gili-Fivela & Mariapaola D'Imperio. 2022. Comparing prosody of Italian varieties and dialects: Data from Neapolitan. In Sónia Frota & Marina Vigário (eds.), *Proceedings of Speech Prosody 2022*, 140–144.

Cruz, Marisa. 2013. *Prosodic variation in European Portuguese: Phrasing, intonation and rhythm in Central-Southern varieties*. Lisboa: Universidade de Lisboa dissertation.

Díaz Gómez, Liliana, Carmen Muñiz Cachón, María Jesús López Bobo, Ruth González Rodríguez & Miguel Cuevas Alonso. 2007. La entonación en dos zonas rurales del centro de Asturias. *Archivum* 56. 263–289.

D'Imperio, Mariapaola. 2002. Italian intonation: An overview and some questions. *Probus* 14(1). 37–69.

Dorta, Josefa. 2013. Estudio fonético-fonológico de la entonación declarativa e interrogativa canaria en voz femenina. In Antonio Pamies Bertrán (ed.), *De lingüística, traducción y lexico-fraseografía: Homenaje a Juan de Dios Luque Durán* (Colección Interlingüística 111), 173–187. Granada: Editorial Comares.
Durand, Jacques. 1990. *Generative and non-linear phonology*. London: Longman.
Elordieta, Gorka. 2007. A constraint-based analysis of the intonational realization of focus in Northern Bizkaian Basque. In Tomas Riad & Carlos Gussenhoven (eds.), *Tones and tunes: Volume I, typological studies in word and sentence prosody*, 199–232. Berlin: Mouton de Gruyter.
Elordieta, Gorka, Sónia Frota & Marina Vigário. 2005. Subjects, objects and intonational phrasing in Spanish and Portuguese. *Studia Linguistica* 59. 110–143.
Escandell-Vidal, Victoria. 2011. "Verum focus" y prosodia: cuando la duración (sí que) importa. *Oralia* 14. 181–201.
Estebas-Vilaplana, Eva. 2017. The teaching and learning of L2 English intonation in a distance education environment: TL_ToBI vs. the traditional models. *Linguistica* 57(1). 73–91.
Face, Timothy L. 2007. The role of intonational cues in the perception of declaratives and absolute interrogatives in Castilian Spanish. *Estudios de Fonética Experimental* 16. 185–225.
Feldhausen, Ingo. 2010. *Sentential form and prosodic structure of Catalan*. Amsterdam: John Benjamins.
Feldhausen, Ingo. 2011. The prosodic phrasing of sentential objects. *Lingua* 121(13). 1934–1964.
Feldhausen, Ingo. 2016. Inter-speaker variation, Optimality Theory and the prosody of clitic left-dislocations in Spanish. *Probus* 28(2). 293–333.
Feldhausen, Ingo & Maria del Mar Vanrell. 2014. Prosody, focus and word order in Catalan and Spanish: An Optimality Theoretic approach. In Susanne Fuchs, Martine Grice, Anne Hermes, Leonardo Lancia & Doris Mücke (eds.), *Proceedings of the 10th International Seminar on Speech Production (ISSP)*, 122–125. Cologne: University of Cologne.
Feldhausen, Ingo & Maria del Mar Vanrell. 2015. Oraciones hendidas y marcación del foco estrecho en español: Una aproximación desde la Teoría de la Optimidad Estocástica. *Revista Internacional de Lingüística Iberoamericana* 13(2). 39–60.
Féry, Caroline. 2004. Gradient prosodic correlates of phrasing in French. In Trudel Meisenburg & Maria Selig (eds.), *Nouveaux départs en phonologie: Les conceptions sub-et suprasegmen-tales*, 161–182. Tübingen: Narr.
Féry, Caroline. 2006. The prosody of topicalization. In Kerstin Schwabe & Susanne Winkler (eds.), *On information structure, meaning and form*, 69–86. Amsterdam: John Benjamins.
Féry, Caroline. 2016. Models of intonation. In Caroline Féry (ed.), *Intonation and prosodic structure* (Key Topics in Phonology), 94–134. Cambridge: Cambridge University Press.
Frota, Sónia. 2002. Tonal association and target alignment in European Portuguese nuclear falls. In Carlos Gussenhoven & Natasha Warner (eds.), *Papers in laboratory phonology 7*, 387–418. Berlin: Mouton de Gruyter.
Frota, Sónia & Pilar Prieto. 2015. Intonation in Romance: Systemic similarities and differences. In Sónia Frota & Pilar Prieto (eds.), *Intonation in Romance*, 392–418. Oxford: Oxford University Press.
Frota, Sónia, Marisa Cruz, Flaviane Svartman, Marina Vigário, Gisela Collischonn, Aline Fonseca & Carolina Serra. 2015. Intonational variation in Portuguese: European and Brazilian varieties. In Sónia Frota & Pilar Prieto (eds.), *Intonation in Romance*, 235–283. Oxford: Oxford University Press.
Frota, Sónia, Marisa Cruz, Joelma Castelo, Nádia Barros, Verònica Crespo-Sendra & Marina Vigário. 2016. Tune or text? Tune-text accommodation strategies in Portuguese. *Proceedings of the International Conference on Speech Prosody* 2016. 1129–1133.
Gabriel, Christoph. 2006. Focal pitch accents and subject positions in Spanish: Comparing close-to-standard varieties and Argentinean Porteño. In Rüdiger Hoffmann & Hansjörg Mixdorff (eds.), *Speech Prosody 2006*, paper 028. Dresden: TUDpress Verlag der Wissenschaften.

Gabriel, Christoph. 2010. On focus, prosody, and word order in Argentinean Spanish: A minimalist OT account. *Revista Virtual de Estudos da Linguagem special edition* 4. 183–222.
García-Lecumberri, María Luisa. 2003. Análisis por configuraciones: La escuela británica. In Pilar Prieto (ed.), *Teorías de la entonación*, 35–61. Barcelona: Ariel.
Gordon, M. 2004. Syllable weight. In Bruce Hayes, Robert Kirchner & Donca Steriade (eds.), *Phonetically based phonology*, 277–312. Cambridge: Cambridge University Press.
Grice, Martine. 1995. *The intonation of interrogation in Palermo Italian: Implications for intonation theory*. Tübingen: Niemeyer.
Grice, Martine, Michelina Savino & Timo B. Roettger. 2018. Word final schwa is driven by intonation: The case of Bari Italian. *The Journal of the Acoustical Society of America* 143. 2474–2486.
Gussenhoven, Carlos. 2000. The lexical tone contrast of Roermond Dutch in Optimality Theory. In Merle Horne (ed.), *Prosody: Theory and experiment* (Text, Speech and Language Technology 14), 129–167. Dordrecht: Springer.
Gussenhoven, Carlos. 2004 [2009]. *The phonology of tone and intonation*. Cambridge: Cambridge University Press.
Gussenhoven, Carlos & Peter van der Vliet. 1999. The phonology of tone and intonation in the Dutch dialect of Venlo. *Journal of Linguistics* 35. 99–135.
Gutiérrez-Bravo, Rodrigo. 2003. Subject inversion in Spanish relative clauses. In Twan Geerts & Haike Jacobs (eds.), *Romance languages and linguistic theory*, 150–166. Amsterdam: John Benjamins.
Hanssen, Judith Elisabeth Gerarda. 2017. *Regional variation in the realization of intonation contours in the Netherlands*. Nijmegen: Radboud Universiteit dissertation.
Hayes, Bruce & Aditi Lahiri. 1991. Durationally specified intonation in English and Bengali. In Johan Sundberg, Lennart Nord & Rolf Carlson (eds.), *Music, language, speech, and brain: Proceedings of an International Symposium at the Wenner-Gren Center, Stockholm, 5–8 September 1990*, 78–91. London: Red Globe.
Hellmuth, Sam. 2006. *Intonational pitch accent distribution in Egyptian Arabic*. London: School of Oriental and African Studies (SOAS) University of London dissertation.
Hellmuth, Sam. 2018. Text-tune alignment in Tunisian Arabic yes-no questions. In Marisa Cruz, Sónia Frota & Pedro Oliveira (eds.), *Prosodic variation (with)in languages: Intonation, phrasing and segments* (Studies in Phonetics and Phonology). Sheffield: Equinox.
Henderson, Robert. 2012. Morphological alternations at the intonational phrase edge. *Natural Language & Linguistic Theory* 30. 741–787.
Holt, D. Eric. 2018. Optimality Theory and Spanish/Hispanic linguistics. In Kimberly Geeslin (ed.), *The Cambridge handbook of Spanish linguistics*, 31–51. Cambridge: Cambridge University Press.
Hoshi, Hidehito. 1998. On multiple sympathy candidates in optimality theory. In Jessica Maye & Mizuki Miyashita (eds.), *Proceedings of the 4th Annual Southwest Workshop on Optimality Theory (SWOT)*, 13–28. Tucson: The University of Arizona.
Hume, Elizabeth, Jennifer Muller & Aone van Engelenhoven. 1997. Non-moraic geminates in Leti. *Phonology* 14(3). 371–402.
Jun, Sun-Ah & Cecile Fougeron. 2000. A phonological model of French intonation. In Antonis Botinis (ed.), *Intonation: Analysis, modelling and technology* (Text, Speech and Language Technology 15), 209–242. Dordrecht: Springer.
Jun, Sun-Ah & Cecile Fougeron. 2002. Realizations of accentual phrase in French intonation. *Probus* 14. 147–172.
Kisseberth, Charles W. 2010. Optimality Theory and the theory of phonological phrasing: The Chimwiini evidence. In Nomi Erteschik-Shir & Lisa Rochman (eds.), *The sound patterns of syntax*, 217–246. Oxford: Oxford University Press.

Kubozono, Haruo. 2021. On the relationship between the tone and the syllable: A moraic account. Presentation at Phonetics and Phonology in Europe 2021 (PaPE), Universitat Pompeu Fabra, June 23.
de Lacy, Paul. 2002. The interaction of tone and stress in Optimality Theory. *Phonology* 19(1). 1–32.
Ladd, D. Robert. 2008. *Intonational phonology*. Cambridge: Cambridge University Press.
Levi, Susannah V. 2002. Limitations on tonal crowding in Turkish intonation. In *Proceedings of Phonologica, 9th International Phonology Conference*, 1–16. Vienna: S.P.
López Bobo, María Jesús, Ruth González Rodríguez, Miguel Cuevas Alonso, Liliana Díaz Gómez & Carmen Muñiz Cachón. 2005. Rasgos prosódicos del centro de Asturias: Comparación Oviedo-Mieres. *Estudios de Fonética Experimental* 14. 167–199.
Martínez Celdrán, Eugenio & Paolo Roseano. 2019. Stress clash in Spanish, Catalan, and Friulian from a prosodic perspective. *Spanish in Context* 16(3). 475–522.
Martorell, Laura, Doris Hoogeveen & Ana M. Fernández Planas. 2007. Aproximació a l'entonació del català de València en el marc del projecte AMPER [An approach to Valencian Catalan intonation within the framework of the AMPER project]. *Estudios de Fonética Experimental* 16. 99–118.
McCarthy, John J. 2008. *Doing Optimality Theory: Applying theory to data*. Oxford: Blackwell.
McCarthy, John J. 2010. An introduction to Harmonic Serialism. *Language and Linguistics Compass* 4(10). 1001–1018.
McCarthy, John J. 2011. Autosegmental spreading in Optimality Theory. In John A. Goldsmith, Elizabeth Hume & Leo Wetzels (eds.), *Tones and features*, 195–222. Berlin: Mouton de Gruyter.
Moraes, João & Manuela Colamarco. 2008. Accomodation of intonational patterns in Brazilian Portuguese short utterances: Compression or truncation? In Leda Bisol & Cláudia Regina Brescancini (eds.), *Contemporary phonology in Brazil*, 2–21. Newcastle upon Tyne: Cambridge Scholars.
Muñiz Cachón, Carmen & Paolo Roseano. 2022. Prosodia del asturiano centromeridional: Rasgos característicos y anotación en Astur_ToBI. In Beatriz Blecua, Jordi Cicres, Marina Espejel & María Jesús Machuca (eds.), *Propuestas en fonética experimental: Enfoques metodológicos y nuevas tecnologías*, 210–214. Girona: Universitat de Girona.
Myers, Scott. 1997. OCP effects in Optimality Theory. *Natural Language & Linguistic Theory* 15. 847–892.
Myrberg, Sara. 2010. *The intonational phonology of Stockholm Swedish*. Stockholm: University of Stockholm dissertation.
Pierrehumbert, Janet Breckenridge. 1980. *The phonology and phonetics of English intonation*. Cambridge, MA: MIT dissertation.
Pierrehumbert, Janet B. & Mary E. Beckman. 1988. *Japanese tone structure*. Cambridge, MA: MIT Press.
Post, Brechtje Maria Bowine. 2002. *Tonal and phrasal structures in French intonation*. Nijmegen: Katholieke Universiteit Nijmegen dissertation.
Post, Brechtje. 2011. The multi-facetted relation between phrasing and intonation contours in French. In Christoph Gabriel & Conxita Lleó (eds.), *Intonational phrasing in romance and Germanic: Cross-linguistic and bilingual studies*, 43–74. Amsterdam: John Benjamins.
Prieto, Pilar. 2001. L'entonació dialectal del català: El cas de les frases interrogatives absolutes [Dialectal intonation in Catalan: Absolute interrogatives]. In August Bover, Maria-Rosa Lloret & Mercè Vidal Tibbits (eds.), *Actes del 9è Col·loqui de la North American Catalan Society*, 347–377. Barcelona: Publicacions de l'Abadia de Montserrat.
Prieto, Pilar. 2002. Tune-text association patterns in Catalan: An argument for a hierarchical structure of tunes. *Probus* 14(1). 173–204.
Prieto, Pilar. 2005. Syntactic and eurhythmic constraints on phrasing decisions in Catalan. In Merle Horne & Marc van Oostendorp (eds.), *Boundaries in intonational phonology*. [Special issue]. *Studia Linguistica*, vol. 59, 194–222.

Prieto, Pilar. 2006a. Word-edge tones in Catalan. In Mariapaola D'Imperio (ed.), *Autosegmental-metrical approaches to intonation in Europe: Tonal targets and anchors*. [Special Issue]. *Italian Journal of Linguistics*, vol. 18, 39–71.

Prieto, Pilar. 2006b. Phonological phrasing in Spanish. In Sonia Colina & Fernando Martínez-Gil (eds.), *Optimality-theoretic advances in Spanish phonology*, 39–60. Amsterdam: John Benjamins.

Prieto, Pilar. 2008. Tonal alignment patterns in Catalan nuclear falls. *Lingua* 1450. 1–16.

Prieto, Pilar & Marta Ortega-Llebaria. 2009. Do complex pitch gestures induce syllable lengthening in Catalan and Spanish? In Marina Vigário, Sónia Frota & M. João Freitas (eds.), *Phonetics and phonology: Interactions and interrelations*, 51–70. Amsterdam: John Benjamins.

Prieto, Pilar. 2011. Prosodic effects on phrasing: Clash avoidance in Catalan. In Nicole Dehé, Ingo Feldhausen & Shinichiro Ishihara (eds.), *New insights into the Prosody-Syntax interface: Focus, phrasing, language evolution*. [Special issue]. Lingua, vol. 121, 1923–1933.

Prieto, Pilar & Teresa Cabré (eds.). 2007–2012. *Atles interactiu de l'entonació del català* [Interactive atlas of Catalan intonation]. http://prosodia.upf.edu/atlesentonacio/ (accessed 23 March 2020).

Prieto, Pilar & Teresa Cabré (eds.). 2013. *L'entonació dels dialectes catalans* [The intonation of Catalan dialects]. Barcelona: Publicacions de l'Abadia de Montserrat.

Prieto, Pilar & Verònica Crespo-Sendra (eds.). 2011. *Atles interactiu de l'entonació del valencià* [Interactive atlas of Valencian intonation]. http://prosodia.upf.edu/aev/ (accessed 23 March 2020).

Prieto, Pilar & Paolo Roseano. 2020. Current issues and challenges in Spanish intonational research. In Fernando Martínez-Gil & Sonia Colina (eds.), *The Routledge handbook of Spanish phonology*, 222–233. London: Routledge.

Prieto, Pilar, Jan van Santen & Julia Hirschberg. 1995. Tonal alignment patterns in Spanish. *Journal of Phonetics* 23. 429–451.

Prieto, Pilar, Mariapaola D'Imperio & Barbara Gili Fivela. 2005. Pitch accent alignment in Romance: Primary and secondary associations with metrical structure. *Language and Speech* 48(4). 359–396.

Prieto, Pilar, Lourdes Aguilar, Ignasi Mascaró, Francesc Torres-Tamarit & Maria del Mar Vanrell. 2009. L'etiquetatge prosòdic Cat_ToBI [Prosodic transcription Cat_ToBI]. *Estudios de Fonética Experimental* 18. 287–309.

Prieto, Pilar, Joan Borràs-Comes, Verònica Crespo-Sendra, Paolo Roseano, Rafèu Sichel-Bazin & Maria del Mar Vanrell. 2015. The intonational phonology of Catalan and its dialectal varieties. In Sónia Frota & Pilar Prieto (eds.), *Intonation in Romance*, 9–62. Oxford: Oxford University Press.

Prince, Alan & Paul Smolensky. 1993 [2004]. *Optimality Theory: Constraint interaction in generative grammar*. Malden, MA: Blackwell.

Rao, Rajiv. 2007. Phonological phrasing in Barcelona Spanish. In Erin Bainbridge & Brian Agbayani (eds.), *Proceedings of the 34th Western Conference on Linguistics (WECOL)*, 345–360. Fresno, CA: Department of Linguistics, California State University.

Rischel, Jørgen. 1974. *Topics in West Greenlandic phonology: Regularities underlying the phonetic appearance of wordforms in a polysynthetic language*. Copenhagen: Akademisk Forlag.

Rodriquez, Francesco. 2020. *Implementationsprozesse sizilianischer Intonationsmuster: Ein optimalitätstheoretisches Modell*. Freiburg im Breisgau: Albert-Ludwigs-Universität BA thesis.

Rodriquez, Francesco, Paolo Roseano & Wendy Elvira-García. 2020. Grundzüge der sizilianischen Prosodie. *Dialectologia et Geolinguistica* 28. 81–104.

Rodriquez, Francesco, Paolo Roseano & Teresa Cabré Monné. 2022. Text-tune accommodation processes in the intonation of European Portuguese yes-no questions: An OT analysis. In Sónia Frota & Marina Vigário (eds.), *Proceedings of Speech Prosody 2022*, 847–851.

Roettger, Timo B. & Martine Grice. 2019. The tune drives the text: Competing information channels of speech shape phonological systems. *Language Dynamics and Change* 9(2). 265–298.

Roseano, Paolo & Ana María Fernández-Planas. 2018. L'amuntegament tonal en castellà, català i friülà i en la Teoria de l'Optimitat [Tonal crowding in Castilian, Catalan and Friulian and in Optimality Theory]. *Sintagma* 30. 23–37.
Roseano, Paolo, & Francesco Rodriquez. 2021. Representation of the prosody of Ladin chanted calls. Paper presented at the 1st International Conference on Tone and Intonation (TAI). Syddansk Universitet Sønderborg, 6–9 December.
Roseano, Paolo, Maria del Mar Vanrell & Pilar Prieto. 2015. Intonational phonology of Friulian and its dialects. In Sónia Frota & Pilar Prieto (eds.), *Intonation in Romance*, 101–139. Oxford: Oxford University Press.
Samek-Lodovici, Vieri. 2006. Absence of stress culmination and prosodic phrasing. In Alan Prince, Eric Baković, Junko Ito & John McCarthy (eds.), *Wondering at the natural fecundity of things: Essays in honor of Alan Prince*. Santa Cruz: Linguistics Research Center, UC Santa Cruz. https://escholarship.org/uc/item/2zp3z165 (accessed 2 June 2021).
Samek-Lodovici, Vieri. 2019. Prosody-driven scrambling in Italian. In Ingo Feldhausen, Martin Elsig, Imme Kuchenbrandt & Mareike Neuhaus (eds.), *Romance languages and linguistic theory 15: Selected papers from 'Going Romance' 30, Frankfurt*, 178–196. Amsterdam: John Benjamins.
Schubö, Fabian. 2020. Intonation phrase formation in sentences with clausal embedding. *The Journal of Comparative Germanic Linguistics* 23. 161–201.
Selkirk, Elisabeth. 2000. The interaction of constraints on prosodic phrasing. In Merle Horne (ed.), *Prosody: Theory and experiment* (Text, Speech and Language Technology 14), 231–261. Dordrecht: Springer.
Selkirk, Elisabeth. 2008. Bengali intonation revisited: An Optimality Theoretic analysis in which FOCUS stress prominence drives FOCUS phrasing. In Chungmin Lee, Matthew Gordon & Büring Daniel (eds.), *Topic and focus: Cross-linguistic perspectives on meaning and intonation* (Studies in Linguistics and Philosophy 82), 215–224. Dordrecht: Springer.
Sichel-Bazin, Rafèu, Trudel Meisenburg & Pilar Prieto. 2015. Intonational phonology of Occitan: Towards a prosodic transcription system. In Sónia Frota & Pilar Prieto (eds.), *Intonation in Romance*, 198–234. Oxford: Oxford University Press.
Smith, Jennifer L. 2011. [wh] complementizers drive phonological phrasing in Fukuoka Japanese. *Natural Language & Linguistic Theory* 29(2). 545–559.
Steriade, Donca. 1991. Moras and other slots. In Denis Meyer & Satoshi Tomioka (eds.), *Proceedings of the 1st Meeting of the Formal Linguistics Society of the Midwest*, 254–280. Madison: University of Wisconsin.
Truckenbrodt, Hubert. 1995. *Phonological phrases: Their relation to syntax, prominence and focus*. Cambridge, MA: MIT dissertation.
Truckenbrodt, Hubert. 1999. On the relation between syntactic phrases and phonological phrases. *Linguistic Inquiry* 30. 219–255.
Truckenbrodt, Hubert. 2005. A short report on intonation phrase boundaries in German. *Linguistische Berichte* 203. 273–296.
Vanrell, Maria del Mar, Francesc Ballone, Carlo Schirru & Pilar Prieto. 2015. Sardinian intonational phonology: Logudorese and Campidanese varieties. In Sónia Frota & Pilar Prieto (eds.), *Intonation in Romance*, 317–349. Oxford: Oxford University Press.
Vanrell, Maria del Mar, Ingo Feldhausen & Lluïsa Astruc . 2018. The discourse completion task in Romance prosody research: Status quo and outlook. In Ingo Feldhausen, Jan Fliessbach & Maria del Mar Vanrell (eds.), *Methods in prosody: A Romance language perspective*, 191–227. Berlin: Language Science Press.
Vigário, Marina. 2016. Segmental phenomena and their interactions: Evidence for prosodic organization and the architecture of grammar. In Susann Fischer & Christoph Gabriel (eds.), *Manual of*

grammatical interfaces in Romance (Manuals of Romance Linguistics 10), 41–73. Berlin: Mouton de Gruyter.

Vigário, Marina, Marisa Cruz & Sónia Frota. 2019. Why tune or text? The role of language phonological profile in the choice of strategies for tune-text adjustment. In Sasha Calhoun, Paola Escudero, Marija Tabain & Paul Warren (eds.), *Proceedings of the 19th International Congress of Phonetic Sciences, Melbourne, Australia*, 567–571. Canberra: Australasian Speech Science and Technology Association.

Watkins, Laurel J. 1984. *A grammar of Kiowa*. Lincoln: University of Nebraska Press.

Welby, Pauline. 2006. French intonational structure: Evidence from tonal alignment. *Journal of Phonetics* 34. 343–371.

Yip, Moira. 2002. *Tone*. Cambridge: Cambridge University Press.

Zec, Draga. 1988. *Sonority constraints on prosodic structure*. Stanford, CA: Stanford University dissertation.

Zhang, J. 2002. *The effects of duration and sonority on contour tone distribution: A typological survey and formal analysis*. London: Routledge.