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## ABSTRACT

Preliminary results show some influence of sentence length and focus related accent position on Fo-declination in read German declarative utterances. For the declination line linear regression lines have been computed. An additional measurement was made on the first Fo-maximum of each declining contour. The slope of the regression line decreases with increasing utterance duration, and the first Fo-maximum of long sentences is lower when the focal accent has been placed on the second Fo-maximum.

## 1. INTRODUCTION

During the last decade special attention has been paid again to a phenomenon of pitch behavior on sentence level, the so-called declination of the fundamental frequency contour and a simultaneous lowering of the peaks of accented syllables towards the end of declarative sentences. Depending on different types of investigations two general models explaining the phenomenon have been put forward. One refers to the underlying physiological mechanisms and thus tries to explain the phenomenon of declination by the decrease of the subglottal pressure [1], where-

as the other model - mainly found in acoustical and perceptual investigations - often assumes a "pre-planning" strategy of the speaker, which would explain the finding that at least in read sentences of different length in some languages, e.g. Danish, the Fo-onset increases and the steepness of the slope decreases with the duration of the utterance [4]. Similar relations are expected for German. Using varied utterance duration and focus related accent position, variations of the slope and of the first Fo-maximum as one starting point of Fo-contours are expected.

## 2. MATERIAL AND INFORMANTS

The material consisted of 36 simple sentences, divided into four blocks of utterance triples of different length (6, 10, and 14 syllables). Each block consisted of one short sentence amended twice with additional information at the end. This will be shown in the following:

- 1: *Morgen kommt Maria. ...*
  - 2: *... mit dem Auto. ...*
  - 3: *... nach Hannover.*
- Additionally different focal accent positions (1st, 5th, 9th, and 13th syllable) were posed on the utterance triples, contextually controlled by appropriate ques-

tions, e.g.:

- q: *Wann kommt Maria?*  
a: *Morgen kommt Maria.*
- Four tokens of all sentences were read aloud in random order by each of three male native German speakers who were students.

## 3. PROCEDURE

The recorded material was acoustically analysed with respect to the Fo-variation by means of an LPC-analysis. Best-fit all-points linear regression lines have been computed, as well as the mean Fo of each intonation contour. Additional measurements were made on the first Fo-maximum and the intersection between the regression line and the y-axis. The actual duration of each sentence in ms should give further information, and the offset was expected to keep a speaker-dependent equal level.

## Tab.1: FACTORS AND VARIABLES.

- F1: sentence length  
(short, medium, long)  
F2: accent position  
(2 in short, 3 in medium, 4 in long sentences)  
V1: slope of the regression line  
V2: first Fo-maximum  
V3: intersection of the regression line with the y-axis  
V4: mean Fo of the intonation contour  
V5: sentence duration

## 4. GENERAL RESULTS

Tab.1 shows the two factors and the five dependent variables used for the analysis. First a survey of overall means, illustrated by the figures, is given to show general trends. Then the factors have been statistically computed for each speaker separately. While the general behavior of the three speakers is quite

similar, there are some differences in detail. The design of the material required a "ONEWAY"-analysis. Since the analysis was calculated twice over the same data set, the significance level was lowered according to the "Bonferroni" procedure to  $\alpha=0.025$ . An a posteriori-test ("SCHEFFE") followed to find the significant differences between each of two variables within the same factor. Here the significance level was also lowered to the value  $\alpha=0.025$ .

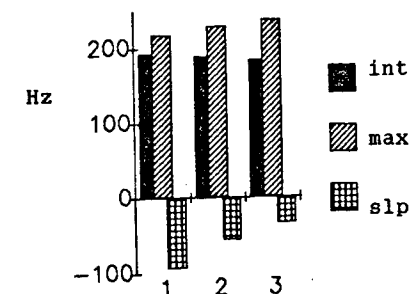


Fig.1: SENTENCE LENGTH means of intersection, first Fo-maximum and slope / 3 types of sentence length / 1 accent position on the 1st syllable / all speakers

4.1. Varied sentence length  
Here the accent position was always on the first syllable. As expected, Fig.1 shows a substantial decrease of the slope with increasing utterance length. There is a main effect for all informants:

- M:  $F(2,47)=61.2813$ ;  $P<.001$ ;  
J:  $F(2,47)=27.4799$ ;  $p<.001$ ;  
R:  $F(2,45)=54.3722$ ;  $p<.001$ .
- But there is only a weak increase of the first Fo-maximum as well as in the decrease of the intersection. The mean Fo of the intonation contours is not remarkable, and the duration in ms just illustrates the actual

duration of the linguistically varied sentences.

**4.2. Varied accent position**  
The slopes on Fig.2 to Fig.4 also decrease as the focal accent is moved towards the end of an utterance. But in the long sentences on Fig.4 a significant difference can only be detected between the earlier and the later accent positions:

M:  $F(3,62)=11.6998$ ;  $p<.001$ ;  
J:  $F(3,63)=3.6151$ ;  $p<.025$ ;  
R:  $F(3,61)=36.4458$ ;  $p<.001$ .

Accordingly to the decreasing slope the mean Fo of the declining contours increases significantly for each informant and ends up on a speaker-individual but equal level in all sentences.

The first Fo-maximum of Fig.3 and Fig.4 shows a peculiar, more or less speaker dependent lowering, when the accent has been placed on the 5th syllable (the second position). And it increases again as the accent is moved towards the end of an utterance.

The intersection does not show any notable variation, while the sentence duration in ms increases feebly with the accent at the end.

## 5. SOME INDIVIDUAL RESULTS

### 5.1. Speaker M

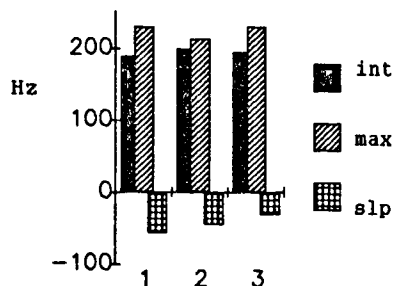
Regarding the first Fo-maximum speaker M does not show any main effect neither on the factor "sentence length" nor on the factor "accent position". Just when he produces the long sentences with focal accent on the second position the first Fo-maximum approaches a significant lowering  
( $F(3,62)=3.2015$ ;  $p=.0297$ ).

### 5.2. Speaker J

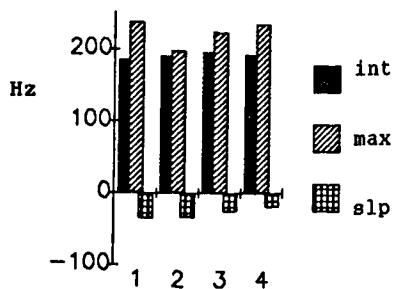
Speaker J does show significant differences on the first Fo-maximum when the



**Fig.2: ACENT POSITION (2)**  
means of intersection,  
first Fo-maximum and slope :  
short sentences / 2 accent  
positions / all speakers



**Fig.3: ACENT POSITION (3)**  
means of intersection,  
first Fo-maximum and slope :  
medium sentences / 3 accent  
positions / all speakers



**Fig.4: ACENT POSITION (4)**  
means of intersection,  
first Fo-maximum and slope :  
long sentences / 4 accent  
positions / all speakers

accent position is varied. In short sentences the first Fo-maximum increases significantly when the accent is placed on the second and thus on the last position

( $F(1,31)=9.4327$ ;  $p<.025$ ), and in long sentences the first Fo-maximum decreases extremely significant when the accent is placed on the second position

( $F(3,63)=9.2232$ ;  $p<.001$ ). Medium sentence length does not show any effect.

### 5.3. Speaker R

For speaker R both factors "sentence length" and "accent position" show a high influence on all variables. That is not valid for speaker M and J.

Concerning the first Fo-maximum, it is significant low with the accent on the second position in medium and long sentences

( $F(2,47)=6.9829$ ;  $p<.025$ ;  
 $F(3,61)=14.7907$ ;  $p<.001$ ), and there is, contrary to speaker J, a lowering tendency in short sentences with second accent position  
( $F(1,30)=5.2496$ ;  $p=.0294$ ).

## 6. DISCUSSION

So far as has been tested in this investigation, sentence length and focal accent position exercise influence on some parameters relating to the declination phenomenon. One of them is the slope of the declining contour, computed as a global all-points linear regression line. It decreases significantly with increasing utterance duration, and with varied accent position towards the end of an utterance. The first Fo-maximum only shows some significant effect with varied accent position. This means that, if the accent has a medium position the first Fo-maximum is lower than in the other cases. Concerning

varied sentence length the first Fo-maximum increases weakly but not significantly in longer utterances.

This investigation is a preliminary study which has not been totally completed yet. Hence one should be cautious about interpretation. It seems more important at this stage to point out problems remaining in this kind of analysis. One of them is the discussion about the use of an all-points linear regression line rather than a top-line or a baseline. The global regression line can be affected by a late focal accent and thus increases, while the declination contour decreases [2, 3].

Furthermore concerning this investigation, at the next stage all the focal accents must be cut off before computing linear regression lines, and then be measured separately. In this way one could obtain better information about the influence of varied accent position on the declination line.

## 7. REFERENCES

- [1] GELFER, C. (1987), *A simultaneous physiological and acoustic study of fundamental frequency declination*. Phil. Diss., CUNY, New York.
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