PRODUCTION OF BROAD AND NARROW FOCUS IN GERMAN — A STUDY APPLYING A QUANTITATIVE MODEL

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ABSTRACT

The present paper examines the influence of broad and narrow focus on the F_0 contours of short German utterances. The contours were analyzed using the Fujisaki-model in order to yield quantitative results. In utterances of statements, narrow focus boosts the accent command amplitude assigned to the focused item, which generally exhibits a clear accent peak. Secondary accents are reduced. The broad focus condition is characterized by accent merging. In utterances of questions, little influence of the focus condition on the accent command amplitude was observed which may be assigned to the fact that question-final accents generally exhibit higher accent command amplitudes than statement-final ones. The phrase command amplitude in narrow focal conditions is reduced compared with the broad focal condition.

1. INTRODUCTION

In German the 'sentence accent' and the 'focus' of an utterance are strongly interrelated. By 'sentence accent' we mean the last accent in the utterance which is generally the semantically most important. The term 'focus' [1, p.267ff.] describes the semantic concept, by which parts of a sentence, single words or even syllables receive more prominence than others. This concept also applies to isolated sentences, where it is gouverned by the syntactic relationship between the constituents.

In a discourse the focus may be determined by the context preceding an utterance. 'New' information is contrasted with 'old' information, i.e. background information which is not necessarily given explicitly, but may be tacit knowledge of the speakers or even common sense. The salient part of a message, which is also called the 'focus domain', is marked by placing the sentence accent on a word belonging to it, the 'focus exponent' [2]. Depending on the extent of the focus domain it is called a 'broad' or 'narrow' focus, the former extending over more than a single content word.

2. SPEECH MATERIAL AND METHOD OF ANALYSIS

The experiment uses 10 versions of a sentence with declarative word order which can be uttered either as a statement or an echo-question: "Sie haben den Wagen geliehen"—"*They (have) rented the car*". The sentence was designed using voiced sounds only to produce a continuous F_0 contour.

Table 1. Conditions of intended sentence mode and focus examined.

No.	focus domain	focus	sent.mode
1	'sie'	narrow	statement
2	'Wagen'	narrow	statement
3	'geliehen'	narrow	statement
4	'sie'	narrow	question
5	'Wagen'	narrow	question
6	'geliehen'	narrow	question
7	'den Wagen geliehen'	broad	statement
8	'einen Wagen geliehen'	broad	statement
9	'den Wagen geliehen'	broad	question
10	'einen Wagen geliehen'	broad	question

The various versions were produced by embedding the target sentence into short contexts to elicit the intended focus and sentence mode (statement/echo-question).

In versions 1 to 6, narrow focus was placed either on 'sie', 'Wagen' or 'geliehen'. The context creates a contrast between the target sentence and a preceding message: "*They didn't rent the bus... They rented the car.*"

Versions 7 to 10 were taken from a discourse environment describing a sequence of events which take place in chronological order: *You see, they rented the car. When they wanted to return it,...*". This shall be called the "broad focal condition". In versions 8 and 10 the definite article 'den' was replaced by the indefinite article 'einen', in order to test if this influenced the location of the focus exponent: "Sie haben einen Wagen geliehen"- "*They (have) rented a car*".

Table 1 gives all combinations of intended sentence mode and focus examined.

14 native speakers (8 male, 6 female) of German participated in the experiment and read every context plus the target sentence twice. They were informed that the data was used for a study on German intonation.

The utterances were recorded on a portable DAT- or tape recorder using a head microphone. As a result of an auditory check for correct sentence mode and fo-

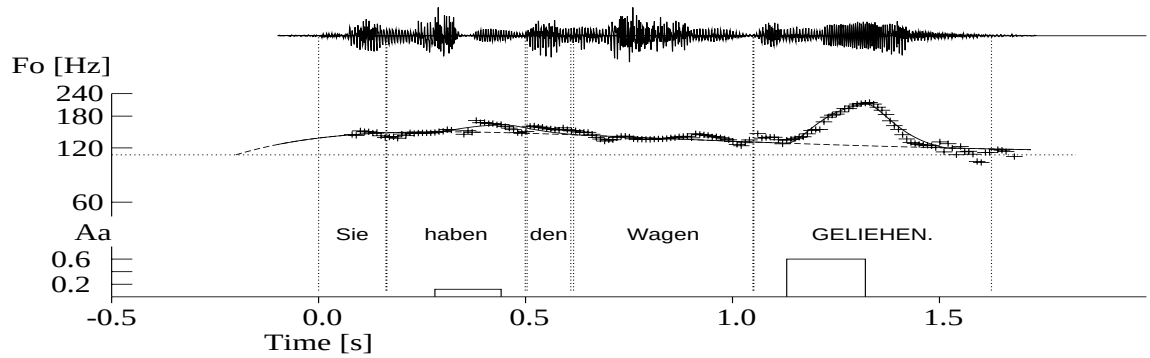

Fig. 1. Example of analysis of the utterance "Sie haben den Wagen ge**lie**hen." — *"They have* **ren***ted the car."* with narrow focus on 'geliehen'.

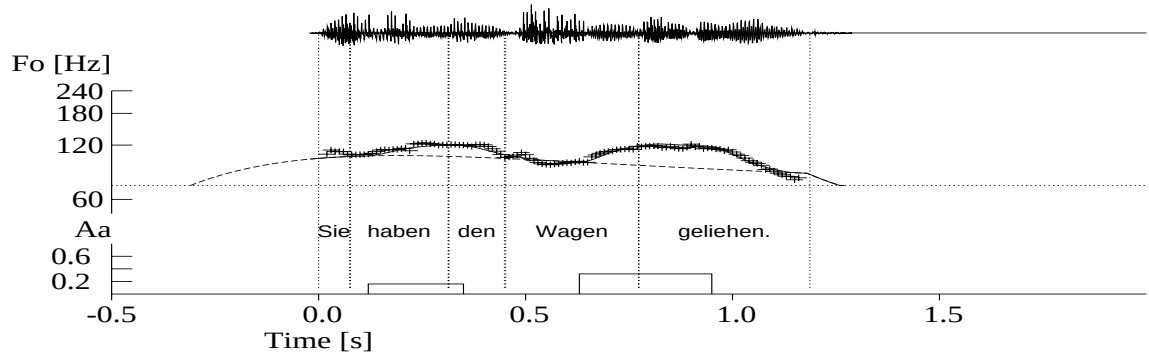

Fig. 2. Example of analysis of the utterance "Sie haben den Wagen geliehen."—*"They have rented the car."* with broad focus, sentence accent on 'geliehen'.

cus position, utterances by two speakers were found unacceptable and had to be excluded from further analysis. The target utterances "Sie haben den/einen Wagen geliehen" from the remaining sets were A/D-converted at 10 kHz/16 bit. The F_0 contours were then extracted and checked and the word boundaries were determined. Finally the F_0 contours were analyzed with the quantitative Fujisaki-model of the generation process of F_0 contours [3] by the method of Analysis-by-Synthesis.

The model has been shown to be capable of producing close approximations to a given contour, expressed as a time function of the logarithm of the fundamental frequency, from two kinds of linguistically meaningful input commands: phrase commands (impulses) and accent commands (stepwise functions), which are characterized by the following model parameters: Ap: phrase command magnitude; $T0$: phrase command onset time; Aa: accent command amplitude; $T1$: accent command onset time; $T2$: accent command offset time.

The phrase components produced by the phrase commands account for the declination characteristics of each of the prosodic phrases, hence for the global shape of the F_0 contour. The accent components produced by the accent commands model the local shapes of the F_0 contour. In earlier studies (see, for instance, [4]) we have shown that in German onsets and offsets of accent commands are strongly related with tone switches [5] at accented syllables and boundary tones.

Phrase and accent components are superimposed on a baseline, represented by $\log Fb$ to form an F_0 contour in the $\log F_0$ domain.

Table 2. Location of the sentence accent chosen in the broad focus condition.

No.	syntactic unit	'Wagen'	'geliehen'
7	'den Wagen geliehen.'	1	11
8	'einen Wagen geliehen.'	12	0
9	'den Wagen geliehen ?'	0	12
10	'einen Wagen geliehen?'	12	0

3. RESULTS

3.1 General Observations

In order to examine how the manifestations of narrow and broad focus in the F_0 contour differ, conditions were compared where the location of the sentence accent was the same for both. In the utterance "Sie haben den/einen Wagen geliehen.", 'Wagen' and 'geliehen' are equally good candidates for becoming the location of the sentence accent in the broad focal condition.

According to Stock [6] the noun modifying a verb generally becomes the location of the sentence accent. If, however, the noun is preceded by a definite article

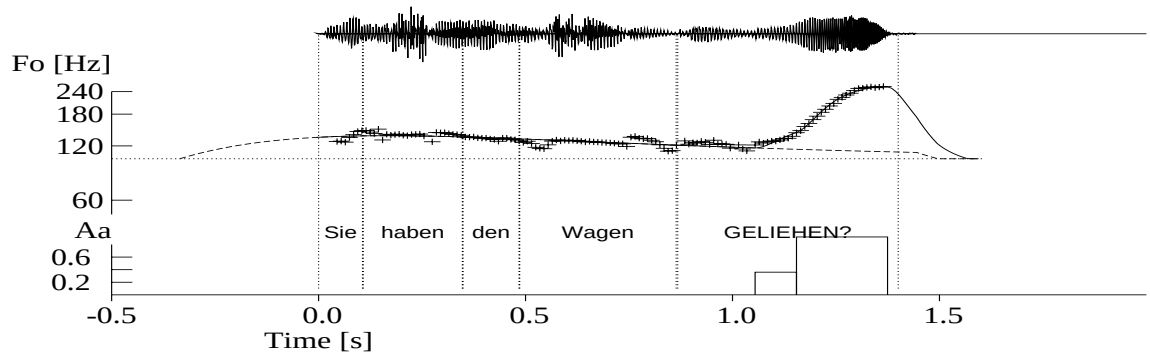

Fig. 3. Example of analysis of the utterance "Sie haben den Wagen ge**lie**hen ?" — *"They have* **ren***ted the car ?"* with narrow focus on 'geliehen'.

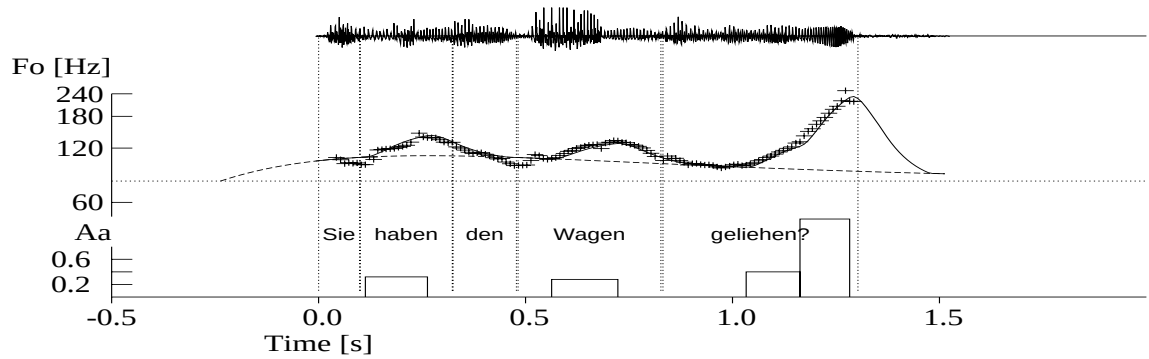

Fig. 4. Example of analysis of the utterance "Sie haben den Wagen geliehen ?"—*"They have rented the car ?"* with broad focus, sentence accent on 'geliehen'.

this indicates that the contents of the noun is already known and the accent shifts to the verb [6, p.47]: "ich habe *die* Schnitte ge**gess**en" (definite article) vs. "ich habe *eine* **Schnit**te gegessen" (indefinite article) — "*I have* **ea***ten the sandwich*" vs. "*I have eaten a* **sand***wich*".
Table 2 gives the location of the sentence accent was chosen by the subjects and hence shows that in almost all cases the subjects behaved as the rule suggests.

Statements Figures 1 (narrow focus) and 2 (broad focus) both show utterances of statements where the sentence accent is placed on 'geliehen'. From the top to the bottom there are displayed: The speech waveform, the extracted F_0 contour ('+'-signs), the model-generated contour (solid line), the text of the utterance, and the corresponding accent commands. The dotted vertical lines denote word boundaries.
Some observations made on many pairs of narrow and broad focus in the data can be stated :
In both examples the accented syllable of 'geliehen' is connected to a falling tone switch. The narrow focal condition exhibits a single accent command with high amplitude Aa of 0.59 on 'geliehen' producing a peak in the F_0 contour. A small secondary accent is placed on 'haben'.
In the broad focal condition the fall on 'geliehen' occurs at the offset of an accent command with Aa of 0.38 which starts on the accent syllable of the preceding word 'Wagen' producing a 'hat pattern'. Hence the accents commands assigned to 'Wagen' and 'geliehen' merge. 'haben' also receives a secondary accent.

Echo-questions In Figures 3 (narrow focus) and 4 (broad focus) utterances of questions are displayed where the sentence accent is placed on 'geliehen'.
In both conditions, the focused item is marked by a rising tone switch to a high level of F_0 which is further boosted by a question-final rise. The rising tone switch starts later in the accent syllable than in the statement condition.
In the broad focal condition secondary accents are produced on 'haben' and 'Wagen' which are connected to smaller accent commands. We see that the main difference between narrow and broad focus is the reduction of secondary accents in the former one.

3.2 Accent command amplitude Aa

In order to quantify the differences between the focal conditions, the accent command amplitude Aa was determined which corresponds to the interval the tone switches take at the accent syllables of 'haben', 'Wagen' and 'geliehen' and hence gives a measure of the prominence the items receive. Table 3 show mean and standard deviation for all pairs of narrow and broad focus, for statements and questions. In cases where no

Table 3. Mean Aa for narrow and broad focus conditions with the same sentence accent location, statements (top) and question (bottom). Values for items bearing the sentence accent are set in bold face.

No.	sentence accent	focus	'haben' μ/σ	'Wagen' μ/σ	'geliehen' μ/σ	Number of subjects
2	'Wagen'	narrow	.04/.08	**.50/.21**	.00	12
3	'geliehen'	narrow	.09/.13	.14/.19	**.53/.27**	12
7	'geliehen'	broad	.09/.08	.24/.09	**.34/.19**	11
8	'Wagen'	broad	.26/.11	**.32/.08**	.00	12
5	'Wagen'	narrow	.07/.11	**.59/.15**	.21/.13	11
6	'geliehen'	narrow	.07/.11	.11/.13	**.63/.18, .48/.22**	12
9	'geliehen'	broad	.13/.11	.14/.11	**.45/.13, .50/.13**	12
10	'Wagen'	broad	.11/.14	**.54/.17**	.23/.13	12

Table 4. Mean Ap for narrow and broad focus conditions.

No.	sentence accent	focus	sentence mode	Ap μ/σ
1	'sie'	narrow	statement	.30/.10
2	'Wagen'	narrow	statement	.31/.10
3	'geliehen'	narrow	statement	.37/.11
4	'sie'	narrow	question	.36/.09
5	'Wagen'	narrow	question	.35/.09
6	'geliehen'	narrow	question	.38/.13
7	'Wagen'	broad	statement	.45/.15
8	'geliehen'	broad	statement	.42/.11
9	'Wagen'	broad	question	.36/.09
10	'geliehen'	broad	question	.42/.10

tone switch was present, Aa was set to 0.0. The table confirms the observations made on the examples discussed: The narrow focal condition is generally connected with higher Aa for the sentence accent and reduced Aa in secondary accents. This tendency is stronger in the statements. The differences between narrow and broad focus condition are to a certain extent speaker-dependent. Whereas the accent command amplitude for the sentence accent in the broad focal condition is generally lower, accent merging in sentence no. 7, for instance, was only found in 8 of 11 speakers.

3.3 Fb and Ap

As the focal condition most obviously affects the accent component of the Fujisaki-model, the influence on the phrase component was also examined. Table 4 gives mean values for Fb and Ap for all statement and question conditions.

In utterances of questions, only the first part of the phrase component is visible, the part after the rising tone switch can only be inferred from the slight downwards trend of the F_0 contour where the accent commands are superimposed. Fb is therefore difficult to estimate from the F_0 data. For this reason it was decided to determine a mean value for Fb from the utterances of statements of a speaker and use it as an initial (and maximum) value for the analysis of this speaker's utterances of questions.

Whereas the mean Fb remains almost constant for all cases, Ap is reduced for the narrow focus conditions. The effect is the strongest in statements and depends on the location of the focused item. Hence the phrase component is clearly influenced by the local requirements of the F_0 contour. Falling (terminal) tone switches early in the utterance and suppression of secondary accents as found in narrow focus reduce the extent to which the declination line is adjusted at the head of the utterance and hence result in a reduced Ap.

4. CONCLUSION

We have shown some characteristics of broad and narrow focus with respect to the shape of F_0 contours of short German utterances. It must be stated, however, that the data was rather limited and perceptual evaluation of the patterns found is desirable. The results indicate that a quantitative approach towards the realization of focus is promising. Work is in progress for implementing rules of focal representation in a Text-to-Speech system for German based on the current study.

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