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Text-tune accommodation strategies in the intonation of European Portuguese yes/no questions: an OT analysis

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Abstract

A key notion in intonational research is the independence of sentence intonation (tune) and its segmental configuration (text). Yet, there is one aspect of intonation that fewer studies are concerned with: the text-tune interface (TTI). The goal of this paper is rendering accommodation processes at the TTI more explicit by formalizing them within the framework of Optimality Theory (OT) as well as the autosegmental-metrical (AM) model of intonation. The combination of OT and AM is suitable because OT takes conflict resolution as its central notion, and AM successfully bridges the gap between the continuous nature of the distribution of fundamental frequency and OT's deterministic violation mark assignment. We base our analysis on reported acoustic data of information-seeking yes/no questions in different varieties of European Portuguese (EP), where three text-tune accommodation (TTA) strategies can be observed: tonal truncation, vowel epenthesis, and blocking of final vowel deletion. We put forward a set of intonational as well as segmental faithfulness and markedness constraints which capture TTA strategy selection in EP and, furthermore, prove to be useful in typology, laying the groundwork for further research on TTA processes in a consistent and comparable way.

Index Terms: intonation, European Portuguese, text-tune interface, text-tune accommodation, Optimality Theory

1. Introduction

The goal of this paper is a constraint-based analysis of TTA strategies in EP yes/no question contours realized on nuclear words with final stress by means of AM ([1], [2], [3], [4]) and of OT ([5]), tackling the issue of phonologically encoded alignment ([6]) and two-stage associations (primary and secondary association) of tonal categories ([4] [6], [7]). For this purpose, in s.2 we propose a formalization that explicitly captures these aspects of intonation in a format that is compatible with evaluation mechanisms of OT. Said formalization will be applied in s.3 to TTA strategies in yes/no question contours reported for different varieties of EP. Subsequently, in s.4 we proceed to define intonational faithfulness and markedness constraints that make use of the concept of α- and β-association and therefore manage to capture the dialectal variation of TTA strategy selection in EP (s.5).

2. Phonological representation of the tune

The alignment of tones can be distinctive (e.g., in English pitch-accents (PAs) ([6], [8])) or Japanese accentual phrases ([6])) and has therefore been said to be phonologically encoded ([3]). In [6] it was proposed that tones be associated in a dual fashion (later revisited in [4], [9], i.a.). For example, PAs form a primary association (henceforth: α-association) with a non-terminal prosodic constituent, like the stressed syllable, while their component tones form secondary associations (henceforth: β-associations) with constituents on a lower level of the metrical structure (namely on the segmental level). The same concept was later applied to boundary tones (BTs), where the tonal group forms an α-association with a high-level prosodic category (e.g., [10] for Sicilian intonational phrases (IPs)) and its component tones form β-associations on the segmental level.

Yet, the concept of two-stage association of tonal groups still lacks a formalization that is compatible with OT's deterministic violation mark assignment. So far, tonal alignment has been treated with special alignment constraints in OT ([11], [12], [13], i.a.), thereby making the task of tonal alignment one of grammatical derivation rather than one of contrastive phonological features.

Therefore, we propose an enriched formal representation of PAs and BTs that encodes explicit information on α- and β-associations by means of special α- and β-features.

Let's consider a fictitious sequence of tones T* T%, where T* tends to align with the left edge of the stressed syllable's (σˈ) onset, while T% tends to align with right edge of the IP, and let's imagine these tones align with a ˈV.CV sequence. By using contextual notation from rule-based phonology, we can reformulate these facts as contextual feature descriptions: T* α-associates with its non-terminal association domain σˈ (α=σˈ), and β-associates with the left edge of a vowel[1] ([v), such that (|) the stressed syllable (σˈ) dominates (>) said edge (__) (1 left).

(1)

$$\begin{bmatrix} \{L^*\}_\alpha \\ \alpha = \sigma' \\ \beta(L^*) = \ [_V \mid \sigma' > \_\_ \end{bmatrix} \qquad \begin{bmatrix} \{\text{L\%}\}_\alpha \\ \alpha = IP \\ \beta(\text{L\%}) =]_{C/V} \mid \_\_ \equiv \ ]_{IP} \end{bmatrix}$$

The BT T% then α-associates with its higher-level association domain IP (α=IP) and β-associates with the right edge of a

[1] For the sake of brevity, here we set forth that the β-associations are directly with a segment, but they actually are with the segment occupying a certain *position* in the metrical structure (i.e., in this case, with the vowels that constitute the first element of the onset). See [14] for a discussion.

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segment (]$_{C/V}$), such that (|) it (__) coincides (≡) with the right edge of the IP domain (]$_{IP}$) (1 right).

This enriched representation of the tune will enable us to treat tune alignment without the need for special alignment constraints in our OT analysis (s.5), while also explicitly formalizing the contrastive and therefore phonological character of alignment.

3. TTA in European Portuguese questions

The reason for choosing EP as the language of analysis is that previous literature ([15], [16], [17]) suggests that EP displays a wide range of TTA strategies that do not point towards a language-specific preference for either accommodation directions: text-to-tune or tune-to-text. As shown in [17], both types of strategies can be observed across geographical regions of Portugal: the North tending towards tune-to-text accommodations, the South tending towards text-to-tune accommodations, and the Central regions showing a transitional behavior between the two. More precisely, as far as EP yes/no questions are concerned, [18] summarizes the following TTA strategies: (1) BT truncation, (2) intonationally driven vowel epenthesis, and (3) blocking of final /ɨ/-deletion.

The following sections (3.1-3.3) show reported acoustic data of these TTA processes in EP – drawn from the InAPoP ([19]) and collected using a reading and discourse completion task – as well as phonological interpretations in terms of dual association. We will be looking at two yes/no question contours: L*+H L% (Fig. 1 left) and L* HL% (Fig. 1 right).

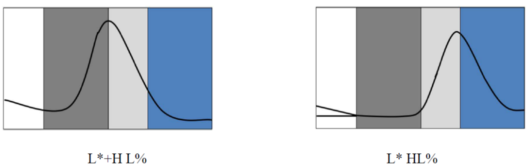

Figure 1: *Stylized curves of L*+H and L* HL% in EP. Dark cells =stressed syllable, light-gray cells = first posttonic unstressed syllable, blue cells = last posttonic unstressed syllable. [19]*

3.1. Boundary tone truncation

Fig. 2 shows the realization of a yes/no question contour L* HL% on the word ‘mar’, produced by a speaker of Northern EP from Braga. While the low pitch accent L* as well as the H target of the BT are realized on the stressed syllable ‘mar’, the L target of the BT is truncated due to the lack of posttonic segmental material. Since TTA is achieved by modifying the tune structure, this is a so-called tune-to-text adjustment.

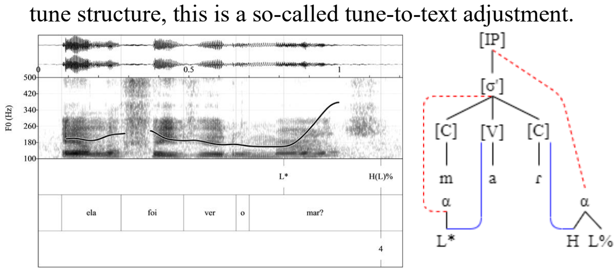

Figure 2: *Truncated yes/no question contour L* H(L%) ‘Ele foi ver o mar?’ ([15]) and its simplified phonological interpretation.*

In phonological terms, the L* tone forms an α-association (dashed red line in Fig. 2) with its association domain, the stressed syllable σ' (α=σ'), while the L* component tone forms a β-association (solid blue line in Fig. 2) with the vowel of the stressed syllable (β(L*) = V | σ' > __). The BT group HL% forms an α-association with the IP (α = IP). When it comes to its component tones, H forms a β-association with the right edge of the stressed syllable (β(H) =]$_{C/V}$ | σ' > __), while L% does not form the β-association with the right edge of the utterance that it is phonologically encoded for (β(L%) =]$_{C/V}$ | __ ≡]$_{IP}$).

3.2. Intonationally driven epenthesis

Another strategy can be found in the Central EP variety of Castelo Branco. Fig. 3 shows the realization of a yes/no question contour L*+H L% on the stressed syllable of the word ‘angelical’. The PA L*+H is realized as a rise from a tonal valley at the beginning of the stressed syllable ‘ca’ to a tonal peak at the right edge of the same syllable.

Instead of not realizing the BT as in the previous example, an additional schwa-like segment [ɨ] is inserted which enhances the utterance’s fitness for pitch transmission by providing another voiced segment. The BT L% is then realized at the end of inserted [ɨ]. Since this is a modification of the text, this is a so-called text-to-tune adjustment.

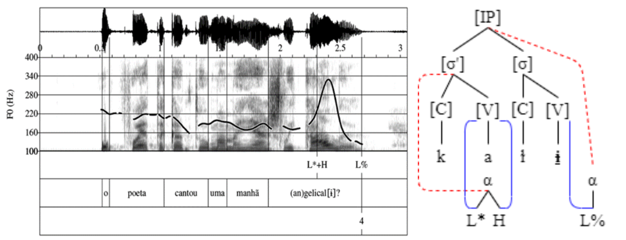

Figure 3*: Yes/no question contour L*+H L% ‘O poeta cantou uma manhã angelical[ɨ]?’ with [ɨ]-epenthesis ([15]) and its simplified phonological interpretation.*

From a phonological perspective, this means that the PA L*+H forms an α-association with the stressed syllable ‘ca’ (α = σ’), while its component tones L* and H form β-associations with the left and right edge of the syllable respectively (β(L*) = [$_{C/V}$ | σ'>__ and β(H) =]$_{C/V}$ | σ'>__). The BT L%, again, forms an α-association with the IP (α=IP), and it is only due to the insertion of [ɨ] that it can also form a β-association with the rightmost segment of the utterance (β(L%) =]$_{C/V}$ | __ ≡]$_{IP}$), without crowding it.

The Central EP variety of Castelo Branco also displays cases of deletion of the BT L% instead of [ɨ]-epenthesis.

3.3. Blocking of final [ɨ]-deletion

The last strategy we want to focus on in this paper is the blocking of final [ɨ]-deletion which is a usual phonological process of EP. Fig. 4 shows the realization of a yes/no question contour L*+H L% on the word ‘nove’, produced by a speaker of the Southern EP variety of Funchal. Normally, ‘nove’ /nove/ would be reduced to [nɔv] which would turn it into an oxytone and therefore more prone to tonal crowding in EP. The PA L*+H is realized as a rise from a tonal valley at the beginning of the stressed syllable ‘no’ to a tonal peak at the right edge of the same syllable. The final [ɨ] is then preserved, when it normally would have been deleted, to accommodate the BT L% at the end of the utterance.

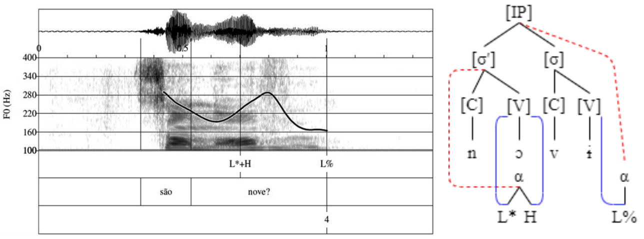

Figure 4*: Yes/no question contour L*+H L% 'são nov[ɨ]?' with preserved /ɨ/ ([15]) and its simplified phonological interpretation.*

In phonological terms, L*+H forms an α-association with the stressed syllable σ', while its component tones L* and H form β-associations with the left and right edge of the stressed syllable's vowel [ɔ], respectively ($\beta(L^*) = [_V \mid \sigma' >$__ and $\beta(H) =]_V \mid \sigma' >$__). Due to the preservation of the final vowel, 've' can project a syllable that can accommodate L% on its vocalic nucleus. Therefore, L% forms an α-association with the right edge of IP ($\alpha =]_{IP}$) and a β-association with the rightmost vocalic segment ($\beta(L\%) =]_V \mid$ __ $\equiv]_{IP}$).

4. Constraints for TTA strategy selection

Considering our proposed formalization of phonological α- and β-associations, we can formulate a set of intonational faithfulness (4.1.) and markedness (4.2.) constraints which will be used additionally to the segmental constraints like MAX-IO ('do not delete'), DEP-IO ('do not insert') and *[ɨ]# ('No [ɨ] at the right word boundary')[1].

4.1. Intonational faithfulness constraints

The faithfulness constraint MAX-IO(β(T)) penalizes tone deletion which in the proposed formalization is equivalent to a tone lacking a β-association.

> **MAX-IO(β(T)):** Assign one violation mark to every β-feature of T in the input that does not have a corresponding β-feature in the output.

The faithfulness constraint RESPECT-IO(β(T)) accounts for gradual faithfulness of an output tone's β-association $\beta_{output}(T)$ to the position that its underlying counterpart $\beta_{input}(T)$ specifies phonologically, by penalizing every segment that intervenes between these two positions in the output candidate's metrical structure.

> **RESPECT-IO(β(T)):** Let $\{\beta_{input}(T), \beta_{output}(T)\}$ be a corresponding β-feature pair and let $\{m_1 \ldots m_n\}_{output}$ be the set of all metrical positions of the output candidate. Assign one violation mark to every segment that intervenes between $\beta_{input}(T)$'s corresponding metrical position m_k and $\beta_{output}(T)$'s association site m_m.

4.2. Intonational markedness constraints

The markedness constraint $*\beta(T)_{[-voiced]}$ penalizes the association of a tone with a metrical position that coincides with a [-VOICED] feature since voiceless segments cannot transmit pitch.

> **$*\beta(T)_{[-voiced]}$:** Assign one violation mark to every β-association site that coincides with a [-VOICED] feature on the segmental level.

The last markedness constraint *CLASH(β) avoids tonal crowding on the structural level by penalizing β-associations that coincide in the same metrical position in the output.

> ***CLASH(β):** Assign one violation mark to every β-association that coincides with another β-association at the same structural position in the output.

5. Results: OT analysis

In this section we will provide an OT analysis of the TTA processes of s.3 with the constraints that were presented in s.4. For the sake of readability, we will assume in our examples that all α-associations remain intact which then allows us to only represent the terminal level of the metrical structure as sequences of [C] or [V] that can be subscripted with a tone if they act as its β-association site (e.g., $[_L V]$).

Fig. 5 shows a tableau that models the yes/no question from Braga as shown in Fig. 2. Upon receiving the segmental string /mar/ and the tonal string $\{L^*\}_\alpha$ $\{HL\%\}_\alpha$ as an input, the grammar selects candidate (b) '[m][$_{L*}$a][r]$_H$' as its output which deletes the BT L% in order to avoid crowding both BTs H and L% at the end of the utterance, like for example candidate (a) does.

The winning candidate (b) violates Max-IO(β(T)) (because L% does not surface) and RESPECT-IO(β(T)) (because L* surfaces one segment leftwards from its designated position), so both these constraints must be dominated by *CLASH(β(T)) which disfavors coinciding β-associations (i.e., crowding).

/m a r/ [C] [V] [C] $\{L^*\}_\alpha$ $\{HL\%\}_\alpha$	$*\beta(T)_{[-v]}$	MAX	DEP	*[ɨ]#	*CLASH(β)	MAX(β)	RESPECT(β)
a. m a ɾ ˈ[C] [$_{L*}$V][C]$_{HL\%}$					*		*
b. ☞ m a ɾ ˈ[C][$_{L*}$V][C]$_H$						*	*
c. m a ɾ ˈ[C][$_{L*}$V][C]						**!	

Figure 5*: Simplified tableau for the input /mar/-$\{L^*\}_\alpha\{HL\%\}_\alpha$ in the Northern variety of Braga. Truncation (b) wins.*

Fig. 6 shows a tableau which models the yes/no question from Castelo Branco as shown in Fig. 3. Upon receiving the segmental string angeli/kal/ and the tonal string $\{L^*+H\}_\alpha$ $\{L\%\}_\alpha$ as an input, the grammar selects candidate (c) '[k][$_{L*}$a]$_H$.[l][ɨ]$_{L\%}$' as its output which inserts [ɨ] at the end of the word to provide more segmental material fit for pitch transmission that can accommodate the BT L%.

Therefore, the constraints DEP-IO and *[ɨ]# are the lowest-ranked ones in this hierarchy because they disfavor the

[1] Note that {*[ɨ]#, DEP-IO} can be considered a placeholder for a richer set of constraints that regulate [ɨ]-epenthesis in EP.

insertion of an underlyingly absent segment and the presence of [ɨ] at a right word boundary respectively.

The subhierarchy {MAX-IO(β(T))} >> {DEP-IO, *[ɨ]#} thus rules out truncated candidates like (a), which abide by {DEP-IO, *[ɨ]#} by means of tone deletion. Reversing this subhierarchy {DEP-IO, *[ɨ]# >> MAX-IO(β(T))} would hence result in (a) being optimal which also can be observed in Central EP varieties[1].

/k a l/ [C] [V] [C] {L*+H}$_\alpha$ {L%}$_\alpha$		*β(T)$_{[-v]}$	MAX	*CLASH(β)	RESPECT(β)	Max(β)	DEP	*[ɨ]#
a.	k a ɫ [C] [L*V] [C]H					*!		
b.	k a ɫ [C][VL*][C] H,L%			*	*			
c.	☞ k a ɫ ɨ ˈ[C][L*V] H.[C][V]L%						*	*

Figure 6: *Simplified tableau for the input angeli/kal/-{L*+H}$_\alpha${L%}$_\alpha$ in the Central variety of Castelo Branco. [ɨ]-epenthesis (c) wins.*

Fig. 7 shows a tableau which models the yes/no question from Funchal as shown in Fig. 4. Upon receiving the segmental string /nove/ and the tonal string {L*+H}$_\alpha$ {L%}$_\alpha$ as an input, the grammar selects candidate (a) '[n][L* ɔ]H.[v][ɨ]L%' as its output which does not delete the final vowel to provide more segmental material fit for pitch transmission that can accommodate the BT L%.

Said segment is deleted, whenever the markedness constraint *[ɨ]# ranks high. Since this is not the case here, *[ɨ]# is the lowest-ranked constraint in this hierarchy, thereby selecting (a) as its optimal candidate which besides of preserving final [ɨ] satisfies all the other higher-ranked constraints.

/n o v e/ [C] [V] [C] [V] {L*+H}$_\alpha$ {L%}$_\alpha$		*β(T)$_{[-v]}$	MAX	*CLASH(β)	Max(β)	RESPECT(β)	DEP	*[ɨ]#
a.	☞ n ɔ v ɨ ˈ[C][L*V] H.[C][V]L%							*
b.	n ɔ v ˈ[C][L*V] [C] H, L%			*				
c.	n ɔ f ˈ[C][L*V] [C] H, L%	**		*				

Figure 7: *Simplified tableau for the input /nove/-{L*+H}$_\alpha${L%}$_\alpha$ in the Southern variety of Funchal. Preserving final /ɨ/ as well as the tonal string (a) wins.*

[1] See [14] for a discussion on how to model gradual variation of TTA strategy selection in Castelo Branco EP.

6. Discussion

Since our proposed constraints address general properties of phonological tune representation, they are promising for intonational typology. For instance, when articulatory time pressure manifests as the result of tonal crowding and is avoided by tone deletion, there are crosslinguistic differences as to what kind of tone is to be deleted. In EP and other Romance languages (e.g., [10]) this is usually a BT (T%), while in Turkish, for instance, a PA tone (T_{PA}) gets deleted ([20]). This could be modelled in both languages by an ordering of constraints of the MAX-IO(β(T)) family: MAX-IO(β(T%)) >> MAX-IO(β(T_{PA})) favors PA tone deletion as in Turkish, while MAX-IO(β(T_{PA})) >> MAX-IO(β(T%)) favors BT truncation as in EP.

In a similar fashion, treating RESPECT-IO as a constraint family could lead to insightful conclusions regarding typological differences in alignment stability. In ([21]), for instance, it is reported that in Greek prenuclear L*+H accents L* is consistently aligned with the onset of the stressed syllable, while the trailing tone H shows less rigid alignment behavior. If canonical alignment positions were encoded as α- and β-features in tune representations, then a hierarchy of the RESPECT-IO constraint family can capture the differences in alignment stability by ranking the constraints that target more rigidly aligned tone categories higher. For Greek prenuclear L*+H this means that RESPECT-IO(β(T*)) >> RESPECT-IO(β(T~)) – '~' referring to unstarred tones – could explain its preference for stable L* alignment as opposed to stable H alignment.

Future research will need to focus on modelling other TTA processes that were not found in EP (e.g., peak retraction ([10], i.a.), tonal coalescence ([22]), and lengthening ([22], [23], i.a.)) in order to refine the proposed constraint set and phonological representations and to test its typological explanatory power. For example, our proposed constraint *CLASH(β(T)) is limited insofar that it can only deal with tonal crowding when conceived as a competition for association at the same metrical position, but it cannot account for cases in which tones crowd in a domain (e.g., σ') without sharing the same association site.

Furthermore, fitness for pitch transmission was admittedly simplified in this paper, since a contrast between [-VOICED] (unfit) and [+VOICED] (fit) was sufficient for the selected EP data, but it might be not detailed enough to capture the varying degree of pitch transmission fitness of different segment types. Also, it does not (and probably should not) account for aspects affecting pitch transmission fitness and articulatory time pressure that are purely phonetic, e.g., speech rate. This further rises the question: to which extent should the phonetic details of TTA processes be accounted for in phonological terms?

7. Conclusions

By explicitly encoding the tune's distinctive alignment and association behavior as phonological α- and β-features and by taking these as a basis for constraint formulation, we have modelled variation in TTA strategy selection across dialectal regions (Northern, Central and Southern EP), drawing from beneficial theoretical aspects of both AM and OT. The resulting constraint set allows for hierarchies that can successfully model BT truncation, intonationally driven epenthesis and blocking of final [ɨ]-deletion.

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