

# Phonetic effects of speaking style on final rises in German questions and statements

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## ABSTRACT

Potential intonational means to distinguish questions from statements in German are typically attributed to some sort of final rising pitch [10, 24, 30, 36]. However, final rises are neither characteristic for every question type (e.g. *wh*-questions, alternative questions) nor compulsory in any [25, 32, 34]. Furthermore, they are frequently associated with non-final statements and thus not restricted to questions [10, 24, 30, 36]. Therefore, final rises are no reliable cues to interrogativity. Recent studies suggest that phonetic aspects of intonation can contribute to resolve the underspecified nature of the tonal structure [27, 28, 33]. A reading task shows that questions are phonetically distinguishable from continuous statements by a higher excursion of the final rise [27]. This paper reports two experiments showing that this finding also holds for controlled spontaneous speech.

**Keywords:** interrogativity, intonation, German, read speech, controlled spontaneous speech

## 1. INTRODUCTION

Rising intonation as a characteristic intonational feature of questions is a widely observed phenomenon. Typological studies [4, 20, 21, 35] show that the majority of languages have a tendency to realize questions with a final rise. Ohala [29] attributes this tendency to the frequency code, which assumes an innate relationship between smallness and its associated attributes like uncertainty or dependency and higher pitch.

On the other hand, the association of final rises with incomplete utterances, both questions and statements, seems to be equally frequent [7, 21]. According to Gussenhoven [16], this connection can be derived from another biological code, the production code, which links rising intonation to the notion of incompleteness of the speaker's turn [16]. While it is possible to assume that a final rise may come from two separate sources, there seems to be no way to tell the two rises apart by intonation only.

Furthermore, the association of rising intonation with questions can be described as a tendency at best. There are languages that do not use final rises at all [4, 21, 35] and numerous restrictions in those that do. In German, for example, rising intonation is assumed to be characteristic for *yes-no-questions* and *declarative questions*, while *wh-questions* are typically described to have a falling intonation [10, 24, 30, 36]. Even the question types associated with rising intonation show exceptions. In most earlier descriptions of German intonation, the existence of falling *yes-no-questions* is mentioned and typically explained via attitudinal modifications [3, 23, 36, 37]. More recent experimental and corpus studies show that falling *yes-no-questions* are in fact quite frequent [25, 31, 34]. Consequently, every sentence type can principally be found with every contour in German [32]. For other comparable languages like English [11, 13] or Dutch [19] there is evidence that even attributes like 'typically rising' are lacking a quantitative basis and falling *yes-no-questions* are not only common but predominant in certain speaking styles. Bolinger [4] assumes that the frequent association of rising intonation with questions is the result of oversimplification and exceptions are probably found for every language. Consequently, final rising intonation is no infallible cue to interrogativity (cf. [5]).

This seems to be no problem for spoken language, since intonation always co-occurs with lexical, syntactical, and pragmatic-contextual cues and is thus in most cases redundant as a marker of interrogativity. Regardless of this redundancy, it may be asked if there is more to the intonation of interrogativity than a final rise. The typological studies of question intonation did not restrict the universal feature of questions to rising pitch but to high pitch in general [4, 20, 21, 35]. Final rises are only one aspect of high pitch that has become grammaticalized in the tonal structure [16]. Other aspects might be found on the paralinguistic phonetic level. Studies on several languages suggest that variation on the phonetic level is a possible cue to interrogativity [8, 12, 15] even in languages where a final rise is already considered

the primary cue like in Dutch [18] or French [9]. For English, it is frequently assumed that continuation is associated with a *low rise* contrasting with a *high rise* for questions (cf. [22]). Additionally, there is some evidence in early investigations on German intonation. Kuhlmann [26] and von Essen [36] suppose that questions may rise higher than incomplete statements. Furthermore, Batliner [1] observed that a higher rise in questions increases the hearer's perceived obligation to answer. Accordingly, while the frequency code might not be a reliable question marker through its grammaticalized form in the tonal structure alone, it might be through or with the phonetics of intonation.

A recent study on the phonetics of German question intonation suggests that interrogativity does indeed have a significant effect on the phonetic realization of intonation contours by increasing the excursion of the final rise in *alternative questions* and *yes-no-questions* compared to *continuous statements* [27]. Furthermore, these results support the rare assumption that even *alternative questions* show intonational cues to interrogativity [6, 36], thus contradicting the more common assumption, that *alternative questions* resemble *continuous statements* regarding intonation (cf. [14, 22]).

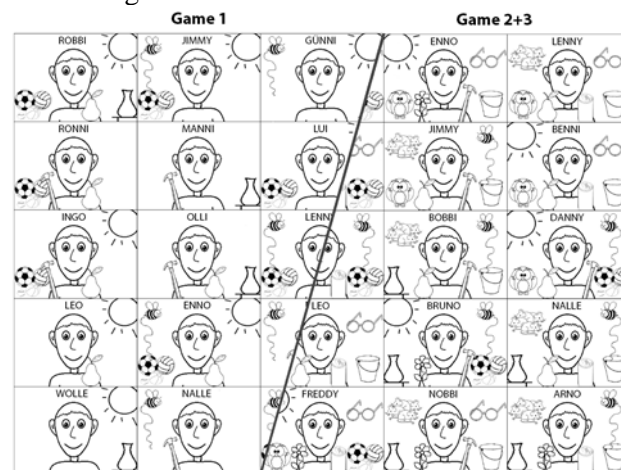
This paper reports two experiments on the phonetic effects of interrogativity in spontaneous speech. The aim of this study is to answer two research questions. 1) Does interrogativity show effects on the phonetic realization of intonation in spontaneous speech? 2) Are the phonetic effects of interrogativity greater in spontaneous speech, in read speech, or of equal size in both.

## 2. METHOD

### 2.1. Materials

Experiment 1: For the first experiment we constructed game-tasks to elicit *yes-no-questions* (*YQ*), *alternative questions* (*AQ*), and *continuous statements* (*CS*) in three different spontaneous game-situations with controlled segmental material. The play sheets for all three games contained 25 portraits (cf. figure 1) with six different positions for illustrations of target items each. The 12 possible target items were illustrations intended to elicit specific segmentally controlled word-forms (e. g. [va:.zə] 'vase', [blu:.mə] 'flower', [zənə] 'sun'). For game 1 six different sheets were constructed. Six target items were selected for each sheet. Each of the 25 portraits was illustrated with one to six items with

a unique combination for each. For game 2 six additional sheets were designed. This time six pairs of items were selected for each sheet. Every pair was assigned to one position within the cell of each of the 25 portraits (e. g. upper left corner). Only one item of the pair was present for every cell and the combination of items was again unique for each. Game 3 consisted of the first three play sheets of game 2.



**Figure 1:** Example of the play sheets for the elicitation of spontaneous speech for game 1 on the left half, for game 2 and 3 on the right half.

Experiment 2: For the reading task the target utterances from the first experiment were transcribed for each speaker. Twenty items of each of the three sentence types (*CS*, *AQ*, *YQ*) were selected. The test items were interspersed with 140 fillers to a total of 200 sentences and added to a list in a pseudo-randomized order.

### 2.2. Speakers

Both experiments were conducted with 21 students (11 female, 10 male) from the University of Oldenburg. All speakers were between 18 and 30 years old, born and raised in the north-western part of Lower Saxony and monolingual speakers of German.

### 2.3. Procedure

Experiment 1: The speakers participated pairwise in all three game-situations. The players took turns so both produced utterances that contributed to the experiment. Each player was handed six play sheets for game 1 and 2 and three play sheets for game 3. Additionally, each player received a sheet with solutions for every round of the first two games.

The aim of game 1 was to elicit *yes-no-questions*. Each player was instructed to identify the target portrait on the other player's solution

sheet by asking about the presence of a target item of his/her choice (e.g. *Habe ich eine Vase? / Do I have a vase?*). The aim of game 2 was to elicit *alternative questions*. Again, each player tried to identify his target portrait. The players were instructed to ask, which target item of a pair was present in a certain position, thus only asking alternative questions (e.g. *Habe ich eine Vase oder eine Blume? / Do I have a vase or a flower?*) The other player was only allowed to answer with a declarative sentence, naming the target item. The aim of game 3 was to elicit statements consisting of two connected phrases. Each player was instructed to select a portrait of his/her choice from the play sheet and give the other player a hint by revealing two of the cell's items (e.g. *Ich habe eine Vase und eine Blume. / I have a vase and a flower.*). The other player had to identify the described portrait.

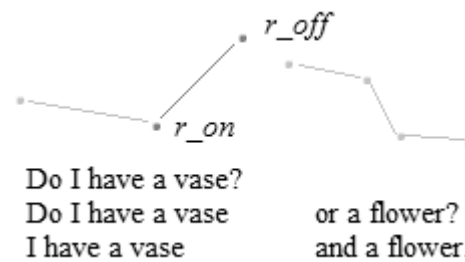
Experiment 2: The transcribed utterances and fillers were presented visually via a PowerPoint® presentation with one sentence per slide. The subjects were instructed to familiarize themselves with the sentence material in silence before they read them out aloud. Recordings for experiment 1 were made in a quiet room at the University of Oldenburg to keep the recording situation as natural as possible. Experiment 2 was recorded in a sound booth. All recordings were made with a portable digital recorder (Tascam HD P2) at a sampling rate of 48 kHz and 16 bit resolution via a head mounted microphone (DPA 4065 FR).

## 2.4. Acoustic Analysis

The data were annotated according to the German adaptation [32] of the ToDI system [17]. For each of the three sentence types only those utterances were selected for further acoustic analysis which were realized with a low-rising L\*H H% contour (L\* H-H% in classical ToBI; [2]). Only intonational phrases, in which the final rise continued to rise into the vowel of the second syllable of the nuclear word, were classified as low-rising. Contours that reached their peak in the first syllable and continued on the same level were classified as plateaus and excluded from the analysis as well as every other nuclear contour type. Additionally, utterances including prenuclear accents were excluded.

As illustrated in figure 2, two points of measurement were determined: the beginning of the final rise (*r\_on*), located in the nuclear syllable, and the peak of the final rise (*r\_off*), located at or around the end of the nuclear word. The excursion

of the final rise was calculated from the difference of these two points. The resulting Hertz values were converted to a logarithmic semitone scale to ensure comparability between sexes.



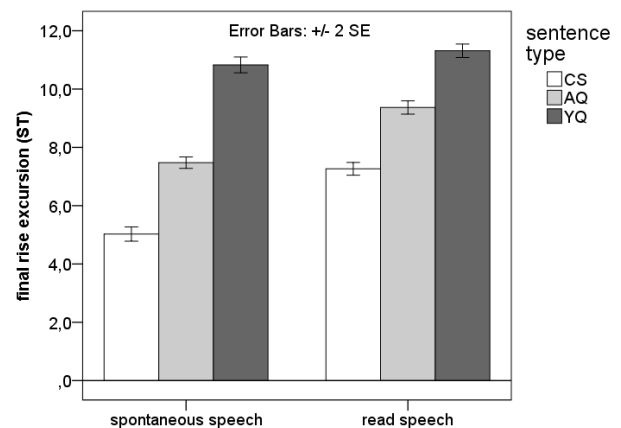
**Figure 2:** Points of measurement for the acoustic analysis of low-rising intonation contours for the three sentence types.

## 2.5. Statistic Analysis

Linear mixed effect models were used for statistical analysis to take high inter-speaker variability into account as a random factor. SENTENCE TYPE (*CS/YQ/AQ*) and SPEAKING STYLE (*spontaneous/read*) were used as fixed factors and SPEAKER as a random factor. *Final rise excursion* was used as the dependent variable.

## 3. RESULTS

The experiments produced a total of 1017 utterances for spontaneous speech (female = 584, male = 433) and a total of 1402 utterances for read speech (female = 799, male = 603) according to the target structure.



**Figure 3:** Phonetic effects of SENTENCE TYPE (white=CS, light grey=AQ, dark grey=YQ) and SPEAKING STYLE on the *final rise excursion*.

Figure 3 shows that questions were realized with higher excursions of the final rise both in spontaneous and read speech. *Alternative questions* were realized on average two semitones higher than *continuous statements* and *yes-no-questions*

were realized four semitones higher than *continuous statements*. Additionally, *yes-no-questions* were realized on average two semitones higher than *alternative questions*. Figure 3 also shows that there are differences between speaking styles as a whole. All three sentence types were realized on average between 0.5 and 1.9 semitones higher when uttered in read speech compared to spontaneous speech.

Significant effects of SENTENCE TYPE were found for the *final rise excursion* between CS and AQ in spontaneous speech (CS=5.0 ST, AQ=7.5 ST,  $F=357.77$ ,  $p<.001$ ) and in read speech (CS=7.3 ST, AQ=9.4 ST,  $F=431.17$ ,  $p<.001$ ), between CS and YQ in spontaneous speech (CS=5.0 ST, YQ=10.8 ST,  $F=1277.77$ ,  $p<.001$ ) and read speech (CS=7.3 ST, YQ=11.3 ST,  $F=1212.11$ ,  $p<.001$ ), and between AQ and YQ in spontaneous speech (AQ=7.5 ST, YQ=10.8 ST,  $F=601.32$ ,  $p<.001$ ) and read speech (AQ=9.4 ST, YQ=11.3 ST,  $F=271.49$ ,  $p<.001$ ). Significant effects of SPEAKING STYLE for the *final rise excursion* were found for CS (spontaneous=5.0 ST, read=6.7 ST,  $F=229.50$ ,  $p<.001$ ), for AQ (spontaneous=7.5 ST, read=9.4 ST,  $F=239.97$ ,  $p<.001$ ), and to a much smaller extent for YQ (spontaneous=10.8 ST, read=11.3 ST,  $F=271.49$ ,  $p<.05$ ).

#### 4. DISCUSSION

The results of experiment 2 provide further evidence that final rises are realized with greater excursions in questions than in statements thus supporting previous findings [27]. Furthermore, experiment 1 suggests that these effects are not restricted to read speech but hold for spontaneous speech as well. Regarding the first research question, this study concludes that the phonetic realization generally provides possible cues for interrogativity in German regardless of the speaking style. This is in agreement with the findings of Kuhlmann [26], von Essen [36] and Batliner [1] and comparable to findings for languages like Dutch [18], French [9] or English (cf. [22]). The results also show that *alternative questions* are distinguished from *continuous statements*, thus contradicting the assumption that both are exclusively signalled as continuous and cannot be told apart (cf. [14, 22]).

Additionally, the comparison of experiment 1 and 2 shows that each of the three sentence types is realized with significantly larger excursions of the final rise when uttered in read speech than in spontaneous speech. Thus, regarding the second research question, we conclude that there are

differences in the phonetic realization of final rises depending on the speaking style. However, the three sentence types are kept equally sufficient apart in both styles. Consequently, there are no differences in the phonetic effects of interrogativity between the speaking styles. The results are only to some degree generalizable on real spontaneous speech but the phonetic differences in scaling suggest a higher degree of spontaneity than the read data from experiment 1.

It is noticeable that differences between the mean values of both speaking styles for *yes-no-questions*, though reaching statistical significance, are only about half a semitone and thus probably not perceptual relevant. One explanation might be that speakers try to keep the two continuous sentence types further apart from the final question type when uttered in spontaneous speech to avoid that they are accidentally interpreted as final questions and may result in an interruption. In read speech this concern is absent. Another explanation might be that there is some sort of peak value for each speaker; hence the read *yes-no-questions* cannot be raised further without exceeding the speaker's natural pitch range.

Furthermore, while questions and statements are distinguished through scaling of the final rise, it is noticeable that final *yes-no-questions* are distinguished from non-final *alternative questions* to the same or even greater extent, thus resulting in three phonetically distinct final rises. Instead of assuming a third parameter like phrase-finality, we suggest that this effect might be motivated by the same pragmatic difference. *Alternative questions* are distinguished from *continuous statements* by being questions at all and thus requiring a listener response. *Yes-no-questions* might differ from *alternative questions* by requiring a more immediate response, since *alternative questions* are continued by the speaker after the rise on the first phrase. The difference in rise excursion might signal the degree of interrogativity as a need for the listener's reaction and is therefore higher in question types that call for such a reaction immediately than in question types that are first completed by the speaker himself. To resolve this tripartite distinction further research on the categorical or continuous nature of interrogativity in intonation will be necessary.

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