ON VOWEL QUANTITY AND POST-VOCALIC CONSONANT DURATION IN DUTCH

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ABSTRACT

In Dutch, CV:Cən words contain a long vowel in syllable-final position while CVCən words contain a short vowel followed by an ambisyllabic consonant. Our measurements indicate that the duration of the intervocalic consonant is not affected by the quantity of the preceding vowel or its differential status as a tautosyllabic or ambisyllabic consonant. Instead, the duration of the second syllable is inversely affected by the duration of the vowel in the first syllable. These results are discussed in terms of the differential moraic representation of words containing long and short vowels.

1. INTRODUCTION

Durational properties of the speech signal have been well-studied for a variety of languages, including English, Swedish, Estonian, and Dutch. Factors known to influence segment and word durations range from phonetic and phonological factors up to syntactic and semantic factors. In this paper, we will concentrate on some phonetic and phonological factors influencing segment durations in Dutch. In particular, we will focus on the durational properties of minimal word pairs containing long and short vowels. Dutch has a phonemic vowel length contrast, as illustrated by the nouns 'taak' ([ta:k], 'task') versus 'tak' ([tak], 'branch'). In Dutch, long vowels can occur in both open and closed syllables whereas short vowels occur only in closed syllables. When these nouns are pluralized by adding the suffix '-en', 'taken' ([ta:kən]) is said to consist of a first open syllable [ta:], containing the long vowel [a:] and a second syllable [kən] with a tautosyllabic [k]. On the other hand, 'takken' ([takən]) consists of the closed syllable [tak], containing the short vowel [a] and is closed by a so-called ambisyllabic [k]. In metrical phonology, these words would be represented as shown in Figure 1.

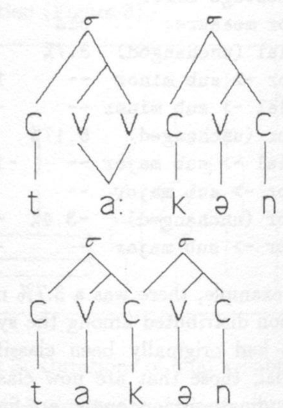

FIGURE 1: Metrical representation of 'taken' (top) and 'takken' (bottom).

The long [a:] in 'taken' is represented by two vowel slots on the CV tier. For 'takken', short [a] is represented by one vowel slot while the ambisyllabicity of medial [k] is reflected by the fact that it is attached to both the first and second syllable.

Given this difference in phonological representation between tautosyllabic and ambisyllabic medial consonants, one could ask whether this phonological contrast would surface as a phonetic difference in terms of consonant duration. In fact, our interest was triggered by a figure in the standard textbook on Dutch phonetics ([3]), reproduced here as Figure 2.

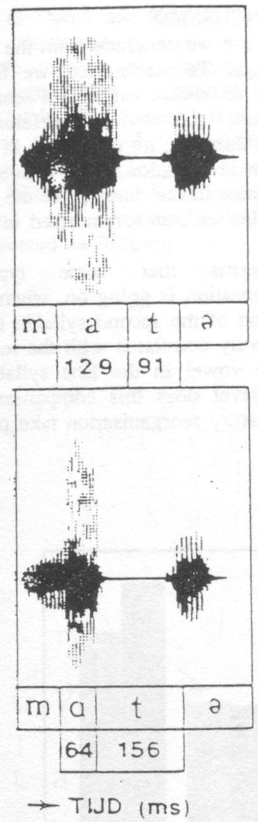

FIGURE 2: Waveforms of 'mate' (top) and 'matte' (bottom) and the relevant segment durations. (Figure taken from [3], p. 126, with permission from the authors).

This figure shows the waveform of 'mate' [ma:tə] in the top panel and that of 'matte' ([matə]) in the bottom panel. The ambisyllabic [t] in 'matte' is much longer in duration than the tautosyllabic [t] in 'mate'. In fact, this figure suggests that the total duration of V plus C is constant for both the short and long vowel word, indicating a compensation whereby the consonant is lengthened by the same amount that the vowel is shortened. Nooteboom's dissertation [2] also reported differences in Dutch nonwords of the type 'papápap' versus 'pa:pá:pa:p'. Nooteboom found that the ambisyllabic consonant following the stressed short vowel was significantly longer (approximately 10 ms) than the tautosyllabic consonant following the stressed long vowel.

Given these intriguing findings, we felt that a closer look at these effects was warranted using additional minimal word pairs.

2. METHODS

Thirty-two test words (16 minimal pairs) were selected. These word pairs contained four long-short vowel pairs which have minimal spectral differences ([a:]-[a], [o:]-[o], [e:]-[I], and [ø:]-[œ]). These words were embedded in a carrier phrase in randomized order. Five speakers (three males, two females) were then recorded on a DAT-recorder. The test words were digitized at 10 kHz, and segment durations (initial consonant 'C1'; stressed vowel; medial consonant 'C2'; and second-syllable '-en') were then measured from a graphics display terminal, using standard visual and auditory criteria. All segment durations represent average values across all speakers and test words.

3. RESULTS

No significant differences in the duration of the medial consonant were found between long and short vowel word pairs. Contrary to earlier findings, there was no difference in duration between the ambisyllabic consonant following a short vowel (99 ms) and the tautosyllabic consonant following a long vowel (101 ms).

Since there was no difference between medial consonants, one might expect that the difference in total word duration between words like 'taken' and 'takken' would simply amount to the difference in duration between long [a:] (176 ms) and short [a] (82 ms). Interestingly, however, this turned out not to be the case: The mean difference in vowel duration is 94 ms, while the difference in word duration is only 68 ms. Thus, there is a discrepancy of some 26 ms which has to be accounted for. The question then is: where did this 26 ms go?

There was a small but reliable difference between long and short vowel words in the duration of the initial consonant. Initial consonants preceding long vowels were somewhat longer (81 ms) than those preceding short vowels (77 ms). However, this only increases the difference in total word duration between 'taken' and 'takken', so that we now have to account for a 30 ms difference.

The only remaining possibility was the second-syllable portion '-en'. The duration of '-en' turned out to significantly differ, depending on whether the first syllable contained a long or a short vowel. The duration of '-en' (179 ms) was longer when preceded by a first syllable containing a short vowel as compared to the duration of '-en' when preceded by a long vowel (147 ms).

4. DISCUSSION

What can we conclude from the present findings? To summarize, we found a small difference in initial consonant duration, an obvious difference in vowel duration, no difference in medial consonant duration, and a substantial difference in the duration of the second syllable '-en', as summarized in Figure 3.

It seems that some type of compensation is going on, where the duration of the second syllable is negatively correlated with the length of the vowel in the first syllable. At what level does this compensation or articulatory reorganisation take place?

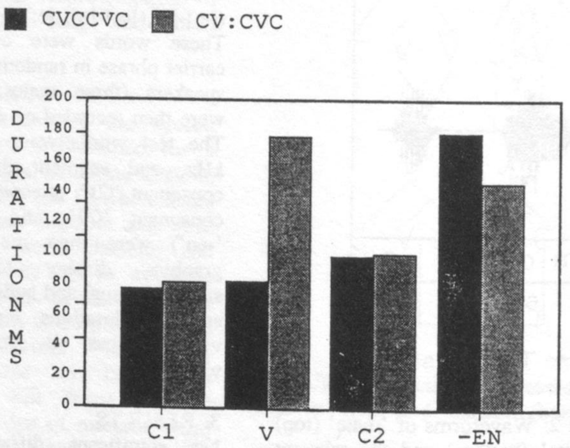

FIGURE 3: Segment durations in ms. Segment durations of words with short vowels and ambisyllabic consonants are represented by black bars while segment durations of words with long vowels and tautosyllabic consonants are represented by grey bars.

One way to gain some insight into these data may be to look at the moraic representation of these words. The mora is essentially a phonological unit involved in the determination of syllable weight, such that light syllables are represented by one mora and heavy syllables by two moras. This distinction in terms of syllable weight plays an important role in the assignment of word stress in languages such as Dutch and English. Although what counts as a heavy or a light syllable varies across languages, it has been argued that in order to account for Dutch word stress, one has to assume that closed VC syllables are heavier than open long vowel syllables [1]. Within this framework, then, 'taken' and 'takken' would be represented as follows:

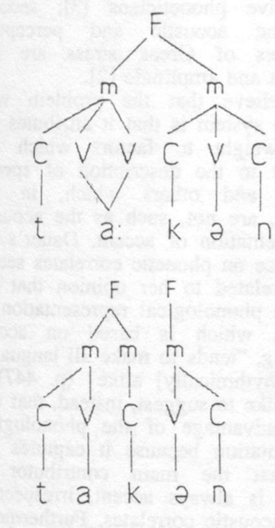

FIGURE 4: Moraic representation of 'taken' (top) and 'takken' (bottom). M indicates 'mora', F indicates 'foot'.

The long vowel in 'taken' is represented by one mora. The second syllable containing schwa is also represented by one mora. Together these two moras combine into one Foot. For 'takken', the first syllable is represented by two moras, and the second syllable by one mora. The two moras of the first syllable combine into one Foot, and the second syllable forms a Foot of its own. (While there is some controversy about the moraic representation of schwa, it is important to note that under any analysis of schwa, 'taken' and 'takken' would still differ in terms of moraic structure). At this level of representation, then, the difference between words like 'taken' and 'takken' becomes obvious: 'taken' consists of one foot, while 'takken' consists of two feet. The puzzling effect of '-en' duration can now be described as follows: the stressless Foot of 'takken' is longer in duration than the weak branch of the Foot in 'taken'. In other words, the longer duration of '-en' when following a first syllable with a short vowel may be due to the fact that in this case '-en' forms an independent Foot.

At present, very little is known about the effect of metrical foot structure on phonetic segment duration, since it is very difficult to find minimal word pairs in terms of foot structure while keeping the phonetic context the same. The present results, where the same syllable is longer in duration when preceded by a heavy syllable relative to a light syllable, at least seem to suggest that foot structure may systematically affect segment durations.

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