THE EFFECT OF SYLLABLE STRUCTURE ON VOWEL DURATION

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ABSTRACT

This production study investigated the influence upon vowel duration of syllable structure and the postvocalic consonant. The results obtained showed a differential effect of syllable structure on the measured vowel durations as a function of the postvocalic consonant. The hypothesis that the amount of coarticulation between this consonant and the preceding vowel conditioned this effect was partially confirmed by the results.

INTRODUCTION

Vowels are elastic segments; they can be compressed and expanded by the influence of a large number of factors, including among others: the number and type of the surrounding consonants and the location of the syllable boundary \[7\] \[5\].

In this contribution we have investigated the sensitivity of vowel durations to two of these factors and their interaction: (a) the syllable structure and (b) the postvocalic consonant. The effects of these factors have been analysed separately in previous research, but their interaction has not received much attention.

The effect of syllable structure on the duration of vowels is well known. Vowel shortening in the class Elongated Syllable Vowel Shortening (CSV) by Maddieson [3] and the number of syllables can both be seen as a tendency towards an increase of the amount of coarticulation in the number of segments in a syllable and in those segments and syllables involved.

The syllable environment of the vowel also has an abscissa influence on its duration. Thus the postvocalic vowels. For example, the feature of voicing of this consonant exerts strong effects upon vowel duration; voiced consonants tend to lengthen the preceding vowel; whereas voiceless consonants tend to shorten the segment. Another phenomenon may also influence the duration of vowels: the amount of coarticulation. Fowler [1] pointed out that coarticulation reflect itself in the shortening of the segment that undergoes the effect of coarticulation.

As can be shown in figure 1, coarticulation is a function of the strength of the consonant. In this case, we refer to the parameter /m/ as it is in the word "prima". The respective F-values of the post-hoc comparisons between the vowels /e/ and /a/ in the word "peared" will coarticulate more strongly than the heterosyllabic /e/ in the word "peared". This may account for the vowel lengthening in the word "peared".

In figure 2 we present the durations of the vowels, pooled over repetitions, vowel type and subjects. Both main effects were significant at the 0.05 level. Syllable structure: F(1,9) = 31.27, Consonants: F(1,9) = 11.50. Shifting the syllable boundary to the right of /m/ did not existent (not significant at the 0.05 level) for the consonants /s/, /l/, /r/, /m/ and /s/. The respective F-values of the post-hoc comparisons between the vowels /e/ and /a/ in the word "peared" will coarticulate more strongly than the heterosyllabic /e/ in the word "peared". This may account for the vowel lengthening in the word "peared".

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Fig. 2 Mean durations of vowels as a function of the following consonant and the location of the syllable boundary

Klaassen-Don's [3] results. Only the durations of the vowels before /m/ did not follow the expected pattern, since despite its low coarticulatory measure found by Klaassen-Don [3], large syllable structure effects were obtained. Our hypothesis on the relationship between coarticulatory strength and the effect of syllable structure on vowel duration clearly does not tell the whole story. Further research is needed to identify other factors also playing a role in the determination of vowel duration.

The same can said for the VC durations we measured. Other factors may play a role, and obscured tendencies as they are not equal in their effects for the different consonants involved. These factors are among others: the lengthening of /s/ when it is syllable initial, the influence of the following consonant in the tautosyllabic condition (cf. UmEda above mentioned expectation on the basis of vowel + consonant duration in figure 3.

DISCUSSION

We have investigated the effects of two factors: syllable boundaries and postvocalic consonants on vowel duration. The results of our experiment show main effects of both factors. Preconsonantal vowels are shorter in closed than in open syllables. These results are consistent with the closed vowel shortening hypothesis mentioned in the introduction. However, an interaction between the syllable structure and the postvocalic consonant was also observed. The size of the difference in vowel duration between the two types of syllable structure (hetro- and tautosyllabic consonants) was not constant for the four types of consonants examined. Indeed, as seen in three of the four consonants observed the size of this difference corresponded to the amount of coarticulation expected between the /l, v, n/ based on of coarticulatory effects, as assessed by Klaassen-Don [3]: the effect of /m/ is an exception we will discuss later.

Thus, all three effects under focus in this experiment, viz., syllable structure, consonant type and their interaction were found to have significant effects on the duration of preconsonantal vowels. We also measured the total duration of the vowel-consonant sequences. Figure 3 shows the durations of the VC-sequences, pooled over vowels, repetitions and subjects. Two main effects are significant at the 0.05 level: consonant (F(3,27) = 15.27) and vowel (F(1,9) = 5.52). The same can said for the VC durations we measured. Other factors may play a role, and obscured tendencies as they are not equal in their effects for the different consonants involved. These factors are among others: the lengthening of /s/ when it is syllable initial, the influence of the following consonant in the tautosyllabic condition (cf. UmEda above mentioned expectation on the basis of vowel + consonant duration in figure 3.

CONCLUSION

The results obtained in our experiment suggest the following tentative conclusion: coarticulation and timing phenomena are related, and coarticulation is sensitive to linguistic structure like syllable boundaries. These conclusions were derived from our observation that syllable structure has a different effect upon vowel duration depending upon the properties of the postvocalic consonant.

Our results show that to arrive at a proper characterization of the acoustic properties of speech, we cannot view speech simply as a linear concatenation of phonetic segments, but we must take into account its linguistic (i.e. structural) nature. Research in the perceptual domain has also revealed the importance of linguistic structure in determining subject's perception performance. For example, in a phoneme monitoring study [6], French subjects showed a preference for syllabic segmentation. When presented CV or CVC targets (like /ba/ or /ba1/) to detect in words whose initial syllable was this CV or CVC (like 'balance' or 'balcon') they reacted quicker when the syllable structure of the target matched that of the target-bearing word (as /ba/ or /ba1/). This production study represents a first step in identifying the acoustic cues supporting decisions about the identity of segments and syllables. We found that syllable structure influenced vowel duration to varying degrees depending upon the postvocalic consonant. The variability in the syllabic influence could have interesting consequences for studies in speech perception. In particular, since the syllable structure effect in French has only been tested with one class of consonants (liquids), it is important to establish whether this effect generalizes to other types of postvocalic consonants and syllables or whether it depends specifically upon the strong allophonic character of the vowels and liquids used. We are currently conducting phoneme monitoring experiments in French with the aim of determining the role of syllable structure in language perception.

BIBLIOGRAPHY