

MARKO MARJOMAA, TAISTO MÄÄTTÄ, TUOMAS MAGGA (Oulu)

INITIALLY- AND FINALLY-STRESSED DIPHTHONGS OF THE GUOVDAGEIDNU DIALECT OF NORTH SAAMI

The dialect has four segmentally distinctive diphthongs, *ie*, *ea*, *oa*, and *uo*. The diphthongs occur always in the first syllable in the material. The diphthong system is symmetrical. The former segment of the diphthong is always higher than the latter segment. Each diphthong can be initially- or finally-stressed. The properties of the consonant centre and *latus* together have an interplay with the stress type of the diphthong of a word, the details of which are not gone into in this context (see Magga 1984 : 43 ff.) The initially- and finally-stressed diphthongs are in opposition. The phonetic bases, i.e. the acoustic parameters, of the within-diphthong prominence were studied by means of measuring the features of fundamental frequency, duration and the acoustic quality of the diphthong.

The first major experimental work on Guovdageidnu dialect was "Duration in the Quantity of Bisyllabics in the Guovdageidnu Dialect of North Lappish" by T. Magga (1984). In his work T. Magga measured the quantity features of 5050 test words uttered by three informants. He measured the duration of the vowel centre, consonant centre, and *latus*. T. Magga did not measure the fundamental frequency nor the quality of the vowels. T. Magga's study serves as a classified material from speakers of the Guovdageidnu dialect. The division into initially- and evenly/ finally-stressed diphthongs has been worked out on the basis of classifications by P. Sammallahti (1977) and T. Magga (1984).

In harmony with the used terms referring to stress, we chose to try to find out, if the acknowledged (initially and finally stressed) parameters can be found as acoustic cues for distinguishing the initially and finally "stressed" diphthongs. The important roles of the fundamental frequency and duration in the perception of stress have been studied in several languages (see e.g. Lehiste 1970 : 125). The high sensitivity of human perception to F₀ variation is also shown by tests searching discrimination thresholds (Flanagan 1957 : 534; +/- 1 Hz for F₀ in the span 80 Hz to 160 Hz). According the J. Laver (1994 : 511), next in rank order come duration, intensity, and vowel quality, in this order. Language-specific variation may exist, though, because duration, for instance, has a more prevalent role in certain languages than in others in distinguishing phonemic length. A notable example is offered by the Finnish language. Duration is a strong stress cue in some languages, e.g. in English and Russian. In the Saami language, considered a quantity language, duration has a role in distinguishing different degrees of gradation. In line with the present theme, we want to study, whether in Saami stress also has an effect on the dura-

tion of the whole diphthong and its segments. Intensity was not measured in this study, while it seems to provide a rather ambiguous and weak cue for the perception of stress, and besides, the inherent sonority distorts the dimension from measurement, along with vowel quality change. The diphthong quality was measured to study if the initial and final segments have a more peripheral quality, conditioned by an initial stress and final stress respectively (cf. Laver 1994 : 513).

2. Material and Method

2.1. Informants

The test material consists of bisyllabic words selected from the recordings by Tuomas Magga for his doctoral dissertation. Test words were recorded in the years 1981 and 1982 and were read by three male informants. Following facts about the informants are from the time recordings were made.

All the informants live in Guovdageaidnu and speak the usual variety of the Guovdageaidnu dialect with no special features. The informants lived off from Guovdageaidnu for some years in earlier stages of their lives, but now they all have been living for years in Guovdageaidnu.

Informant A: age 37, born and bred in Guovdageaidnu. He was away from Guovdageaidnu for 12 years.

Informant B: age 27, born in Norrland but moved to Guovdageaidnu in his early childhood. He spent 10 years away from Guovdageaidnu.

Informant C: age 33, born and bred in Guovdageaidnu. He was away from Guovdageaidnu for 13 years.

2.2. Test Words

The Guovdageaidnu dialect of North Saami has four diphthongs *ie*, *ea*, *oa*, and *uo*, which always occur in the first syllable. Each of these diphthongs can be initially or finally stressed. The test includes 29 words with an initially-stressed diphthong and 27 words with a finally-stressed diphthong. The test words were embedded in the following carrier sentence *Juogo --- daddjui?* 'Was—already said?' Within this kind of carrier sentence the test word has the main stress on it. The words were uttered by the three informants. The material in all consists of 168 words.

The initially and finally stressed words were subdivided according to the consonant centre, so that words with consonant centres of types *-b-* and *-ab-* were chosen (see Magga 1984, for the consonant centre types). Consonant centre type *-b-* includes words with one consonant in the consonant centre. The consonant can be either voiced or voiceless, but in this study this division has been left out of consideration. The consonant type *-ab-* includes consonant centres with e.g. *-skk-* and *-hp-*. The influence of the consonant centres was not taken into consideration in this study. These consonant centres were chosen, because both initially and finally stressed diphthongs may combine with these kinds of consonant centres. The only restriction concerning the latic vowel was that a short vowel was required.

2.3. Measurements

Because of the small number on informants and the likelihood of ideolectical differences, the informant's acoustic values are measured and shown separately. The following parametres were measured by means of the computer program Multi-Speech 1.0:

- (A) total duration of the diphthong
- (B) duration of the diphthong segments
- (C) F0 maximum of the diphthong
- (D) F0 values at the two diphthong segments
- (E) acoustic vowel quality at the typical quality steady states of the diphthong segments.

The acoustic features of the diphthongs were measured according to the following procedure:

- (1) a waveform registration of the word with diphthong was produced
- (2) a good fit of time resolution of the waveform was zoomed (the total duration of the diphthong of the diphthong measured)
- (3) a spectrogram (with 125 points, corresponding to a broad band spectrogram) was produced, synchronous with the waveform display (also linking the cursors of the two windows)
- (4) the diphthong segmentation was done by dividing the dubious glide phase in two, on the basis of formant glides in the spectrogram (the durations of the diphthong segments measured)
- (5) the steady states of the segments were defined on the spectrogram
- (6) pointing the cursor at the steady state time point on the spectrogram, an "LPC frequency response at cursor" was registered (formant F1 and F2 values were measured)
- (7) with an optimal time domain resolution, an F0 contour of the registered over the same display with the spectrogram (F0 values were measured)

Arithmetical mean values for each informant and each parametre were calculated, to describe the classes of diphthongs along the parametres.

3. Results

3.1. Duration

The duration of the initially-stressed diphthong is consistently longer than the duration of the finally-stressed one. The difference is 45 ms to 68 ms in favour of the former class. The initially-stressed diphthong is 28% to 38% longer than the finally-stressed one (Tables 1 and 2).

Table 1

Durations of the initially-stressed diphthongs and the 1st and 2nd segment in ms

Informant	Total duration of the diphthong	Duration of the 1st segment	Duration of the 2nd segment
A	219	127	92
B	189	115	74
C	248	150	98

Table 2

Durations of the finally-stressed diphthongs and the 1st and 2nd segment in ms

Informant	Total duration of the diphthong	Duration of the 1st segment	Duration of the 2nd segment
A	171	82	89
B	145	72	73
C	180	87	93

The first segment in the initially-stressed diphthong is longer than the second segment and about 60% on the average of the total diphthong duration. The variation between informants is quite small (Table 3).

Table 3

Durations of the segments of the initially-stressed diphthongs in percent

Informant	Duration of the 1st segment	Duration of the 2nd segment
A	58%	42%
B	61%	39%
C	61%	39%

The between-segment proportion within the diphthong becomes more even in the finally-stressed diphthongs. The second segment tends to be somewhat longer in the finally stressed diphthongs. The second segment is 51% of the total duration of the diphthong on the average. This indicates a slight transfer of prominence over to the second segment, as compared with the initially-stressed diphthongs (Table 4).

Table 4

Durations of the segments of the finally-stressed diphthongs in percent

Informant	Duration of the 1st segment	Duration of the 2nd segment
A	48%	52%
B	50%	50%
C	48%	52%

The difference is although so minor that perceptually segments are durationally equal. Also in this case differences between informants are minor ones.

3.2. F0

The maximum value of the F0 always occurs on the first segment of the diphthong, irrespective of the stress pattern of the diphthong. The initially-stressed diphthongs show a steeper slope-down of the F0 contour than the finally-stressed do. Accordingly, a bigger difference of F0 values at segments 1 and 2 indicates a higher 1st segment prominence. The F0 values at the second segment are relatively higher. The latter element of the diphthong is held on a higher level (as compared to the initially-stressed pattern) of prominence by means of a slower drop, even though the F0 goes down from the 1st segment (Figure 1).

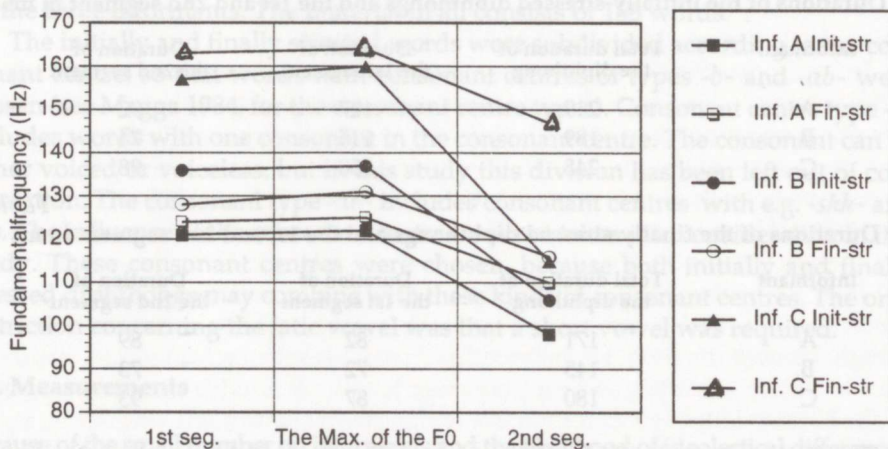


Figure 1. F0 maximum and F0 values at the 1st and 2nd segment of initially- and finally-stressed diphthongs. Informants A, B, and C.

3.3. Quality

The quality of the diphthongs shows quite large variation between the informants. The prominence shift by means of changes in the diphthong segment quality is thus not easy to show diagrammatically as a pattern common to all the three informants. We therefore chose one informant, informant C, to serve for an example of quality changes in the segments along with the stress pattern change.

Among the front diphthongs /ie/ and /ea/, the initially-stressed ones show a higher (and thus more peripheral) vowel quality for the 1st segment than do the finally-stressed ones /ié/ and /eá/. By the same token, the back diphthongs /uo/ and /oa/, with an initial stress pattern, get F1 values with evidence of a higher vowel quality for the first segments than do the corresponding finally-stressed ones, /uó/ and /oá/. This pattern is realized in all but two individual instances of the data of the three informants.

The second segments of the diphthongs represent a contrary tendency, i.e. the 2nd segments of the diphthongs obtain a somewhat lower vowel quality when the stress falls on them. Accordingly, with informant C the first segment's feature "high(-er)" (with respect to the second segment) is emphasized as high, if the stress falls on it. Correspondingly, the second segment's feature "low(-er)" is emphatically low with the pattern finally-stressed.

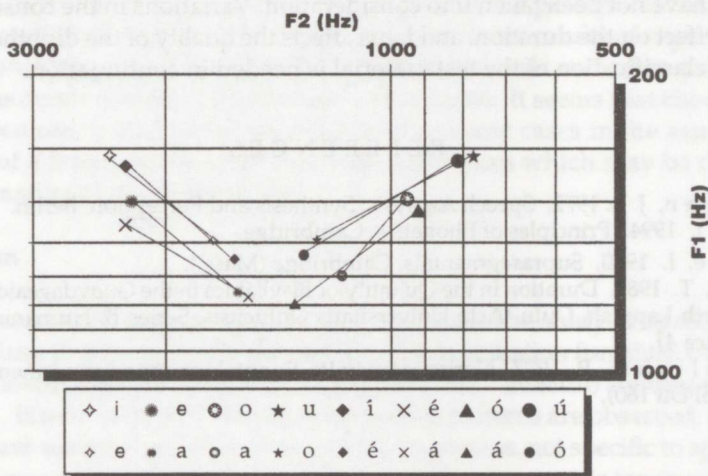


Figure 2. Acoustical vowel chart of diphthongs produced by informant C. The 1st segment of the diphthong has been marked by a bigger symbol. Finally stressed diphthongs has been marked by (*).

4. Discussion

In this paper we have studied the acoustic phonetic properties of initially- and finally-stressed diphthongs by methods of experimental phonetics. As stress is considered a complex of prosodic and segmental cues contributing to the prominence of the stressed element, we wanted to experiment, whether a really existing set of phonetic parameters entitle us to use the linguistic labelling of the categories as initially-stressed and finally-stressed.

A positive answer to the issue of the study was obtained. The use of the features measured can be regarded as cues of prominence on the 1st and 2nd segment

not for much interpretation. The conclusion for the quality of the segments as cues of prominence is probably a more roundabout one.

The fact that F0 does not show higher values for the second segment with the finally-stressed condition must be due to an overall fundamental frequency pattern over the word, with a contour slope toward the sonant of the primary-stressed syllable. By means of the final stress pattern, the angle of the slope is made smaller.

An analogical case is found in the parametre of duration. The durational proportion of the segments manifests the stress placement within the diphthong. The 60% portion of the first segment decreases to < 50% with the stress transfer over to the second segment to a non-dominant duration is crucial.

The quality variation in the diphthong segments shows itself as emphasizing the very property of the segment it has, with the occurrence of stress on the segment. The first segments are generally higher than the second segments in the Guovdageaidnu diphthongs. The placement of stress on it raises phonetic quality of the initial element. In contrast, all second segments are lower than the first segments. The placement of stress on the latter segment lowers that segment. The rule reads simply as follows: raise the first segment and lower the second segment of the diphthong with placement of stress on the first and second segment of a Guovdageaidnu diphthong.

A weakness of the present study is that the effect of the consonant centre and the latus have not been taken into consideration. Variations in the consonant centre have an effect on the duration, and latus affects the quality of the diphthong. A more rigorous classification of the test material is needed in continuation.

REFERENCES

- Flanagan, J. L. 1972. *Speech Analysis, Synthesis and Perception*, Berlin.
- Laver, J. 1994. *Principles of Phonetics*, Cambridge.
- Lehiste, I. 1970. *Suprasegmentals*, Cambridge (Mass.).
- Magga, T. 1984. Duration in the Quantity of Bisyllabics in the Guovdageaidnu Dialect of North Lappish, Oulu (Acta Universitatis Ouluensis. Series B. Humaniora 11. Philologica 4).
- Sammallahti, P. 1977. *Norjansaamen Itä-Enontekiön murteen äänneoppi*, Helsinki (MSFOu 160).