

Boundary Signaling in Relation to Temporal Pattern Differences: The Relevance of the Role of Duration

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ABSTRACT

In this concluding part of a pilot study, further evidence is presented of differences in boundary signaling between languages with contrastive vs. non-contrastive duration. It will be shown that (i) in languages where duration is non-contrastive the durational increase functioning as a boundary signal is greater than in those languages where duration is contrastive, and that (ii) this durational increase co-occurs with a greater degree of variation in duration within the paragraph. Further, it is argued that recognizable temporal patterns exist in relation to a durational target, and that the effort evident on the part of the speaker to maintain a target duration is realized differently in the two language types.

1. INTRODUCTION

The project reported on here aims at exploring further the differences apparent between languages with contrastive vs. non-contrastive duration, with regard to (i) temporal patterns, and (ii) boundary signaling within the grammatical unit of the paragraph [1]. Three tendencies will be examined in connection with these issues: (i) the realization of temporal patterns appears to depend on the role that duration plays in the language, (ii) durational variations occurring at boundary position are different in the two language types, and (iii) this difference correlates with the degree of variation in duration within the grammatical unit under investigation, i.e., in languages where duration is not linguistically significant, a greater degree of variation is evident.

Experimental investigations of temporal patterns in speech production have examined the relevance of speech timing for grammatical units, for example [2], [3] and [4]. In the present study temporal patterns will be described in terms of how their realizations conform to a clearly recognizable durational target, depending on the role of duration in the languages examined.

In connection with preboundary lengthening, research has not yet resolved the issue of separating durational differences relating to boundary signaling from those attributable to rhythmic factors. In [5] it was found that durational effects driven by prosody should be kept distinct from preboundary lengthening. The analysis of durational variations that follows confirms this finding by providing evidence (i) that there is a clearly identifiable

effort on the speakers' part to conform to a durational target, and (ii) that this effort has to be considered as independent from the apparent durational increase in boundary positions.

2. THE EXPERIMENT

The material analyzed in this study consists of six paragraphs recorded three times by 16 speakers of eight different languages: Finnish, Hungarian, Hindi, Latvian, Brazilian Portuguese, English, Cantonese and Russian (the first four representing languages with contrastive duration), with two speakers per language, one male and one female. Each paragraph consists of three sentences (hereafter A, B, and C). The sentences in the six paragraphs were the same, except for their ordering. The paragraphs were constructed in such a way that all the sentence orderings were possible, similarly to the experiment described in [6]. All 16 speakers, though familiar with the text to a significant degree, were not previously aware of the objective of the experiment. The recording took place in the Phonetics Laboratory at Simon Fraser University. Altogether 288 paragraphs were analyzed for the purpose of this study.

3. TEMPORAL PATTERNS

Measurements of paragraph durations reveal a tendency to keep to a target duration associated with this grammatical unit. The mean durations of most paragraphs (224 out of 288) cluster around similar durational values with relatively small standard deviation values. Measurements of sentence and pause durations were obtained in order to identify the pattern of durational variations in relation to their position within the paragraph. Paragraph-final syllable durations were obtained in order to establish the extent of durational increase at paragraph boundaries. Segmental duration variations were examined for the purpose of assessing the degree to which long and short segments are kept distinct in languages with contrastive duration.

3.1 SENTENCE DURATION IN RELATION TO SENTENCE ORDER

A comparison of the duration of sentences in relation to their position within the paragraph reveals that variation is greater in languages where duration is not contrastive. Durational variations at the sentence level were examined by assessing (i) the difference between mean sentence duration regardless of sentence order, and (ii) the mean

duration of sentences in different positions. The pattern emerging may be summarized as follows: (i) in the first position, the maximum durational difference from the mean sentence duration is 0.12s in languages with contrastive duration (Hungarian 0.06s, Finnish 0.05s, Hindi 0.04s, Latvian 0.12s); the maximum durational difference is 0.19s in languages with non-contrastive duration (Brazilian Portuguese 0.18s, English 0.14s, Cantonese 0.1s, Russian 0.19s); (ii) in the second position, the maximum durational difference from the mean sentence duration is 0.09s in languages with contrastive duration (Hungarian 0.06s, Finnish 0.09s, Hindi 0.03s, Latvian 0.04s); the maximum durational difference is 0.17s in languages with non-contrastive duration (Brazilian Portuguese 0.08s, English 0.13s, Cantonese 0.17s, Russian 0.1s); (iii) in the third position, the maximum durational difference from the mean sentence duration is 0.15s in languages with contrastive duration (Hungarian 0.08s, Finnish 0.13s, Hindi 0.06s, Latvian 0.15s); the maximum durational difference is 0.22s in languages with non-contrastive duration (Brazilian Portuguese 0.22s, English 0.16s, Cantonese 0.16s, Russian 0.35 s).

The tendency for durational variations to be greater in languages with non-contrastive duration is demonstrated in Figure 1 which indicates the maximum differences from the mean sentence duration in the three sentence positions with regard both language types. Further, it is in the third sentence position that the greatest degree of durational variation may be observed.

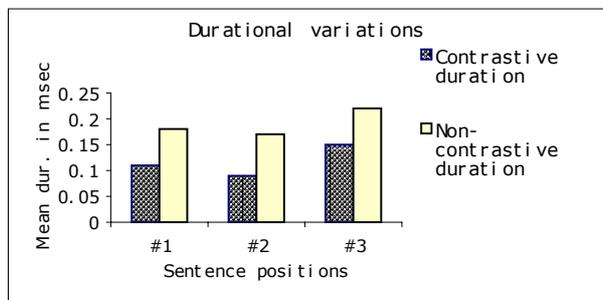


Figure 1. Sentence level durational variations.

3.2 PAUSE DURATION

An examination of the measurement values shown in Tables 1 and 2 reveals that paragraph duration tends to remain stable (note the relatively small standard deviations). This observation seems to be valid for languages with contrastive as well as those with non-contrastive duration. The question that suggests itself is why, despite evident durational variations at the sentence level, does the duration of the paragraph appear to be unaffected to any great extent in either of the two language types. In this section an answer will be sought to this question by examining pause duration patterns in relation to their possible role in maintaining a durational target within the paragraph.

Sentence Order	Languages with contrastive duration							
	Hungarian		Finnish		Hindi		Latvian	
	M	SD	M	SD	M	SD	M	SD
A	2.63	0.3	1.76	0.54	2.89	0.23	1.84	0.65
B	4.74	0.21	5.39	0.61	5.21	0.52	4.61	0.32
C	2.37	0.14	1.75	0.12	2.11	0.46	2.39	0.17
A	2.63	0.3	1.76	0.54	2.89	0.23	1.84	0.65
C	2.41	0.62	1.69	0.14	2.02	0.71	2.27	0.11
B	4.79	0.32	5.35	0.73	5.22	0.65	4.78	0.28
B	4.72	0.25	5.53	0.61	5.14	0.12	4.74	0.51
A	2.58	0.18	1.78	0.2	2.87	0.3	1.82	0.24
C	2.37	0.14	1.75	0.12	2.11	0.46	2.39	0.15
B	4.72	0.25	5.53	0.61	5.14	0.12	4.74	0.51
C	2.41	0.62	1.69	0.14	2.02	0.71	2.27	0.11
A	2.68	0.56	1.68	0.17	2.81	0.45	1.72	0.12
C	2.4	0.34	1.71	0.22	2.09	0.23	2.3	0.16
A	2.58	0.18	1.78	0.2	2.87	0.3	1.82	0.24
B	4.79	0.32	5.35	0.73	5.22	0.65	4.78	0.28
C	2.4	0.34	1.71	0.22	2.09	0.23	2.3	0.16
B	4.74	0.21	5.39	0.61	5.21	0.52	4.61	0.32
A	2.68	0.56	1.68	0.17	2.81	0.45	1.72	0.12
Par.	Dur. 11.4 0.67 9.62 0.72 10.56 0.57 9.98 0.12							

Table 1. Sentence duration (in seconds) in the four languages with contrastive duration in relation to sentence position within the paragraph.

Sentence Order	Languages with non-contrastive duration							
	B. Portuguese		English		Cantonese		Russian	
	M	SD	M	SD	M	SD	M	SD
A	2.0	0.54	2.26	0.61	2.34	0.31	2.07	0.25
B	4.61	0.31	3.88	0.83	5.71	0.54	4.45	0.34
C	2.43	0.14	1.92	0.45	1.89	0.44	2.6	0.21
A	2.0	0.54	2.26	0.61	2.34	0.31	2.07	0.25
C	2.58	0.67	1.73	0.19	1.77	0.81	2.41	0.24
B	4.91	0.62	3.95	0.98	5.81	0.83	4.67	0.28
B	4.51	0.31	3.65	0.59	5.75	0.45	4.21	0.32
A	1.87	0.25	2.19	0.4	2.21	0.32	2.19	0.21
C	2.43	0.14	1.92	0.45	1.89	0.44	2.6	0.21
B	4.51	0.31	3.65	0.59	5.75	0.45	4.21	0.32
C	2.58	0.67	1.73	0.19	1.77	0.81	2.41	0.24
A	1.75	0.57	2.41	0.24	2.54	0.52	2.6	0.21
C	2.63	0.45	1.83	0.27	1.8	0.26	2.54	0.17
A	1.87	0.25	2.19	0.4	2.21	0.32	2.19	0.21
B	4.91	0.62	3.95	0.98	5.81	0.83	4.67	0.28
C	2.63	0.45	1.83	0.27	1.8	0.26	2.54	0.17
B	4.61	0.31	3.88	0.83	5.71	0.54	4.45	0.34
A	1.75	0.57	2.41	0.24	2.54	0.52	2.6	0.21
Par.	Dur. 9.89 0.45 8.27 0.38 10.48 0.34 11.03 0.42							

Table 2. Sentence duration (in seconds) in the four languages with non-contrastive duration in relation to sentence position within the paragraph.

It was pointed out above that it is the third sentence position that appears to be associated with the greatest degree of variation (see Figure 1). In assuming that this consistent pattern of sentence duration variation may be

functioning as a timing adjustment, and thus it may further be hypothesized that the duration of intersentential pauses -- in particular, the second intersentential pause -- facilitates that function. Should this be the case, it would imply that the duration of both the second intersentential pause and the sentence in the third position may be dependent on the duration of the first two sentences and the first intersentential pause. Such an assumption is substantiated in this experiment in 201 out of the 288 paragraphs. By way of illustrating this tendency, the temporal structure of the paragraph with regard to sentence and pause duration is presented by providing one example from both language types studied in this experiment:

Hungarian (duration is contrastive): The mean duration of the paragraphs examined is 11.4s (SD: 0.67). In a typical sentence that represents the temporal pattern referred to above, the durational distribution is as follows: the duration of the paragraph is 11.8s; the first and second sentences (A + C) have 2.81s and 2.36s duration (*M*: 2.63s and 2.41s respectively). The first intersentential pause is 0.40s. The third sentence (B) is 0.31s shorter than the mean B duration, and the pause preceding it is 1.40 s.

Cantonese (duration is non-contrastive): The mean duration of the paragraphs examined is 11.03s (SD: 0.42). In a typical sentence that represents the temporal pattern referred to above, the durational distribution is as follows: the duration of the paragraph is 10.82s; the first and second sentences (B + A) have 5.77s and 1.98s duration (*M*: 5.75s and 2.21s respectively). The first intersentential pause is 0.21s. The third sentence (C) is 0.03s longer than the mean C duration; the pause preceding it is 0.63s.

3.3 PARAGRAPH-FINAL SYLLABLE DURATION

While boundary signaling may start before the last syllable [7], in this study it was decided to consider the role of paragraph-final syllable duration only, this being the most likely position where boundary signaling could be realized by the greatest degree of durational increase. Accordingly, last-syllabic durational measurement values were compared in sentences in all positions. It was further hypothesized that although durational increase is manifested in these positions in both language types, the increase is greater in languages with non-contrastive duration.

The measurement values suggest the presence of a distinct pattern, one that emerges through the comparison of the two language types. In languages with contrastive duration, durational increases associated with the last syllable average 35 msec (max. increase: 51 msec). In languages where duration is not contrastive, durational increases in the last syllable average 81 msec (max. increase: 104 msec). The pattern thus supports the assumption stated above with regard to preboundary lengthening in relation to the two language types; the results of t-tests indicate a statistically significant difference ($p < .05$).

3.4 SEGMENTAL DURATION

The hypothesis for segmental duration in this project was that languages with non-contrastive duration will manifest a greater degree of durational variation at the segmental level than those with contrastive duration. The rationale that underlines this assumption is that the maintaining of distinctions between short and long segments -- such distinctions being linguistically significant -- would constrain durational variation in languages where it has a grammatical function [8]. Accordingly, it was further assumed that the maintaining of this distinction would entail a lesser degree of durational variation at the segmental level in languages with contrastive duration.

Durational variations associated with the segment were analyzed by dividing the vowels 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 where duration is not contrastive, it was the stressed vowels that were measured (both primary and secondary stressed).

In connection with durational variation at the segmental level in languages with contrastive duration, the following tendencies could be 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. The realization of this tendency in the languages analyzed in this study is presented below:

Hungarian. The durational increase or decrease for long stressed vowels is within the range of +/-35 msec, for long unstressed vowels +/-21 msec, for short stressed vowels +/- 32 msec, and for short unstressed vowels +/-18 msec.

Finnish. The durational increase or decrease for long stressed vowels is within the range of +/-57 msec, for long unstressed vowels +/-47 msec, for short stressed vowels +/-50 msec, and for short unstressed vowels +/-39 msec.

Hindi. The durational increase or decrease for long stressed vowels is within the range of +/-43 msec, for long unstressed vowels +/-26 msec, for short stressed vowels +/-31 msec, and for short unstressed vowels +/- 7 msec.

Latvian. The durational increase or decrease for long stressed vowels is within the range of +/-46 msec, for long unstressed vowels +/-29 msec, for short stressed vowels +/-37 msec, and for short unstressed vowels +/-18 msec.

Durational measurements of primary stressed vowels in languages where duration is non-contrastive attest to a noticeably higher degree of variation. Measurement values in B. Portuguese indicate an increase or decrease within the range of +/-83 msec, in English +/- 86 msec, in Cantonese +/-102 msec, and in Russian +/-110 msec. A lesser degree of variation was observed for vowel segments bearing secondary stress: in B. Portuguese within the range of +/-57 msec, in English +/- 72 msec, in Cantonese +/-84 msec, and in Russian +/-93 msec.

4. DISCUSSION

The results of the analysis clearly indicate the presence of two separate tendencies with regard to the temporal organization of the paragraph. The first tendency is associated with durational variation depending on the position of the three main constituents in the paragraph. The durational variations observed in the three sentences suggest that they tend to conform to a definite pattern, one that compels recognition of the existence of a durational target. As indicated above, (i) durational variations at the sentence level are most evident in paragraph-final position, and (ii) the duration of the second intersentential pause appears to be dependent on the durations of the two preceding sentences and of the first intersentential pause. In evaluating these two observations, it may be justified to suggest that they indicate efforts on the part of the speakers to "adjust" duration to a definite timing target. This effort, which is evident in both language types, appears to override the variation in duration associated with sentences in different positions. While this variation is present in both language types, it is clearly evident that the degree of variability in duration is different, being greater in languages with non-contrastive duration. The second of the main tendencies recognized during the course of this analysis is the presence of durational increase in sentence-final syllables. The measurement values show that durational variation is greatest for syllables in paragraph-final position. In comparing variations in duration observed in paragraph-final position with those in first and second sentence position in the two language types, two tendencies emerge: (i) while durational variations are manifested in all positions, it is in the paragraph-final position that they register mainly as increases in duration; (ii) durational variations, while apparent in both language types, occur to a greater degree in languages with non-contrastive duration. With regard to the tendencies observed in connection with durational variation at the segmental level, the constraint on the extent of variation in languages with contrastive duration was pointed out in Section 3.4. Consequently, the degree of durational variation is expected to be greater in languages where duration does not have a significant grammatical function. The results of the present experiment confirm the validity of this assumption.

Three findings emerge from this controlled experiment. First, the two tendencies identified -- durational variations realized in connection with sentences in different positions and intersentential pauses, and the degree of preboundary lengthening -- appear to represent two different mechanisms. Second, both tendencies are realized differently with regard to the degree of durational variation involved, depending on language type (i.e., whether duration is contrastive or non-contrastive in the language in question). Third, the implications of the patterns of durational variation at the segmental level point to significant differences between the two language types. The tendency apparent for the maintaining of durational differences between long and short segments coincides

with a lesser role for duration in boundary signalling in languages with contrastive duration, whereas in languages with non-contrastive duration preboundary lengthening co-occurs with a significantly greater degree of durational increase.

5. CONCLUSIONS

The experiment reported on in this study was designed to further test the hypothesis according to which the realization of temporal patterns confirms the existence of efforts on the part of the speakers to conform to a durational target. In relating the findings presented in this analysis to the manifestation of preboundary lengthening, it may be stated that the hypothesis -- according to which boundaries are signaled by durational increase is somewhat constrained in languages where duration is contrastive -- appears to be born out by the tendencies shown in the present study.

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