

The Intonational Systems of English and Croatian: A Bitonal Generative Compositional Approach

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This paper presents the results of a research aimed at providing a comparison of the English and Croatian intonational systems within the framework of the bitonal generative compositional approach. This is done by comparing the intonational phrases of the original English corpus with their Croatian translational equivalents. The Croatian translational equivalents have been digitalized and subjected to the same type of computer analysis as was originally employed by Pierrehumbert (1980) in establishing the bitonal model. Conclusions are reached about the similarities and differences between the inventories of intonational morphemes in the two language.

1. The bitonal generative compositional model

The aim of this paper is to serve as a basis for a comparison of the intonational systems of English and Croatian within the framework of the bitonal generative compositional approach. This approach was introduced into the analysis of English intonation by Pierrehumbert (1980) and was latterly developed and fully established by Pierrehumbert and Hirschberg (1990) and Hobbs (1990). In the course of the last decade it has been applied to a whole range of prosodically different languages, including Japanese (Pierrehumbert and Beckman 1988), German (Féry 1989) and Bengali (Hayes and Lahiri 1991). The motivation for choosing the bitonal generative compositional model (henceforth BGC) as the basis for the comparison is complex.

In the first place, as in any kind of comparison, when comparing two prosodic systems, one needs some kind of "common denominator", i.e., the basic analytical unit through which similarities and differences will be expressed. This means that the basic criterion in choosing a particular approach will be the applicability of this approach to both languages. Most notably, the entire prosodic system of Croatian is determined by its being a pitch-accent language, i.e., by the existence of the lexical tone and hence by the interaction of lexical and post-lexical prosody. One would thus naturally give priority to a model that reflects such prosodic nature more adequately than others. As

the explanatory analysis of the Croatian lexical prosody has so far been performed using the autosegmental approach (Inkelas and Zec 1988), a model based on discrete tone levels can be considered as superior in the lexical prosodic analysis of Croatian. In view of the logical tendency of prosodic theory to analyse and describe lexical and post-lexical tonal phenomena by relying on the same analytical entities, in dealing with the intonational phenomena of Croatian it is preferable to adopt an approach based on discrete tone levels. After all, it has been shown on other pitch-accent languages, such as Swedish (Bruce 1991), that autosegmental rules of spreading and deletion, which deal with tone levels, can very effectively explain the phenomena of interaction of lexical and post-lexical prosody, conceiving of these in terms of the neutralization and anticipation of lexical tones under the influence of the intonational context.

An additional advantage of the model at hand is that it uses the same phonological inventory of analytical intonational units for British and American English, since the intonational differences between these two varieties are accounted for primarily by rules of phonetic implementation (cf. Silverman and Pierrehumbert 1990).

Besides, in view of the differences of rhythmical nature between Croatian and English and the interaction of rhythmic and tonal phenomena, a phonologist will naturally prefer an approach which sees the crux of intonational differences in terms of differences of location of basic analytical entities at different points of the time dimension. This kind of approach is more suitable for the comparison of Croatian and English than a model which assigns tunes to complete rhythmic wholes, which in the two rhythmically incompatible systems are incomparable.

After all, for reasons explained in detail in Josipović 1993, 1995, I find this intonational model inherently superior to the others and believe that this is the reason why it is the only model which has been successfully used for the practical purpose of intonation synthesis (Pierrehumbert and Beckman 1988).

In short, I find the approach based on analysing intonation in terms of discrete tone levels well-suited to the prosodic nature of both languages under consideration and thus adopt it for their comparison.

With respect to its approach to intonational meaning, the intonational model under consideration is compositional, which means that melodic patterns are analysed into intonational morphemes, and the entire meaning of intonational patterns is seen as a result of the combination and interaction of the individual intonational morphemes involved. It should be noted, however, that this kind of approach does not deny the existence of some idiomatic configurations of intonational morphemes whose meaning is holistic by nature.

The basic unit of intonational description in this model is the **tune**, which corresponds to what is often called a melodic/intonational pattern. The tones it consists of are melodic correlates of accent and phrase grouping, and its domain is the prosodically defined **intonational phrase** (*I*). Every tune is a sequence of tones, T, organized into three kinds of intonational morphemes: **pitch accent** (T*), **phrase accent** (T) and **boundary tone** (T%).¹

¹ The symbol "T" in combination with the diacritic signs * and % is used for tone in general, irrespective of whether it is an H or an L tone.

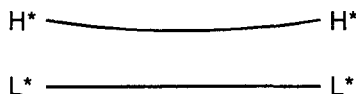
Every *I* has at least one melodic accent, which is, in keeping with the conventions of metrical phonology, indicated by an asterisk. On the level of each accentual phrase, one melodic accent is associated with the most prominent syllable. In English this accent can consist of one or two basic tones, H or L. In the former case, we get H* or L* respectively, and in the case of bitonal melodic accents, the possible combinations are H*+L, H+L*, L*+H and L+H*. With these complex melodic accents, one of the tones is always subordinated in prominence to the other, which is associated with the most prominent syllable in the accentual phrase and is hence indicated by an asterisk. The subordinated tone is a floating tone which always immediately precedes or follows the asterisked tone. In principle, it is linked to the tone-bearing unit adjacent to the syllable carrying the T*. However, in some cases the segmental material may be insufficient for a full realization of all intonational morphemes, so both tones of the complex melodic accent are compressed into the accented syllable. Nevertheless, the relation between T* and T in bitonal accents can be compared to the relation between the accented and unaccented syllable in the foot. The functional link between the component tones of complex melodic accents is indicated by the “+” sign.

Although the model allows for any combination of component tones within bitonal melodic accents, the inventory of English intonational morphemes does not include combinations of tones of the same kind, so one of the component tones of the English melodic accent always has to be H and the other has to be L. This is so because it turns out that in English there are no contexts where such combinations would be distinctive, which is explained by the nature of English interpolation rules. In any case, it should be noted that the inventory of melodic accents is language-specific, so other languages need not have those six melodic accents characteristic of English. So, for example, Féry (1989) identifies only L+H* and H*+L in Standard German, Thorsen (1980) identifies only L*+H in Danish, and in languages where accent has no tonal correlate, such as Zulu, melodic accent does not exist at all as an intonational morpheme. This relativity concerning the inventory of melodic accents in languages implies that, in order to compare the English intonational system with the Croatian one within this model, one first needs to establish the inventory of Croatian melodic accents for Croatian, which will be done shortly.

The last melodic accent in the intonational phrase coincides with the nuclear tone. This means that one intonational phrase has at least one melodic accent, and theoretically, because of recursiveness as an essential feature of human language, it can have an infinite number of them. Of course, in practice, this number is always limited, so in everyday speech one will rarely come across intonational phrases comprising more than two to three melodic accents.

Since the BGC model does not rely on the notion of tonal register and uses two tonal levels only, for the understanding of the phonological identity of the basic analytical entities it is crucial to know the difference between H and L tones. Pierrehumbert (1980: 68ff) points to the following three differences: First, in the same environment, H is always realized as phonetically higher than L. Second, H and L behave differently under emphasis: with the increase of emphasis H is raised and L is lowered (up to the point of saturation). The third difference refers to the behaviour of these tones in rules of interpolation, which at this point cannot be discussed in detail.

Instead, this difference can be illustrated by showing how the melodic shape between two H* tones differs from that between two L* tones:



This difference between H and L tones with respect to tonal interpolation results from an essential difference in their nature, i.e., the fact that, in speech, L is subject to saturation, whereas H is not.

As opposed to the melodic accent, the **phrase accent, T**, does not show any affinity towards metrically strong syllables. This tone is realized immediately after the nuclear accent and it significantly determines the post-nuclear movement of F_0 . As with the other types of intonational morphemes, with the phrase accent too the speaker has a choice between two tones, H and L, and each of these two has some meaning which can be isolated.

The phrase accent is realized immediately after the last melodic accent in the phrase, close to the end of the word which traditional intonologists would call nuclear. Its precise phonetic location varies and is phonologically irrelevant. In a more recent version of the BGC model, the domain of the rule assigning the phrase accent is the intermediate phrase (*i*). This means that there are cases where *I* branches into two *i*'s and includes two phrase accents. The BGC model does not in any way imply the universality of the phrase accents. Thus, the idea of the phrase accent as an intonational morpheme need not be applicable to all languages.

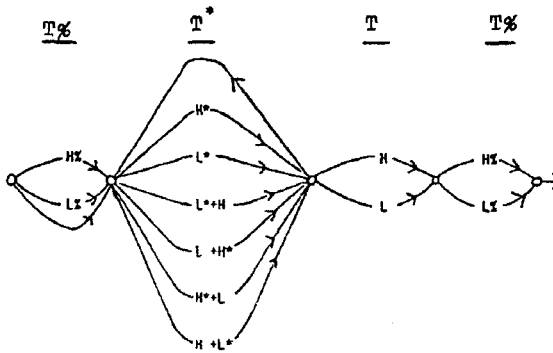
For the understanding of the significance of the phrase accent as a theoretical entity of intonology it is useful to point to the difference between the BGC model and the traditional models concerning the treatment of the post-nuclear part of the intonational pattern. In contradistinction to the traditional models, BGC analyses the post-nuclear contour ("tail") into two different intonational morphemes, one of which is the phrase accent. The isolation of the phrase accent in phonological analysis does not necessarily mean that T must be visible as a prominent point in the melodic contour. By its very presence in the phonological representation it plays an important role in determining the overall shape of the contour. Postulating the phrase accent is a decisive factor in enabling the BGC model to capture subtle intonational variations without the need for a third level.

The phrase accent is in several respects similar to the floating tone of the bitonal melodic accent. Apart from the fact that both are floating tones, they share the feature of not being associated with metrically strong syllables and not showing affinity towards prominent tone-bearing units. Besides, spreading rules treat them as a unique category. The main difference between them is that the floating tone of the bitonal melodic accent appears at a relatively constant distance from T*, whereas the distance between T* and the phrase accent varies considerably depending on the context. The latter two are commonly neutralized if they are compressed into a short stretch of segmental material.

The third kind of intonational morpheme in the BGC model is the **boundary tone**, T%. It is obligatorily linked to the right edge of the *I*. The model also allows for an optional T% at the beginning of the *I*, i.e., at the left edge of the intonational phrase. In the BGC model this tone is one of the three basic elements which every well-formed *I* must have.

With the boundary tone, the speaker also has the choice between two tones: H and L. The final H% is affected by the Upstep Rule, which adds the phonetic value of this tone to that of the preceding phrase-accent tone, reducing all melodic patterns ending in H% to the category of rising tunes. The default initial boundary tone for both American and Standard British English is L% (cf. Lindsey 1985: 53). Thus the initial boundary tone in the analysis of English is indicated only if it is high (H%). Such cases correspond to those configurations which in the British tradition are identified as "high pre-head". The final H% is phonetically defined by Ladd (1992: 322) as "an abrupt final rise taking place in the course of the last 300-500 msec of the intonational phrase or utterance".

Every well-formed English intonational phrase must then consist of at least one melodic accent (T*), one phrase accent (T), and a final boundary tone (T%). Such tunes are generated by the finite-state grammar, and each of the possible combinations of these three kinds of intonational morphemes represents a well-formed English tune. Taking into consideration only the simplest type of tune, that is, the one with one melodic accent and one phrase tone only, the English inventory of well-formed tunes is reduced to the following combinations:



(Pierrehumbert 1980: 29)

Diagram 1: Well-formed English tunes

The overall shape of any given tune results from the combination of these intonational morphemes and their interaction, intonational rules determining the way these basic elements of the tune are linked together, as well as the rules which assign concrete F₀ values to individual tones. In this paper, however, I will restrict myself to the comparison of the inventories of intonational morphemes in the two languages.

2. Empirical comparison of English and Croatian intonation

2.1. *The aims and assumptions of the research*²

The research was aimed at providing a comparison of the inventories of intonational morphemes of English and Croatian in the light of the BGC model. It was based on the results of a preliminary research presented in Josipović (1993), which established the extent and nature of the influence of post-lexical context upon the prosodic identity of lexical accents in Croatian, within the framework of the intonational minimum. At this point I will briefly sum up the conclusions of that research, which served as the starting assumptions for the present one.

In the phonetically controlled circumstances of the so-called intonational minimum, in the majority of cases, in the context of the Croatian intonational phrase, a preserved lexical prosodic pattern (henceforth LPP) can be identified. Within the framework of the BGC approach the LPP is analysed as the melodic accent H* (in the case of “falling” accents) or H*+H (“rising” accents). These intonational morphemes have no real equivalents in English – the former because of the difference in location within the syllable between Croatian and English, and the latter on account of the non-existence of the H*+H morpheme in English. The greatest influence on intonation in this sense is found with the most resilient, “rising” accents (which are analysed as a spread H tone) and in the final position in the *I*. The frequency of preservation of the LPP in Croatian intonation also rises with the increase in the degree of metrical and pragmatic prominence of the word in the *I*. In cases where the LPP is not preserved, i.e., where lexical prosody is influenced by the intonational pattern, the only BGC morpheme which was identified is L*+H. As alternative means of expression to the intonational morpheme L*+H, a whole range of prosodic and paralinguistic features were found by informal observation.

Starting from these premisses about the extent and nature of the influence of the post-lexical context upon the prosodic identity of Croatian lexical accents in the intonational minimum, the present research was aimed at comparing the inventories of intonational morphemes of the two languages in analogous pragmatic contexts. The analogous contexts were obtained by translation, or by adaptational translation of the original BGC corpus into Croatian. In other words, the situations and examples from the BGC corpus were “translated” into Croatian, and the prosodic adequacy of the examples that were chosen was confirmed by a brief and informal preliminary research, in which native speakers of five different varieties of English took part.³ For each of the BGC intonational morphemes a group of representative intonational phrase types was chosen from the BGC corpus.⁴

² The research presented in this paper was done for the purpose of the Ph. D. thesis Josipović (1993), so this presentation of the research is a somewhat modified version of chapter II.2.3. from the thesis.

³ An exhaustive list of the intonational phrases included in the corpus, as well as the explanations of the prosodic and cultural adaptation involved in their translation, is provided in the *Appendix* in Josipović (1993).

⁴ The samples under consideration were taken from the fundamental works of the BGC theory: Pierrehumbert (1980) and Pierrehumbert and Hirschberg (1987). However, in a few cases, in order for all categories to be equally represented, for certain intonational morphemes, examples from two other BGC sources were taken (No s. 55-58, 104). The phrases in question come from the corpus used by Lindsay

The corpus consisted of 254 types. As there were four speakers reading the corpus twice, the total number of tokens was 2032. At this point it should be noted that some of the intonational phrases contained more than one sample of a given intonational morpheme. This explains why the number of intonational phrases in the corpus does not coincide with the number of intonational morphemes analysed.

The research thus consisted in establishing in which cases the intonational morphemes from the Croatian corpus corresponded, or failed to correspond, to the ones found in the analogous contexts from the BGC corpus. The identification of these morphemes was carried out by combining a perceptive and acoustic analysis of the digitalized corpus.

2.2. Procedure

The choice of the subjects was entrusted to the phonology teacher in the Department of Croatian at Zagreb University. Apart from a normal hearing status, which is implied in any research of this kind, the following criteria were applied: a clear realization of the four-accent system, general clarity and expressiveness of diction, and experience in studio recording. Before the recording took place, the four speakers (two male and two female) had a brief training session, in which they were familiarized with the corpus and the reading technicalities. The training also included a trial reading of the examples. The subjects were naive to the purpose of the research.

The phrases were written out on numerated index cards, which were arranged in random order. The recording was done using a REVOX B 77 tape recorder in a sound-proof studio (loudness 70 dB; frequency range 20 Hz - 20 kHz). As all phrases were read twice, the recording was done on two successive mornings, in order for the task not to become tedious for the speakers.

The material obtained in this way was recorded in the same studio, using the same equipment, in the original order. Then it was digitalized by means of the software package *Loughborough Sound Images Speech Station*, version 2.00. The procedure of digitalization was analogous to the one employed by Pierrehumbert (1980); the frequency of sampling was 10 kHz.

The information obtained by computer analysis about the identity, location and variability of prominent points of melodic contours was used in the identification of individual intonational morphemes. This identification was carried out in the way in which it was done in the BGC model.

2.3. Research questions

The questions to which the above described analysis of the data was to provide answers were the following:

(1985); in No. 104, we are dealing with Lindsay's interpretation of the famous Liberman and Sag example: "*Elephantiasis isn't incurable*".

1. How often and in which cases do English melodic accents have Croatian lexical prosodic patterns (LPP) as their correlatives in the respective Croatian translational equivalents?
2. Does the Croatian intonational morpheme L^*+H , which was identified in the research referred to earlier (Josipović 1993), appear as a correlate of the English L^*+H , and is it possible to identify any other BGC melodic accent in the Croatian corpus?
3. What is the relation between non-melodic H and L intonational morphemes in the two corporuses?
4. Is there a systematic use of some non-morphemic or non-intonational means of expression in Croatian contexts where English uses intonational morphemes which were not found in Croatian?
5. Do the results of the phonological comparison of the two corporuses have any contrastive implications regarding intonational rules and meaning?

2.4. Results

The first two tables, 1 and 2, show the realization of different BGC intonational morphemes in the pronunciation of individual speakers, whereas the next two, 3 and 4, contain data on the overall performance, irrespective of individual differences. Melodic accents and non-melodic tones are shown in separate tables.

Individual columns show the realization of the 10 intonational morphemes in Croatian translation equivalents. So, for example, in the first column of Table 1, for the speaker DN, number 62 for LPP means that in 62 cases (out of the theoretically possible 64 (Σ), this speaker realized the Croatian LPP in Croatian translational equivalents in contexts where English has H^* . So, in 62 cases in contexts under consideration it was possible to identify H^* or H^*+H in the speech of DN, with all the contrastive implications of their realization mentioned above and discussed in detail in Josipović (1993).

The intonational morpheme $H\%$ was looked at separately in the initial ($H\%$ -init.) and final ($H\%$ -fin.) position in the *I*. The data for the low boundary tone ($L\%$) have been left out, because even an informal observation of the corpus made it clear that in 100% cases the English $L\%$ corresponded to the Croatian $L\%$ (though not the other way round), which will be commented upon later in the interpretation of the results.

The question mark indicates cases where on a given word it was impossible to identify the intonational morpheme, either because on the accented syllable or in its immediate environment there was no perceptually or acoustically identifiable prominent point which would clearly point to some particular morpheme, or because the identity and location of the peak offered the possibility of ambiguous phonological interpretation. The sign “ø” is used with phrase accent tones which, owing to differences in phrase grouping between Croatian and English, were not realized by any intonational morpheme in places where in the corresponding English context such phrase-accent tones were present.

For cases where the identification of intonational morphemes was phonologically controversial, explanations will be offered later.

Table 1. *Individual results – melodic accents:*

		H*	L*	H*+L	L*+H	H+L*	L+H*
Σ		64	64	64	64	20	20
MI	LPP	61	55	64	57	20	20
	L*+H	2	9	-	6	-	-
	?	1	-	-	1	-	-
MA	LPP	64	64	64	64	20	20
	L*+H	-	-	-	-	-	-
	?	-	-	-	-	-	-
DN	LPP	62	63	60	54	20	20
	L*+H	1	1	4	8	-	-
	?	1	-	-	2	-	-
VJ	LPP	60	54	56	60	20	20
	L*+H	3	8	3	3	-	-
	?	1	2	5	1	-	-

Table 2. *Individual results: non-melodic tones:*

		L	H	H% INIT.	H% FIN.
E		64	64	20	64
MI	L	59	56	19	50
	H	5	8	-	13
	?	-	-	1	1
	∅	-	-	-	-
MA	L	63	57	19	63
	H	1	7	-	1
	?	-	-	1	-
	∅	-	-	-	-
DN	L	61	47	17	52
	H	3	10	2	12
	?	-	5	1	-
	∅	-	2	-	-
VJ	L	63	50	14	56
	H	-	10	3	8
	?	-	2	3	-
	∅	1	2	-	-

Table 3. *Overall results: melodic accents*

	H* ($\Sigma = 256$)		L* ($\Sigma = 256$)		H*+L ($\Sigma = 256$)		L*+H ($\Sigma = 256$)		H+L* ($\Sigma = 80$)		L+H* ($\Sigma = 80$)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
LPU	247	96.484	236	92.187	244	95.31	235	91.797	80	100	80	100
?	3	1.172	2	0.782	5	1.953	4	1.562	-	-	-	-
L*+H	6	2.344	18	7.031	7	2.735	17	6.641	-	-	-	-

Table 4. *Overall results: non-melodic tones*

	L ($\Sigma = 256$)		H ($\Sigma = 256$)		H% INIT. ($\Sigma = 80$)		H% FIN. ($\Sigma = 256$)	
	No.	%	No.	%	No.	%	No.	%
L	246	96.094	210	82.03	69	86.25	221	86.328
H	9	3.515	35	13.672	5	6.25	34	13.281
?	-	-	7	2.734	6	7.5	1	0.391
Ø	1	0.391	4	1.562	-	-	-	-

Starting the analysis of the results from the **melodic accents**, I shall first refer to Table 3, which shows that the majority of the melodic accents in the corpus (95%) were identified as LPP.

From the post-lexical point of view, the high tone of the LPP, irrespective of whether it is spread or not and whether it is linked to a monomoraic or bimoraic syllable, has its correlate in the nuclear contour which, within the framework of the British approach, Nakić (1981) and Škarić (1991) identify in Croatian as **falling**. This "falling" nucleus corresponds in its phonetic description, as well as in frequency, to the intonational morpheme LPP. Both authors point out the "falling nucleus" as the most common type of intonational nucleus in Croatian.

The fact that the LPP turns out to function as the predominant melodic accent in Croatian only confirms the significant role of Croatian lexical prosody in accounting for the differences between Croatian and English. The series of pitch tracks with which I start the illustration of such differences provides a comparison between the realization of individual intonational morphemes from the BGC corpus and Croatian lexical prosodic patterns which in the same or comparable contexts appear in their respective Croatian translational equivalents.

The first pair of examples, illustrations 1 and 2 (JPH 316⁵ and DN 13), reflect a difference between the two melodic patterns which does not follow from the difference in the identity of the intonational morpheme, but rather from the difference in the implementational rule which determines the location of the H tone. Thus, in the Croatian example the H* tone is located in the first half of the accented syllable, whereas the English H* is by definition located close to the end of the syllable.



Illustration 1. JPH 316: *Anna came with Manny.*
 H* L- L%

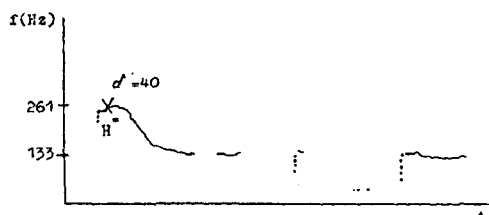


Illustration 2. DN 13: *Ana je došla s Ivom.*
 H*

In cases where the Croatian word carrying the melodic accent has a spread (“rising”) LPP, both the acoustic and the perceptual difference between the English H* and the Croatian LPP are less pronounced. However, there is no justification to treat the spread LPPs as equivalents of the English H*, because the domain of the latter is strictly limited to the accented syllable. This can be illustrated by the pair of examples JPH 353 and MI 53. While in the English example after the H* tone on the word *Madelin* there follows an abrupt melodic fall, in the Croatian example the high tone is manifested

⁵ Examples from the BGC corpus taken from Pierrehumbert (1980) are indicated by the abbreviation “JPH”, and the number following this abbreviation (in this case 316) indicates the page where the original example is found and where the speaker’s initials are provided. The value *d* (where applicable) indicates the distance of the peak from the beginning of the syllable, expressed in percentage.

in the post-accentual syllable as well. This syllable could have preserved the tonal level of the peak had it not been for the microprosodic influence of the “low” segments /r/ and /a/.

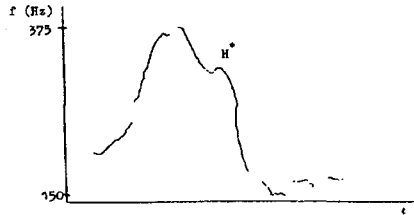


Illustration 3. JPH 353: *I imagine Madeline did it.*
H*

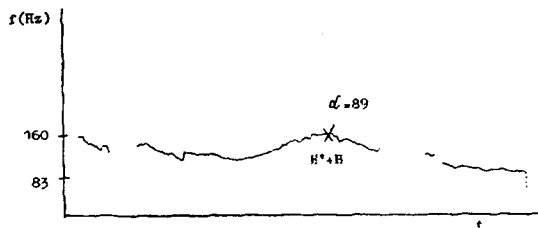


Illustration 4. MI 53: *Mislim da je Mira kriva.*
H*+H

The following pitch track (Illustration 5) shows a typical realization of the melodic accent L* on the word “blueberry”, while the corresponding pitch track from the Croatian corpus, presented in Illustration 6, reflects the realization of the Croatian LPP (in this case H*+H) in the same context:

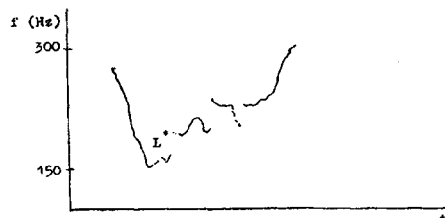


Illustration 5. JPH 312: *More blueberry bread, Manny?*
L*

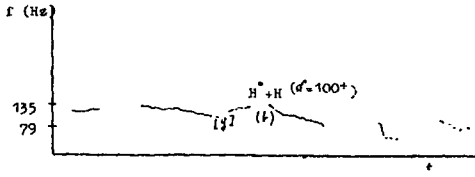


Illustration 6. MA 36: *Još malo gibanice, Ana?*
 H^*+H

By analogy with the above examples, the next three pairs of pitch tracks illustrate cases where English intonational phrases have the BGC melodic accents H^*+L , L^*+H and $H+L^*$, and their Croatian correlates have the LPPs of the words in question.

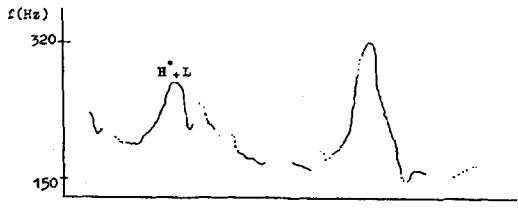


Illustration 7. JPH 351: *It's a wonderful place to be an undergraduate*
 H^*+L

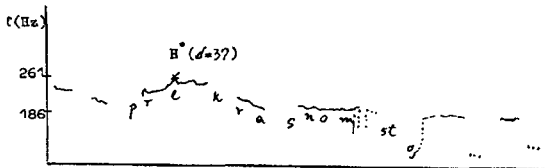


Illustration 8. VJ 52: *To (ti) je prekrasno mjesto za studiranje*
 H^*

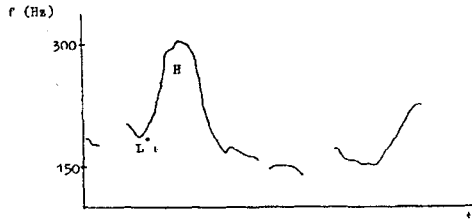


Illustration 9. JPH 291: *The cardamon bread was palatable*
 L^*+H

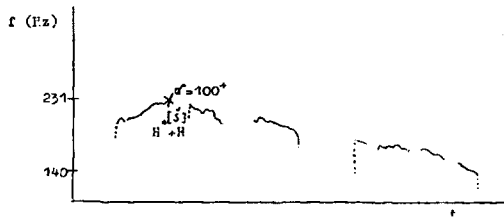


Illustration 10. VJ 68: *Kremšnite su bile probavljive*
 H^*+H

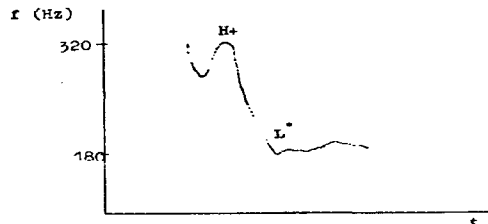


Illustration 11. JPH 342: *God damn it!*
 $H+L^*$

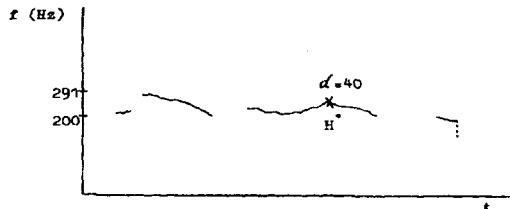


Illustration 12. VJ 68: *U vražju mater!*
 H^*

Finally, illustration should be provided for cases where Croatian has LPP in contexts where English has L+H*. Since the most illustrative examples of this kind come from the Pierrehumbert and Hirschberg (PH) corpus, in which the majority of examples come without pitch tracks, a typical realization of the L+H* morpheme in English will be shown on example JPH 330, provided in Illustration 13. The next pitch track after it represents a Croatian / illustrating the use of the LPP in the context where in the PH corpus L+H* was identified.

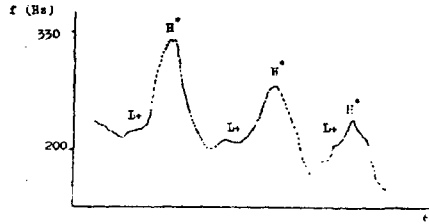


Illustration 13. JPH 330: There are many intermediate levels
 L+H* L+H* L+H*

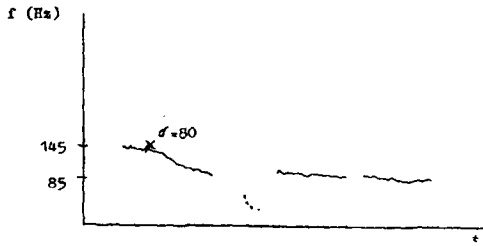


Illustration 14. MI 81: Franjo je pojeo grah.
 H*+H

As can be seen in Table 3, the only melodic accent in the corpus apart from the one corresponding to the LPP is L*+H. By virtue of its phonetic realization, as well as the frequency and context of its occurrence, this Croatian intonational morpheme basically corresponds to the entity which Škarić (1991: 311) defines as “fall-rise-fall”, or “inverted” nucleus, characteristic of languages spoken in the Balkans.

Out of the total of 48 cases where L*+H was identified in the corpus, it appears in 17 cases where English has it too, while in the remaining 31 it appears in contexts where English has other melodic accents: H*, L* and the suffixed accents H*+L and L*+H. It is interesting to note that L*+H was not identified in any of the contexts for the English prefixed accents. The distribution of this intonational morpheme in the Croatian corpus compared to English can be shown by means of a diagram representing the total number of cases where L*+H was identified (48). The individual segments of the diagram refer to the English intonational morphemes to which the Croatian L*+H corresponds.

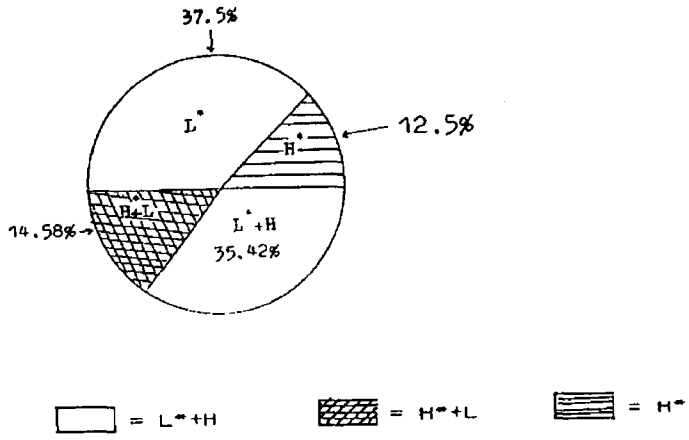


Diagram 2. English correlates of the Croatian L*+H

The differences in the distribution of English correlates of the Croatian L*+H were checked by a t-test of proportion and the following results were obtained:

$$\begin{aligned}
 t_{H^* - L^*} &= 2.55 & p < 0.02 \\
 t_{L^* - H^*+L} &= 2.28 & p < 0.05 \\
 t_{H^*+L - L^*+H} &= 2.17 & p < 0.05
 \end{aligned}$$

On the basis of these results it can be concluded that all these differences are significant. A separate test of proportion was used to work out the difference between cases where the Croatian L*+H appears as an equivalent of the English intonational morpheme L*+H on the one hand and those where it appears as a non-equivalent correlate of another melodic accent on the other. The value obtained for t is 2.33, $p < 0.02$, which means that this difference is significant, too. In other words, the Croatian L*+H appears significantly more frequently as a correlate of some other English melodic accents than it does as the equivalent of the English L*+H.

The series of pitch tracks that follows illustrates cases where the Croatian L*+H appears in the above mentioned situations, presented in the following order:

1. as the equivalent of the English L*+H (DN 56)
2. as a correlate of the English L* (MI 25)
3. as a correlate of the English H* (DN 4)
4. as a correlate of the English H*+L (VJ 53)

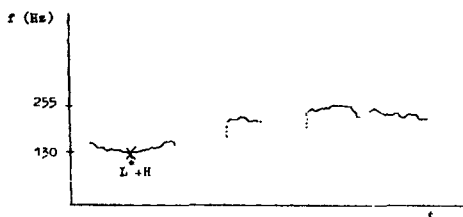


Illustration 15. DN 56: Denis je zgodan.
 L*+H

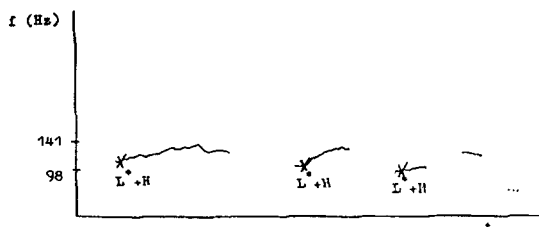


Illustration 16. MI 25: Imaju li šljive peteljke?
 L*+H L*+H L*+H

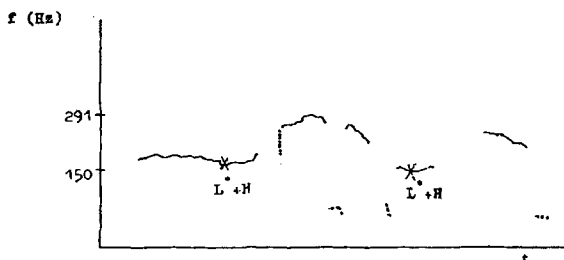


Illustration 17. DN 4: Mogu li te prekinuti?
 L*+H L*+H

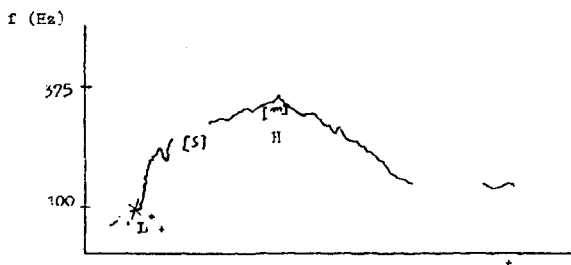


Illustration 18. VJ 53: Mislim da je Mira kriva
 L*+H

At this point a few words are in order about those cases in which the identification of intonational morphemes was phonologically controversial. It follows from Table 3, that the Croatian language has not got the four melodic accents which English has: L^* , H^*+L , $H+L^*$, and $L+H^*$. This kind of analysis will be substantiated by arguments for each of these four accents separately in the text that follows.

The intonational morpheme L^* can be recognized as a clear “valley” in the part of the melodic contour corresponding to the accented syllable. Such valleys, of course, do exist in the Croatian corpus, but they are identified as part of the melodic accent L^*+H , because, as a rule, they are followed by an H tone on the post-accentual syllable, which typically, as in the example in the pitch track in Illustration 19 (DN 69), spreads to the end of the phonological word.

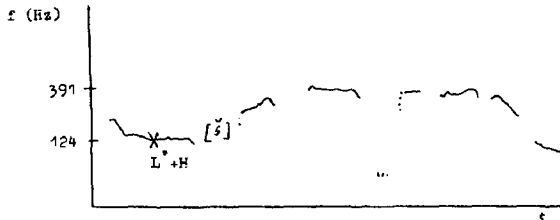


Illustration 19. DN 69: *Kremšnite su bile probavljive*
 L^*+H

There are, admittedly, cases where after the L^* no rise can be identified, but they all occur in contexts for the neutralization of L^* and L^*+H , immediately before the phrase accent tone, when owing to the insufficiency of the segmental material the H tone of the melodic accent cannot be distinguished from the H tone of the phrase accent (as in the example MI 97), when in the context of the following L phrase-accent tone the high tone is neutralized by the glottalization of the final part of the I (VJ 101), or in the contexts for Downstep ($H L^*+H$), as in DN 36.

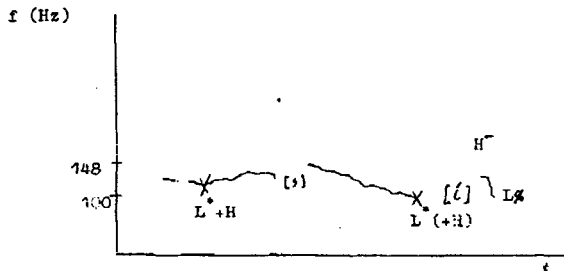


Illustration 20. MI 97: *Mogu sad ići?*
 L^*+H $L^*(+H) H H\%$

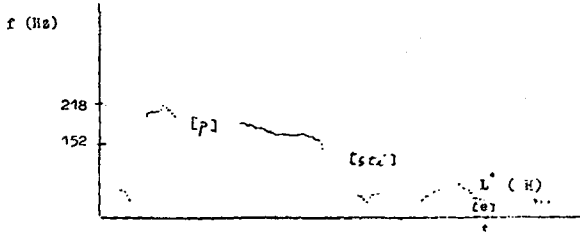


Illustration 21. VJ 101: *Oprosti, Benjamine*
 H*+H L*(+H) L L%

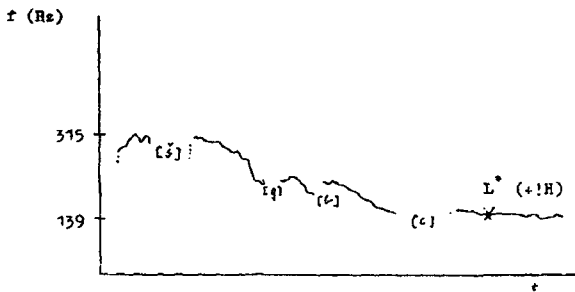


Illustration 22. DN 36: *Još malo gibanice, Ana?*
 H* H*+H H*+H L*(+!H) L L%

Since configurations of this kind were found only in contexts for neutralization, such as those in the preceding three examples, it can be concluded that for Croatian it is not necessary or justified to introduce L* as a separate intonational morpheme. In short, no configurations were found in Croatian that would require the introduction of L* like the one illustrated in the following English example:

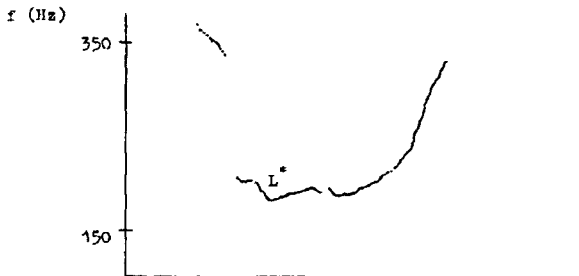


Illustration 23. JPH 311: *I'm sorry, Benjamin?*
 H% L* L L H%

The analysis of the Croatian corpus does not turn out to require the introduction of the morpheme H^*+L either. The issue that arises in this connection concerns the phonological nature of the fall after the melodic accent H^* , which corresponds to the so-called falling LPPs. This fall could be phonologically interpreted in three ways:

1. as part of the LPP, if falling accents are treated as H^*+L ;
2. as an intonational morpheme introduced after the lexical tone by a late redundant intonational rule (cf. Inkelas and Zec 1988);
3. as a result of an interpolation rule.

The first solution turns out to be the least acceptable, since it has been shown that the analysis of the lexical prosody of Standard Croatian can function most elegantly with one tone only (cf. Inkelas and Zec 1990, Josipović 1993). Thus, the reinterpretation of falling accents as H^*+L would involve an unnecessary complication, the more so as this would also require the reinterpretation of spread (rising) accents as tritonal entities.

The second solution is somewhat more acceptable in that it would not complicate the system of analysis of Croatian lexical prosody. However, in view of the obvious preservation of the LPP in the majority of cases, it would entail the introduction of tritonal entities on the post-lexical level of analysis. Alternatively, if we conceive of this L tone as an entity independent of the melodic accent, this solution would require the introduction of a new type of intonational morpheme. Neither of the two alternatives would in itself be unacceptable. However, as long as the introduction of such a new entity does not turn out to be indispensable, we are justified in avoiding it as an unnecessary complication of the analytical system.

According to the third, so far the most acceptable solution, the fall after the H tones of all Croatian LPPs is interpreted as a result of an interpolation rule, which in Croatian simply determines the fall of F_0 after the realization of the melodic accent. This rule is comparable to the English interpolation rule lowering F_0 in the inter-stress interval between two H^* s. The result of such an F_0 fall is a dip in the melodic contour.

In the Croatian corpus no **prefixed melodic accents $H+L^*$** or **$L+H^*$** , were identified. This is what they look like in English:

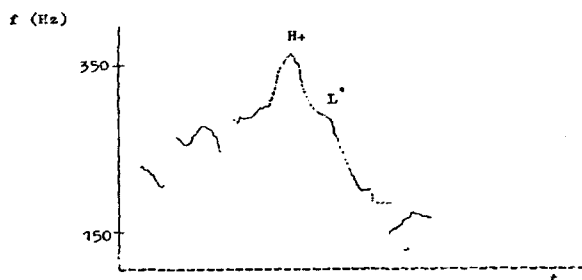


Illustration 24. JPH 350: *I didn't really believe him.*
 H^* $H + L^* L L\%$

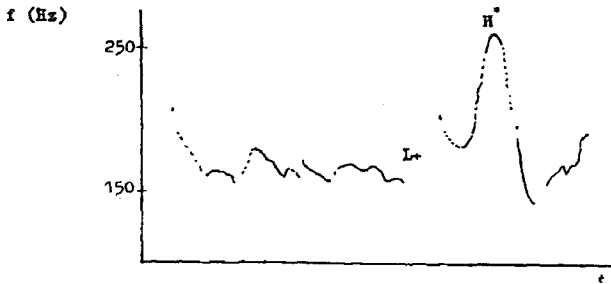


Illustration 25. JPH 350: *There's a lovely one i Canada.*
 L* H* L L%

It is interesting to note that the prefixed accents as a category are set apart from the rest of the melodic accents in that in none of the Croatian examples was L*+H identified in contexts where English has one of these two morphemes. A t-test of proportion showed this difference between prefixed accents and all other melodic accents to be significant. The values of t range from t = 2.86 to t = 4.71, with p < 0.01.

The correlate of the English prefixed accents in Croatian is thus the LPP. This means that the meaning of the prefix (which, like all other aspects of intonational meaning, cannot be discussed in this paper) must be expressed by some other means in Croatian. This indeed follows from the corpus itself. That is, already in the course of translating the dialogues from the BGC corpus into Croatian there arose the need to introduce some pragmatic particles like *pa*, *ma* and *evo*, the emphatic pronoun *ti*, and the emphatic pronominal subject. Whenever it sounded acceptable, such words were avoided in the original version, but during the trial reading in the course of the training session, it turned out that speakers spontaneously introduced such words even when they were not written in the text. This shows that the speakers felt these as naturally belonging to the context. In order for the dialogues to be acted out as spontaneously as possible, the speakers were told to feel free to insert such words wherever they felt the need to do so. The analysis of the corpus confirms that the prefixed accents function as a separate category in this respect. It turns out that in Croatian the meaning expressed by prefixed accents is regularly and systematically expressed by such non-intonational means.

Apart from the above mentioned words, in this category of examples there is often a change in the quality of voice, final glottalization and delayed peak. As the latter feature turns out to be linked with the initial position in the *I*, in the present corpus it is treated as an intonational allomorph of the LPP.

The examples that follow illustrate the use of such means. It should be noted that in this category of examples it was possible to detect some other phenomena, which cannot be illustrated by pitch tracks and are not the concern of this paper anyway. Apart from the voice quality, which is hard to define, these phenomena include the use of characteristic facial expressions and gestures. At this point at least those less elusive ones can be illustrated in the following six examples (Illustrations 26-31):

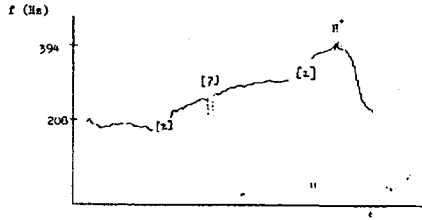


Illustration 26. VJ 85: Pa izbijaju joj zubi
 $H^*+H \quad H^* \quad L \quad L\%$

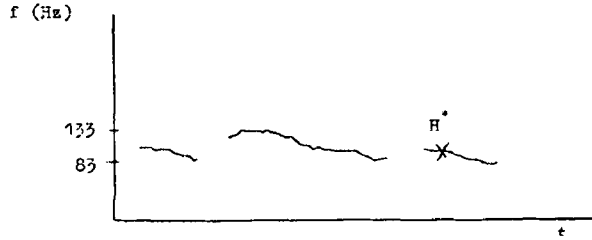


Illustration 27. MI 85: Ma izbijaju joj zubi
 $H^*+H \quad H^* \quad L \quad L\%$

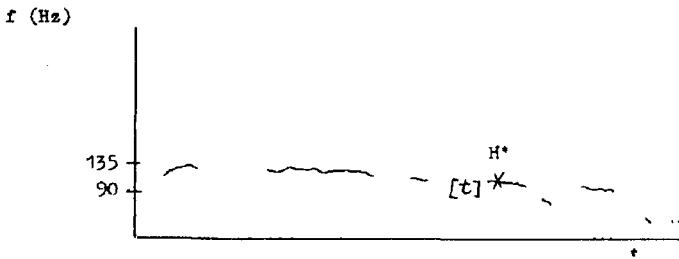


Illustration 28. MI 86: Pa nećemo valjda ići tim putom
 $H^* \quad H^*+H \quad H^* \quad H^* \quad H^*+H \quad L \quad L\%$

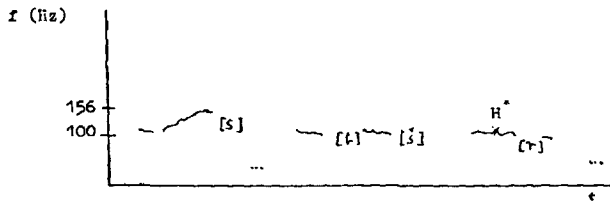


Illustration 29. MA 90: Pa nisam mu baš vjerovao
 $H^*+H \quad H^* \quad H^*L \quad L\%$

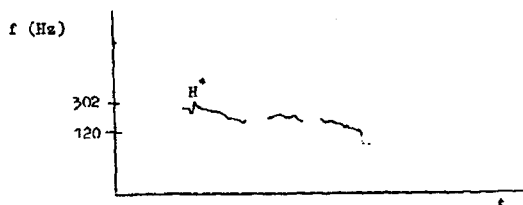


Illustration 30. DN 87: *Dovraga!*
 [1] H* L L%

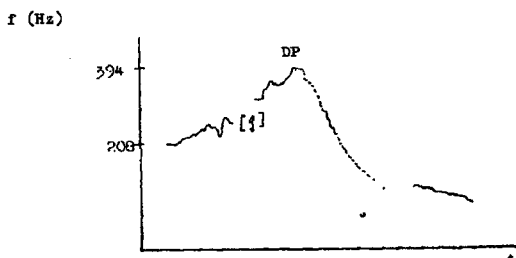


Illustration 31. VJ 67: *Jürgen je iz Njemačke*
 LPU- DP H* L L%

All these examples show that such non-intonational means of expression are regularly combined with the LPP as the intonational morpheme. As can be seen from the first two examples, VJ 85 and MI 85, some of these means can be used alternatively. This does not happen only with different speakers, but quite commonly also with one and the same speaker, who can use two different means in two different instances of reading. Apart from *pa* and *ma* such alternative means include the optional use of the emphatic pronoun and, less commonly, the emphatic pronominal subject, as in the following examples:

Pa ja ti ne jedem govedinu.

Pa nisam mu (ja) baš vjerovao.

I have quoted only real cases of spontaneous insertion of these pronouns, but all examples from this category which were used in the corpus could actually be translated in such a way as to include some of these non-intonational means of expression and perfectly fit into the context of the dialogue they belong to. A case in point is the intonational phrase “*Izbijaju joj zubi*”, which in the context at hand could be translated by using both types of pronouns – emphatic subject and emphatic dative:

Njoj ti izbijaju zubi

Likewise, example no. 67, which in the version presented in Illustration 31 had only the delayed peak as an alternative means of conveying intonational meaning, could also have been translated in the following ways:

Pa, Jürgen je iz Njemačke

Evo, Jürgen je iz Njemačke

Jürgen ti je iz Njemačke

All combinations of the above mentioned alternative means are also imaginable. Owing to limitations of space, the meaning of each of them, as well as the meaning of intonational morphemes proper, will have to be discussed in a separate paper. What follows now are the results of the analysis for the non-melodic intonational morphemes – phrase- accent and boundary tones.

As explained earlier with respect to the low boundary tone, L%, it was found that English had equivalents in Croatian in all 256 cases, so this result was not subjected to formal statistical analysis. This is, after all, in agreement with the empirically established and well-known fact that falling contours are more common in Croatian than in English (cf. Nakić 1981). This, admittedly, does not necessarily mean that in all cases where English has L%, Croatian will have it too, but in a limited corpus like this, a 100% correspondence between the two languages with respect to the intonational morpheme L% is hardly surprising.

For the rest of the non-melodic tones, the X^2 test was used to check the difference between the frequencies obtained and the theoretical ones, in order to establish whether the difference between the equivalent responses (i.e., cases where individual tones are equivalent in the two languages) is statistically significant. For the phrase-accent tone L, $X^2 = 0.39$ (n.s.), i.e., the difference between the two languages with respect to the low phrase-accent tone is not significant. As for the remaining three non-melodic morphemes, H, H%-init. and H%-fin., equivalent responses do occur significantly less frequently than the theoretical ones ($p < 0.01$). In other words, the statistical data confirm a greater frequency of occurrence of high non-melodic tones in the English language. As this category includes, apart from the boundary tones, also the phrase-accent tone H, it is important to stress that the results at hand have implications that go beyond the differences in the frequency of rising and falling contours in the two languages. These implications, however, will have to be left for a separate paper about the meaning of the intonational morphemes under consideration.

For reasons specified earlier, in some cases neither H nor L could be identified for the non-melodic tones, so these cases are indicated as ? or \emptyset . Thus the fact that for high non-melodic tones equivalent responses are significantly fewer than the theoretical ones does not necessarily mean that L tones from this category occur more frequently in Croatian as equivalents than they do as non-equivalent correlates or “substitutes” for English morphemes. This was checked by the t- test of proportion, and the following results were obtained:

t L - H	=	5.19	p < 0.02
t L - H _{INIT}	=	2.79	p < 0.05
t L - H _{FIN}	=	4.00	p < 0.05

On the basis of these results, it can be concluded that the L non- melodic tones in Croatian occur significantly more frequently as equivalents of English morphemes (i.e., where English also has them) than as non-equivalent correlates (“substitutes”) of the English high tones.

Concerning the non-intonational means of expression referred to earlier, it is interesting to note that in this category of intonational morphemes as well alternation or combination with such means can be regularly observed. This particularly refers to H%-init. With this intonational morpheme, it is most often a change of voice quality and an increase in loudness of speech that can be observed. There are also cases of inserting pragmatic particles, though not to the extent in which this is done for melodic accents, so it cannot be established with certainty whether these particles are really the correlates of the initial H% in the given intonational phrases, such as in:

MI 99: *E, pa to je stvarno predobro da bi bilo istinito!*

Expressions functioning as alternatives to the initial H% can be manifested in Croatian in the prosody of the key word - by emphatic lengthening of the nucleus or the use of the L*+H morpheme, as in the following two examples:

MA 100: *To je jaako pametan prijedlog!*

MA 104: *Elefantijaza nije neizlječiva!*

L*+H

The same strategy can be observed in the realization of Croatian correlates of the other English high non-melodic tones, H%-fin. and H, even irrespectively of the identity of these tones in Croatian. This phenomenon, however, also has to be left for a separate paper on intonational meaning.

Cases where non-melodic L tones are equivalent in the two languages are so obvious from the examples quoted so far that it appears unnecessary to provide illustrations for each of them separately. This equivalence will therefore be illustrated using one example for all three low non-melodic tones :

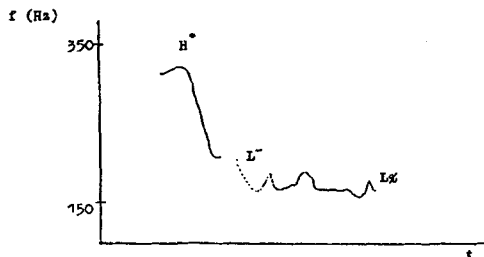


Illustration 32. JPH 316: *Anna came with Manny*
 (L%) H* L L%

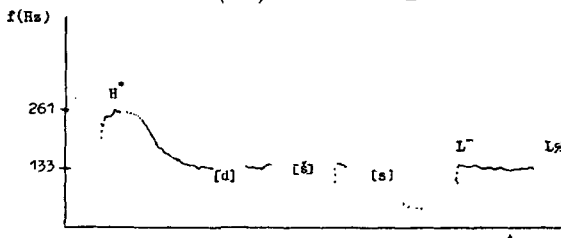


Illustration 33. DN 13: *Ana je došla s Ivom*
 (L%) H* L L%

The pairs of pitch tracks that follow in illustrations 34 and 35, 36 and 37, 38 and 39 will show some contrastively interesting cases in which individual non-melodic tones in the two languages are not equivalent:

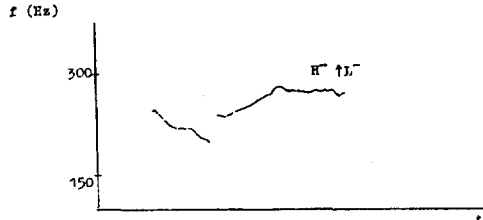


Illustration 34. JPH 308: *Can I go now?* (irritated)
 $H^* H \uparrow L\%$

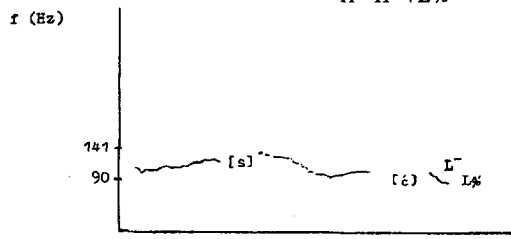


Illustration 35. MI 98: *Mogu sad ići?* (irritated)
 $L^*+H H^* L^*+HL L\%$



Illustration 36. JPH 258: *Another orange!?*
 $H\% L^* H^* L L\%$

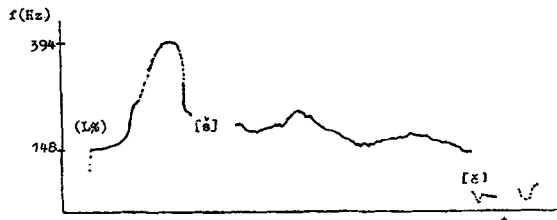


Illustration 37. DN 20: *Još jedna naranča!?*
 $(L\%) H^* H^*+H H^*+H L L\%$

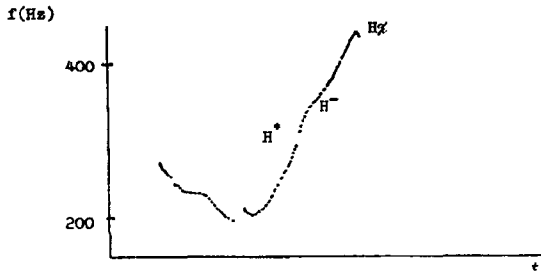


Illustration 38. JPH 307: *Can I go now?* (ordinary question)
 $H^* H H\%$

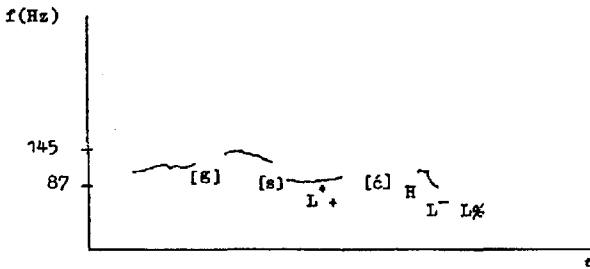


Illustration 39. MI 97: *Mogu sad ići?* (ordinary question)
 $H^*+H H^* L^*+H L- L\%$

Interestingly, there are a few cases where the English L has the Croatian H as its correlate. This, in fact, explains why for L the difference between frequencies obtained and theoretical frequencies is not statistically significant. In these cases one regularly finds one particular type of phonological context, which is manifested phonetically as a high plateau. For the analysis of such contexts the crucial role is played by the rule of Upstep. This intonational rule, which can also be seen in example JPH 308 quoted in Illustration 34, was found in Croatian examples where H appears as the correlate of the English L phrase-accent tone. As the phonological nature and the implications concerning the meaning of this combination of intonational morphemes deserve to be the topic of a separate paper, the illustration of the differences between English and Croatian concerning non-melodic tones at this point has to be limited to a pitch track representing the translational equivalent of the English example PH 29:

(Let's see. Put the tab into slot A.)

Turn the model over. *(Put tab B into slot B.)*

$H^*+L H^*+L H^*+L L L\%$

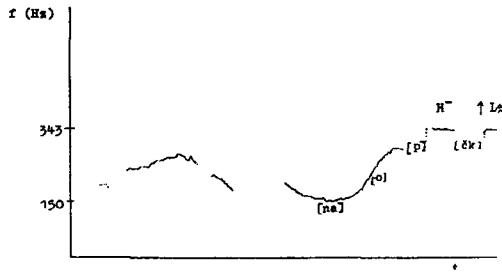


Illustration 40. DN 45: *Okrenite stol naopačke...*

$H^* + H \quad H^* \quad L^* + H \quad H \uparrow L\%$

Postulating non-melodic tones in the Croatian intonational system makes it possible to overcome an obvious disadvantage of the earlier approaches to the analysis of Croatian intonation. Those approaches were characterized by the limitation of the distribution of individual nuclear tones to the final word in the intonational unit. A case in point is Škarić (1991), who establishes such limitations in distribution for the so-called “rising”, “rise-fall” and “level” nuclei. By contrast, in the BGC approach these three contours can be analysed as combinations of melodic accents with different non-melodic tones, possibly with the application of some intonational rules in certain contexts.

By themselves, limitations in the distribution of intonational entities would not represent a weak point of the approach, provided they could be justified by explanatory reasons. However, these three contours do not turn out to share any features of meaning which would justify treating them as a single phonological category. On the other hand, failing to analyse them into intonational morphemes we miss generalizations on the meaning that each of them shares with some other non-final nuclei.

2.5. Conclusions

The conclusions of the research can be summed up as answers to the research questions formulated in 2.3. and can be expressed in the following five points:

1. All English melodic accents in their Croatian translational equivalents have Croatian LPPs as their correlates in a statistically significant majority of cases. The prefixed melodic accents of English are set apart from the rest of the melodic accents by virtue of never having $L^* + H$ as their correlate in Croatian, their Croatian correlate always being the LPP.

2. The Croatian intonational morpheme $L^* + H$, whose presence in the Croatian inventory was shown in an earlier research, can sometimes occur as the equivalent of the English $L^* + H$. However, it turns out that it does not appear in this function in the majority of cases. On the contrary, cases where it occurs as a non-equivalent correlate of other English melodic accents are in a significant majority. Apart from $L^* + H$, no other BGC melodic accent was identified in the Croatian corpus.

3. The same bitonal inventory of non-melodic tones as in English, T and T%, was found in Croatian. A comparison of their meaning in the two language has to be left for

a separate paper. What should be noted here is the significantly wider use of high non-melodic tones in English.

The ratio of H and L non-melodic tones in the two languages suggests that, compared to English, Croatian makes a more extensive use of alternative, redundant non-intonational pragmatic means of expressing the meaning of H and H%. Such alternative means can indeed be detected by informal observation of intonational variations within the corpus, but not being the direct concern of this paper, they were not systematically explored.

4. The conclusions set out above imply that in Croatian unmarked intonational morphemes in combination with non-intonational means function more often as equivalents of their marked correlates than they do in English. In the category of Croatian melodic accents, the unmarked morphemes are the LPPs, whereas the unmarked non-melodic morphemes are the low ones, L and L%.

5. The results of the phonological comparison of the two inventories of intonational morphemes have also some important implications concerning differences in intonational meaning, as well as differences in the use intonational rules. These issues, however, could not be discussed in the present paper.

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INTONACIJSKI SUSTAVI ENGLESKOG I HRVATSKOG

U ovom radu prikazuje se istraživanje kojim se uspoređuju intonacijski sustavi engleskog i hrvatskog jezika u okviru dvotonskoga generativnog kompozicijskog pristupa. Intonacijske fraze izvornoga engleskog korpusa uspoređuju se s njihovim hrvatskim prijevodnim ekvivalentima. Potonji se digitaliziraju i podvrgavaju istom tipu kompjutorske analize koji je koristila Pierrehumbert (1980) pri zasnivanju dvotonskoga modela. Donose se zaključci o razlikama između inventara intonacijskih morfema u dvama jezicima.