

BOUNDARY TONES AS EVIDENCE FOR THE EXCLUSION OF L(OW)-TONE FROM PHONOLOGICAL REPRESENTATION



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In this paper I analyse Pierrehumbert's (1980) use of the boundary tone, which occurs at the extremes of the intonation phrase. Depending on whether the tone is initial or final, it shows a privative or equipollent behaviour. I argue that such characteristic of the boundary tone yields an incoherent phonological model of intonation, and therefore, needs some revision. In the framework of the restrictive principles included in Generative Phonology, and more specifically, in Government Phonology, I propose that both structural positions should be treated under a privative approach. The advantages of such approach are borne out by the fact that the model shows a coherent treatment of tone, and also that it is maximally simple.

PHONOLOGICAL BACKGROUND

Here, I take for granted one of the fundamental ideas developed in Government Phonology (Kaye, Lowenstamm and Vergnaud 1990), namely, that phonological contrasts are captured by the presence or absence of monovalent melodic units. I shall follow Trubetzkoy (1969) in referring to this idea as the privative approach. This entails that, in the model I propose for intonation (Cabrera-Abreu 1996), tonal contrasts are understood as the **presence or absence** of a **monovalent** tonal property, which I shall refer to as **T(one)**¹. So, for example, a relatively high pitch vowel, say /a/, is represented as in (1)(a), and a relatively low pitch vowel is represented as in (1)(b).

(1)	(a)	T	(b)
		a	a

Notice that, in (b), /a/ is tonally characterised by the absence of T — according to the privative approach to tonal oppositions.

In order to define the nature of T later in the paper, that is, whether T corresponds to former H(igh) or L(ow) (as in Pierrehumbert 1980), it is necessary to remind the reader that the present model has developed from earlier systems of intonation which, nevertheless, adopt an alternative view of phonological contrasts. Such a view is characterised by the representation of phonological contrasts in terms of opposite, and in principle, equally weighted values of a bivalent tonal feature, like for example, [+high] versus [-high], or as it is also represented, simply H versus L. Following Trubetzkoy's terms, I shall refer to this approach as the equipollent view.

¹ This view is well-established in other theories of phonology, like Dependency Phonology (Anderson and Ewen 1987), etc. For a detailed discussion on the topic related to the preference for privativeness rather than equipollence, see specially, van der Hulst (1989), den Dikken and van der Hulst (1988). For an outline, see Harris and Lindsey (1995).

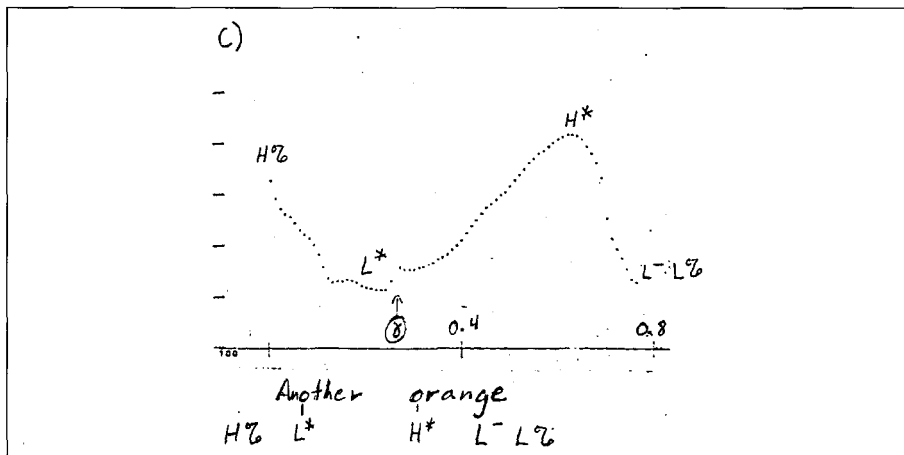
The motivation for adopting the privative view rather than the equipollent view is that the former approach has the potential for tightly **constraining** the generative capacity of the model I develop here. In order to clarify this claim, let us consider for a moment the predictions inherent in an equipollence approach. For instance, a model in which a bivalent feature is used, predicts that both values stand an equal chance of being specified in the lexical form of phonological representations, and of participating in phonological processes. This issue has long been recognised, and addressed within various forms of phonological underspecification, and falls outside the scope of the present paper. On the other hand, a model with a monovalent feature reduces the amount of lexical forms and phonological processes by half. In the context of a restrictive phonology, then obviously, this approach is preferred.

This leads us on to the question of the nature of this monovalent feature. In principle, it could potentially be either H or L. As I shall show shortly, an analysis of Pierrehumbert's use of the boundary tone in intonation leads us to select H as the nature of such monovalent feature. If we are faithful to our intention to design a constrained model, we are forced to reject L, and consequently, rely only on the presence or absence of H; in this way we achieve a significantly higher level of restrictiveness.

PIERREHUMBERT 1980

The publication of *the Phonology and Phonetics of English Intonation* (1980) by Pierrehumbert (henceforth P'80), constitutes the foundation of a wide range of current phonological models of intonation (for example, Gussenhoven 1984, Lindsey 1985, Ladd 1980, 1993, Grice 1992, 1995). The P'80-type of model is mainly characterised by two tones, H and L, which constitute the fundamental components of the phonological representation of pitch, and by a set of interpolation rules, which control the interpretation of such tones. In addition, metrical relations are captured by means of the metrical grid (Lieberman and Prince 1977). In order to illustrate such components, let us briefly focus on an analysis of the utterance *Another orange* based on Pierrehumbert's model. The fundamental frequency (henceforth F0) contour of this utterance is illustrated in the scanned figure below, and Pierrehumbert's own transcription is also included (I shall include another example in the following section):

(2) 'Another orange'. (Pierrehumbert 1980:149)



Let us begin by considering *metrical relations* (see Liberman and Prince 1977 for grid construction). As can be seen in the above figure, some tones are followed by an asterisk (L* and H*), whereas others are not (H%, L- and L%). The asterisk is used by Pierrehumbert as a short-hand device to show that a particular syllable is prominent with respect to those syllables which are not prominent, and consequently, lack the asterisk in the representation. In this case, prominence is understood in phonetic terms as a combination of the following three factors in the interpretation of the segments which compose the prominent syllable: extra loudness, duration, and also a characteristic pitch shape or a change in the trend of the F0 contour (see Hogg and McCully (1987) for an introduction to theories of phonology which are based on the use of the metrical grid).

Those tones which are followed by a percentage symbol or a dash are not associated with any particular syllable. Moreover, according to the above definition of prominence, they do not count as metrically prominent. With respect to the tone followed by a percentage symbol (henceforth, boundary tone), Pierrehumbert argues that it is responsible to account for pitch specifications at the edges of the intonation domain (as its name indicates). In the case of *Another orange*, H% accounts for the initial high pitch, and L% for the final low pitch. As far as the dashed tone is concerned (henceforth phrase accent) — although its role is redundant in the above utterance since low pitch could also be accounted for by L% — it is in charge of the pitch movement between the last accented syllable and the rightmost boundary tone.

Another component in Pierrehumbert's model are tones, *H* and *L*. These generally account for relatively high pitch and relatively low pitch in the F0 contour, respectively.

Finally, notice that H and L are associated to specific structural positions, (starred tones to accented syllables, boundary tones to edges, and phrase accents tones just between the starred tone and the boundary tone) and that there are syllables which remain phonologically unspecified as far as their tonal characteristics is concerned. For example, —*ther* in *Another* has no tone which can account for the rising pitch movement. The point I want to draw attention to here is that, although some syllables remain tonally unspecified in phonological representation, they receive some pitch specification in phonetic interpretation. If this is so, then which is the source of such interpretation? According to Pierrehumbert, tonally unspecified stretches of speech receive their pitch specification from *interpolation rules*. For instance, an interpolation rule dictates that the F0 trace between L and H is a slope, as can be seen in the case of *-nother O*².

P'80'S BOUNDARY-TONE ASSIGNMENT FOR ENGLISH

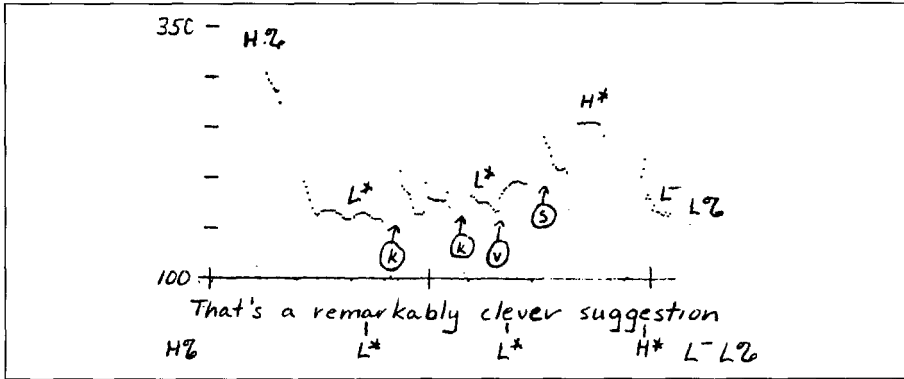
The leftmost boundary tone

Having introduced the reader into a brief summary of the components of Pierrehumbert's model in the previous section, we can now turn to analyse the nature of the boundary tone. Specifically, I examine tonal association to the initial intonation-phrase boundary, which include H and L or *zero*; that is, L and absence of tone are treated as equivalent. Given such situation, then this can be understood as evidence in support of the rejection of L from phonological representation.

Take the following example, in which tone is associated to metrically accented syllables, and to the edges of the intonation phrase:

² Another interpolation rule accounts for a horizontal trace between two Ls.

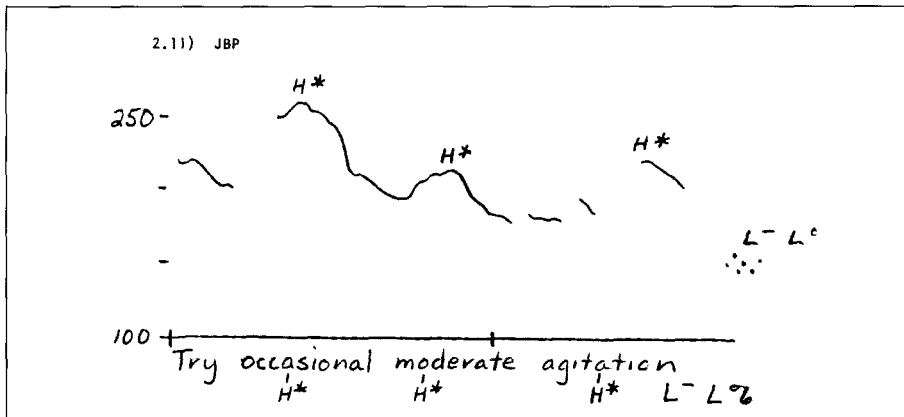
(3) 'That's a remarkably clever suggestion'. (P'80: 172).



As I also illustrated earlier, at the level of intonation, only some syllables are associated to tone. Those syllables which remain unspecified in phonological representation receive their pitch specifications by means of a battery of interpolation rules in the phonetic component. For example, *-kably clever sug-* receive their pitch specifications by means of a rule which interpolates a gradient line between the low pitch on *MAR-* and the high pitch on *-GES-*. In relation to the phrase-accent, it is also redundant in the present structure, since the falling movement can be accounted for with simply the boundary tone (had it been a situation in which a fall was followed by a rise, then H* and L- would have been necessary to account for the falling movement (from H* to L-), and H% would have accounted for the rise).

The crucial point to observe in this model, is that, under certain conditions, the initial boundary tone can remain unspecified in phonological representation, and that it is under these conditions specifically, that L and zero convey exactly the same information. However, this approach to tonal distribution does not apply to accented syllables, which must always be specified as either H or L. Similarly, the phrase accent must always be present. As an illustration of this, consider the example below, compared to the one in (3):

(4) 'Try occasional moderate agitation'. (P'80: 172).



In cases like this, the absence of tone at the left edge of the intonation domain is interpreted as mid or low pitch, or in Pierrehumbert's own words, 'the F0 onset may be some kind of neutral value' (1980:43). The remaining relevant tonal locations, accented syllables and phrase accents, are all associated to either H or L. It is on this type of evidence — the behaviour of the initial boundary tone — which I focus, in order to support the argument that it is possible to exclude L from phonological representation. But before we turn to examine yet another piece of evidence, let us probe a little deeper into Pierrehumbert's model.

Pierrehumbert's treatment of the initial boundary tone is based on an extension of an idea included in Liberman (1975:120-125), where, based on observation, he stipulates that an initial boundary tone cannot be aligned with an accented syllable. So, for example, an utterance like *Peter has a dog* — with tones associated as in (5) — is ill-formed, due to the fact that *Pe-* from *Peter* is already accented (L*), and hence, cannot also be associated to H%:

(5)* Peter has a dog
 | | | |
 H% L* H* L- L%

Liberman's proposal is restricted to this particular metrical structure, in which the first syllable is accented. He claims that in this case, «the meter would be wrong, since it is normally the beginning of a note that is felt as the 'beat'». If this is the case, then, *Pe-* would be interpreted on low pitch, and this would leave no space available for the interpretation of H%.

The main shortcoming of Liberman's idea is that the elimination of the above structure is not captured formally, and for this reason, the model can still generate ill-formed structures. As I shall show below, Pierrehumbert develops Liberman's idea further, by excluding L% from the representation, regardless of the metrical structure, but a principled account of the tonal specifications of this boundary is still missing.

As I stated earlier, Liberman's condition, in which an initial boundary tone can remain unspecified only if the first syllable of the phrase is accented, is reinterpreted by Pierrehumbert in slightly different terms³. For instance, notice that in the structure in (5), in which the first accented syllable occurs well away from the left edge — and therefore, the presence of a left boundary tone is perfectly possible — the left edge itself remains unassociated. In fact, the absence of tone here is clearly not conditioned by the metrical structure. Instead, Pierrehumbert stipulates that if the F0 onset shows this type of neutral value, then the boundary tone can remain phonologically unspecified. On the other hand, if the F0 shows a rather high value, then the boundary tone should be specified as H. Thus, the choice of the presence or absence of a boundary tone at the left edge of the intonation phrase is primarily conditioned by the shape of the F0 contour in that particular location. In addition, she claims that the occurrence of H% in phonological representation is further justified by its correlation with a particular meaning; that is, H% adds a note of vivacity to an intonation pattern.

An important point to notice here is that the presence or absence of L% does not necessarily imply the existence of two different phonological representations. In addition, as I have already illustrated above, the presence or absence of L% results in identical pho-


³ Note that Liberman's original condition still applies for H% in Pierrehumbert's model.

netic interpretations. In view of these circumstances, in which L% has no particular task to perform (in fact, it is clearly redundant), and in which I pursue a minimalist model of intonation, I argue that the leftmost L% ought to be excluded from phonological representation. Thus, either H can be associated to the leftmost boundary, or otherwise, such a boundary is to remain unspecified. This is formalised by adopting a purely privative approach⁴.

LINDSEY (1983)

The rightmost boundary tone

In the context of a privative approach to tonal association, let me present yet another proposal, this time by Lindsey (1983), which suggests that this approach should also be adopted for the rightmost boundary tone (in relation to this metrical position, Pierrehumbert's model allows for either H or L to be associated, and the option for L to remain unspecified is not available). The motivation for this proposal stems from two facts. First, some patterns predicted by Pierrehumbert's model, for example, a H phrase accent followed by a L boundary tone, do not occur phonetically. Such a pattern, which would show the F0 shape illustrated below, is interpretable only with the final fall as nuclear (that is, H*L-L%)⁵:

(6) 
John went to the park

Secondly, her model misses an important semantic generalisation. According to Lindsey,

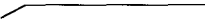
- (7) All contours which terminate away from a neutral low pitch (i.e. terminal rises and mid or high levels) have a characteristic of 'incompleteness'. It would be nice to relate this to a common phonological characteristic, and the most obvious candidate would be the H% boundary tone (1983:31).

From this point of view, the contour included in footnote is accounted for by a H phrase accent followed by another H boundary tone.

With this account, Lindsey treats both edges of the intonation phrase **uniformly**: H can be either present or absent. In addition, this analysis nicely correlates with the events in the semantic component of intonation. Thus, these two factors, which allow for a greater degree of generalisation, offer a range of benefits over Pierrehumbert's proposal.

⁴ This line of argument is also developed in Lindsey (1983), where he claims that if L% does not convey any semantic meaning (contrary to H%, which clearly does), then he can find no reason for maintaining L% in phonological representation any longer.

⁵ Pierrehumbert is aware of this, and in order to save this phonological structure, she invokes a rule of up-step, whereby the phonetic value of L% is computed at the same level as that of H-. The interpretation of this structure shows the following shape:


John went to the park

ANALYSIS OF THE ABOVE FINDINGS

As the reader has doubtless noted, both Pierrehumbert's and Lindsey's model, and for that matter, any model of intonation which combines privativeness with equipollence, is destined to bring about some degree of indeterminacy to phonological components, especially to the nature of tonal units. Under an equipollent view, the predictions are that tonal units have two equally weighted values. Therefore, we understand that they stand the same chance of being present in phonological representation. As far as pitch accents and phrase accents are concerned, this prediction is confirmed. However, soon after gaining some kind of understanding of the nature of tonal units, we encounter cases such as boundary tones, which show a privative behaviour. This is certainly discouraging, since this finding throws doubt on to our initial assumptions. The equally weighted values of tonal units are no longer balanced; one of the values is now more robust than the other, in that it enjoys a wider distribution.

Another point of indeterminacy is how the model decides which TBUs should bear a unary feature and which should bear a binary feature. It is obvious that a particular location of tone in the structure is not the factor. Note that pitch accents and phrase accents show the same type of equipollent tonal contrasts, and yet their distribution in phonological structure is completely unrelated. The former is associated to accented syllables and the latter is, in fact, floating.

In view of the questions raised above, and of the tendency in current generative studies to develop maximally restricted theories (Harris 1994), one wonders why previous models of intonation have not rejected an equipollence approach to tonal contrasts and adopted a privative approach instead. The answer to this question is straightforward: with a single tone it is impossible to show a falling or rising pitch movement on a single syllable. In addition, in the event of rejecting L (as I suggest), those former models which had recourse to L as the trigger for **downstep** (Clements 1979) would be unable to account for this phenomenon. Moreover, models which allow L to **spread** (Pulleyblank 1986) would leave many contours unaccounted for. Hence, the expulsion of L from phonological models creates problems which are even more fundamental than the original ones. Ideally then, what we need is a coherent model which explicitly defines the nature of tone, and can account for falling and rising pitch movements, and for the phenomena of spreading and stepping.

Having presented evidence which points to the possibility of rejecting L from specific locations in models which describe intonation, in the following section I present an outline of an alternative model without L tone, which can account, at least, for contour tones (a falling or rising movement in pitch on a single syllable. See Yip 1989).

In essence, I claim that the key factor to such an alternative is to be found in the nature of T(one) B(earing) U(nits), (henceforth TBUs). I shall propose that, rather than associating tone to accented syllables, — as I illustrated in §2 — one of the alternative options, which is to associate tone to the boundaries of prosodic domains, should be pursued. Since, by definition, each domain shows two edges (or boundaries), then it is possible to account for contour tones by associating different values to each boundary, as in the fashion which I shall illustrate in the following section.

A PROPOSAL FOR A SINGLE-TONE MODEL OF INTONATION

As I stated earlier, the rejection of L from the model raises a fundamental question of how to account for a falling or rising movement on a single syllable, since earlier models propose the combination of H and L⁶, as illustrated below:

⁶ Another phenomenon which may pose a problem for a single tone model is downstep, since it is generally agreed that L is the phonological factor which is responsible for this. In Cabrera-Abreu

- (8) (a) Falling
 σ^{*7}
 | \
 H L
- (b) Rising
 σ^*
 | \
 L H

Notice that, with the presence or absence of T (since there is no longer a contrast between H and L, there is no point in keeping H as the representation of tone) as a means of showing phonological contrasts, it appears to be impossible to capture any sort of pitch movement. This proposal allows the model to go as far as capturing high (presence of T) and/or low (absence of T) manifestations of pitch, as I show below:

- (9) High
 σ^*
 |
 T
- Low
 σ^*

With the goal of finding a satisfactory solution to this shortcoming without having to reject our hypothesis of a single-tone model, I propose together with other intonationalists (Hirst 1988) to associate tones exclusively to boundaries. That is, I suggest that it is possible to treat **boundaries** of prosodic domains (Nespor and Vogel 1986) exclusively as TBUs. This alternative will allow me to capture elegantly a four-way distinction as follows⁸:

- (10) (a) high
 T T
 | |
 []
- (b) falling
 T
 |
 []
- (c) low
 T
 |
 []
- (d) rising
 T
 |
 []

Let me now present a preliminary and crude analysis of the utterance in (2) (*Another orange*), with the single-tone model⁹, so that the reader can have a taste of how the model works.

- (11) T
 |
 [ID [O Another]O
- T
 |
 [H orange]H]ID

(1996), chapter 6, I propose that the presence of toneless boundaries belonging to empty categories is the main factor which triggers downstep in intonation. The same can be said to apply in tone languages, although the details of such an account fall outside the scope of the present work.

⁷ 'σ' stands as a short-hand device to refer to a syllable.

⁸ The interested reader is referred to Cabrera-Abreu (1996) for a complete view of the model under discussion.

⁹ The reader is warned that this only amounts to a preliminary analysis and that it does not correspond to the final analysis I present in Cabrera-Abreu (1996). Also, I do not include an analysis of the utterances in (3) (*That's a remarkably clever suggestion*), and (4) (*Try occasional moderate agitation*) in this paper, since other components of the model would have to be introduced, and these are outside the scope of this article.

The outer boundaries correspond to the Intonation Domain (ID). Inside this domain, there is the Onset (O), and the Head (H). The initial T associated to the leftmost ID boundary accounts for the initial high pitch. Notice that the boundaries which follow remain unassociated to T. For this reason, pitch drops, until another boundary in phonological representation is associated to T. This T provides the necessary information for pitch to start rising again, and to reach a relatively high point in the F₀ contour. Since the remaining boundaries are unassociated to T, pitch falls.

CONCLUSION

The main advantage of this type of representation over that of Pierrehumbert and her followers is that, for the former, I propose a unified tonal association; rather than associating tones to accented syllables and to boundaries, tones are exclusively associated to the latter. Another asset of the single-tone model is that the nature of tone is explicitly clear. Unlike Pierrehumbert's, in which tonal contrasts are based both in equipollency and privativeness, in the single-tone model, tonal contrasts are of single type, that is, privative. These two points yield a coherent phonological model of intonation. In addition, by adhering to a privative approach, phonological representations enjoy a higher degree of economy. Hence, in the context of a minimal model, the single-tone model is preferred over the two-tone model.

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