

THE EFFECT OF SENTENCE ACCENT ON QUANTITY

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This paper will focus on the phonological aspects of the temporal structure of quantity in Central Swedish. Its domain is the vowel and consonant sequence resulting in the temporal pattern of complementary length, namely vowel + short consonant (V:C) or short vowel + long consonant (VC:). Quantity will be studied from the sentence perspective by investigating the prosodic effect of sentence accent (SA) on the VC-sequences.

Investigation

The tonal manifestation of SA in Stockholm Swedish is treated exhaustively by Bruce (1977). The present investigation builds on his tonal findings. Two speakers from Stockholm, EH, female, the main informant in Bruce (1977) and TB, male, representing the same dialectal variety, produced the test material. The test words were stöka (V:C) and stöcka (VC:). The qualitative difference between the long and short vowel is rather small. They were placed alternatively in one of the three positions (1,2,3) in the base sentence "Man kan lämna långa nunnor efter åtta." (One can leave tall nuns after eight). The test words, like the basic words (underlined) in the three sentence positions, are stressed with word accent 2 on the first syllable.

The test material consisted of 12 sentences. Six of them contained the test words in one of the three accented positions without SA, SA falling on the adverbial. The other six sentences contained the test words with SA.

Results and discussion

The VC-sequences without sentence accent are regarded as a reference for studying the effect of SA on quantity.

1. The temporal structure of quantity. The overall means of the durations of the vowel and the following consonant are plotted in figure 1. The diagram represents the temporal space for the manifestation of the VC-sequences (lower limitations in terms of incompressibility, cf Lindblom et al 1976, left aside). The range is illustrated by ellipses, constructed according to the standard deviations of vowel and consonant. The data points of both speakers and both types of sequences fall in such a way that they may easily be accounted for by straight lines. The temporal structure

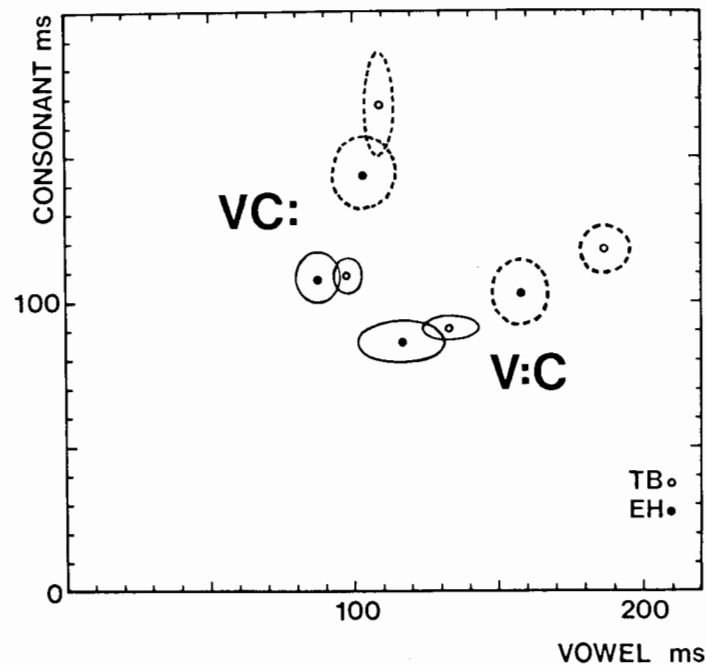


Figure 1. The effect of sentence accent on the temporal structure of the /V:C/- and /VC:/-sequences, consonant durations plotted against vowel durations. Sentence accent with broken-line circles. Pooled means and standard deviations for two speakers from Stockholm.

of the two types of sequences with and without SA are very similar for both speakers. Figure 1 shows also that the sequences with SA not only lie further apart from those without SA: Each type of sequence is also more separated from its counterpart.

The temporal effect of SA on quantity in Stockholm Swedish is a considerable increase of the segment durations which makes the temporal structure of the two contrasting VC-sequences more dissimilar. Thus the temporal contrast becomes clearer in focus position, given more prominence by the SA.

2. The increase of segment durations. The durations of the segments do not increase in a uniform way. It is evident from figure 1 that the increase of segment duration is largest for the long segment of each type of sequence, i.e. the long vowel in (V:C) and the long consonant in (VC:).

The V/C relations. The proportion of the increase of segment duration in each position and in all positions together is given in table 1. The ratio of the durational increase is defined as the relationship between the consonant and the vowel, $k = \Delta C / \Delta V$. It expresses the degree of lengthening of the consonant compared to that of the preceding vowel.

Table 1. Increase in segment durations. The factor k gives the proportion of the lengthening of the consonant compared to that of the preceding vowel.

sequence	speaker	position				pooled
		1	2	3	1-3	
V:C	TB	0.48	0.43	0.72	0.53	0.48
	EH	0.46	0.48	0.39	0.43	
VC:	TB	4.70	5.17	6.18	5.36	3.50
	EH	3.00	1.76	2.06	2.23	

Although there is some variation across the three sentence positions for both speakers, the short consonant is prolonged approximately by a factor of 0.5 of the preceding long vowel, while the duration of the long consonant increases much more in comparison with its preceding short vowel.

A non-uniform change of segment durations in VC-sequences with complementary length is also found in other prosodic contexts in Central Swedish and also in Central Bavarian, namely with differing speaking rates and stresses (contrastive vs neutral) and for words pronounced in isolation vs embedded in a sentence (cf Gårding et al 1975, Bannert 1976). This would suggest that the increase in segment duration due to different conditions is both linear and non-uniform.

The degree of lengthening. When the relationship of the non-uniform increase in segment duration between the vowel and the following consonant is established, it is sufficient to know the degree of lengthening for only one segment, e.g. the vowel. The relative degree of lengthening of the long and short vowel is given in table 2.

For this parameter, too, the change is not invariant. Both speakers behave differently for the three sentence positions and for the two categories of vowels. These differences may be accounted for with reference to two individual differences:

1) There are different durations between the speakers on the three

Table 2. Percentage of the increase in vowel duration with SA.

sequence speaker		position				
		1	2	3	1-3	pooled
V:C	TB	42.7	48.4	29.9	39.9	37.2
	EH	28.4	38.9	36.1	34.3	
V C:	TB	10.2	12.5	10.9	11.2	14.5
	EH	14.9	20.5	19.8	18.3	

sentence positions in the reference cases without SA (figure 1).

- 2) The speakers have two different tonal behaviours. Speaker EH has a tonal rise in the postconsonantal vowel, the pitch level of which is lower than that in the accented vowel. Speaker TB, however, reaches the high F_0 -level for the SA, which is higher than that in the accented vowel, in the consonant itself. Therefore, TB seems to need more time for producing the consonant.

But these minor differences in temporal behaviour remain well within the typical pattern of complementary length.

3. Preserving the temporal identity of the VC-sequences

It can be hypothesized that the change in the temporal patterns of the VC-sequences is governed by a dominant phonological principle, which is due to perceptual mechanisms: Preserve or sharpen the temporal contrast.

Two ways of increasing segment durations. There are two possibilities for the means by which segment durations in focus position may be increased:

- (1) equally to both segments either in absolute terms (ms) or as a percentage of the segment duration without SA,
- (2) differently to both segments. Then the question arises: How different and why?

In figure 2, two kinds of equal increase of segment duration and their effect on the temporal pattern of the sequences are illustrated. The reference points are the pooled means for the durations of the /V:C/- and the /VC:/-sequences without SA for both speakers taken together.

An absolute increase in the duration in ms, equal for both the vowel and the consonant, will result in shifting the VC-points along a straight line, corresponding to the slope $k=1$. As a consequence, however, the temporal structures of the two contrasting sequences will become more similar to each other. It is known

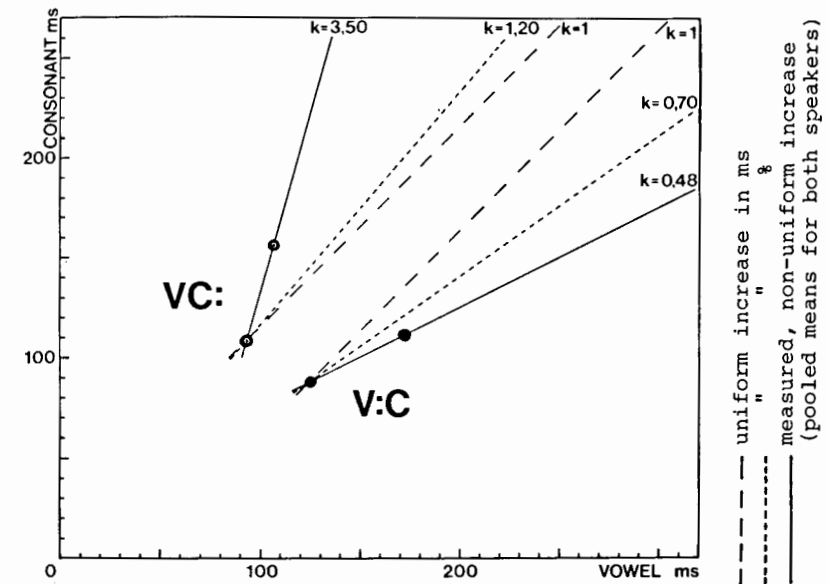


Figure 2. Different ways of increasing segment durations in the VC-sequences. The factor k gives the degree of lengthening for the consonant compared to the preceding vowel.

that durational differences must become greater with increasing segment duration in order to be perceived (cf the discussion in Lehiste 1970).

A relative increase of the duration, equal for both segments, is shown by the dotted lines. The slope (factor k) is now smaller for the /V:C/-sequence and larger for the /VC:/-sequence due to the asymmetric temporal structure within the sequences. This relative increase will result in enlarging the temporal difference between the sequences. But it seems obvious that this equal relative change of duration does not lead to a sufficient dissimilarity between the sequences with SA, either. The measured pooled means clearly lie further apart from each other than either of the possibilities would predict. Whereas the duration of the long vowel increases twice as much as that of the following short consonant ($k \approx 0.5$), the duration of the long consonant increases by far faster than that of the short vowel ($k \approx 3$).

The segment-to-sequence ratio. Due to the temporal patterns of the VC-sequences, they can be viewed as a unit of production and per-

ception. Then the relationship between the unit and its two parts will represent a measure of the temporal structure of quantity of complementary length. The vowel-to-sequence ratio $V/(V+C)$, expressing this relationship, was introduced by Bannert (1976) and applied to three languages with complementary length, Central Bavarian, Northern Icelandic, and Central Swedish.

Because of the phonological dependencies between the vowel and the following consonant, it seems inadequate to state the temporal structure of VC-sequences with complementary length by calculating the segment ratios $V/V:$ and $C/C:$ (cf the criticism in e.g. Lindblom et al 1976). Neither of these ratios can account for the temporal changes of the two speakers.

The segment-to-sequence relations, given as the $V/(V+C)$ ratios, are plotted in figure 3. It is clear that, when represented in this way, both speakers change the temporal structure of the sequences in exactly the same way.

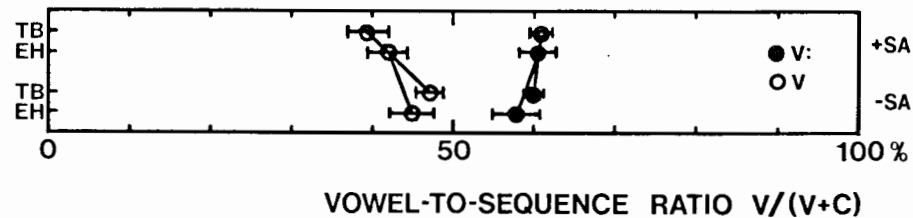


Figure 3. Variation of internal temporal structure of the VC-sequences in sentence accent position for each speaker. The relationship between the segments within the sequences is expressed by the vowel-to-sequences ratio.

The addition of SA to quantity in Stockholm Swedish increases the temporal distance, e.g. in terms of the segment-to-sequence ratio, between the two types of VC-sequences. Thus the temporal contrast for perception is well maintained or even enlarged.

References

- Bannert, R. (1976): Mittelbairische Phonologie auf akustischer und perzeptorischer Grundlage. Travaux de l'Institut de Linguistique de Lund X, B. Malmberg and K.Hadding (eds), Lund: Gleerup.
- Bruce, G. (1977): Swedish word accents in sentence perspective. Travaux de l'Institut de Linguistique de Lund XII, B.Malmberg and K.Hadding (eds), Lund: Gleerup.
- Gårding, E., O. Fujimura, H. Hirose, and Z. Simada (1975): Laryngeal control of Swedish word accent. Working Papers 10, 53-82. Phonetics Laboratory and Department of General Linguistics, Lund University.
- Lehiste, I. (1970): Suprasegmentals, Cambridge, Massachusetts: MIT Press.
- Lindblom, B., B. Lyberg, and K. Holmgren (1976): Durational patterns of Swedish phonology: Do they reflect short-term memory processes? Mimeographed. Department of Phonetics, Stockholm University.