

## Durational correlates of quantity in Swedish, Finnish and Estonian: data from spontaneous speech

Olle Engstrand and Diana Krull  
Institutionen för lingvistik  
S-106 91 Stockholm, Sweden

### ABSTRACT

Audio recordings of lively conversational speech produced by three Swedish, four Finnish and three Estonian speakers were analyzed for durational correlates of quantity distinctions. The data suggested that duration contrasts are maintained more consistently by Finnish and Estonian than by Swedish speakers. This is attributed to the unusually complex structure of the Finnish and Estonian quantity systems, and to the fact that Finnish and Estonian, in contrast to Swedish, do not use vowel quality or diphthongization as correlates to quantity distinctions.

### INTRODUCTION

Finnish and Estonian quantity differs from Swedish quantity in the following respects (see Engstrand & Krull, in press, for details): 1) *Complexity, distribution*. Swedish uses two combinations of long and short segments in the VC domain (V:C, VC:) whereas Finnish uses all four possible combinations. In Swedish, this contrast occurs only in lexically stressed syllables whereas it appears in both stressed and unstressed positions in Finnish. Estonian uses a hierarchical system in which three syllabic quantity degrees, Q1-Q3, are made up of various combinations of three segment lengths. 2) *Phonetic correlate*. In Finnish and Estonian, quantity contrasts are mainly based on duration while Swedish quantity is also correlated to vowel quality and diphthongization. In the present experiment we asked the question whether contrasts on a highly exploited feature dimension, such as the Finnish and Estonian quantity dimensions, would on the whole require more precise signal information than contrasts on a less exploited dimension such as the Swedish quantity dimension. In other words, do Finnish and Estonian speakers tend to preserve the durational correlate of quantity to a greater extent than do Swedish speakers?

### METHOD

The subjects were three male native speakers of Central Standard Swedish, four female native speakers of Finnish, and three native speakers of Standard Estonian (two female, one male). Lively conversations were recorded, digitized and measured for segment durations in lexically stressed syllables of content words.

### RESULTS

Figure 1 shows box-whisker graphs (Velleman & Hoaglin, 1981:65f) representing the duration data for short and long vowels and consonants for the Swedish subjects (note differences between scales).

The dispersion is large as usual in conversational speech, but there is a clear effect of phonological length: long vowels have greater durations than short vowels ( $p < 0.001$  for all speakers, Mann-Whitney U-test), and long consonants have greater durations than short consonants ( $p < 0.001$  for RL,  $p < 0.01$  for JS, and  $p < 0.05$  for AV). The data thus display a complementary pattern VC: vs. V:C.

Duration data from Finnish VC: and V:C sequences are shown in Figure 2. To save space, only three of the four speakers are shown. Again, the dispersion is considerable, but vowel and consonant durations are clearly correlated with phonological length: long vowels have greater durations than short vowels, and long consonants have greater durations than short consonants. These differences are highly significant ( $p < 0.001$ ). In general, the contrast between V:C and VC: sequences is seen more clearly

in the Finnish than in the Swedish data. The relatively clear separation between the durations of the long and short segments also holds between VC and V:C sequences (not shown in the figure). Consequently, VC has shorter duration than V:C ( $p < 0.001$ ) whereas the ratios in these combinations are fairly similar.

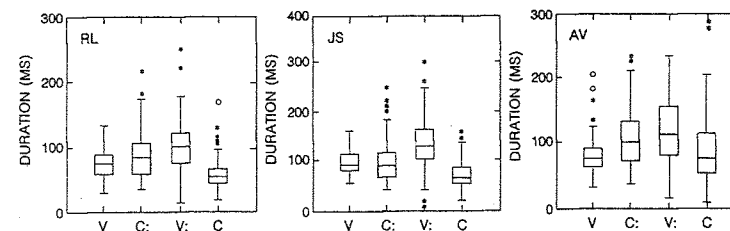


Fig. 1. Duration of short and long Swedish vowels and consonants. Speaker RL: n=85, 85, 98, 98; JS: n=73, 73, 89, 89; AV: n=79, 79, 101, 101.

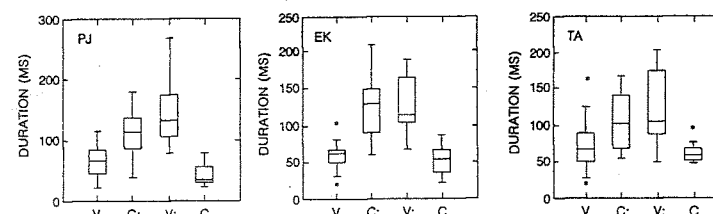


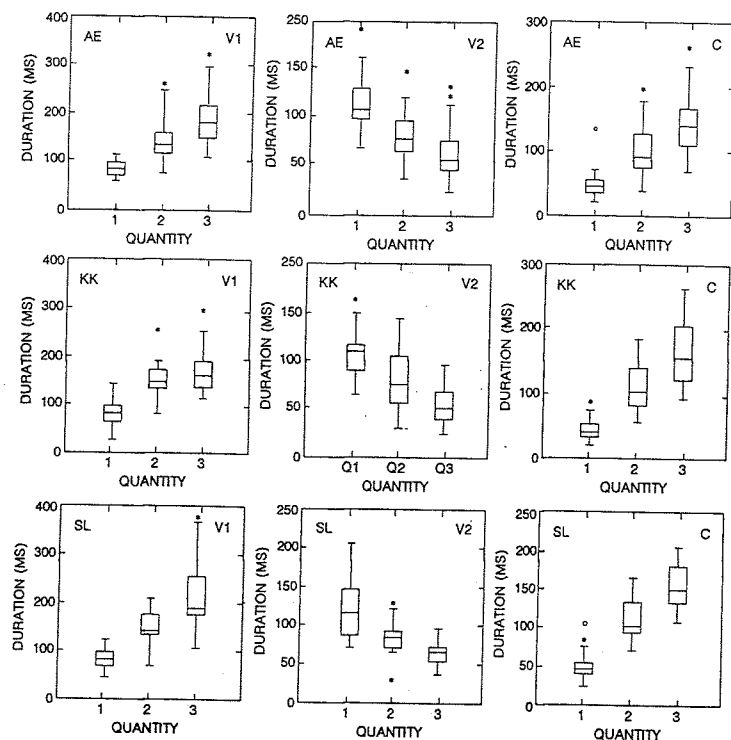
Fig. 2. Duration of short and long Finnish vowels and consonants in VC: and V:C sequences. Speaker PJ: n=24, 24, 11, 11; EK: n=13, 13, 13, 13; TA: n=18, 18, 7, 7.

The Estonian data are shown in Figure 3. Rows correspond to speakers and columns to measures. The left column illustrates the durational increase in the first vowel of vowel-consonant-vowel sequences as an effect of increasing phonological length (VCV, VCCV, VVCCV). The middle column shows the opposite effect on the second vowel; note the complementary distribution in these measures. All these effects are quite evident and statistically significant for all three speakers ( $p < 0.001$  in most cases except the differences in V1 and V2 between Q2 and Q3 for speaker KK [middle row of Figure 3] where  $p < 0.05$  and  $p < 0.01$ , respectively). The duration of the middle consonant (not shown in the figure) does not change to any considerable extent across these vowel quantity conditions. The right column illustrates the durational increase in the consonant of vowel-consonant-vowel sequences as an effect of increasing phonological length (VCV, VCCV, VCCCV). Again, these effects are clearly seen and highly significant for all three speakers ( $p < 0.001$ ). These consonant differences are accompanied by V2 differences that are comparable to those shown in the middle column. The duration of V1 does not change to any appreciable extent.

Duration ratios for the three languages can be compared in Figure 4 in the order Swedish, Finnish and Estonian from top to bottom. The Swedish and Finnish ratios both represent VC: and V:C sequences and are thus directly comparable. The differences between these ratios are highly significant for all speakers of both languages ( $p < 0.001$ ).

Furthermore, the V/C: and V:/C ratios are better separated in the Finnish than in the Swedish data; the pooled differences between the Swedish and the Finnish V/C: ratios and the Swedish and the Finnish V:/C ratios are both highly significant ( $p < 0.001$ ).

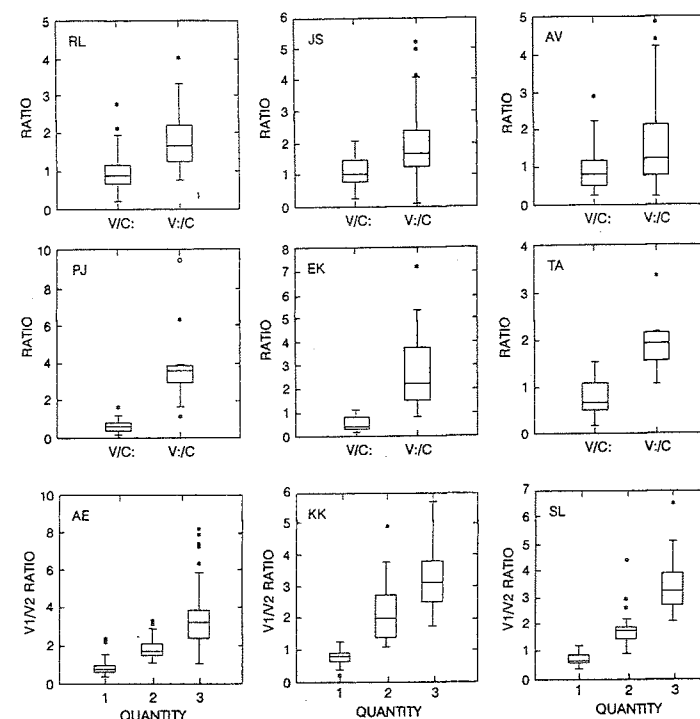
The bottom row shows effects of quantity degree on Estonian V1/V2 ratios. These ratios represent the net result of the marked complementary distribution of the V1 and V2 durations seen in Figure 3. The ratios therefore separate quantity degrees better than the durations of V1 or V2 taken individually. The separation between the quantity degrees is very clear and highly significant for all measures ( $p < 0.001$ ).



**Fig. 3.** *Left two columns:* Duration of first and second vowels (V1, V2) in Estonian VCV, VVCV and VVVCV sequences. Speaker AE: n=48, 45, 64; KK: n= 29, 26, 24; SL: n= 26, 22, 22. *Right column:* Duration of intervocalic consonant in VCV, VCCV and VCCCV sequences. Speaker AE: n= 48, 42, 45; KK: n=29, 28, 36; SL: n= 26, 16, 27.

### CONCLUSION

We conclude that our data support the view, stated in the introduction, that contrasts on a highly exploited feature dimension, such as the Finnish and Estonian quantity dimensions, would on the whole require more precise signal information than contrasts on a less exploited dimension such as the Swedish quantity dimension. This is compatible with results presented in Engstrand (1986) and could also be taken to support Lindblom's principle of "sufficient contrast" according to which the speaker uses only the amount of articulatory precision necessary to guarantee the listener's lexical access in any given situation (Lindblom, 1987).



**Fig. 4.** *Top row:* V/C: and V:/C ratios for the Swedish speakers. *Middle row:* V/C: and V:/C ratios for the Finnish speakers. *Bottom row:* V1/V2 ratios for the Estonian speakers. From left to right: Q1, Q2, Q3. Further explanation in text.

### ACKNOWLEDGMENTS

This work was supported in part by the Swedish Council for Research in the Humanities and Social Science (HSFR) and by the National Board for Technical Development (STU).

### REFERENCES

- Engstrand, O. 1992. Durational correlates of quantity in Swedish and Finnish: Data from natural speech. In D. Huber (ed.), *Fonetik-92: Papers from the Sixth Swedish Phonetics Conference held in Gothenburg, May 20-22, 1992.*, 47-50.
- Engstrand, O. & D. Krull. Durational correlates of quantity in Swedish, Finnish and Estonian: cross-language evidence for a theory of adaptive dispersion. *Phonetica*, in press.
- Lindblom, B. 1987. Adaptive variability and absolute constancy in speech signals: two themes in the quest for phonetic invariance. *Proceedings of the XIth ICPHS, Tallinn, Estonia, August 1-7, 1987*, Vol. 3, 9-18.
- Velleman, P. & D. Hoaglin. 1981. *Applications, basics, and computing of exploratory data analysis*. Boston, Massachusetts: Duxbury Press.