Preface

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1. The topic

This special issue was meant to gather a forum of discussion about an area of investigation within the study of intonation which has emerged in the last two decades, that is 'tonal alignment'. Under this label one generally assumes the details of the temporal coordination between tonal elements (such as tonal targets of pitch accents and/or edge marking tones) and structural elements (such as syllables) or even specific segments in the string. Though this area of investigation is generally subsumed under the more general autosegmental-metrical framework of intonation ('AM theory', see Ladd 1996 for a review), it is not necessarily confined to a specific theoretical approach. Actually, as Ladd (1996) points out, alignment work is theory-neutral in principle, which is proven by the fact that some of the early contributions in this field were not couched within this approach (e.g. Caspers & van Heuven 1993, Kohler 1987). Different approaches are also represented by the contributions of this volume (for instance, Xu and Liu's and van Santen et al.'s contributions).

One of the reasons that led me to gather such an array of articles is that tonal alignment studies have drawn a great amount of attention for quite some time now. Evidence of this fact is that the latest editions of prestigious international conferences on prosody and phonetics ('Speech Prosody', 'ICPhS') have included a special session or symposium on alignment. Despite the growing attention of the prosody community on alignment studies, this is the first time that an entire volume has been dedicated to this topic. Interest in such studies is both of a theoretical nature (e.g., the determination of tonal targets is paramount for supporting autosegmental theories of intonation) as well as of a more technological and modeling nature (models of tonal target alignment have been employed for the intonation module of TTS systems, cf. van Santen & Hirschberg 1994). Another point to notice is that, despite the accumulation of alignment data on more and more languages (not exclusively European), the evidence and the interpretation of the results is often quite controversial.

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These results can be summarized as follows. In the past two decades there has been an increasing amount of evidence that L(ow) and H(igh) points of the f_0 curve behave as systematically controlled targets, whose temporal and melodic coordinates are quite consistent for a given pitch accent type (see Bruce 1977 for Swedish, Silverman & Pierrehumbert 1990 for American English, Arvaniti & Ladd 1995, 1998, 2000 for Greek, Ladd et al. 1999, 2000 for British English, Prieto *et al.* 1995 for Spanish, D'Imperio 1995, 2000, 2001 for Neapolitan Italian, Xu 1998, 1999 for Mandarin, *inter alia*). While some of these studies have emphasized the role of prosodic factors (tonal crowding, position within the intonation phrase, etc.) in determining exact tonal alignment, more recently, work by Ladd and colleagues (see Ladd this volume) has suggested that when such prosodic effects are excluded, the alignment of tonal targets is consistently governed by "segmental anchoring" (Segmental Anchoring Hypothesis, **SAH** henceforth). In other words, the beginning and the end of a tonal movement (usually but not exclusively related to a pitch accent) would be anchored relative to specific segments within, say, the stressed syllable, such as the onset, the vowel, or the coda, and that this alignment would be resistant to changes in syllabic/segmental structure and/or speech rate, while holistic features of the contour, such as speed of the rise (hence slope) would be variable, as a consequence of the tone-to-segment alignment.

A position close to that of strict segmental anchoring, which would actually be better characterized as 'syllabic anchoring', is the one maintained by Xu (Xu 2002, Xu & Wang 2001, Xu & Liu this volume), though in his view the origin of the alignment regularities is to be find in a universal phasing pattern between the laryngeal and the supralaryngeal system, which is reminiscent of attractor-state models of the kind developed to account for limb movement by Kelso (1984) (see below for more detail on this issue).

Yet, both the SAH and Xu's hypothesis are contradicted by results that indicate that syllable structure detail, segmental composition and even speech rate crucially affect target alignment (van Santen & Hirschberg 1994, D'Imperio 2000, 2002, D'Imperio *et al.*, in press, *inter alia*). Among these findings, it appears for instance that the presence of coda sonorants has the effect of delaying H accent peaks of American English H* accents, relative to syllables with no coda (van Santen & Hirschberg 1994). Also, D'Imperio (2000) found that the peak of the Neapolitan Italian L+H* was located closer to the vowel offset in closed syllables (see also D'Imperio *et al.* in press), while the peak of the yes/no question L*+H would shift from being

aligned within the stressed vowel in open syllables to being aligned with the coda in closed syllables. A similar pattern was found by Gili Fivela & Savino (2003) for Pisa and Bari Italian and Hellmuth (2005) for Egyptian Arabic (see also Welby & Lœvenbruck (2005) and this volume for similar effects for the French late rise). Similarly, effects of segmental composition (consonant manner and voicing within onset and coda) have been found for tonal alignment in English (van Santen & Hirschberg 1994) and Dutch (Rietveld & Gussenhoven 1995). Finally, with respect to the effects of speech rate on f_0 peak alignment, despite some findings arguing for stability under rate changes (Ladd *et al.* 1999), several studies have reported a significant effect of this factor, though not consistently (Xu 1998, Ishihara 2003, D'Imperio *et al.,* in press).

Some of the contributions presented in this volume do also represent a challenge for the SAH, and either propose viable alternatives (cf. Welby & Lœvenbruck, this volume, proposing a notion of "anchorage", see below) or more simply soften the requirements of strict segmental anchoring (cf. Prieto, this volume). Other contributions, such as that of Xu & Liu (this volume), are more in line with the SAH, though from a quite different perspective. Before going through more detail regarding the contributions, I would like to briefly review the notion of phonological association and how it relates to alignment.

2. Association and alignment

Tune-text alignment is one of the three main components of a grammar of intonation listed by Pierrehumbert (1980), where the text is metrically organized into a grid (Liberman & Prince 1977). In Pierrehumbert's system pitch accents are characterized not only in terms of their component tones but also by "a feature controlling alignment with the text" (Pierrehumbert 1980:9). Therefore, a LH sequence of tones can potentially be employed to describe two different pitch accents, L*+H or L+H*, depending on which one will be *associated* to a strong metrical position (i.e., a stressed syllable).

The idea of a "phonological association" between tune and text was first proposed within the framework of autosegmental phonology (Goldsmith 1979). Within classic autosegmental treatments, association is a mechanism employed in order to link elements on different tiers, and is marked by an asterisk, reflecting the association relation between the specific tone carrying it (also called

'starred' tone) and the stressed syllable. Hence, within the AM theory of intonation, the notion of association usually refers to the 'special link' between an element on a tonal tier and a prosodic domain (such as the syllable).

Before reviewing the notion of association in current AM theory, it is important to underline the relevance of Bruce's work (Bruce 1977) for later work on alignment, which lies in capturing a very simple, yet still unnoticed, generalization about a property of Swedish word accents, generally known as 'Accent I' and 'Accent II'. In Standard Stockholm Swedish, both accents have a falling configuration over the stressed syllable; different dialects of Swedish show different locations for the pitch peak in each of these accent types, though they keep one crucial distinction between them: the peak of Accent II is always realized later within the stressed syllable than Accent I. Bruce formalized this opposition by making use of a feature [+/-Accent II], whose correlate is "late vs. early timing of the pitch obtrusion" (Bruce 1977: 11).[1] In other words, in this account, association does not determine a specific pattern of alignment (shape *per se*), since the whole accentual contour is associated with a stressed syllable. The phonetic details of peak alignment are instead determined by the accent feature specification. Tonal alignment is therefore taken to be contrastive in this theory. This idea shares some similarities with later work by Ladd (Ladd 1983), who proposed the use of the feature [+delayed peak] in order to represent the alignment of tones relative to the syllable to which they are associated. Ladd's central concern was to capture similarity in meaning between pitch accents that appeared to differ only in form. These accents are the 'plain' fall and its 'scooped' variant in English, where the scooped fall would be characterized by a delayed peak. The main difference with the treatment of Pierrehumbert and colleagues' theory is, hence, that alignment does not fall out from the association relation between starred tones and structural elements, but it is itself specified as an independent feature.[2]

Work on Japanese by Pierrehumbert & Beckman (1988) led to a very explicit formulation of association as a relation between a set of structural elements (such as syllables or moras) and one of the elements of a specific substantive tier (such as a tone tier). Namely, if a tone or tone sequence is associated with a certain syllable, this implies that the speaker will produce (and/or perceive) the physical realization of the tonal element(s) (i.e., the specific pitch level manifesting the tone(s)) 'together with' the segments that compose the syllable (i.e., within the same temporal span).[3] The notion of

starredness comes out of this kind of association relationship. In the original Pierrehumbert's approach, the star is essential to distinguish a pitch accent from edge related tonal events. Secondly, the star is a means to indicate 'relative alignment'. Namely, while L*+H aligns the L target with the stressed syllable and the H target 'trails' it, in L+H* the L target 'leads' while the H target is specified to cooccur temporally with the stressed syllable (or occur just beyond it). Moreover, the star notation can also be taken to represent a 'strength relationship' between the two tones, in a way that is akin to the stressed/unstressed relationship between syllables in a foot. This notion of metrical strength as a property of starred tones is the basis of a representational proposal by Grice (1995). Finally, starred tones have been claimed to be temporally more stable than unstarred tones (Frota 2002), and/or more resistant to modifications in the f_0 domain (Arvaniti *et al.* 2000).

Hence, though phonetic alignment falls out of the notion of association, the two concepts cannot be readily equated. Arvaniti and colleagues (Arvaniti *et al.* 2000) already lamented the fact that alignment is often used as the main diagnostic for determining tone starredness. Some of the most evident reasons why association does not directly and unequivocally translate into a certain pattern of phonetic alignment is that, first, different tonal targets of pitch accents do not necessarily align with the associated syllable and, second, languages tend to align tones towards a certain edge of their associated structural domain. The possibility that a tone could 'spill over' onto the syllable following the Tone Bearing Unit (TBU) was already recognized by Pierrehumbert & Beckman (1988). For instance, the prenuclear H* of English, as well as of other languages (such as Italian and Spanish) has a target peak that is usually located within the postaccentual syllable, without compromising the association relationship between tone and metrically strong syllable. This 'peak delay' has been noticed also for tonal languages (Xu 2001).

As for the 'preferred' phonetic alignment scheme of pitch accents across languages, it appears that targets of starred tones, such as H*, tend to occur towards the right edge of the stressed syllable in certain dialects of American English (i.e., "right-peripheral" alignment according to Pierrehumbert & Beckman 1988), while the opposite seems to be true for starred tones of Standard Swedish.[4] Moreover, within the same language, a starred tone might be aligned differently depending on the specific pitch accent to which it belongs. So, in Neapolitan Italian, the L* of L*+H tends to occur much earlier than the L* of H+L* of broad focus declaratives (D'Imperio 2000).

The alignment of visible acoustic targets alone can be even more puzzling if we want to directly employ alignment as a window on the phonological representation of a specific pitch accent. For instance, in some cases, neither of the tones in a pitch accent appears to be aligned with the stressed syllable, as in the case of the Greek prenuclear rise (Arvaniti *et al.* 1998) and Glasgow English nuclear accents (Ladd 1996). Specifically, both cases are characterized by a LH rise in which the L is aligned before the onset of the stressed syllable while the H is aligned with postaccentual segments. Neapolitan Italian offers a mirror-like but similarly difficult situation. Namely, the L and H of both the question and the statement LH rises are aligned within the boundaries of the stressed syllable, though both target tones are later for questions (D'Imperio 2000). A question is then how is such a contrast represented in the mind of Neapolitan speakers? Which one is the 'starred' tone?

We also know that seemingly small details of alignment appear to be extremely relevant in perceiving linguistic contrast, such as modality (Pierrehumbert & Steele 1989, D'Imperio & House 1997, D'Imperio 2000) or even lexical contrast, such as that between geminate/singleton minimal pairs of Italian of the type *nono*/*nonno* 'grandfather/ninth' (D'Imperio *et al.* to appear) as well as between singletons and geminates induced by an external sandhi rule, i.e. "Raddoppiamento Sintattico" (Petrone 2005). Specifically, D'Imperio *et al.* (to appear) show that fine details of tonal alignment help listeners in the identification of closed versus open syllables. In order to test this hypothesis, the tonal alignment as well as the durational properties of two natural productions of the words *nono* 'ninth' and *nonno* 'grandfather' of the Neapolitan variety of Italian (both carrying a yes/no question L*+H accent) were manipulated through resynthesis, while subjects were asked to identify the lexical item. As mentioned above, in this variety rising pitch accents show a relatively later peak when associated to closed syllables. The results show that the alignment manipulation significantly produced a category boundary shift in the *nonno* base stimulus series, supporting the hypothesis that fine detail of tonal alignment is not only employed to signal intonation meaning contrast but it might also be stored as part of the phonological specification of lexical items. This has obvious consequences for models of phonetic implementation and speech perception.

Two of the contributions of this volume address specific perception issues. Gili Fivela's paper explores the complex relationship between phonetic detail and phonological description by conducting both a

production and a perception study on three rising Pisa Italian pitch accents, i.e., H*, H+L* and H*+L. Specifically, the author documents the alignment differences within their target tones, and points to an interesting effect in perception, that is pitch height information appears to have more of an effect in the identification of the contrast between H* and H*+L than the alignment of their peaks. On the production side, Gili-Fivela shows additional evidence for alignment differences of the starting point of the rise in the prenuclear H* accent, depending on position of the target word within the utterance as well as on range manipulation. The author also proposes a novel, hybrid, transcription for two of the accents, in which the H tone is starred (i.e., H* and H*+L), that is [L+]H* and [L+]H*+L. The choice of an optional transcription of the preceding low target, which is acoustically discernable in most cases, is due to the fact that its presence would only be a phonetic property of a rise to a peak (thus, not a property of H+L*, which is characterized by a plateau) in this variety of Italian, without a distinctive function.

Prieto's paper addresses a set of perceptual issues having to do with the functional role of tonal alignment in signaling the edges of prosodic units such as the syllable and the word. For instance, it appears as if H targets of prenuclear rises of Catalan and Spanish align with the right edge of the word (see Estebas-Vilaplana 2000 for Catalan). Also, recent studies on the tonal marking of the French Accentual Phrase (AP) by Welby (2002, 2003b) show that the L target of the LH initial rise, which can be secondarily associated with the left edge of this constituent (or with a later syllable edge), is aligned at the boundary between the last function word and the first syllable of the first content word of the AP (see also D'Imperio *et al.* in press). Interestingly, Welby's results for perception (Welby 2003a) show that French listeners use the alignment of this L tone as a cue to word segmentation (in nonword pairs such as *mélamondine* and *mes lamondines* 'my lamondines').

In sum, the specific details of the coordination between tones and the segments (linked to the structural unit) are in the current AM model not part of the phonological representation itself and do not directly fall out of it. Recent work on representational issues in AM theory has proposed that the notion of secondary association[5] can link tones of pitch accents (not only of edge tones) and edges of structural (prosodic) elements, such as the syllable and the mora (Prieto *et al.* 2005). This representational device would describe alignment contrasts between pitch accents sharing the same tonal composition (such as LH rises) but having different timing properties, which could otherwise not

be readily captured by merely employing the star notation of standard AM approaches (such as in the case of the three-way contrast between accentual LH rises of Catalan).

A quantitative model of pitch alignment ('Linear Alignment Model') has on the other hand been proposed within a different theoretical framework, that of general superpositional models, and is exemplified by the work of van Santen and colleagues (see van Santen & Möbius 2000 and van Santen *et al.*, this volume), though in this model the notion of tonal 'target' is quite different from the one proposed within the AM theory (see below for further details on this approach).

3. The paradox: reconciling variability with stability

Despite the regularities found, which are at the basis of the SAH, very recent research on alignment variability across dialects of the same language (Atterer & Ladd 2004, Arvaniti & Garding in press), as well as across speakers and styles of the same dialect (see Welby & Lœvenbruck this volume) has shown a much more complex picture, which is difficult to reconcile with the idea of a strong segmental anchoring and even more with the phasing model proposed by Xu (Xu 2002, Xu & Liu this volume).

For instance, Atterer & Ladd (2004) report great variability in the alignment of syllable-initial f_0 minima between Northern and Southern German dialects, and similar kinds of effects have been reported for dialects of American English (Arvaniti & Garding in press). The stability of tonal alignment in production, especially in intonational languages, might, under such a view, have been quite overestimated. If the type of synchronization that alignment embodies is adequately represented by only one possible synchronization scheme (as proposed by Xu, see below) between tones and associated syllables, then it becomes difficult to account for such dialectal and inter-speaker variability.

Echoing the proposals for a "window" of timing values for segmental phasing, such as those by Keating (1990) and Byrd (1997), Welby & Lœvenbruck (this volume) suggest to solve the controversial issue of variability in alignment patters with the idea of "anchorage", i.e., a region within the segmental string within which the target tone would anchor. An anchorage would account for the variability in alignment found for some tones. According to the authors, however, the notion of an immovible anchor point will be more appropriate to account

for the stability of alignment found for other tones. The authors test the SAH as well as a holistic hypothesis of constant slope for the LH* late rise ('accent primaire') of French. Interestingly, their results do not point to a constant anchoring point for the L tone of the LH* late rise, neither do they find a constant slope for the same accent. On the other hand, the authors find evidence for a stable alignment of the H of the late rise within the bounds of a segmental anchorage, as well as for the L of the LH initial rise.

As mentioned above, it appears that the alignment pattern of the L tone of the French initial rise might have a perceptual, functional load, marking the left edge of a content word. Similar findings were reported for English in the *Norma Nelson / Norman Elson* study reported in Ladd & Schepman (2003), in which it was found that the L valley between consecutive accents (on the two different words) was always aligned with the onset of the second accented syllable, thus disambiguating the syllabic affiliation of the medial nasal segment. It is possible, then, as suggested by de Jong (to appear), that another important element in the determination of alignment schemes is the functional load of tonal elements, so that we can predict more or less alignment variability depending on whether the tone marks, say, a phrase edge or a prominent syllable. This prediction seems to be borne out for Seoul Korean (Park 2003), where edge tone alignment is much less variable than pitch accent target alignment.

Prieto (this volume) explores the notion of the alignment of tones and prosodic edges, i.e., the hypothesis that the temporal location of the H target in LH prenuclear rises of Catalan might (also) serve a demarcative function, i.e. marking the right edge of a word (and thus neither simply be located at a fixed distance from the L, nor at a fixed distance from the onset of the stressed syllable). For instance, a prediction was that the H tone would be located at the end of the stressed syllable, which also corresponds to the end of the word, in utterances such as *Mirà batalles* '(s)he watched battles', but be located later, i.e. at the end of the word, in *Mirava talles* '(s)he used to watch carvings'. The results shown by Prieto challenge once more the strong version of the SAH, since the author finds neither a stable alignment of tone to word edge, nor a stable alignment relative to a specific segment within the stressed syllable. Nevertheless, Prieto remarks a tendency in her data for H alignment to be earlier when the right edge of the accented syllable corresponds, or is very close to, the end of the word.

Xu & Liu's contribution deals with a very interesting and challenging hypothesis, i.e. that of the synchronization of the tonal and

the segmental plane through some kind of human-to-human coordination system, which is reminiscent of models proposed to account for bimanual and bipedal coordination by Kelso (1984). In order to account for surface variability in tonal target realization, Xu proposes that underlying pitch targets (which would have a complex mapping with the peaks and valleys measured in the signal) are synchronized to the syllable as a whole as opposed to some subsyllabic unit. In other words, alignment to acoustic segments would at most be an epiphenomenon of a global synchronization pattern of the tones to the stressed syllable.

Recent work on articulatory data for tone-to-segment alignment (D'Imperio 2002, D'Imperio *et al.* 2003, in press) has proposed that laryngeal gestures might be timed to occur with some specific articulatory gestures, such as minima and maxima of consonantal trajectories or peak velocity within the onset consonantal gesture for certain peak accents. The synchronization scheme proposed by Xu & Liu, however, would not have a mere physiological origin, since the vocal tract and the glottis are not claimed to be biomechanically bound. The alignment scheme would, on the other hand, be due to some specific kind of phase-locking between the laryngeal and the supralaryngeal systems that might be part of a higher level, cognitive/attentional system. These kinds of effects of phasing between two systems can even take place between the speech of two different people entering in motoric synchronization or "entrainment" (Cummins 2003). The phasing pattern is proposed by Xu & Liu to be the basis for segmenting virtually non-segmentable and intrinsically dynamic phones, such as glides. In other words, given an observable alignment pattern between tones and easily segmentable segments, such as nasals, it would be then possible to recover edges of segments that are more difficult to determine, such as glides.

A potential problem for this approach is that in intonational languages not each tone needs to be associated to a syllable, and each syllable does not need a tonal specification in non-tonal languages. AM theory allows, in fact, for sparse tonal specification. There is evidence that in numerous languages not every tone-bearing unit needs to be linked to a tone and *vice versa*, an example of this type being English. This sparsity is a potential problem for a model such as the one proposed by Xu and colleagues, since it might be that synchronization between the laryngeal and supralaryngeal systems, and the pressure to achieve the kind of phase-locking proposed by this model, might be more true of languages such as Mandarin than for languages such as English, French, or Italian, where the pressure

towards a zero degree phase angle in the co-production of tonal and syllabic cycles might be less important, and thus account for the greater variability observed.

Additionally, despite the fact that, within each speaker and/or dialect, the tone-to-syllable edge alignment pattern can indeed be quite stable, this hypothesis still needs to deal with the issue of the segmentally-induced differences in tonal alignment, of the kind reported by Rietveld & Gussenhoven (1995) for perception and by van Santen & Hirschberg (1994) for production, and which are instead taken into account within the Linear Alignment Model illustrated by van Santen *et al.* (this volume). Van Santen's model is in fact a modified version of the standard Fujisaki model (Fujisaki 1983) in that it specifically integrates a 'Segmental Influence Curve' (which is meant to account for and predict alignment patterns due to segmental perturbation induced by segment class as well as syllabic affiliation of the same segment), as an additional component relative to the already existing '*Phrase Curve*' and '*Accent Curve*'.

As van Santen and colleagues point out, the determination of a sample of anchor points within the accent curve does not make the Linear Alignment Model any more discrete than Fujisaki's model. That is because, as the authors put it, "these anchor points have no special phonological status", they are not targets in the sense of AM theory, and their selection is not critical. According to this model, the speaker's target is a dynamic event, an accent curve, and not a point in a time and frequency domain. Nevertheless, as the same authors point out, this selection of points has to be sufficiently dense in order to adequately represent the accent curve. Gauging how adequate this representation of the curve is, in my opinion, an interesting empirical issue that should be investigated through perception and production studies.

Therefore, we are presented with a puzzling situation. Either we have to say that the details of temporal alignment of, at least, starred, associated tones are due to (language-specific) phonetic implementation of different phonological entities, or, as proposed by Prieto *et al.* (2005) and D'Imperio (2000), that alignment itself might be an essential part of the notion of phonological association. For instance, we might postulate the existence of alignment constraints requiring the second tone within a pitch accent to be as close as possible to the right edge of the syllable (see Prieto *et al.* 2005). External factors might be at the basis of such regularities, related to, say, the goal of rendering the perceived target of the fall more salient by producing it within a spectrally stable region, and/or to some

general constraints of a physiological and/or cognitive nature, but also possibly to other factors, such as sociolinguistic requirements (as in the case of Swedish starred tones).

Actually, the linguistic, communicative function of speech, and prosody in particular, might be the key within this complex picture, as de Jong (in press) rightly points out, for alignment as well as for more general timing patterns. It might well be, as he proposes, that there is a conflict between what he defines as "hardware" requirements (physiological and higher-level, cognitive and/or attentional constraints) as compared to "shareware" requirements, originating from the essential fact that language is principally meant to be understood. Hence, despite all model predictions that are too heavily based on language-external constraints, the ultimate answer to all the variability found might simply be in the fact that speech is learned, and is not merely determined by any physiological, attentional, or functional constraint in and of itself.[6] This view is quite appealing, and calls for much needed perception studies of tonal alignment and its linguistic, functional valence.

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Notes

[1] In later work, Bruce (1987) gave an AM description of these accents (with Ls and Hs starred tones).

[2] Later research has shown that Ladd's line of argument was not entirely justified, since the scooped and plain fall are not variants of the same pitch accent in English. In fact, their meanings can be contrasted in a categorical way, and their peak alignment has been claimed to be binarily and not gradually manipulated (Pierrehumbert & Steele 1989).

[3] From the point of view of the temporal interpretation of association, it represents (Pierrehumbert & Beckman 1988: 153) "temporal overlap between substantive elements and structural positions", or, in other words, if the structural element is a mora and the associated substantive element is a tone, what this means is that the tone will "occur simultaneously with any phoneme segments associated to that mora" (p. 119).

[4] Actually, in Standard Swedish there seems to be sociolinguistic pressure enforcing this kind of alignment, since non-standard dialects align starred tones later.

[5] The notion of secondary association of edge tones dates back to Pierrehumbert & Beckman (1988) and has recently been exploited to account for the peculiar behavior of phrase accents in a variety of languages (Grice *et al.*

2000). In Pierrehumbert & Beckman's original interpretation, some phrasal tones (i.e., phrase accents) can seek a secondary association with a TBU, apart from being associated to the specific phrasal domain they belong to.

[6] As de Jong (in press) proposes: "motoric and functional factors get encoded in the speech that speakers learn, though none of them actually determine the temporal patterning in that speech".

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