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Aspects of the timing of fundamental frequency in German chanted call contours

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This investigation examines the timing of the transition between two intonational targets with respect to syllabic borders. As an exemplary pattern the chanted call contour has been chosen. The results reveal that the transition occurs earlier in CV:.CV structures than in CVC.CV structures, when calculated from the end of the vowel. A third timing pattern occurs in CVCV structures. The possibility that this 'third way' is connected to the status of ambi-syllabicity is discussed.

1. Introduction

In this paper we present data from a preliminary investigation on f0 timing in the `chanted call' contour. The chanted call is an intonation pattern that exists functionally and formally similar in several languages. Ladd (1996) provides the following description:

"In many European languages, in certain situations, people who are some distance away from a speaker can be called or hailed using a chanted tune on two sustained notes, stepping down from a fairly high level to a somewhat lower level." (p. 136)

We are mainly interested in how syllable borders and the segmental structure take influence on the timing of the f0 contour. The chanted call is an exemplary pattern that we hope will be useful for the investigation of text-tune associations in general, and for cross-linguistic comparisons in particular. It is reasonably stable in its form and function across languages, easy to elicit and even elicitable with different levels of emphasis. Though we aim at cross-linguistic comparisons and a more general picture of text-tune associations in the long run, we will here only present German data.

The formal side of the chanted call is described by Ladd (1996) as a (L)H*!H succession. This autosegmental-metrical notation refers to an optional low tone, a high accentuated ('starred') tone, followed by a downstepped high tone. The L-tone falls on any pre-nuclear syllable, the starred tone is associated with the nucleus. The !H falls on the last syllable if there is only one syllable after the nucleus. In other contexts, the alignment of the !H is more variable. These cases are not discussed here, as the material of the current investigation is restricted to bi-syllabic trochaic words.

2. Aims and Hypotheses

In the present investigation we focussed on the precise timing of the transition of the H* tone to the !H tone. We wanted to know whether this transition is aligned with the syllabic border, as for example predicted by the model of Xu (2002). We therefore investigated bi-syllabic words containing three different types of syllabic composition: long vowels followed by a single consonant (CV:.CV), short vowels followed by two consonants, one of them associated with the next syllable (CVC.CV) and short vowels followed by a single consonant (CV<u>C</u>V). For German, a single consonant after a short vowel is often analysed as short but ambi-syllabic (this possibility is here symbolised as <u>C</u>). If the transition from the first to the second tone is aligned to the syllabic border, one would expect the following timing difference: In a CV:.CV structure the transition should occur close to the end of the long vowel, while in a CVC.CV structure the transition should occur close to the end of the post-vocalic consonant. In view of the measurements, the hypothesis can be formulated in a strong and in a weak form. In the strong form, one would expect that the distance between the tonal transition and the end of the syllable should be equal across the categories. In the weak form, one would expect at least differences in the distance between the transition and the end of the vowel, as the end of the vowel coincides with the end of the syllable in CV:.CV structures but not in CVC.CV structures. Measured from the end of the vowel, the transition should thus occur earlier in CV:.CV structures than in CVC.CV structures.

It is important to note that the hypothesis can only be tested with those two structures where the syllabic border coincides with segmental borders (CV:.CV and CVC.CV). The CV<u>C</u>V structure was included to see whether the timing of the f0 contour provides evidence for the ambi-syllabic status of the consonant. But conclusions concerning ambi-syllabicity can only be drawn if the other two structures provide strong evidence that the timing of the tonal transition is in fact aligned to the syllabic border.

3. The Experiment

3.1. Material

The material was part of a larger corpus. The part of the corpus used in this study has been designed in a way that comparisons with other languages will be easy to perform, above all comparisons with Swedish and Finnish. We used segmental contents and phonotactic structures that occur in similar forms in German, Swedish and Finnish. Furthermore, we tried to find target words that are or at least resemble proper names or pet names to make the task more natural for the subjects.

All words are composed of an initial consonant, /m/ or /v/, followed by a long or short /i/ in the stressed syllable. This vowel is then followed by either a single consonant (always /n/) or a consonant cluster (/lm/ or /ns/). The final vowel in the unstressed syllable is /a/ or /e/. With that we have three categories with a number of different target words each:

<u>Category 1</u> (CV:.CV): Miena, Miene
<u>Category 2</u> (CVC.CV): Wilma, Wilme, Minsa
<u>Category 3</u> (CV<u>C</u>V): Minna, Minne

3.2. Subject and recording method

One female subject participated in the experiment. The recordings took place in an anechoic chamber of the Department of Phonetics (IPSK) at the University of Munich, Germany. The target words were presented in written form and randomised order. The subject was told that the words were pet names and asked to address the pet, which successfully evoked the `chanted call' intonation contour. Each word was uttered (or rather called) five times in a row, either in isolation or with the word 'kleine' (little) before the target word. This possibility was chosen to elicit the optional prenuclear L tone (which was not investigated here). It should have no impact on the tonal structure of the target word.

3.3. The localisation of the tonal transition

To test the hypotheses, it is necessary to detect a certain event of the f0 contour that represents the transition from the H* tone to the !H tone. Originally, we considered the maximum of the contour as the crucial event. It turned out, though, that the first tone of the contour is often realised as a high plateau where the precise location of the maximum is quite arbitrary. We therefore tried to find a method to determine the end of the plateau and chose a procedure successfully applied in Knight (2002): the end of a high plateau is defined as the point where the f0 contour reaches a value of 4% below the maximum. In the following, we will refer to the point determined by the 4% criterion as 'the beginning of the fall' (BOF).

4. Results

The results are based on 20 utterances of the CV:.CV category (10 x Miena, 10 x Miene), 20 utterances of the CVC.CV category (5 x Wilma, 5 x Wilme, 10 x Minsa) and 18 utterances of CV<u>C</u>V category (10 x Minna, 8 x Minne).

The three categories and the location of the BOF have been investigated with respect to two segmental borders, on both absolute and relative scales. First, we measured the distance between the BOF and the end of the stressed vowel (EOV). Second, we measured the distance between the BOF and the end of the consonant that followed the stressed vowel (EOC). Both distances were also measured in relative values with the total word length set to 100%. Table 1 shows the two distances in absolute and relative values.

Table 1: Absolute and relative mean distances between the BOF and two other events, the end of the first vowel (EOV) and the end of the postvocalic consonant (EOC). Standard deviations in brackets.

category	number of tokens	Δ BOF-EOV in ms	Δ BOF-EOV in %	Δ BOF-EOC in ms	Δ BOF-EOC in %
CV:.CV	20	24 (13)	4.5 (2.5)	37 (16)	6.9 (2.7)
CVC.CV	20	121 (25)	21.7 (3.3)	0 (15)	0.1 (2.8)
CV<u>C</u>V	18	41 (20)	8.6 (4.3)	42 (21)	9.2 (4.8)

For the statistical analysis, both means across the three categories were compared with a one-way-ANOVA. The absolute differences in Δ BOF-EOF were significant ($F=133.378$, $p<0.000$). A post hoc Tukey HSD test revealed significant differences between all three groups (CV:.CV vs. CVC.CV: $p<0.000$, CV:.CV vs. CV<u>C</u>V: $p=0.031$, CVC.CV vs CV<u>C</u>V: $p<0.000$). The most prominent structure is CVC.CV. Here, the BOF occurs much later after the end of the vowel than in the other two structures.

The absolute differences in Δ BOF-EOC were significant as well ($F=34.032$, $p<0.000$). The post hoc Tukey HSD revealed only significant differences between the CVC.CV structure and the other two structures ($p<0.000$ in both cases). The difference between CV:.CV and CV<u>C</u>V was not significant ($p = 0.635$).

The relative values were included to estimate potential speech rate effects. By and large, these results resemble the results of the absolute measurements. The BOF occurs again much later in CVC.CV structures, if measured from the end of the stressed vowel. There is a difference between CV:.CV and CV<u>C</u>V as well, but the effect is weaker. The same can be said about the relative values for Δ BOF-EOC. Here, as well, the BOF is much closer to the EOC in the CVC.CV structure than in the other two categories.

5. Discussion and Conclusion

Our investigation showed that the timing of the BOF is different in each of the three word structures. In its weak form our hypothesis has been confirmed. Viewed from the end of the first vowel, the BOF occurs earliest in CV:.CV structures, latest in CVC.CV structures and somewhere `in between' in CVC̲V structures. As for the hypothesis in its stronger form, we cannot claim that the BOF is precisely aligned with the syllabic border. To make such a claim, the distance between the BOF and the end of the vowel in CV:.CV structures would have to be much more similar to the distance between the BOF and the end of the coda consonant in CVC.CV structures. That is to say, one would expect that the absolute and/or relative values of ΔBOF-EOF for the CV:.CV words resemble the ΔBOF-EOC values for CVC.CV words. Table 1 shows that this is not the case.

Consequently, it is also hard to claim that the BOF timing provides evidence for the ambi-syllabicity of single intervocalic consonants after short vowels. The results show that there is a timing difference when compared to the other two structures. This timing difference does not contradict an ambi-syllabic interpretation, but the timing resembles much more that in the CV:.CV structure than that in the CVC.CV structure. This is most obvious with regard to the distance between the BOF and the end of the second consonant.

All of that suggests that there are other factors involved that control the timing of the transition between the two tones. The distance to the second vowel might be one of those factors. In CV:.CV and CVC̲V structures, the distance to the end of the second consonant (and thus to the beginning of the second vowel) is virtually equal. The speaker might try to keep a `minimal distance' to the second vowel in order to complete the contour and reach the lower value for the second vowel in time.

As to future investigations, we will look at how the BOF is aligned when the emphasis of the chanted call is systematically varied. Critical points in the alignment of the chanted call should show more clearly in experiments where changes in emphasis induce changes in the duration of the segments of the target words. There is already evidence that segment lengthening, e.g. under focus, is non-linear (see Heldner 2001) and we expect similar effects for the chanted call. This should also help to explore some more anchor points of the tune timing. Furthermore, we will transfer the chanted call pattern to other languages in order to find out whether syllabic structure types not found in German have different impacts on the timing.

6. References

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