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Pitch scaling as a question cue in German wh-questions

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Abstract

A recent study showed that questions and statements with final rising intonation can be distinguished through the phonetic realization via pitch scaling in German (Michalsky 2014, 2015a, 2017). This study investigates whether statements and questions with final falling intonation show comparable phonetic differences in pitch scaling (cf. Brinckmann and Benzmüller 1999). To answer this question, we conducted a reading task to compare the phonetic realization of intonation in statements and nearly string identical wh-questions. The results show that the nuclear accent peak in wh-questions was realized about 2 semitones higher than in statements. This suggests that similar to yes/no-questions and incomplete statements (Michalsky 2014, 2015a, 2017), wh-questions can be distinguished from otherwise intonationally identical statements through phonetic pitch scaling. Furthermore, the continuous nature of this effect supports the claim that the phonetic realization of questions functions to signal a continuous questioning attitude of the speaker rather than a categorical grammatical function.

Introduction

The intonation of wh-questions can be investigated from a phonological as well as phonetic point of view. Earlier studies of German intonation are primarily concerned with intonational phonology and thus the choice of intonation contour. Those studies find that wh-questions are typically realized with the same falling intonation contour as prototypical complete statements (cf. Oppenrieder 1988, Féry 1993, Grice & Baumann 2002). Accordingly, it is often assumed that wh-questions and statements cannot be distinguished through intonation. However, some earlier studies found that yes-no-questions and incomplete statements that were realized with the same final rising intonation contour can be distinguished through the phonetic realization as questions show a significantly greater excursion of the final rise (Kuhlmann 1931, von Essen 1964, Batliner 1989). This was recently confirmed (Michalsky 2014, 2015a, 2017).

From a theoretical perspective the boundary tone constitutes a fitting domain to signal pragmatic function since it is assumed to cue meaning spanning the whole intonational phrase (Pierrehumbert & Hirschberg 1990, Peters 2014). This poses the question whether questions and statements can be distinguished phonetically when realized with falling intonation and thus a low boundary tone instead of rising intonation and a high boundary tone. According to previous research there are four possible places for phonetic scaling that need to be considered. 1) the height of the final boundary tone as found by Michalsky (2014, 2015a, 2017) for rising intonation, 2) the height of the nuclear peak as found by Brinckmann and Benzmüller (1999) for German wh-questions, 3) the postnuclear low tone preceding the final boundary tone as suggested by Haan (2002) for wh-questions in Dutch, or 4) the prenuclear peak as suggested by Petrone and Niebuhr (2014) among others.

Furthermore, Michalsky (2014, 2015a, 2017) found pitch scaling of the final rise to distinguish not only questions from statements but also different question types. The differences could also perceptually be associated with a questioning attitude, suggesting that this results from the phonetic continuum corresponding to a continuum in meaning rather than a question category also proposed by Batliner (1989). Finding phonetic effects in wh-questions as well would lend further support to the hypothesis of a continuous meaning.

We arrive at the following research questions: Does the pragmatic function significantly affect the phonetic realization of wh-questions and complete statements with the same intonation contour? According to the research background we investigate phonetic cues in the prenuclear accent, the nuclear accent, the postnuclear low and the final boundary tone.

Method

Speakers

17 female speakers participated in the experiment. All participants were native speakers of Standard High German, born and raised in the

northwest of Lower Saxony and between 22 and 29 years old. At the time of the experiment, all of them were enrolled at the University of Oldenburg. The decision to include only female speakers is based on the results of Michalsky (2014, 2015a, 2017), who found no effect of speaker sex on the phonetic effects of pragmatic function.

Material

Since the aim of this study is to compare complete questions and statements with final falling intonation, we chose wh-questions as a question type since these are typically realized with falling intonation in read speech (cf. Oppenrieder 1988, Féry 1993, Grice & Baumann 2002). Furthermore, wh-questions show verb-second order. Accordingly, they can be designed almost string identically to statements with the exception of the subject position, which is substituted by the wh-word. We included a modal verb to move the lexical verb into phrase final position thereby increasing the postnuclear stretch. An example of the target structure is given in figure 1.

(1) Wh-question:
Wer will nachher zu X gehen?
%LH*L H*LL%
Who wants to go to X later?
Statement:
Y will nachher zu X gehen.
%LH*L H*LL%
Y wants to go to X later.

For the lexical item in the object position (X), the item expected to receive the nuclear accent, we chose proper names. All names consisted of exclusively sonorous segments and two syllables with a trochaic rhythm. The second syllable always ended in a Schwa (e.g. *Suse* [ˈzuː.zə] or *Narne* [ˈnaː.nə]). The subject position (Y) was either also occupied by a proper name in the case of a statement or the wh-word *wer* (*who*) in wh-questions. The proper names in subject position consisted of three syllables, only sonorous segments, ended in Schwa, and received lexical stress on the second syllable (e.g. *Simone* [zi.ˈmoː.nə] or *Hermine* [hɛɐ̯.ˈmiː.nə]). While the modal verb was kept constant, the lexical verb alternated between *gehen* (*go*) and *bleiben* (*stay*). 16 lexical variants were included for both statements and wh-questions and the material complemented by 192 filler sentences. The 224 sentences were added to a randomized list with the restriction that every target item was followed by at least one filler sentence.

Procedure

The sentences were presented visually one by one via a PowerPoint© presentation. A short break was included every 56 slides. Misread sentences were repeated after the list was completed. The subjects were instructed to read every sentence in silence before reading them out loud to avoid hesitation and to ensure understanding of the whole sentence structure. Recordings were made in an audio cabin at the University of Oldenburg using a Samsung Meteor microphone at a sampling rate of 48 kHz and 16-bit resolution.

Acoustic analysis

Prior to the acoustic analysis the material was tonally annotated using the German adaptation of the ToDI system (Gussenhoven 2005) by Peters (2014). Since the study focusses solely on the phonetic realization, only utterances with a final falling intonation contour (ToDI: H*LL%, GToBI: H* L-L%) realized in a single intonation phrase were analyzed. Furthermore, only utterances showing a prenuclear peak on the subject/wh-word or no prenuclear peak at all were selected. All deviating tonal structures such as early peaks, late peaks, or downstepped tones were excluded. Effects of tone-linking exceed the scope of this paper.

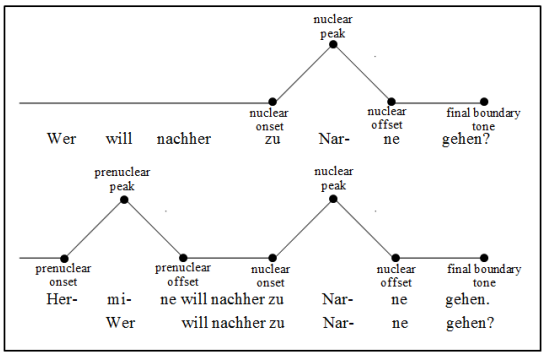

Figure 2: Points of measurement for the acoustic analysis.

As illustrated in figure 2, seven points of measurement were determined: the prenuclear onset, the prenuclear peak, the prenuclear offset, the nuclear onset, the nuclear peak, the nuclear offset, and the low final boundary tone. Additionally, five relative measurements were calculated: the prenuclear rise and fall, the nuclear rise and fall, as well as the final fall (measured from the nuclear peak to the final boundary tone). The measurements were taken in Hz and converted into semitones to a base of 50Hz (cf. Nolan 2003, Michalsky 2016).

Statistical analysis

We conducted linear mixed effect models using SPSS© with PRAGMATIC FUNCTION (wh-question/statement) as a fixed factor and ITEM and SPEAKER as random factors. As dependent variables we used the absolute phonetic measurements *prenuclear onset*, *prenuclear peak*, *prenuclear offset*, *nuclear onset*, *nuclear peak*, *nuclear offset*, and the *final boundary tone* as well as the relative measurements *prenuclear rise*, *prenuclear fall*, *nuclear rise*, *nuclear fall*, and *final fall*. Additionally, a parametric rating was used to determine the effect of the fixed factor per dependent variable (Schendera 2014).

Results

As a main result, our study shows that wh-questions are realized with a significantly higher nuclear peak than statements. The nuclear peak is about 2.08 ST higher in wh-questions (F(1, 97.95)=37.68, p<**.001**) as illustrated in figure 3.

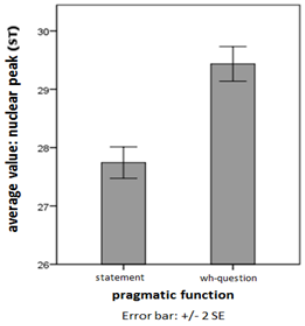

Figure 3: Phonetic effects of PRAGMATIC FUNCTION for the nuclear peak.

Additionally, the nuclear onset is on average 0.74 ST higher (F(1, 126.07)=5.16, p<**.05**) and the nuclear offset 0.66 ST higher (F(1, 103.3)=8.82, p<**.01)**. However, the final boundary tone shows no significant effects. Accordingly, the nuclear accent is raised as a whole but excluding the final boundary tone.

Effects for the prenuclear region are scarce. The results for the prenuclear onset and the prenuclear peak yield no significant results but the prenuclear offset is lowered by about 1.01 ST in wh-questions compared to statements (F(1, 91.17)=6.44, p<**.05)**.

Differences in the absolute parameters between questions and statements also result in differences in the relative parameters. For the prenuclear region, the prenuclear rise shows no significant variation while the prenuclear fall is about 1.64 ST greater in wh-questions than in statements (F(1, 56,34)=23,93, p<**.001**). Furthermore, while the nuclear region is raised as a whole, the dimensions between the tonal targets change since the nuclear peak is raised by a greater magnitude than the onset and the offset. The nuclear rise is on average 1.07 ST greater (F(1, 114.21)=6.96, p<**.01)**, the nuclear fall 1.42 ST greater (F(1, 116.5)=22.96, p<**.001**) and the final fall 1.89 ST greater (F(1, 124.23)=27.85, p<**.001**) in wh-questions compared to statements.

Discussion

The results of this study suggest that wh-questions and statements with the same final falling intonation contour can be distinguished through the phonetic realization. Furthermore, we can provide insight on the four possible places for phonetic scaling effects.

Firstly, similar to Michalsky (2014, 2015a, 2017), who found no effects for the high boundary tone, we do not find effects for the final low boundary tone. Although the nuclear region as a whole shows a significant raising in wh-questions, this does not affect the final boundary tone.

Secondly, Brinckmann and Benzmüller (1999) found wh-questions to differ from statements by a significantly higher nuclear accent peak. This assumption is strongly supported by our study. Furthermore, we want to point out that the differences in nuclear peak height between wh-questions and statements of 2 semitones are of precisely the same magnitude as the differences in the excursion of the final rise between rising questions and statements found by Michalsky (2014, 2015b, 2017).

Thirdly, the effects on the nuclear pitch accent are not restricted to the peak. Both the nuclear onset and the postnuclear low are raised as well resulting in an overall raising of the nuclear accent. This is compatible with Haan's (2002) finding for Dutch. Note that Haan (2002) argued that the raising of the postnuclear low in her data was a secondary effect caused by anticipation of a final rising movement typical for Dutch wh-questions which was absent in our study. However, it is possible that the raised postnuclear low is a consequence of the raised nuclear peak due to which the nuclear fall cannot return to the same baseline as in statements. Consequently, the raised postnuclear low may be regarded as a secondary effect after all.

Fourthly, we did not find effects on the prenuclear region as reported by Petrone and

Niebuhr (2014). The prenuclear fall was even shallower in questions than in statements contradicting previous findings. However, we suggest that the co-occuring raise of the prenuclear offset does not serve as a question cue on its own but was instead caused by the raising of the nuclear accent. Accordingly, it is possible that a lower prenuclear offset and steeper prenuclear fall as reported by Petrone and Niebuhr (2014) could be found with more segmental material between the prenuclear and the nuclear accent.

As regards the theoretical implication of the results mentioned above, the findings show that wh-questions can be distinguished from statements via their continuous phonetic realization. Since this function is not implemented through a categorical distinction in boundary tones it seems that the question cue can appear somewhere in the utterance supporting the assumption of a paralinguistic notion of questioning.

So far, the results are restricted to read speech and it remains an open question whether the differences between wh-questions and statements also hold for spontaneous speech (cf. Michalsky 2015a, 2017). Furthermore, although Michalsky (2015b, 2017) reported the perceptual relevance of differences in final rise excursion of the same size, this finding may not be directly generalizable to nuclear pitch accents and need to be tested. Lastly, this experiment only included wh-questions as a question type realized with a final falling contour. Since wh-questions are lexically marked they may show a different behavior than for example polar questions with final falling intonation. Accordingly, this also remains a topic for further research.

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