

# AN ACOUSTIC ANALYSIS OF BOUNDARY-SIGNALING DIFFERENCES BETWEEN LANGUAGES WITH CONTRASTIVE AND NON-CONTRASTIVE DURATION

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## 1. INTRODUCTION

Languages with contrastive duration tend not to utilize duration for additional grammatical functions (Engstrand and Krull 1994). It may thus be expected that they will behave differently from languages with non-contrastive duration, with regard to boundary signalling. The acoustic analysis undertaken in the present study aims at providing further support for this assumption by examining the temporal patterns apparent within the paragraph. In this paper it is hypothesized that, in the above two types of languages, paragraph-boundary signalling differences correlate with differences evident in the realization of temporal patterns within these speech units. It is argued that, in languages where duration is not contrastive, the durational increase signalling boundary co-occurs with a greater degree of durational variation within the paragraph.

The project reported on here is a direct continuation of a pilot study examining the issue indicated above in six languages: three with contrastive, and three with non-contrastive duration (McRobbie-Utasi 1999). In that study it was concluded that the two observed tendencies -- (i) durational variations realized in connection with sentences in different positions as well as in intersentential pauses, and (ii) preboundary lengthening -- are realized differently, depending on the language type (i.e., on whether duration is contrastive or non-contrastive). Further, it was hypothesized that languages with contrastive duration tend to maintain durational ratios between long and short segments. Consequently, in languages where duration is not linguistically significant, a greater degree of variation could be expected at the segmental level. It is in connection with this latter issue that the present study further explores temporal patterns by way of (i) identifying segment durational patterns in both types of languages, and (ii) relating these patterns to the tendencies reported on in McRobbie-Utasi 1999.

## 2. THE EXPERIMENT

Recordings of six paragraphs by eight speakers were acoustically analyzed. Each paragraph consisted of three sentences (henceforth A, B and C). The sentences in the six paragraphs were the same, except in their ordering. Each speaker was asked to translate the same paragraph. In the experiment there were nine languages in total, five with contrastive, four with non-contrastive duration. The languages with contrastive duration were Hungarian, Latvian, Hindi, Finnish, and Korean; those with non-contrastive duration were English, Cantonese, Brazilian Portuguese, and Russian. The experiment was designed with the objective of first making the subjects familiar with the text. They were informed as to the purpose of the study only after the recording had taken place. Altogether 108 paragraphs were analyzed.

## 3. RESULTS AND DISCUSSION

### 3.1 TEMPORAL PATTERNS

The general tendency that was observed in sentence duration will be summarized here in relation to the six configurations of sentence ordering. Mean durations and standard deviations were obtained for each of the three sentences separately in the three positions. These

durational values were examined by relating them to the mean sentence duration (i.e.,  $\bar{Y}_x$  of A sentences,  $\bar{Y}_x$  of B sentences, and  $\bar{Y}_x$  of C sentences, in all three positions). Divergences from the mean, indicating the degree of variation associated with the ordering of the sentences within the paragraph, are summarized in Figure 1. It may be observed that (i) it is the third position in which durational variations are most apparent, and (ii) these variations are greater for languages with non-contrastive duration.

In connection with the two intersentential pause durations, the pattern that emerges in 69 out of the 108 paragraphs implies the existence of an interesting tendency: first, it was observed that paragraph durations tend to have relatively small standard deviation values; second, it is in the third sentence position that the greatest degree of variation was observed (see Figure 1). If we assume that speakers tend to conform to a durational target (the experiment being designed in such a fashion that speakers were familiar with the text), we may hypothesize that towards the end of the paragraph the durational variations observed may function as timing adjustments. Further, the 69 sentences (a number indicating greater than chance occurrences) confirm the assumption that the duration of the second intersentential pause also plays a role in this timing adjustment. Keeping to a durational target for the paragraph, as indicated by the degree of variability associated with the paragraph-final sentence and the second intersentential pause duration, is valid for languages with contrastive and non-contrastive duration alike.

Variations in duration of the last word in the paragraph were examined with the objective of discovering a possible pattern indicating an increase in duration in paragraph-final sentence positions. In comparing these measurement values with those in the first and second sentence positions, the following tendency could be observed: (i) while durational variations were manifested in all positions, it is in the paragraph-final position that they register mainly as increases in duration; (ii) these increases, while apparent in both language types, are of a greater degree in languages with non-contrastive duration. Subsequently, variations in duration of the last syllable in the paragraph were related to last syllable durations in the three sentences in different positions. The results emerging from the present project are comparable to those reported in McRobbie-Utasi 1999. Measurements from three additional languages confirm the existence of a distinct pattern in the two language types. Languages with contrastive duration have a lesser degree of durational increase in the last syllable than do languages with non-contrastive duration.

### 3.2 SEGMENT DURATIONS

In examining segmental durations, the hypothesis tested in this project was that languages with non-contrastive duration will manifest a greater variation in segments than those languages with non-contrastive duration. The rationale that underlines this assumption was that the maintaining of distinctions between short and long segments -- such distinctions being linguistically significant -- would constrain the variations in duration in languages with contrastive durations. It was thus further hypothesized that the durational distance between long and short segments would have to be

kept preserved -- variations at thesegmental level being constrained by the grammatical function ofduration.

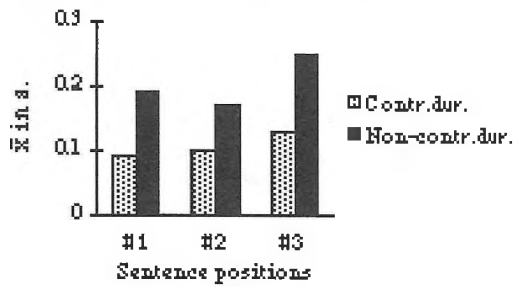


Figure 1. Sentence level durational variations

At this stage of the project only vowel segments have been examined. In languages where duration is contrastive, vowels were divided into four groups (due to the fact that only three sentences were analyzed, not all the texts contain representatives of each of these groups for the same vowel): stressed long vowels, unstressed long vowels, stressed short vowels, and unstressed short vowels. In languages with non-contrastive duration it was the stressed vowels (both primary and secondary stressed) that were measured.

In connection with durational variation at the segmental level in languages with contrastive duration the following tendencies were identified: (i) long stressed vowels occur with the greatest degree of durational variation, and (ii) the smallest degree of variation occurs in connection with short unstressed vowels. An example from Latvian illustrates this tendency: the durational increase or decrease observed for long stressed vowels is within the range of +/- 41 msec, for long unstressed vowels +/- 26 msec, for short stressed vowels +/- 30 msec, and for short unstressed vowels +/- 13 msec. In examining the additional three languages, it was observed that the maintenance of durational distance between short and long segments may be realized differently in relation to the degree of the durational variations observed. The range of the variation may be similar to that observed in Latvian (see example above); or it may be larger (such as, for example, in Finnish, where the durational increase or decrease for long stressed vowel is within the range of 67 msec, for long unstressed vowels +/- 48 msec, for short stressed vowels +/- 60 msec, and for short unstressed vowels +/- 59 msec). It appears that differences in terms of the range of these variations are language specific. The manifestation of durational variation implies the presence of a pattern that assures the keeping of durational distance between long and short vowels within values serving the linguistically significant distinguishing function.

Durational measurements of primary stressed vowels in languages where duration is non-contrastive show a noticeably high degree of variation; measurement values in Brazilian Portuguese indicate an increase or decrease within the range of +/- 76 msec, in Cantonese +/- 91 msec, in Russian +/- 103 msec, and in English +/- 80 msec. The degree of variation attested to vowel segments bearing secondary stress is lesser (in Brazilian Portuguese within the range of +/- 51 msec, in Cantonese +/- 78 msec, in Russian +/- 90 msec, and in English +/- 67 msec).

Figure 2 summarizes the different durational patterns as described above in connection with the two language types.

In evaluating the tendencies with regard to the durational variations associated with segments as presented above, it may be stated that

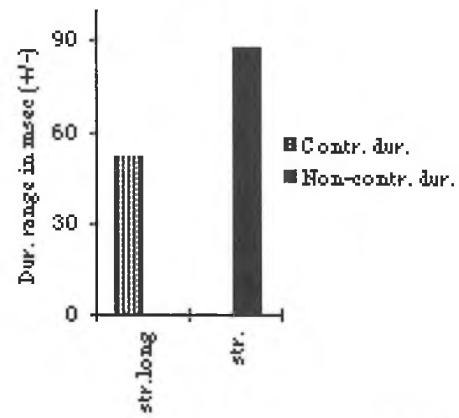


Figure 2. Differences in vowel durational variations between the two types of languages

languages with contrastive duration behave according to two distinct patterns: (i) those where there is clear evidence of keeping the durational ratios of the segment constant, such as in Estonian (Krull and Engstrand 1994, Krull 1999) and in Saami (McRobbie-Utasi 1994), and (ii) those where it is important to maintain a clearly identifiable durational distance between short and long segments (such as in those languages examined in the present project).

#### 4. CONCLUSIONS

A comparison of the realization of temporal patterns evident within the paragraph elicited during the course of this controlled experiment shows that the two language types -- those with contrastive duration, and those with non-contrastive duration -- differ in the degree of variation associated with the paragraph constituent examined, and that this difference correlates with the degree of durational increase signalling boundaries. The apparent tendency for the maintaining of durational differences between long and short segments implies that, in languages with contrastive duration, durational increase plays a lesser role in signalling the paragraph boundary than in languages with non-contrastive duration where paragraph-final lengthening is more evident. (Because of the relatively small data base these conclusions can be considered as no more than tentative).

#### 5. REFERENCES

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