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Juncture*

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1. Introduction

The following report is concerned with juncture, which for the purposes of this paper is defined as a phonologically manifested boundary. A search for boundary signals implies the existence of certain linguistic units, whose boundaries may then be signalled by features associated with the term juncture. These linguistic units may be determined according to some non-phonological (i.e. grammatical) criteria, and the investigation may then be focussed on discovering the phonological manifestations that may accompany the grammatical boundaries. On the other hand, some recurrent phonological features may be observed without reference to the non-phonological structuring of the utterance; these features may suggest the presence of a boundary, and the units bounded by such junctures may be investigated in order to determine whether they constitute some linguistically significant building blocks of speech[1].

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[1] I have considered various aspects of this problem in *An Acoustic-Phonetic Study of Internal Open Juncture* (s. Lit. 15). That publication also contains a bibliography of books and articles dealing with the problem of juncture. Lack of space makes it all but impossible to do full justice here to the work of all scholars who have concerned themselves with some aspect of this question. This is even more true with regard to the two language areas – Finno-Ugric and Slavic – from which the specific examples have been drawn that are discussed in the present paper. Since my primary aim was to present a research report, I have reluctantly decided to omit a critical discussion of previously expressed views concerning juncture, and not to attempt an exhaustive coverage of the relevant literature. The short bibliography presented at the end of this paper contains three types of materials. Certain of the references deal with the problem of boundary signals, especially at word level. A few references are included for each of the languages considered in this paper; their selection was partly determined by the bibliographical information which they contain. Since the present paper constitutes a partial report of a series of studies in which I have been engaged for some time, occasional references are necessary to such earlier publications of which the current paper forms a continuation; these publications are likewise included in the bibliography.

In two previous papers I have presented the view that there exists a relationship between units of the grammatical and phonological hierarchies, in which one may condition the other, but both have some degree of independence[2]. In this paper I shall discuss the phonological manifestation of boundaries between word-level units, and suprasegmental patterns characterizing such units. The specific examples are taken from Finnish, Czech, and Serbocroatian. The discussion is based on information obtained by acoustic-phonetic methods; distributional boundary signals are left out of consideration, although they may – and often do – constitute important criteria for the presence of a boundary. Spectrographic analysis of recorded test utterances constitutes the main research technique[3]. Most of the tapes have also been processed through a circuit designed to measure speech power[4]. The interpretation of intensity curves and oscillograms forms an important, although as yet incomplete, part of the investigation[5].

2. Units and their Boundaries in Finnish

During an acoustic-phonetic study of Finnish, a number of acoustic features was discovered to be associated with syllable

[2] The relationship between syllable boundaries and morpheme boundaries was considered in "Acoustic studies of boundary signals" (Lit. 16). Some questions concerning word boundaries were brought up in "Compounding as a phonological process" (Lit. 17).

[3] Broad-band and narrow-band spectrograms were produced on the two Bell Telephone Laboratories' Model D spectrographs available at The Communication Sciences Laboratory of The University of Michigan, where most of the experimental work connected with this research was performed.

[4] The intensity circuit was designed and built in The Communication Sciences Laboratory by *G. E. Peterson* and *N. P. McKinney*. The signals were displayed on a multichannel Model 1108 Visicorder Oscillograph of the Minneapolis Honeywell Regulator Company. Measurement techniques employed in this and earlier studies are described in *Accent in Serbocroatian: An Experimental Study* (Lit. 18, pp. 2–12).

[5] The contribution of intensity toward establishing suprasegmental patterns characterizing phonological units is difficult to define. Intensity is often associated with stress, and differences in stress may indeed be expected to be accompanied by differences in intensity, all other factors being kept constant. The acoustic correlates of stress, however, are complex; the role of intensity as one of these correlates appears to be different in each of the three languages under consideration.

boundaries and word boundaries. Some of these will be discussed below[6].

There are numerous compound words in Finnish in which the first word ends in a vowel and the second begins with a vowel. In many instances the same V+V sequence may occur in otherwise similar noncompound words; in most cases the V+V sequence then contains a syllable boundary. (The word pair *lintuansa* – *lintu-ansa* may serve as an example.) In instances such as these, differences between the manifestations of the V+V sequence may be interpreted as signals of the presence of a word boundary. The test material analyzed in the course of the study contained 86 words of this type. The description of the boundary signals is based on productions of these pairs by all informants, although illustrations can be presented and actual measurements reported for only some of the speakers.

The phonetic quality of the second vowel in the V+V sequence was found to depend to a considerable degree on the presence or absence of a word boundary. Figure 1 presents an acoustical vowel diagram for certain of the vowels produced by speaker J.P. in words belonging to this type. On the diagram, the outer quadrangle (the solid line) connects points representing the average formant positions of the vowels /i ä a u/ occurring in the second position of a V+V sequence in instances in which the second vowel started the first syllable of the second element of a compound; the inner quadrangle (the dashed line) connects points representing the average formant positions of the same vowels in analogous position in noncompound words. As may be seen from the vowel diagram, the positions of the vowels occurring in noncompounds are considerably closer to the center of the acoustical vowel diagram than the positions of the same vowels occurring in noncompound words. The

[6] The data presented here are taken from an extensive study of boundary signals in Finnish, which will be reported in a forthcoming joint publication with *Kalevi K. Wiik*. In this study, the basic patterns were first established by studying the speech of several main informants; the generality of the patterns was determined by the study of smaller samples of utterances by a larger group of informants. Six main informants recorded from 567 to 1674 test utterances each, averaging 1000 utterances per informant. A restricted list of 118 test sentences was also recorded by seven informants each at the phonetics laboratories of Turku and Jyväskylä universities, and by four informants at the University of Helsinki. Several supplementary experiments were designed and carried out in order to follow up some hypotheses formulated on the basis of preliminary findings. Listening tests are being carried through to test the reaction of native listeners to the discovered boundary signals.

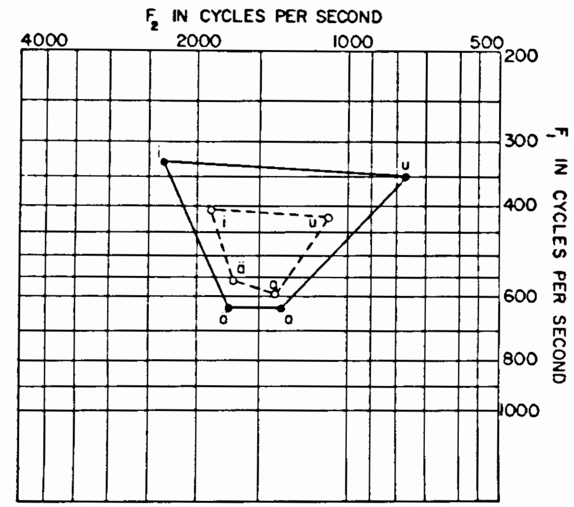

Fig. 1. Acoustical vowel diagram of four vowels occurring in Finnish test words produced by J.P. The solid line connects points representing vowels occurring in word-initial position in the second component of compound words; the dashed line connects points representing vowels occurring in analogous position in noncompound words.

occurrence of a reduced vowel indicates that no word boundary is present, while the occurrence of a non-reduced vowel serves as one of the phonetic features signalling the presence of the boundary.

A further cue to the presence of a word boundary in such sequences appears in the duration of the segments. The sequence V+V had a longer second component, if the second vowel started the next word. If the second word began with a closed syllable (as in the pair *lintuansa* – *lintu-ansa*), the additional duration was shared by the consonant closing the syllable. In the test materials recorded by speakers K-K.W. and J.P., the lengthening of the postjunctural vowel added an average of 4 centiseconds to the duration of the vowel, and 3 centiseconds to the consonant. The two speakers differed with respect to the effect of a following juncture on the vowel preceding the juncture. In utterances produced by J.P., the duration of the prejunctural vowel showed an average increase of 2.5 centiseconds, while K-K.W. had a negligible 0.5 centisecond addition.

A third clue to the presence of a word boundary consisted of the insertion of a brief period of laryngealization or a short glottal stop in cases where a word boundary occurred between two vowels. Such periods of laryngealization were also observed at word boundaries at other points in the utterances, not only setting off the test words in the frame. The glottal stop or laryngealization was likewise observed when the placement of a word boundary contradicted the expected syllabification pattern in sequences containing an intervocalic consonant. The period of laryngealization was particularly prominent in a subtype of test words involving a contrast between a long vowel and a sequence of two identical vowels containing a word boundary.

Figure 2 contains broad-band spectrograms of the pair *lintuansa – lintu-ansa*, spoken by informant S-L.K.; *pyryiltä – pyry-ilta*, spoken by P.K.; *asiasta – esi-aste*, spoken by J.P.; and *rantautua – ranta-utua*, produced by O.I. The feature of laryngealization is clearly observable in all pairs except the last; however, the difference between the

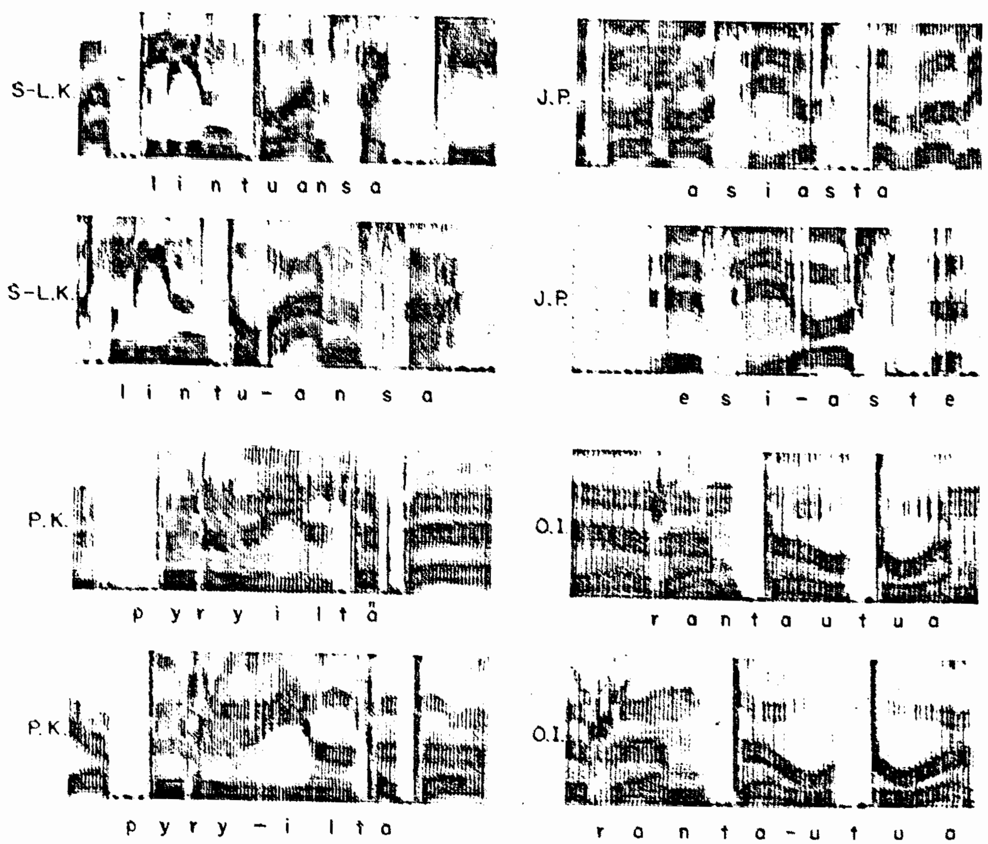

Fig. 2. Broad-band spectrograms of four pairs of Finnish test words, differing in the presence or absence of a word boundary. The utterances were produced by informants S-L.K., P.K., J.P., and O.I.

two /a/ + /u/ sequences as to length and phonetic quality is especially clear in this case. The increased duration of the vowels starting the second word of the compounds as well as of the consonants following these vowels is easily noticeable in every instance.

In this first set of words, the presence of a word boundary contrasted with the absence of a word boundary. The test materials were designed to contain twenty words representing a different type of contrast. In this case, both test words were compounds, i.e. both contained a word boundary, but the compound words differed in the placement of the boundary. In a V+C+V sequence of this kind, the consonant may either end the first word (if it is one of the dentals /s t n r l/) or begin the next word. In Finnish, a syllable boundary ordinarily occurs before an intervocalic consonant. When the word boundary placement contradicted the expected syllabification pattern, the boundary was usually manifested by a period of laryngealization or by a glottal stop. When the second word began with a consonant, no laryngealization was observed.

Since the consonant involved in such V+C+V sequences was frequently a nasal, a special experiment was conducted to study the effect of the placement of the word boundary upon the nasalization of the preceding and following vowel. Two informants (K-K.W. and K-A.W.) participated in the experiment, which involved the use of an oral and a nasal microphone, a two-channel tape recorder, and a multi-channel Visicorder oscillograph connected to a special speech power measuring circuit (cf. footnote 4). Each informant produced 95 frame utterances.

When the nasal consonant started the word, progressive nasalization of the vowel following the nasal consonant was always present. There was no appreciable anticipatory nasalization before a word-final nasal. When a word boundary occurred between a word ending in a nasal and one beginning with a vowel, progressive nasalization was not observed. Figure 3 shows oscillograms and intensity curves for the pairs *maa-nisäkäs – maan-isä* and *puu-neliö – puun-eliö*, produced by informant K-K.W. The oscillograms marked with O represent the signal from the oral microphone; the oscillograms marked N show the simultaneous output from the nasal microphone; the intensity graph corresponds to the nasal oscillogram. The test words were produced in the frame *Mitä. . . . tarkoittaa;* the first word of the frame thus offers additional evidence of the effect of a nasal on the following vowel. A comparison of the two

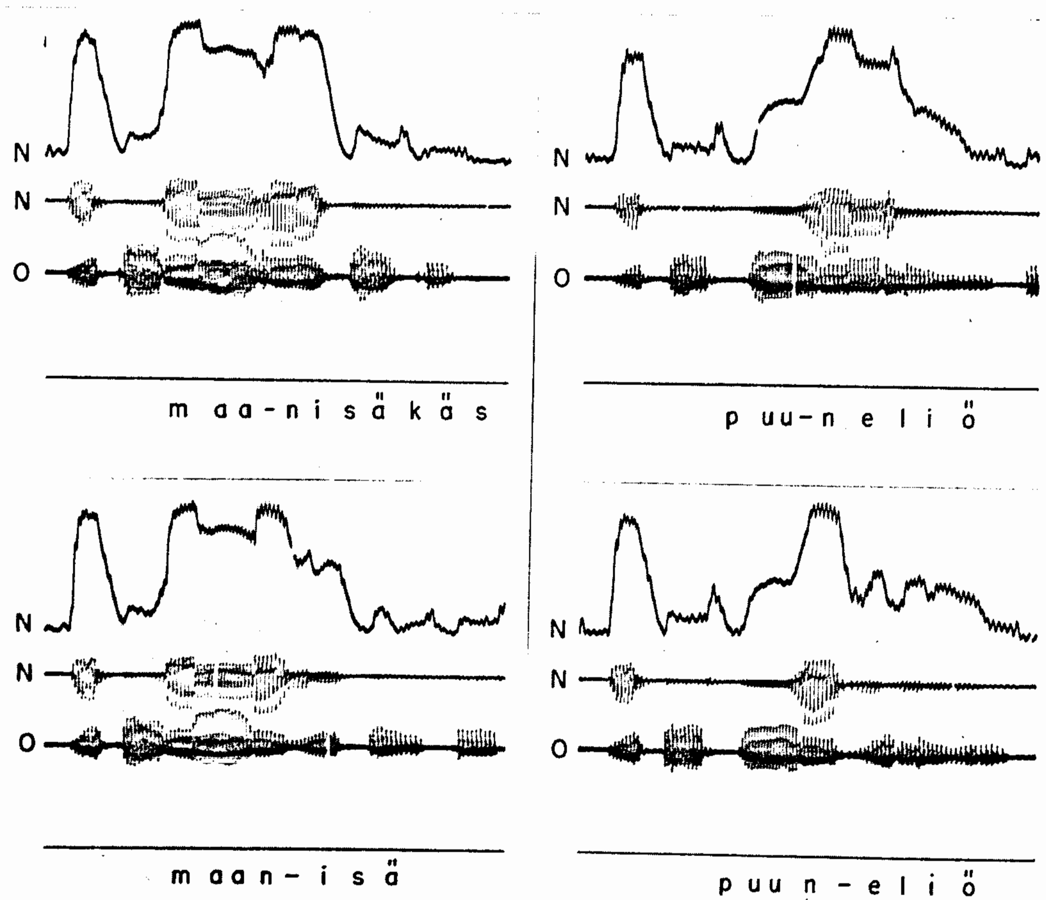

Fig. 3. Oscillograms and intensity curves of two pairs of Finnish test words uttered by K-K.W. Curves labeled N show the output from a nasal microphone, the oscillograms labeled O represent the output of an oral microphone.

oscillograms of each utterance shows the nasalization of the /i/ in *mitä* and the lack of nasalization of /ä/, regardless of whether the next word began with /m/ or with /p/. The /a/ in *maa* was nasalized in both cases, while /u/ in *puu* showed only a slight increase of the intensity of the nasal trace toward the end of its duration. The vowels /i/ in *nisäkäs* and /e/ in *neliö* were fully nasalized, whereas only a very slight degree of nasalization was present in *isä* and *eliö*. The oral oscillograms also suggest the presence of a period with reduced and irregular vocal fold activity before the onset of *isä* and *eliö*.

The boundary signals discussed thus far include differences in phonetic quality, segmental duration, vocal fold activity, and nasal-

ization. All of these serve to establish a word boundary. The study of Finnish also revealed some patterns that serve to identify the units themselves between which those boundaries were observed. These patterns are predominantly of a suprasegmental nature.

Two contrastive degrees of quantity occur in Finnish. The duration of vowels is either phonemically short or phonemically long in every syllable of a word, while consonant quantity is contrastive in intervocalic position. In the speech of informants from Southwest Finland (a considerable number of the informants came from Turku), the realization of a phonemically short vowel in a non-first syllable depended on the nature of the preceding syllable. After a long initial syllable, the durations of short vowels fell within the duration range of stressed short vowels; after a short initial syllable, the duration of the phonemically short vowel was phonetically intermediate between the durations of stressed short and long vowels. The phonetic manifestation of the phonemic quantity of the vowel of the second syllable thus depends on the quantity of the first syllable, and the relationship between the durations of the successive syllables constitutes a unifying pattern that is part of the phonological structure of a word[7].

The duration of the vowels in a number of words of different types was investigated. Table I presents the average durations, in centiseconds, of the vowels occurring in words belonging to nine word types, contained in the test materials produced by K-K.W. The half-long vowel may be observed in the second syllable of every word whose first two syllables have the CV.CV pattern. The table reveals further that the same quantity ratio prevails, when the CV.CV sequence occurs as third and fourth syllable in a polysyllabic word. In essence, the Finnish words appear to be constructed of units larger than one syllable: all words consisting of more than three syllables seem to be built of dissyllabic or trisyllabic components, whose quantity patterns are similar to those of dissyllabic or trisyllabic words. A four-syllable word of the type ex-

[7] The occurrence of a half-long vowel in the syllable following an initial short syllable is a feature Southwestern Finnish shares with Estonian. In Estonian, however, the development of suprasegmental patterns characterizing words as phonological units appears to have proceeded farther than in Finnish: the quantity of the vowel of a non-first syllable is not independently variable, but depends entirely upon the quantity of the first syllable (the problem is discussed, and earlier literature cited, in *Segmental and syllabic quantity in Estonian*, Lit. 14, pp. 21–82). The relatively greater importance of the phonological manifestation of units rather than their boundaries is also reflected in the absence of laryngealization or a glottal stop as a boundary signal in Estonian.

Table I

Average durations, in centiseconds, of vowels in nine Finnish word types produced by K-K.W. In the formulae representing word types, C and V symbolize consonants and vowels; a period is used to indicate syllable boundaries. A representative word is given below each formula. The duration of the syllable-final consonant is included in the two syllables with a CVC structure. N = number of occurrences.

Word type	N	Duration of vowels in successive syllables 1	2	3	4	5
CV.CV *tuli*	44	8.2	12.4			
CVV.CV *tuuli*	64	19.7	7.4			
CVC.CV *vasta*	10	9.5+11.3	7.8			
CV.CVV *salaa*	25	8.9	27.8			
CVV.CVV *tienoo*	23	23.3	25.8			
CV.CV.CV *manala*	9	8.0	12.6	7.9		
CV.CV.CV.CV *manalana*	11	8.2	11.5	8.2	11.5	
CV.CV.CV.CV.CV *lakananani*	18	7.4	10.7	8.4	11.6	6.9
CV.CV.CV.CVC.CV *lakananansa*	10	7.8	10.6	8.4	9.9+11.8	7.0

emplified by *manalana* consists of two CV.CV units; words of the type *lakananani* consist of a CV.CV unit and a CV.CV.CV unit; and words of the type *lakanananansa* consist of a CV.CV.CV unit and a CVC.CV unit (type *vasta*). In the last two word types, the duration of the consonant in the CVC syllable is included in the table. The quantity relationships between successive syllables serve not only to establish word patterns, but also to subdivide words into phonological components that are intermediate between a syllable and a word[8]. No immediate connection between these intermediate units and the morphological structure of the words could be established.

[8] Finnish words are traditionally stated to be stressed on the first syllable; in words of the CV.CV.CV.CV type, secondary stress is assumed to fall on the third syllable. Intensity curves of such Finnish words showed that the intensity of the second syllable of the first CV.CV unit was higher than that of the first syllable of the following CV.CV unit. All listeners, however, agreed that the second syllable was unstressed, while the third syllable (the first syllable of the second CV.CV unit) carried secondary stress. The fundamental frequency of nonfirst syllables in words of this type was usually more or less level. The unstressed second syllable was thus longer and had greater intensity than the stressed third syllable, while fundamental frequency failed to differentiate between the two syllables. The suprasegmental features associated with a single syllable evidently lose their individual significance when they become part of a higher-level pattern.

3. Some Boundary Signals in Czech

It was found in Finnish that the suprasegmental feature of quantity contributed both to identifying the segments immediately adjacent to a word boundary, and to the establishment of the phonological structure of the units themselves which were set off by the boundaries. The use of a modification in the phonatory pattern (laryngealization or a glottal stop) as a manifestation of a word boundary was quite general when the boundary occurred in a V+V sequence. In Finnish, vowel quantity is significant in any syllable of the word; the use of a glottal stop as a boundary marker may therefore be conditioned by the need to provide a point of reference for establishing the phonemic durations of the vowels in prejunctural and postjunctural position. As the Finnish example shows, the use of laryngealization (or other phonatory modification) need not imply the lack of a unifying pattern that could serve to identify phonological units. It appeared interesting to investigate a language with a somewhat similar segmental quantity structure to discover whether this type of boundary signal was indeed present with a comparable relative prominence as in Finnish, and to establish whether quantity contributes in a similar manner to the establishment of word patterns.

The phonological structure of Czech is similar to that of Finnish with respect to stress and quantity: words are stressed on the first syllable, and contrastively short and long vowels may occur in every syllable. Czech has two syllabic consonants, [l] and [r], that do not share in the long-short opposition. A brief study was designed to determine whether the boundary in a V+V sequence would be signalled with equal consistency in cases where the first element of the sequence (i.e. the last syllabic sound of the word preceding the juncture) is a syllabic consonant, whose duration is clearly noncontrastive and need not be signalled. A comparison of syllabic and nonsyllabic /l/ and /r/ in the same position might also contribute some information about syllabicity[9].

The Czech materials analyzed in this connection consist of a set of 32 phrases, in which syllabic and nonsyllabic /l/ and /r/ are followed, in identical consonantal environment, by the four vowels /a o u ū/ that may occur in word-initial position. The sequences also

[9] The Czech materials have been produced and analyzed in collaboration with *Ladislav Matejka*. More details will be presented in a separate publication.

contain a word boundary, whose position relative to /r/ and /l/ determines their syllabic or nonsyllabic nature. Four phrases may serve as examples. The phrase *Petr apoštol* contains the sequence symbolized as *tr + Vp; Petra poštvali* represents the sequence *trV + p*, *pět raportů* the sequence *t + rVp*, and *Petr raportuje* the sequence *tr + rVp*. Similar phrases were constructed for the other vowels with /r/, and for all four vowels with /l/. The 32 phrases were recorded twice by each of two informants. The tapes were processed acoustically using techniques described in footnotes 3 and 4. Figure 4 presents continuous intensity curves and oscillograms for the four quoted utterances produced by speaker L.M.

Table II shows the results of measurements for informant L.M. As a rule, each value given in the table represents the average of

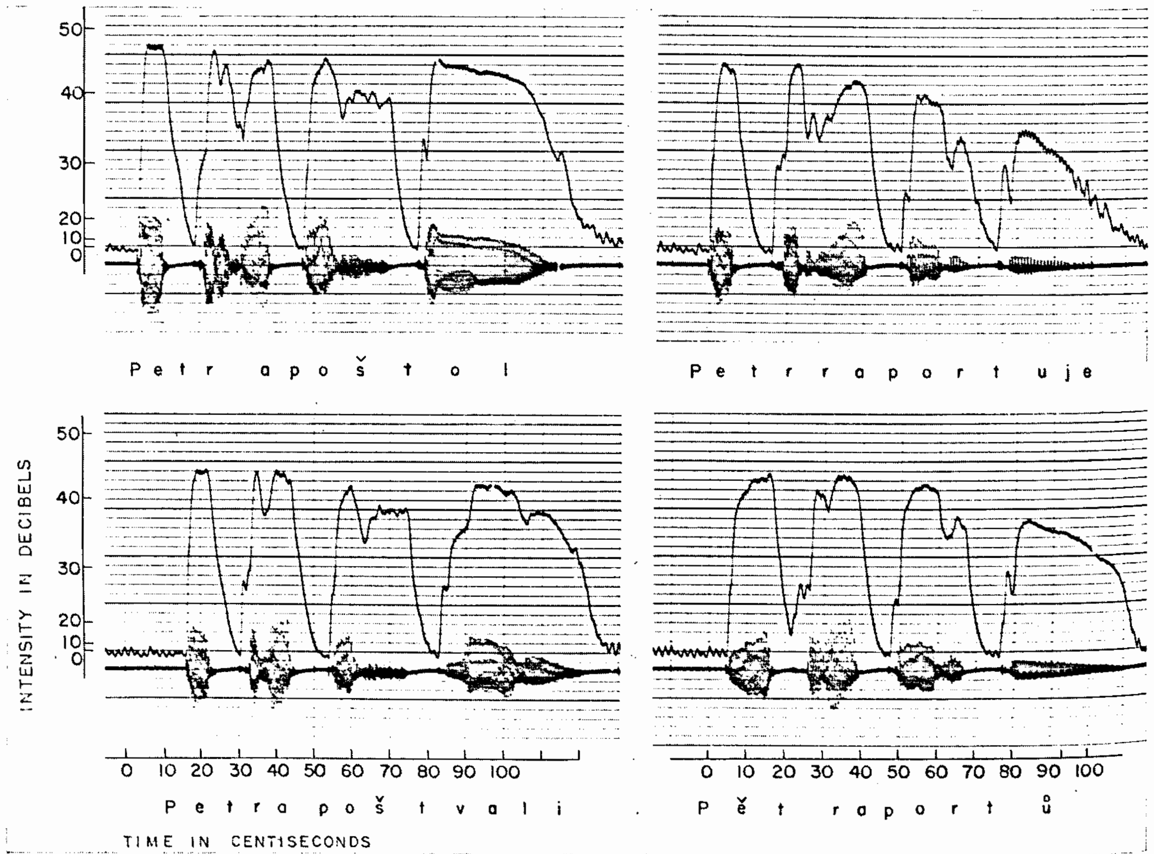

Fig. 4. Continuous intensity curves and oscillograms of four Czech utterances produced by speaker L.M.

Table II

Average formant frequencies, durations, and intensities of prejunctural and postjunctural sounds in a set of Czech utterances produced by speaker L.M. Formant frequencies are given in cycles per second, durations in centiseconds, and intensities in decibels relative to a constant reference level.

Feature under study	1 tl+Vp	2 tlV+p	3 t+lVp	4 tl+lVp	5 tr+Vp	6 trV+p	7 t+rVp	8 tr+rVp
1. Duration of /t/	5.1	9.1	8.1	8.1	7.5	8.4	7.4	8.8
2. Duration of release	4.3	3.1	3.3	3.3	3.1	3.1	4.3	3.6
3. Duration of syllabic /l/ and /r/	4.3+6.1			3.3+6.6	3.1+6.9			3.6+8.7
4. Intensity of syllabic /l/ and /r/	45.4			48.2	52.3			53.8
5. Frequency of F_1	415			375	495			490
6. Frequency of F_2	1265			1395	1370			1405
7. Frequency of F_3	2395			2350	2415			2365
8. Duration of boundary segment	4.9				4.6			
9. Intensity of boundary segment	35.8				34.3			
10. Duration of consonantal /l/ and /r/		3.1+3.7	3.3+5.1	4.8		3.1+4.8	4.3+5.7	6.9
11. Intensity of consonantal /l/ and /r/		42.3	44.8	46.8		49.7	48.2	41.5
12. Frequency of F_1		415	360	360		450	445	465
13. Frequency of F_2		1150	1200	1225		1310	1245	1215
14. Frequency of F_3		2570	2570	2375		2295	2195	2250
15. Duration of V	6.5	6.0	6.3	6.8	6.6	6.8	7.0	7.2
	15.0	10.0	7.5	10.0	14.5	9.0	20.0	15.0
16. Intensity of V	45.5	45.9	51.0	51.0	43.5	48.4	48.3	49.3
17. Duration of /p/	8.9	11.0	10.5	8.8	8.1	10.9	10.7	10.2

eight different occurrences. In the table, durations are given in centiseconds, intensities in decibels relative to an arbitrary, but constant reference level, and formant frequencies in cycles per second. In the case of /r/, the intensity measurements were made from the peak intensities of the vocalic portions between the individual tongue-tip closures; the formant frequencies were measured for the same segments from broad-band spectrograms. The symbol V stands for the vowels /a o u ū/; in row 15 the values for occurrences of /ū/ are given separately. In rows 3 and 10, the duration of the release of /t/ is repeated from row 2.

Although the duration of syllabic /l/ and /r/ in the sequences *tl* + *Vp* and *tr* + *Vp* is not contrastive, each occurrence of these sequences was found to contain a separate boundary segment (cf. row 8 of table II and figure 4). This boundary segment, like the segment found in Finnish utterances in analogous environments, evidently represents the acoustic correlate of a modification of the activity of the vocal folds. In traditional descriptions, the boundary segment is often referred to as a glottal stop. Since a glottal stop by definition implies absence of any airflow through the glottis, the intensity may be expected to drop to zero during the segment identified as a glottal stop. Only four such segments were observed in the 16 instances described here. In the other twelve cases, the boundary segment was realized as a period of irregular or breathy phonation or as a voiceless vocoid, acoustically manifested as a period of noise with energy concentrations at approximately the formant positions of the following vowel. The feature common to all these manifestations was a decrease in intensity of approximately 10 db from the level of a preceding syllabic /l/ and approximately 18 db in the case of /r/ (cf. rows 4 and 9 of the table).

The sequences *tl* + *Vp* and *tr* + *Vp* in which the boundary segment occurred contained a syllabic consonant followed by a vowel A syllabic consonant may occur either between two nonsyllabic consonants or before a word boundary. In the sequences referred to here, either the syllabicity of the prejunctural /r/ and /l/ or the presence of the word boundary must be indicated. If the syllabicity is manifested within the segments themselves, the presence of a word boundary may be deduced from the syllabicity of the prejunctural consonants; if the word boundary is phonetically manifested, the syllabicity of word-final /l/ and /r/ may be deduced from the presence of the juncture. However, in these sequences the boundary segment may also serve to provide a point of reference for the phonemically significant duration of the postjunctural vowel. This seems indeed to be the case, since a separate boundary segment was never found in the sequences *tl* + *lVp* and *tr* + *rVp*. The lack of a separate boundary segment in sequences of this type implies also that either the syllabicity of the word-final manifestations of /l/ and /r/ or the lack of syllabicity of word-initial /l/ and /r/ must be phonetically signalled by some other means. The presence or absence of syllabicity may be manifested during the segments themselves, or boundary signals of a different type may be present.

In actual manifestations of these sequences, it was in fact possible to establish the approximate point in time at which the first member of the sequence (i.e. the syllabic consonant) was followed by the second member of the sequence (the nonsyllabic consonant). In almost every instance, a change in the resonance patterns could be observed on broad-band spectrograms. The intensity curves showed a slight drop in intensity in the transition from syllabic /l/ to nonsyllabic /l/, and a rather considerable decrease in intensity in the case of /r/. Some characteristics of syllabicity were also associated with the segments themselves. In general, syllabic /l/ and /r/ were found to be longer than their nonsyllabic counterparts: the average duration of syllabic /l/ and /r/ was approximately 10.7 csec (including the release of the preceding consonant), that of nonsyllabic /l/ and /r/ – 7.5 csec. The intensity of syllabic /l/ and /r/ was also somewhat higher than the intensity of nonsyllabic /l/ and /r/ (cf. rows 4 and 11 in the table). The average F_2 positions for both syllabic /l/ and syllabic /r/ were approximately 150 cps higher than for nonsyllabic /l/ and /r/ (cf. rows 6 and 13 in the table).

The manifestation of the boundary was less obvious in those cases in which the word boundary was either preceded or followed by a single consonant (cf. columns 2, 3, 6, and 7 in the table). In the sequences *t* + *lVp* and *t* + *rVp* a longer release of the word-final /t/ might be expected than in those cases where /t/ is not followed by a word boundary. The average durations of the /t/ releases, given in row 2 of the table, show no significant differences between the different positions. Neither the duration of the release nor the presence or absence of a voiceless aspiration seemed to function as a boundary signal. A small, but rather regular difference was observed between the durations of initial consonants as compared to medial or final occurrences of the same consonants: initial consonants tended to be somewhat longer. Thus /l/ and /r/ were longer in initial position (cf. row 10, columns 3, 4, 7, and 8) than when they occurred medially (cf. row 10, columns 2 and 6), although they did not quite reach the duration of syllabic /l/ and /r/ (cf. row 3).

The intensities of the vowels preceding and following the boundary appeared to contribute but little to the establishment of the boundaries. The most remarkable feature was the relatively low intensity observed in word-initial vowels following the boundary segment (cf. row 16, columns 1 and 5 and the other occurrences). A possible reason for this low intensity is the modification of the phonatory activity associated with the boundary segment immediately preceding these vowels. The contribution of intensity toward identifying the stressed vowel (i.e. the vowel of the first syllable of a word) is not obvious from these data.

A comparison of V+V sequences for the contrastive presence of syllable boundaries and word boundaries is less fruitful in Czech than in Finnish, since compounds of words ending and beginning in a vowel are rare. Some comparisons were nevertheless carried through between words containing the diphthong /ou/ and sequences of /o/ + /u/ containing a word boundary. Fourteen such utterances were recorded twice by each informant, as well as two compound words containing the same /o/ + /u/ sequence. Figure 5 illustrates the materials and the manifestations of these sequences. The figure contains continuous intensity curves and oscillograms for productions of *mouka*, *kradmo ukazuje*, and *prvoúcta* by speaker L.M. The consonant environment was kept constant for pairs of the kind represented by the first two items.

The boundary segment that appears in the production of *kradmo ukazuje* was present in every such sequence. The average duration of this segment was 5.3 csec. In one out of 14 cases, the segment was manifested as a glottal stop. In the remaining instances the segment was characterized by breathy and irregular phonation, accompanied by a drop in intensity to an average level of 29.2 db from an average of 46.3 db for /o/, 41.9 for /u/, or approximately 15 db. The phonetic nature of the boundary segment observed in these sequences was in every respect similar to that observed in sequences involving syllabic consonants followed by words beginning with a vowel.

The peak intensities of the vowels in the /o/ + /u/ sequence could be established with less difficulty than the intensities of the two components of the diphthong /ou/, where the changes in in-

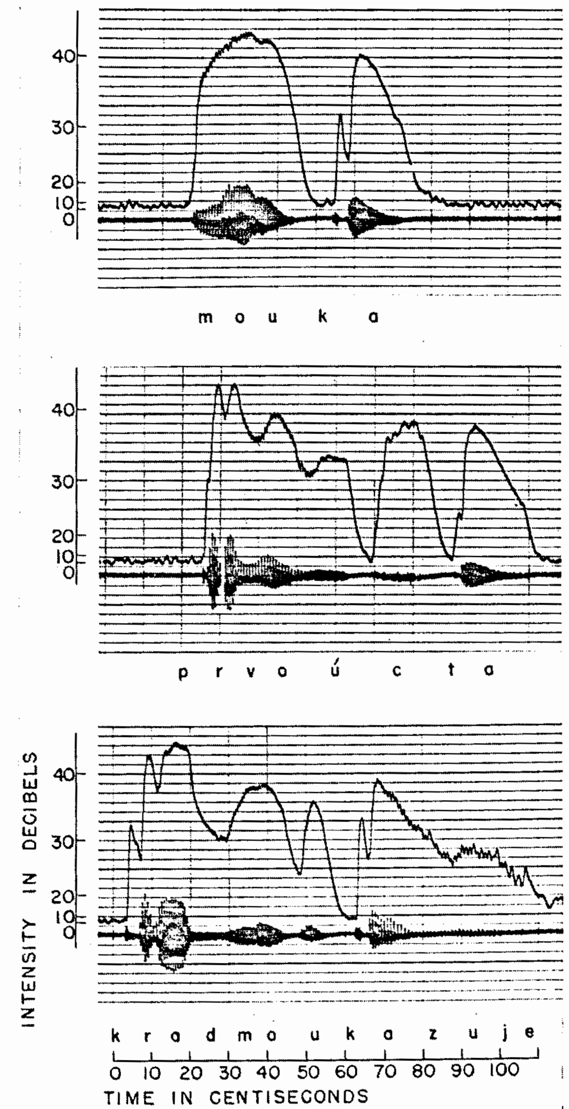

Fig. 5. Continuous intensity curves and oscillograms of three Czech utterances produced by speaker L.M.

tensity were more gradual. However, as may be seen from the reproduction of the intensity curve and the oscillogram of *mouka*, the boundary between the two components can be observed and their durations established with fair accuracy. The average duration of 14 productions of the diphthong /ou/ in such words as *mouka* was

19.5 csec, of which the duration of the first component constituted approximately 9 csec, that of the second 10.5 csec. The average duration of the total /o/ + /u/ sequence, including that of the boundary segment, was 18.2 csec; the duration of /o/ was 5.8 csec, that of the boundary segment 5.3 csec, and that of /u/ 7.1 csec. Since the second component of /ou/ was longer than the first by an approximately equal amount, the greater length of /u/ here does not contribute to the boundary signals.

The two compounds presented an intermediate pattern. The number of examples is clearly too small for any valid conclusions; it is nevertheless interesting to note that a breathy period, with a corresponding drop in intensity, was present in three out of four instances. However, the average decrease in intensity in compounds such as *prvoúcta* was only 7.3 db, or about half of that of sequences like *kradmo ukazuje*. The smooth intensity curve characteristic of the diphthong /ou/ was never observed in manifestations of compound words of this type.

The Czech materials thus have yielded evidence for the systematic use of a special segment as boundary marker. A word boundary between two syllabic sounds was manifested by a modification of the phonatory process even in cases where there was no need to indicate the phonemic length of the prejunctural sound. In Finnish, the presence of this type of boundary signal was accompanied by various qualitative and quantitative differences in the segmental sounds adjacent to the word boundary; quantity was also involved in establishing a unifying suprasegmental word pattern. The situation in Czech appears to be quite different.

In an attempt to determine whether vowel quantity and quality play any part in combining the syllables of a polysyllabic word into a higher-level phonological unit, 642 dissyllabic test words, embedded in frame utterances, were recorded by two informants and analyzed by techniques described in footnotes 3 and 4.

Table III presents the average formant positions and durations of the syllabic sounds in the first and second syllable of this set of words produced by one of the informants. As becomes apparent in studying the table, the short and long vowels differed among themselves in both positions; this is particularly evident in the case of /i/ – /ī/ and /u/ – /ū/. There was, however, no appreciable difference in the phonetic value of the vowels that could be caused by position in either the first or the second syllable.

Table III

Average formant positions and durations of syllabic sounds in the first and second syllable of 642 dissyllabic Czech words produced by L.M. Formant frequencies are given in cycles per second, durations in centiseconds. N = number of occurrences.

Syllable nucleus	First syllable N	F_1	F_2	F_3	D	Second syllable N	F_1	F_2	F_3	D
i	69	390	1835	2465	7.6	67	380	1800	2510	9.0
ī	72	270	2030	3085	15.3	71	270	1990	2970	15.0
e	59	490	1695	2425	7.6	55	475	1665	2360	9.4
ē	50	440	1895	2525	17.2	54	505	1800	2420	15.5
a	51	640	1235	2350	8.7	58	640	1290	2365	9.4
ā	54	725	1325	2405	19.6	58	700	1300	2425	19.4
o	56	465	895	2265	8.9	51	480	985	2235	8.7
ō	42	410	725	2335	19.4	34	440	810	2325	20.7
u	46	390	940	2160	7.1	51	385	900	2045	8.3
ū	42	300	710	2195	13.2	41	340	710	2125	15.4
ou	51	420– 355	905– 670	2095– 2200	6.5– 8.2	58	465– 355	955– 680	2150– 2110	9.1– 9.6
					14.7					18.7
l	20	485	1260	2300	9.9	24	440	1180	2200	10.1
r	30	540	1260	2265	8.6	20	485	1350	2285	10.2

Vowel quality thus seems to play no part in establishing the first syllable of a word. The same may be said about quantity: no systematic differences could be observed in the durations of short and long vowels occurring in the two syllables of a dissyllabic word[10].

Czech thus appears to be a language in which the boundaries are indicated primarily by modifications of the phonatory pattern. Neither segmental nor suprasegmental features emerged which could be identified with certainty as contributing toward the establishment of phonological units, and the boundary signals were primarily of a segmental nature.

[10] Czech words are traditionally assumed to be stressed on the first syllable. The data presented here show that neither vowel quantity nor vowel quality contribute appreciably toward the identification of a stressed syllable. It may therefore be assumed that intensity and/or fundamental frequency carry greater significance as acoustic correlates of stress in Czech than in some other language. The limited intensity data included in table II are inconclusive. The analysis of the intensity and fundamental frequency patterns of a larger set of test items is in progress; it remains to be seen whether these features serve only to characterize the stressed syllable, or play some part in a larger pattern.

4. *Word Patterns in Serbocroatian*

The situation appears considerably different in Serbocroatian. Here the suprasegmental features of intensity, duration, and fundamental frequency combine with a qualitative difference between accented and unaccented vowels to produce phonological patterns which characterize the different word types[11]. The units themselves being clearly phonologically determined, segmental boundary signals have less significance. The possibility exists, however, that modifications of these suprasegmental word patterns may be used by the speakers to indicate the presence of certain morphological and lexical boundaries. A brief consideration of the problem of proclitics may yield some relevant information.

The domain of an accentual pattern in Serbocroatian is, as a rule, a word; however, certain proclitics may form an accentual unit with a following word, which in turn loses its separate accent and becomes part of the larger accentual unit. There are other sequences in which a proclitic, followed by a word with a falling accent on the first syllable, may lack any accent of its own. The phrases *u rȁt* and *u grâd* differ from *ù rat* and *ȕ grād* with respect to the domain of the accentual patterns. In the latter sequences, the accentual pattern embraces the preposition as well as the noun; the sequences *u rȁt* and *u grâd*, consisting of the same segmental phonemes, contain an accentually indeterminate proclitic and a word with a monosyllabic accentual pattern.

The same applies, mutatis mutandis, to words and phrases such as *da bȉje*[11a] – *nȁbije* and *da mȍli* – *zàmoli*. The accentual patterns of monosyllabic, dissyllabic and trisyllabic words having been established, productions of phrases containing unaccented proclitics may be compared with otherwise similar sequences serving as the domain of an accentual word pattern. Any differences between the suprasegmental patterns of the respective pairs may be assumed to signal the presence of a word boundary within the sequences containing an unaccented proclitic.

[11] The Serbocroatian data presented here are drawn from a forthcoming joint publication with *Pavle Ivić*. The patterns referred to in the introductory remarks are described in detail in *Accent in Serbocroatian* (Lit. 18), which also contains a selected bibliography on pp. 136–142, and in *Pavle Ivić* and *Ilse Lehiste* (Lit. 9).

[11a] The symbol [ȉ] is used to indicate the vowel [i] pronounced with a short falling accent.

The eight dissyllabic and trisyllabic utterances quoted above were produced by twelve speakers in the course of a more extensive recording session, embedded in a frame utterance and randomly inserted in a larger set of test sentences[12]. Broad-band and narrow-band spectrograms, intensity curves, and oscillograms were produced from the recorded tapes, and the formant positions of the vowels, the duration of all vocalic segments, the fundamental frequencies at the onset, peak, and termination of each vowel, and the peak intensities of all syllabic sounds were measured. While space does not permit the presentation of the results in detail, certain relevant observations will be pointed out.

The difference in the phonetic quality of accented and unaccented /a/ furnished an important clue for the identification of the stressed syllable in such contrastive pairs as *u rȁt* vs. *ù rat* and *da bȉje* vs. *nȁbije*. For example, the average positions of the first three formants of /ȁ/ in *u rȁt*, produced by seven female speakers, were 910 – 1715 – 2800 cps; in *ù rat*, the formant positions of posttonic /a/ were 730 – 1780 – 2625 cps. In *nȁbije*, the average formant positions of /ȁ/ were 915 – 1720 – 2825 cps, whereas the values for pretonic /a/ in *da bȉje* were 665 – 1825 – 2650 cps. The comparable averages for five male speakers were as follows: /ȁ/ in *u rȁt* 660 – 1420 – 2400 cps, /a/ in *ù rat* 590 – 1420 – 2515 cps; /ȁ/ in *nȁbije* 720 – 1415 – 2565 cps, /a/ in *da bȉje* 595 – 1460 – 2570 cps. Accented /a/ thus always had a higher first formant value than unaccented /a/, whereas unaccented /a/ showed a certain amount of centralization. In this limited set of data, very little difference could be observed between pretonic and posttonic /a/, although both were clearly different from an accented /a/[13].

Table IV presents the fundamental frequency, intensity, and duration data, arranged according to the average fundamental frequency ranges of the informants into low, medium, and high-pitched

[12] The informants and their dialectal background are described in detail in *Accent in Serbocroatian* (Lit. 18), pp. 31–38.

[13] The average positions of the first three formants of short /a/ in pretonic position (in *da mȍli* and *da bȉje*) were 625 – 1430 – 2550 cps for the men and 690 – 1760 – 2800 cps for the women. In posttonic position (in *ù rat* and in three productions of *ȕ grăd* with short /a/) the averages were 630 – 1450 – 2445 cps for the men and 765 – 1765 – 2625 cps for the women. In accented position (in *u rȁt*, *nȁbije*, and *zàmoli*) the positions were, respectively, 710 – 1400 – 2490 cps for the men and 915 – 1710 – 2765 cps for the women. These values fall within the allophonic ranges for stressed and posttonic /a/, established for these speakers during a previous stage of the study and reported in *Accent in Serbocroatian* (Lit. 18), pp. 95–127.

Table IV

Fundamental frequency, intensity, and duration of syllable nuclei occurring in eight Serbocroatian test items uttered by twelve informants, averaged separately for speakers with low, medium, and high pitch. Fundamental frequencies are given in cycles per second, durations in centiseconds, and intensity in decibels relative to a constant reference level.

Test item and group of speakers	First vowel Fund. freq. Beg.	Peak	End	Dur.	Int.	Second vowel Fund. freq. Beg.	Peak	End	Dur.	Int.	Third vowel Fund. freq. Beg.	Peak	End	Dur.	Int.
Low															
u rȁt	106	107	100	11.8	39.5	108	122	113	12.6	42.7					
ù rat	119	128	125	9.8	42.5	131	132	111	9.4	42.5					
u grâd	104	107	96	10.2	41.3	113	125	92	20.0	40.3					
ȕ grād	126	132	117	9.3	43.7	114	114	97	12.3	37.8					
ȕ grăd						80	80	70	9.5	29.5					
Medium															
u rȁt	211	221	214	10.7	40.7	181	217	213	16.3	42.0					
ù rat	202	215	215	11.8	42.7	218	225	225	11.0	43.7					
u grâd	197	207	205	10.8	42.5	225	225	154	24.5	33.0					
ȕ grād	205	234	210	11.8	44.7	171	171	158	13.3	36.0					
High															
u rȁt	260	260	254	8.5	36.0	247	321	319	18.8	46.0					
ù rat	282	318	313	11.7	38.7	308	342	320	11.2	43.0					
u grâd	260	263	246	8.5	38.3	257	292	197	22.7	42.3					
ȕ grād	302	354	305	9.7	41.3	204	204	193	13.3	37.5					
ȕ grăd						200	200	178	10.0	33.0					
Low															
da mȍli	100	102	99	8.0	40.7	109	119	105	11.1	42.3	89	90	83	7.3	36.2
											(1 laryng.)				
zàmoli	110	111	108	10.1	41.0	115	119	103	7.6	41.7	102	102	91	8.1	35.8
da bȉje	104	106	102	7.5	41.5	119	128	115	10.0	42.8	100	100	84	9.2	39.0
											(1 laryng.)				
nȁbije	108	120	114	9.8	41.5	102	102	94	6.8	37.0	93	94	89	6.8	36.7
Medium															
da mȍli	199	199	195	8.2	43.7	218	232	205	15.3	42.0	159	165	165	6.8	36.7
zàmoli	179	181	177	12.5	43.7	194	218	213	7.3	43.7	211	220	211	8.8	38.0
da bȉje	154	154	144	8.5	43.5	156	165	160	9.8	47.0	151	151	138	6.8	41.0
nȁbije	205	210	200	11.0	43.0	161	161	156	6.3	36.0	152	157	155	6.3	35.5
High															
da mȍli	265	267	262	7.8	42.7	293	327	274	14.2	43.0	207	207	201	6.8	32.7
zàmoli	258	269	267	13.5	40.7	294	321	276	8.8	37.3	218	218	187	7.0	34.0
da bȉje	243	254	238	8.5	42.3	297	315	293	9.7	38.3	202	202	190	6.8	37.0
nȁbije	275	309	291	12.7	42.0	209	209	192	6.7	30.0	191	192	190	5.0	35.3

groups. The contribution of intensity toward the identification of the stressed syllable will be considered first.

For informants in whose speech features of intensity are patterned with the same regularity as features of fundamental frequency[14], the intensity relationships between the two syllables of a dissyllabic word with a rising accent on the first syllable differ in a predictable manner from those of comparable words with a falling accent: all other factors being kept constant, the two syllables of a word with rising accent have approximately equal intensity, whereas in a word with a falling accent the second syllable is considerably lower in intensity. Such a step-down decrease in intensity constitutes a characteristic of a word with a falling accent, and may serve as a signal for the presence of such a word. This step-down pattern was indeed present in the phrases *da mȍli* and *da bȉje*, where the stressed syllable, with an average intensity of 42.6 db, was approximately 5.5 db higher in intensity than the posttonic syllable, whose average intensity was 37.1 db. In these two phrases, the intensity of the proclitic was comparable to that of the stressed syllable. The intensity pattern of *nȁbije* showed a similar decrease from the first to the second syllable, while the third syllable remained at approximately the same intensity level as the second. In *zàmoli*, however, the first two syllables had approximately equal intensity, while a drop of 5 db (from an average of 40.9 db to 35.9 db) took place between the second and third syllable. Intensity patterns alone are thus not sufficient for distinguishing between sequences with proclitics and utterances with a rising accent on the first syllable.

In the pairs involving accented and unaccented /u/, an increase in intensity was found to be associated with the placement of accent, amounting to an average of 2.6 db. The change in the intensity of the syllable from which the accent was shifted to the proclitic depended on the nature of the accent. In cases of rising accent, the intensity of the originally stressed vowel decreased by an average of 0.5 db (remaining, for all practical purposes, unchanged); in cases of falling accent the decrease was considerably greater. Details are presented in table IV.

[14] It was found during the earlier study (Lit. 18 and 9) that intensity features were not unambiguously present in the speech of all informants. For the sake of comparability with the earlier materials, the data presented in table IV are organized according to the same pattern that was used in the earlier study. The grouping of speakers according to their average fundamental frequency ranges rather than according to the relative significance of the intensity features makes the fundamental frequency patterns clearer, but obscures partially the intensity patterns. In the speech of those informants who are consistent in their use of intensity features as regular concomitants of the fundamental frequency patterns, the intensity relationships are much more clearly defined.

Figure 6 shows intensity curves and oscillograms of the four utterances *u rȁt*, *ù rat*, *u grâd*, and *ȕ grād*, produced by speaker D1. The words are preceded by the first word of the frame in which the test items were commuted (*Forma . . . data je kao primer*). The different effect of the accent shift to the preposition, depending on whether the shifted accent is falling or rising, is clearly evident from the intensity curves. The figure also illustrates the occasional use of a period of laryngealization between the first word of the frame and the test word. However, the use of this laryngealized period did not serve to differentiate between the two types of sequences: the period

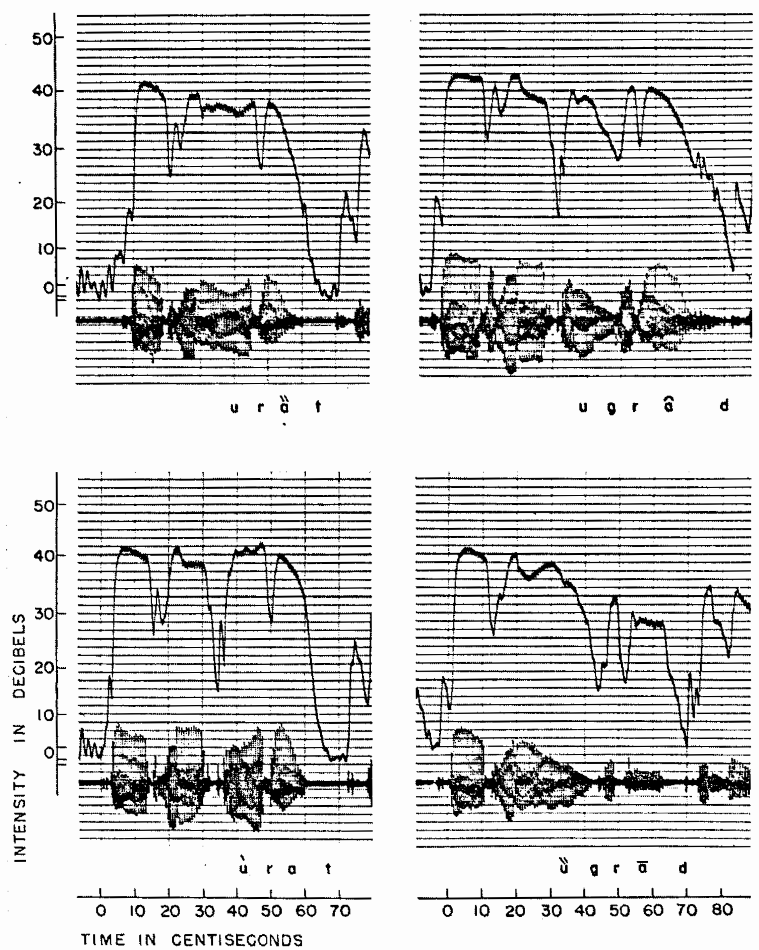

Fig. 6. Intensity curves and oscillograms of four Serbocroatian test items produced by speaker D1.

of laryngealization was used by all speakers with equal frequency before the unstressed proclitic in *u rȁt* and *u grâd* as before the stressed preposition in the sequences *ù rat* and *ȕ grād*, and there were instances where laryngealization was absent before either type of sequence. In the utterances shown on figure 6, laryngealization occurred before *u grâd* and *ù rat*, and was absent in *ȕ grād* and *u rȁt*. The presence of the period of laryngealization also precludes the possibility of assuming that the unstressed proclitic forms an accentual unit with the preceding word.

The contribution of duration toward the identification of the stressed syllable appears relatively greater than that of intensity. During the previous investigation, the ratio between stressed and posttonic short vowels was found to be approximately 3:2, regardless of accent type. This result was confirmed by the present materials, in which the average duration of stressed short vowels was 12.3 csec, that of posttonic short vowels 8.2 csec. As was noted above, the intensity drop between the second and third syllable of *zàmoli* was comparable to that in *da mȍli*, and intensity failed to distinguish between the two sequences. The relatively greater duration of the first syllable in *zàmoli*, as compared to that of the proclitic in *da mȍli*, serves as an unambiguous cue for identifying this syllable as the bearer of accent.

The fundamental frequency patterns of polysyllabic words with falling accents involve a high frequency on the stressed syllable, followed by a posttonic syllable with relatively low frequency. In words with rising accents, the syllable following the stressed syllable has either the same or even a slightly higher fundamental frequency. As may be seen from the data summarized in table IV, the fundamental frequency pattern characterizing the short falling accent in *da bȉje* and *da mȍli* is comparable to the pattern occurring on the first two syllables of *nȁbije*. A comparison of the fundamental frequency values for *zàmoli* with those of *da mȍli* and *nȁbije* is instructive. The fundamental frequency movement of *zàmoli* resembles that of *da mȍli* much more than that of *nȁbije*. Nevertheless, there are some differences that make it possible to distinguish between all three patterns. *Zàmoli* differs from *nȁbije* mainly with regard to the fundamental frequency pattern, and from *da mȍli* mostly with respect to duration. In *da mȍli* the stressed syllable is longer than the pretonic syllable; in *zàmoli* the first syllable is longer than the second. *Nȁbije* shares this feature with *zàmoli;* the duration pattern of *da bȉje* resembles that of *da mȍli*. In addition, the fundamental frequency of the first syllable of *zàmoli* appears somewhat higher than that of the pretonic syllable of *da mȍli*.

The differences between the phrases containing unstressed proclitics and similar sequences serving as the domain of accentual word patterns thus can be described in terms of modifications of the suprasegmental features of fundamental frequency, duration, and intensity. The qualitative difference between accented and unaccented vowels plays a part in establishing the word patterns. No unambiguous boundary signals were provided by modifications in the phonatory pattern.

5. Summary and Outlook

Certain types of boundary signals have been identified in the course of this investigation. These include modifications of the phonatory pattern (laryngealization, breathy phonation, insertion of a glottal stop); modifications of nasalization; articulatory modifications; and modifications of suprasegmental patterns of fundamental frequency, duration, and intensity. Considerable differences in the use of these boundary signals exist between languages; no one single feature could be found which would be common to all manifestations of a word boundary. The manner in which boundaries are realized in a language constitutes an integral part of its structure, and has to be included in its phonological description.

A first approximation may nevertheless be attempted in the classification of languages according to their use of boundary signals. There appear to exist two general types: languages in which boundary signals are primarily of a segmental nature, and languages with well-developed suprasegmental patterns characterizing units of the phonological hierarchy. In languages of the latter type, the presence of these phonologically definable units implies the presence of junctures in sequences of segmental phonemes, which need not be signalled by separate boundary segments. Elements of both types may be present in a language. In the case of Czech, the contribution of suprasegmental features toward establishing word patterns was small[15]; the boundary signals were predominantly segmental in

[15] The acoustic correlates of stress in Czech have not yet been exhaustively investigated. The data presented in the course of this paper make it clear that with respect to the effect of stress on vowel quality and the manifestation of phonemic quantity, Czech differs basically from both Finnish and Serbocroatian.

nature. In the case of Serbocroatian, word patterns were established mainly on the basis of suprasegmental features; the presence of words could be deduced from the presence of these patterns, which in turn served to imply the presence of boundaries. In Finnish, segmental and suprasegmental features were combined in a system in which boundaries were indicated by predominantly segmental features, but word patterns were established by suprasegmental features. The Finnish materials also contributed some evidence for the existence of phonologically definable building blocks of speech occupying an intermediate level between syllables and words in a hierarchy of phonological structures.

The present study has been devoted to boundaries between units not larger than a phonological word. The investigated materials have also brought forth evidence (not reported here) that certain of the boundary signals may be further modified or superseded, when the phonological words themselves become part of larger phonological units. In those instances, the absence of boundary signals may become a higher-level signal. Assimilations were found to take place in Czech and Finnish across word boundaries; neutralizations of contrasts between tonal movements were observed in Serbocroatian utterances in positions removed from primary sentence stress. It is hoped that this study of the phonological structure of word-level units and their boundaries may serve as a basis for future studies of units and boundaries at higher levels in the phonological and grammatical hierarchies.

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Discussion

Sovijärvi (Helsinki): Fräulein *Lehiste* hat u. a. den verschiedenen Grad der Nasalisation bei ihren Untersuchungen über die finnischen Juncture-Erscheinungen als einen distinktiven Faktor betrachtet. Ich möchte sie fragen, wieviel Vpn. sie in ihren Nasenkurvenversuchen gehabt hat; weil es meines Erachtens nicht genügen würde, nur 1–2 Vpn. für die Nasalisationsuntersuchungen zu verwenden. Es ist ja bekannt, daß die individuelle und regionale Nasalisation der Vokalartikulationen sehr verschieden sein kann. Meines Wissens hat die Vortragende nur einen Mann und seine Frau aus Turku bei ihren Nasenkurvenversuchen zur Verfügung gehabt. Ich habe nur bei den gewöhnlichen Tonbandaufnahmen als Vp. fungiert, aber ich habe nicht an den Nasenkurvenversuchen teilgenommen.

Gårding (Lund): I have studied internal open juncture in Swedish. My material consists of minimal pairs uttered at various rates of speech. So far my observations are obtained from one informant only.

The most consistent differentiating factor between the pairs seems to be intensity.

Duration does not behave in the same way as it does in Miss *Lehiste's* material. The final prejunctural allophone is most often considerably longer than the post-junctural initial allophone.

Romportl (Praha): Ich hätte nur zwei kleine Bemerkungen:

1. Ich bedaure, daß von den im gedruckten Referat von Fräulein *Lehiste* behandelten Problembereichen aus dem Tschechischen in der vorgetragenen gekürzten Fassung nicht das Beispiel der «Juncture» in der Nachbarschaft von Liquiden gewählt worden ist. Es könnte interessantere Tatsachen zeigen als die gewählte Frage der Gruppen von zwei Vokalen.

2. Als Grenzsignal ist «coup de glotte» im Tschechischen potenziell. Wie häufig er vorkommt, hängt – auch in schriftsprachlichen Äußerungen – von der lokalen Herkunft des Sprechers, von dem Stil der Äußerung usw. ab. Es wäre nützlich, diese Tatsache bei den weiteren Untersuchungen unter Anwendung eines reicheren Materials zu berücksichtigen.

Pulgram (Ann Arbor): Whether internal boundaries are marked or not depends on the phonological condition of the language. Miss *Lehiste* chose for her argument, as indeed she noted, languages which by some means (especially stress) mark word boundaries (whether stress is distinctive or, as in Czech, merely a boundary marker, is irrelevant). In amplification, though not in correction, of Miss *Lehiste's* remarks it should be said that some languages, notably French, while giving boundary markers for words in isolation (French stresses the last syllable), eliminate all such markers of the lexical unit in utterances larger than a single lexical unit, with the result that word boundaries are eliminated since the longer utterance is now the phonological word *aux Etats-Unis* is /ozetazyni/, and the further result that all boundary markers ("junctures") within such a phrase become impossible. It would be useful to see in this distinction between languages which do and languages which do not allow of boundary markers in an utterance longer than the lexical word, a typological distinction of great importance. This peculiar feature has also its ramification in the syllabation, for in languages that obliterate word boundaries syllabation takes places in complete disregard for word boundaries, for example /o-ze-ta-zy-ni/. In this context it should also be noted that the division of Russian *eta kniga* by English students who do not know the morphological seams in the phrase, into *etak niga* (an example cited by Miss *Lehiste*) is exactly what is to be expected from speakers if a language which marks word boundaries, but which does not allow of a post-pausal, hence also not of a syllable-initial /kn-/.

Jassem (Poznań): 1. It is common knowledge, and Miss *Lehiste* has more knowledge of this than anyone else, after she has studied the phenomenon for several years, that the occurrence of juncture phenomena, just like the occurrence of other phonetic signals, in actual speech depends heavily on such factors as style, tempo, length of the utterance under investigation, etc. Have you, Miss *Lehiste*, a programme directed towards finding differences in the occurrence of junctural signals in various types of speech?

2. An informal experiment has shown to me that a large pannel of naive listeners may almost unanimously mark juncture on their answer sheets, whilst an analysis of the spoken text which they have been asked to mark appropriably with juncture signs, has not revealed any acoustic juncture signals. The junctures are often just "in the listeners' heads".

Kiparsky (Helsinki): Is there a "phonological boundary" in Czech *má úcta* ('my regards') or *je den* 'there is a day' or in similar words? The "phonological boundary" in Russian should be investigated.

Vachek (Praha): The important and convincing arguments should be complemented in two small points. First; the title of the paper should rather have been "Boundary signals" than "Juncture": the idea of juncture, involved by the American descriptivists, arose from the obstinate intention to disregard meaning in language. Second, the instances quoted from Czech look somewhat artificial or bookish; there is no doubt that more suitable specimens of Czech would have demonstrated the speaker's idea just as (or rather more) convincingly.

Rudnyckyj (Winnipeg): Belorussian and Ukrainian with their sandhi-phenomena can contribute much to the problem; especially in diphthongisation of boundaries of lexical units.

Daneš (Praha): I think that it is not very important whether some acoustic signal (clue) is present in each case, is implemented in every particular speech-act. But what is relevant is the fact that in one class of instances (e.g. in Czech compounds *nedouk*, *poukaz*) the glottal stop may be implemented, while in an other class (e.g. *mouka*, *louka*) it may not. It is just this possibility versus the impossibility of implementation of such a signal that constitutes the phonological opposition. It may be said that such a potentionality of language phenomena (to use *Mathesius*' expression) belongs to the set of general characteristic features of human language.

Answer *Lehiste:* I am grateful to the commentators for pointing out various interesting problems connected with juncture that should be studied in more detail in languages treated in the paper as well as in other languages (comments by *Kiparsky*, *Rudnyckyj*, *Sovijärvi*, and others). I agree that the various phonetic factors contributing to the identification of the presence of boundaries may be realized differently in languages other than those described in my report. The manifestation of boundaries constitutes a part of the phonological structure of every language, and languages may differ in this respect as in other aspects of their structure. For example, quantity may be expected to function differently as a boundary signal in languages without phonemic quantity on a segmental level on the one hand and in languages with varying types of phonemically significant quantity on the other (comment by *Gårding*).

It is one of the points of the paper that there exists a hierarchy of phonological units, whose boundaries may be manifested in various ways, or which may merge with other units of the same level to form higher-level units. The lower-level units retain the property that their boundaries may, under certain conditions, be signalled by phonological boundary markers (comments by *Romportl* and *Daneš*). The phonological units, whose boundaries are in fact manifested, may be coterminous with morphological, lexical, or syntactic units, but need not be so at every level, in every case, or in every language (cf. comment by *Pulgram*).

The term *juncture* was redefined in the paper to apply to phonologically manifested boundaries (cf. comment by *Vachek*). There are several theoretical consequences of this redefinition which could not be treated in detail either in the paper or in this brief reply. For example, the application of this definition precludes the possibility of re-labeling morphological boundaries as zero allophones of juncture phonemes.

Replying to comments by Professors *Sovijärvi* and *Jassem*, I would like to add that we are currently engaged in a considerably more detailed study of various sentence types in Serbocroatian as well as Finnish.