

## ACOUSTIC CORRELATES OF VOWEL QUANTITY CONTRASTS IN AN ITALIAN DIALECT

A. Uguzzoni\* and M. G. Busà\*\*

\*Istituto di Glottologia, Bologna, Italy

\*\* Dipartimento LLSM, Bologna, Italy

### ABSTRACT

This paper examines the issue of vowel quantity contrast in a northern Italian dialect in the light of a typology of so-called quantity languages. The results show that in this Italo-Romance variety the quantity contrast has the stressed vowel segment as its domain. The short vowels are less than half the duration of the long vowels, which indicates that this ratio is the main cue for the contrast. Some spectral variation is dependent on the long-short distinction.

### INTRODUCTION

It is a widespread belief that Italo-Romance languages lack vowel quantity contrasts. Our previous studies, though limited to the northern Italian dialects of Emilia, led us to a different opinion. A preliminary phonological interpretation of the large vowel inventory found in a dialect of the Frignano area was proposed. In stressed syllables thirteen vowels are used distinctively: the nine long vowels /i, y, u, e, ø, o, ε, ɔ, a/, and the four short vowels /e, ø, ɔ, a/. This analysis received later some instrumental support. A first research was focussed on the durational differences between the long segments /e, ø, ɔ, a/, and the short segments /e, ø, ɔ, a/ [1]. In a following research the spectral properties of all the thirteen phonemes of the system were examined, but the paper discussed only the formant frequency patterns of the nine long phonemes [2].

These early studies raised several questions which require further experimental investigation and discussion. Firstly, it seems important to establish whether and to what extent quantity contrasts exist in an Italo-Romance variety. Another issue concerns the position of this northern Italian dialect within a typology of so-called quantity languages. A further problem is to propose a hierarchy among the

multiple factors serving as cues for the Frignanese speaker-listener.

To this purpose, the present study investigates the acoustic correlates of the quantity contrasts in the dialect, with particular regard to the temporal and spectral parameters. The first aim is to determine the magnitude of the duration of long and short stressed vowels and the possible durational differences in the consonant following the long/short stressed vowel, to establish whether the domain of the quantity contrast is the vowel segment or the VC sequence. A second objective is the analysis of the spectral differences between the long and corresponding short vowels, and their location in the vowel space of the dialect.

### DATA AND METHODS

The speech material presented here includes both monosyllabic and disyllabic meaningful words stressed on the first syllable; the target vowels are /i, y, u, e, ø, o, ε, ɔ, a/, e, ø, ɔ, a/ and occur in the context of different prevocalic consonant and constant postvocalic consonant, i.e., an alveolar lateral /l/ of the common voiced approximant type. The choice of this corpus was due to the decision of using only meaningful words and reducing the number of variables to simplify the present analysis. The limitations on the distribution of certain vowels in the dialect makes it difficult to find minimal and/or quasi-minimal pairs containing all the vowels under study and forced us to choose the lateral consonant as a postvocalic context. On the other hand, the context which was kept constant was that of the postvocalic consonant, since the duration of the stressed vowel is commonly held to be more affected by the following than the preceding consonant.

The words were put in a carrier sentence and spoken two times by three male native speakers of the dialect. The recordings took place in the subjects'

homes in reduced noise conditions, using a Uher professional tape recorder and monodirectional microphone. The data were analyzed on the 14 bit Sensimetrics SpeechStation system, sampled at 10kHz. Measurements were taken of the stressed vowels and postvocalic consonants durations from both spectrograms and waveforms. For the formant values for F1, F2 and F3, LPC spectra with order 10 were computed in the middle of each vowel.

### RESULTS

#### Durations

The measurements on vowel durations indicate that the speakers of the Frignanese speakers make a very clear distinction between the long vowels /e, ø, ɔ, a/, and the short vowels /e, ø, ɔ, a/. As can be seen from Table 1, the mean short vowel durations are less than half the mean long vowel durations in both CVCV and CVC structures. Vowels have shorter durations in disyllabic than in monosyllabic words, conforming to a common tendency in world languages [3]. Note that this shortening occurs to a similar extent for both short and long vowels, and therefore the V/V: ratio is unaffected.

Table 1. Mean durations in ms and V/V: ratio of the short and long vowel pairs.

	Short	Long	V/V:
CVCV	100.3	209.6	46.13
CVC	119.7	245.9	46.33

Differences in the mean values of the V/V: ratio by vowel type and word structure were found. These are reported in Table 2. In general, the V/V: ratios vary with degree of vowel height. It can be observed that in CVCV words the ratios are smaller for the mid high than for the mid low and low vowels and in CVC words the ratio for the low vowel is the largest. This is explainable if one considers the absolute vowel duration values in relation to the height dimension. As an example, in CVCV words, the vowel having the shortest intrinsic duration ranges from 78 ms (in /e/) to 220 ms (in /a/), while the vowel with the longest intrinsic duration ranges from

122 ms (in /a/) to 225 ms (in /a:/), so that the V/V: ratio increases along the high-low dimension.

Table 2. Mean values of V/V: ratio by vowel type and word structure.

	e/e:	ø/ø:	ɔ/ɔ:	a/a:
CVCV	36.56	40.00	55.17	55.56
CVC	44.79	43.39	43.23	64.47

We looked for possible correlations between the absolute duration values of all the thirteen vowels and the quality differences along the high-low, front-back and round non-round dimensions. Systematic correlations were found only for the high-low dimension, exemplified in Table 3 only for disyllables. The vowel duration values, grouped in sets by degree of height, show that, for both long and short vowels, vowel duration increases from the high to low series. These data are in agreement with the well established phenomenon of intrinsic vowel duration [3, 4].

Table 3. Mean durations of all vowels, in sets, in CVCV structure.

Long		Short	
/i: y: u:/	201.8		
/e: ø: o:/	206.3	/e ø/	81.3
/ε: ɔ: /	211.4	/ɔ/	116.7
/a:/	225.2	/a/	122.0

The data of the single subjects show some interspeaker variability in the absolute vowel duration values. In short, there are greater temporal differences between our three subjects in their production of long than of short vowels. Though limited, these data seem to suggest that the short vowels display a relative stability with respect to the long vowels.

With regard to the duration of the consonant following the four pairs of long/short stressed vowels, our previous study [1], based on one subject, showed different duration values for the target consonant in the CVCV vs. the CVC structure: the C/C: ratio resulted negligible in disyllables while it was

.77.75 in monosyllables, so that long vowels were followed by relatively short consonants, and short vowels by relatively long consonants. The present data confirm the observation for the consonants occurring in the CVCV structure, where the C/C: ratio is around .100. For the consonants in the CVC structure the C/C: ratios for the three subjects are very different: for one subject it is .81.29, while the other two subjects have larger ratios. In this case no generalization can be made.

### Vowel quality

The analysis of the spectral properties of the Frignanese vowels has revealed a certain amount of variation in formant frequencies between the long and short vowels. The data relating to the mean differences in F1 and F2 are visualized in Fig. 1. It can be observed that, for F1 of all the vowels, the three subjects exhibit, though to a different extent, the same tendencies. For F2, subjects SG and RI show a similar pattern, while subject GB behaves in a very different way for the vowel pair /ø:/, ø/, as can be seen from the direction of the bars in Fig. 1. The figure also illustrates how the spectral characteristics differ systematically from vowel to vowel. For F1, the subtraction value is positive for /a:, a/ and negative for the other pairs. This indicates that the durational distinction affects the F1 values of short vowels so that they are smaller in /a/ and larger in /e, ø, ɔ/ than in the corresponding long vowels. For F2, the variation from long to short is more remarkable in /e, ø, ɔ/ than in /a/: with the mentioned exception of GB there is a decrease in frequency for the front vowels /e, ø, a/ and an increase for the back vowel /ɔ/. The effects of duration on the quality of the four vowel pairs can be seen also in Fig. 2.

For representing the data in the formant chart, the F1 and F2 values were converted into Mel using the formula given by Fant [5]. Fig. 2 shows the location of the four vowel pairs in the thirteen-vowel system of the dialect for two of the subjects. The quality variation due to duration is found on both the F1 and F2 axes. For the high-low dimension, a comparison of the short and long members of the pairs shows a lowering of

the vowels /e, ø, ɔ/ and a raising of /a/. It is interesting to note that short /e/ lowers to such an extent that it approaches the quality area of long /e:/. As concerns the front-back dimension, the short vowels /e, ɔ/ centralize with respect to their long counterparts; the shift in F2 for the pair /a:, a/ is minimal. Subject GB's divergent behavior regarding the vowel pair /ø:/, ø/ can be observed also in the formant chart. While for SG short /ø/ has a smaller F2 value than long /ø:/, for GB the formants shift in the opposite direction.

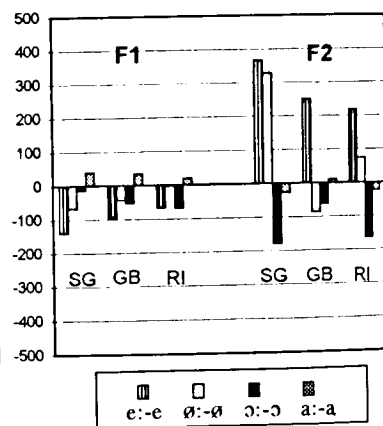


Figure 1 Differences in mean formant frequencies for the pairs of long/short vowels by the three subjects. Values of vowels in CVCV and CVC structures are averaged and expressed in Hz.

### DISCUSSION

The main findings of our research on the acoustic correlates of the vowel quantity contrasts in the Frignanese dialect examined are the following. There is a considerable distinction between the long and the short vowels, which is constant and independent of speakers, vowel type and word structure. With regard to the postvocalic consonants, their duration appears to be unvaried in disyllables, but somewhat variable and speaker dependent in monosyllables. The vowel durational differences are accompanied by spectral differences, which vary in extent according to vowel type.

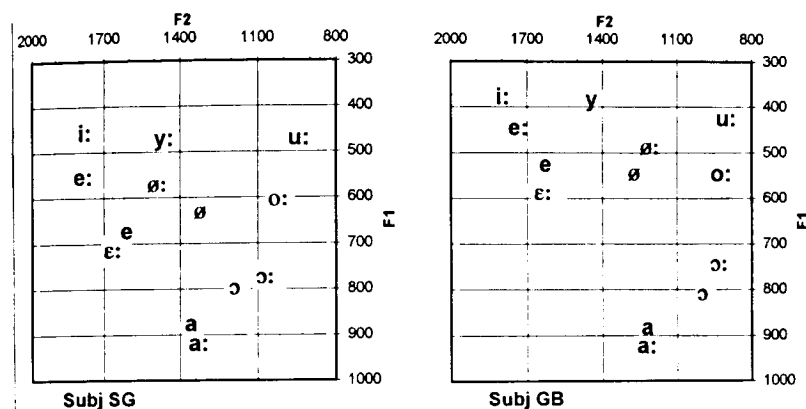


Figure 2. Mean F1 and F2 formant frequencies for the thirteen-vowel system (two subjects). Values of the vowels in CVCV and CVC structures are averaged and expressed in Mel.

On the basis of our production data, a tentative conclusion can be drawn as to which acoustic correlate is most important for the quantity contrast. It seems unquestionable that the crucial factor is the vowel duration distinction, the other two factors being additional. Qualitative vowel variation is dependent on the long/short distinction, like in many languages [4]. As for consonant duration, the fact that two different patterns were found for the two word structures poses a problem of interpretation. Of course we are aware that, to determine the actual hierarchy of importance among the phonetic factors serving as cues for the Frignanese speaker-listener, perceptual experiments are needed.

Finally, at a more general level of discussion, it is worth adding some concise remarks. As far as the data analyzed are representative of this dialect of the Frignano area, the results of the present study support our early hypothesis that this Italo-Romance variety is a quantity language. We attempt a brief definition of the Frignano-specific characteristics in the framework of the languages which make contrastive use of durational differences. Our analysis seems to suggest that the domain of the quantity contrast in the dialect is the vowel segment. There is a two-way quantity

contrast which is found only between vowels occurring in stressed syllables. The durational distinction applies only to some phonemes of the thirteen-vowel system, that is, the four pairs /e:, ø:, ɔ:, a:/ and /e, ø, ɔ, a/. So, the qualities of the four short vowels are a subset of the qualities of the nine long vowels [6]. The short-to-long ratio is about 46 (i.e., 1:2.1) in both CVCV and CVC structures, which classifies this dialect among the languages having strong vowel quantity contrast.

### REFERENCES

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