

Scaling of Final Rises in German Questions and Statements

Jan Michalsky

Department of German Studies, University of Oldenburg, Germany

j.michalsky@uni-oldenburg.de

Abstract

Although certain intonation contours occur more frequently with German questions than with German statements, there is evidence that the semantics of intonational phonology operates on a more abstract level [1][2][3][4]. Hence, it is unlikely that there are pitch patterns in German that are exclusively used in interrogatives. Rather, intonational signaling of interrogativity can be regarded as resulting from the interaction between tonal and phonetic features. The tonal structure provides abstract semantic features, which are modified by paralinguistic features through phonetic realization [5]. This paper deals with the question which phonetic features may serve as cues to interrogativity in German. We report a reading task that was designed to elicit utterances that have phonologically identical nuclear rising pitch contours but differed by pragmatic function, serving either as a question or a statement. The observed absolute and relative scaling of nuclear and prenuclear tonal targets suggests that questions differ from statements by larger f_0 excursions of nuclear rising contours, whereas the scaling of prenuclear accents does not substantially contribute to the expression of interrogativity. We conclude that phonetic cues to interrogativity in German are mainly realized through scaling and are restricted to the nuclear part of the intonational phrase.

Index Terms: intonation, interrogativity, questions, phonetic implementation, scaling, German

1. Introduction

There are two distinct levels of intonation to look at for specific features of German interrogatives: the categorical tonal structure and the continuous phonetic realization [6]. If interrogativity is regarded as a discrete pragmatic function, it may be assumed to be signaled by categorical intonational structure [7]. This view is prevalent in early descriptions of English [8], Dutch [9], and German [10], which attempt to identify pitch patterns that are linked to specific sentence types. Von Essen [10], for example, reports for German that most types of statements occur primarily with falling intonation, while certain question types occur primarily with rising intonation.

Spontaneous speech data suggest a less clear-cut distribution of pitch patterns in German: although certain intonation contours occur more frequently with specific types of questions than with statements, every sentence type may be realized with any contour of the German intonational inventory depending on the pragmatic context [11][3]. This finding is compatible with the majority of recent theories on the semantics of intonational phonology, where more abstract meanings are assigned to different intonation contours. Explanations regarding the phonology of question intonation and the difference between rising and falling contours in questions or across question types range from semantic features like *assertiveness* [12][13], over pragmatic features

like *bias* [14][15] to discourse functions [11] and attitudinal features [16]. On a more abstract level, rising contours ending with a high boundary tone can be described as signaling pragmatic openness or incompleteness of the corresponding intonational phrase [17][2][3][18]. Hence, interrogativity cannot unambiguously be signaled by a specific choice of intonation contour. Rather, semantic features of intonation contours restrict the potential meanings of the associated utterance in a way that e.g. the feature of incompleteness suggests an interrogative interpretation in a certain context. This can explain why this type of intonation occurs more often with interrogative utterances like polar questions and to a certain degree wh-questions, but there is no immediate connection between the contour and the specific pragmatic function. However, if the phonology of intonation can signal certain aspects of interrogativity but not interrogativity itself the question arises whether this is the only contribution intonation can make to signal interrogativity in German, or whether there are other intonational cues, in particular at the level of phonetic realization.

According to Gussenhoven [5], intonational signaling of pragmatic functions may result from an interaction between phonological structure and phonetic realization. For example, emphatic focus may be signaled by a combination of a phonological pitch accent and an increase in its scaling. In this way, continuous variation in the phonetic realization can modify the abstract meaning of the phonological structure. This assumption is in accordance with reports that different types of increased pitch rather than a specific tonal pattern like a final rise were found as a potential universal feature of questions [19][20][21].

Evidence for the relevance of phonetic variation for the signaling of interrogativity has been found for several languages like Swedish [22][23], Finnish [24], Danish [25][26][27], and French [28] amongst others. For Dutch question intonation, Haan [29] identified several phonetic features such as higher f_0 onset, raised register level, and differences in the scaling of the nuclear accent, which results in a shift in the overall global trend from declination to inclination. Eventually, phonetic effects of interrogativity were also found for German. Oppenrieder [30] observed the absence of overall declination in German questions, Brinckmann and Benz Müller [31] found differences in pitch range and f_0 onset and Niebuhr et al. [32] suggest differences in shaping and alignment of prenuclear accents. Note, however, that in these experiments the potential phonetic features were not investigated independently of the phonological structure. A change of pragmatic function was always accompanied by a change in intonation contour like falling intonation in statements against rising intonation in questions [30][31][29][32]. Hence, an effect of the chosen contour on the phonetic realization cannot be excluded.

There are also several possibilities regarding the type of phonetic features involved and the domain of phonetic variation. Most research yielded effects in the scaling of tonal targets [22][23][27][24] but there is also some evidence for the

relevance of the shape of the transitions between tonal targets and of alignment relative to segmental landmarks [32]. As for the size of the affected constituent, there is evidence for the relevance of global parameters such as declination [25][26][28][30], pitch range [33][24][34], or register level [22][23], or local effects such as the scaling of the nuclear [29] or prenuclear peaks [32].

We report a reading task that was designed to investigate the phonetic effects of interrogativity in Standard German while keeping the tonal and grammatical structure constant. Since grammatically identical statements and questions can't be reliably elicited with the same intonational contour in utterance-final position we chose continuous statements and alternative questions where the nuclear rising contour occurs at the end of an intonational phrase with grammatically identical material but within an utterance. A possible generalization of the reported findings to utterance-final rising contours remains to be investigated.

In particular, we were interested in the identification of the relevant phonetic dimensions (scaling, shaping, and alignment) and domains of f0 variation (global, prenuclear or nuclear) that may be used for the distinction between questions and statements independently of grammatical and tonal structure. In the present paper we report results on the scaling of tonal targets only. Neither the phonetic variation of transitions between tonal targets nor their alignment or variation in pitch range or register level turned out to covary systematically with pragmatic function so far and remain open for further investigation.

2. Method

2.1. Speakers

The reading task was conducted with 21 speakers, 11 females and 10 males, aged between 18 and 30. The subjects were students from the University of Oldenburg and were born and raised in the northwestern part of Lower Saxony. All subjects were monolingual speakers of German.

2.2. Material

Two types of test sentences were constructed, questions and statements. Each sentence was designed to elicit two intonational phrases with the same intonation contour on the first phrase while keeping the grammatical structure identical. For the questions we used alternative questions and for the statements continuous statements with V1 word order. Subject and object items were filled with proper names to elicit two accents, a prenuclear and a nuclear one. The following examples illustrate both sentence types (for intonational annotation conventions see 2.4).

Alternative question:

(Will X *nachher zu Y gehen*)_{IP}, (oder bei Z *bleiben*?)_{IP}

H*L L*H H%|0%

Does X want to go to Y later, or stay with Z?

Continuous statement:

(Will X *nachher zu Y gehen*)_{IP}, (kann sie nicht bei Z *bleiben*.)_{IP}

H*L L*H H%|0%

If X wants to go to Y later, she cannot stay with Z.

Using a number of artificial proper names of the type *Mone* ['mo:.nə] and *Mine* ['mi:.nə] as accented words in the prenuclear and another set of artificial proper names of the type *Suse* ['zu:.zə], *Söre* ['zø:.rə], *Neewe* ['ne:.və] and *Narne* ['na:.nə] as accented words in the nuclear position we created 16 lexical variants of each sentence type. The proper names were segmentally controlled such that only voiced segments were used and all words ended in schwa to ensure a disyllabic production. We obtained a total of 32 target sentences, which were interspersed with 192 filler sentences and presented in a pseudo-randomized order.

2.3. Procedure

The test sentences were presented visually via a PowerPoint presentation with one sentence per slide. A line break was inserted after every potential intonational phrase to elicit a phrase boundary. The subjects were instructed to familiarize themselves with the sentence material in silence before they read them out aloud. Recordings were made in a sound booth in the speech laboratory at the University of Oldenburg with a portable digital recorder (Tascam HD P2) at a sampling rate of 48kHz and 16bit resolution via a head mounted microphone (DPA 4065 FR).

2.4. Acoustic analysis

Only the first intonational phrase was selected for acoustic analysis. This phrase was expected to be realized with one of two possible nuclear target contours: a half-completed rise or plateau-contour L*H0% or a low-rising-contour L*HH%. Contours are represented according to the ToDI system [35] and its adaptation for German [3][18]. Equivalent notations in the classical ToBi [36] and GToBi [37] systems would be L*H-L% for the plateau-contour and L*H-H% for the low-rising-contour. The phrases contained two possible pitch accents: a prenuclear H*L accent on the subject-item in X-position and a nuclear L*H with a final boundary tone of H% or 0% on the object-item in Y-position and the following verb. Only utterances realized with the described tonal structure regarding number and position of pitch accents as a reflection of focus structure as well as choice of contour were selected for acoustic analysis.

Four points of measurement were determined as illustrated in figure 1: the beginning of the prenuclear rise, the prenuclear peak, the onset of the final rise and the offset of the final rise. From these measurements the following variables were calculated: The excursion of the rise to the prenuclear peak (*prenuclear rise excursion*), the excursion of the final rise (*final rise excursion*), the difference in the excursions (*excursion difference*) and in the peaks (*peak difference*). The excursions were determined by calculating the difference in frequency from prenuclear onset to prenuclear peak for the *prenuclear rise excursion* and from final rise onset to final rise offset for the *final rise excursion*. The *excursion difference* was calculated by subtracting the *prenuclear rise excursion* from the *final rise excursion*. The *peak difference* was calculated by subtracting the prenuclear peak from the final rise offset. For comparability of the two sexes the measurements were converted to a semitone scale.

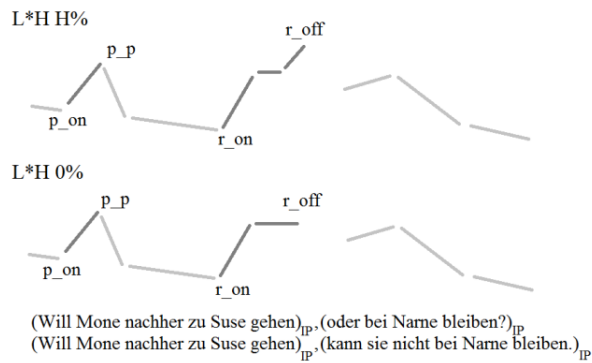


Figure 1: Points of measurement for the acoustic analysis for both target contours. (dark grey = prenuclear and nuclear rise excursion, p_on = onset of prenuclear rise, p_p = peak of prenuclear rise, r_on = onset of final rise, r_off = offset of final rise).

2.5. Statistical analysis

For the statistical analysis linear mixed effect models were used with PRAGMATIC FUNCTION (declarative / interrogative) and SPEAKER SEX (male / female) as fixed factors, and ITEM and SPEAKER as random factors. The dependent variables were *prenuclear rise excursion*, *final rise excursion*, *excursion difference*, and *peak difference*.

3. Results

Most of the intonational phrases were realized with the plateau-contour L*H0% or the low-rising-contour L*HH%. The female speakers produced 97 statements and 117 questions with plateau-contours, and 78 statements and 70 questions with low-rising-contours. The male speakers produced 159 statements and 140 questions with plateau-contours, and 65 statements and 83 questions with low-rising-contours. Four female speakers showed variation in their choice of contour while the other 7 female speakers and all 10 male speakers kept the chosen contours constant (see table1). The distribution of the two target contours shows that the choice of contour varies across speakers but doesn't systematically vary across pragmatic functions.

Speaker	Pragmatic Function	Plateau-contour	Low-Rising-contour
1	Statement	23 (67%)	11 (33%)
	Question	14 (66%)	7 (34%)
2	Statement	13 (48%)	14 (52%)
	Question	6 (40%)	9 (60%)
3	Statement	25 (81%)	6 (19%)
	Question	9 (45%)	11 (55%)
4	Statement	17 (54%)	14 (46%)
	Question	10 (45%)	12 (55%)

Table 1: Distribution of intonational contours across pragmatic functions for four female speakers.

Significant effects of PRAGMATIC FUNCTION were found for the excursion of the final rise in both L*H0% (declarative mean=5.9st, interrogative mean=7.9st, $F=324.92$, $p<.001$) and L*HH% (declarative mean=9.2st, interrogative mean=11.2st, $F=109.24$, $p<.001$) but not for SPEAKER SEX (L*H0%: female mean=6.7st, male mean=7.1st, $F=0.34$, n.s.) (L*HH%: female

mean=8.9st, male mean=11.5st, $F=2.01$, n.s.), illustrated in figure 2.

No significant effects of PRAGMATIC FUNCTION could be found for the excursion of the prenuclear rise, neither for L*H0% (declarative mean=4.4st, interrogative mean=4.3st, $F=0.06$, n.s.) nor for L*HH% (declarative mean=4.1st, interrogative mean=4.0st, $F=0.25$, n.s.), and no effects of SPEAKER SEX (L*H0%: female mean=4.0st, male mean=4.6st, $F=0.52$, n.s.) (L*HH%: female mean=4.0st, male mean=4.1st, $F=0.01$, n.s.).

Consequently, there were significant effects of PRAGMATIC FUNCTION on the difference between final rise excursion and prenuclear rise excursion for L*H0% (declarative mean=1.5st, interrogative mean=3.6st, $F=159.47$, $p<.001$) and L*HH% as well (declarative mean=5.0st, interrogative mean=7.1st, $F=68.10$, $p<.001$) with no significant effects of SPEAKER SEX (L*H0%: female mean=2.6st, male mean=2.5st, $F=0.001$, n.s.) (L*HH%: female mean=4.6st, interrogative mean=7.5st, $F=2.84$, n.s.), illustrated in figure 3.

Finally, for the differences between the absolute final rise offset and the absolute prenuclear peak height, there were significant effects of PRAGMATIC FUNCTION for L*H0% (declarative mean=0.1st, interrogative mean=1.7st, $F=200.51$, $p<.001$) and L*HH% (declarative mean=3.4st, interrogative mean=5.2st, $F=58.53$, $p<.001$) with no significant effects of SPEAKER SEX in L*H0% (female mean=0.5st, male mean=1.0st, $F=0.67$, n.s.) but a small effect in L*HH% (female mean=2.7st, male mean=5.9st, $F=7.67$, $p<.05$), as illustrated in figure 4.

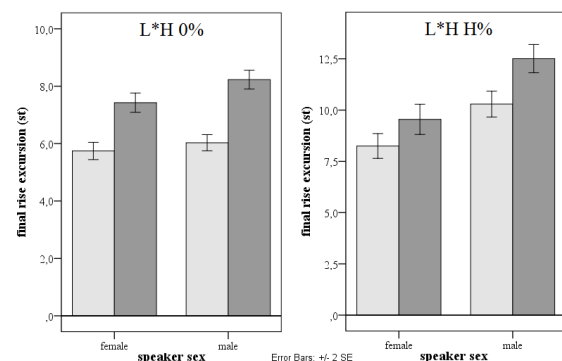


Figure 2: Phonetic effects of PRAGMATIC FUNCTION (light grey = declarative, dark grey = interrogative) and SPEAKER SEX on the *final rise excursion* in semitones for plateau- and low-rising contours.

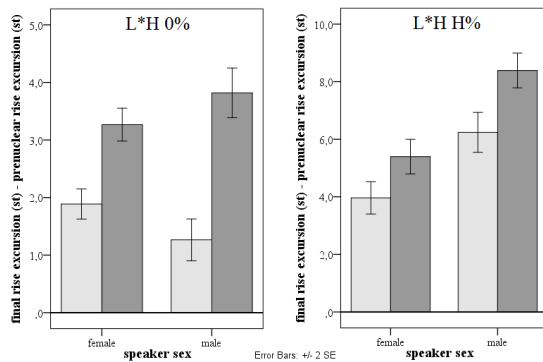


Figure 3: Phonetic effects of PRAGMATIC FUNCTION (light grey = declarative, dark grey = interrogative) and SPEAKER SEX on the *excursion difference* in semitones for plateau- and low-rising contours.

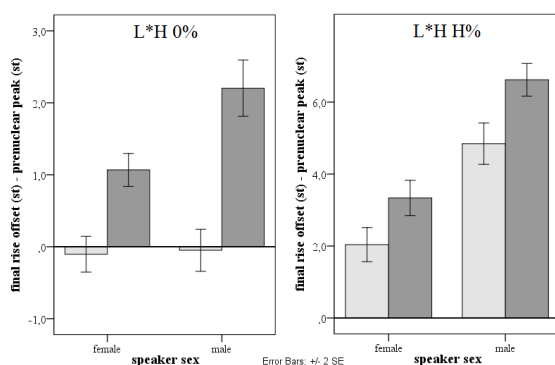


Figure 4: Phonetic effects of PRAGMATIC FUNCTION (light grey = declarative, dark grey = interrogative) and SPEAKER SEX on the *peak difference* in semitones for plateau- and low-rising contours.

4. Discussion and conclusion

The results suggest that the pragmatic function of interrogativity has significant effects on the scaling of intonation contours in German. This is in accordance with the assumption that in a typological perspective increased pitch is characteristic of interrogatives [19][20][21], as well as with experimental studies on several other languages [22][23][27][24][29].

The observed effects, however, were found to be restricted to the nuclear part of the utterance. This contradicts the majority of observations for other languages where interrogativity is found to either affect prenuclear and nuclear accents equally [22][23][27][24] or affect global parameters like declination [25][26][28], pitch range [33][24][34] or register level [22][23] in general. On the other hand, it is in accordance with Haan's [29] findings for Dutch. This suggests that Dutch and German may differ from other languages regarding the dimension of phonetic effects of interrogativity. It is, however, in contradiction to the observations of Niebuhr et al. [32] for German regarding both dimensions and types of effects. A first explanation for these differences may lie in the differences in keeping the phonological structure constant.

The variation of the nuclear part and the stability of the prenuclear part in interrogative utterances resulted in an increased difference between nuclear rise excursion and prenuclear rise excursion as well as between the absolute heights of the peaks of both rises. In other words, the local restriction of the phonetic effects also resulted in a global effect. The differences in absolute height of the peaks of both rises resulted in an even top-line for statements and an inclining top-line for questions. This is comparable to Haan's [29] upsweep, describing the amount by which the final rise exceeds the peak of the preceding nuclear accent peak. It is also compatible with the results from Brinckmann and Benz Müller [31] who observed a difference in the top-lines of statements and question-types.

Our results do not show, however, whether the actual perceptual relevant effect is 1) the difference in the excursion size of the final rise, 2) the relative difference of the excursion size of the final rise compared to the prenuclear rise, or 3) the difference in height of the peak of the final rise compared to the peak of the prenuclear rise. The first view would call for the listener's capability to compare the excursion size to some reference value in order to judge it as high enough to cue a question. The second view assumes the movement of both excursions as the perceptual cue. According to the third view, the perceptual cue would be whether the final rise's offset exceeds the prenuclear peak by a certain amount. The last two assumptions can but need not necessarily be connected because an increase in the excursion size of the final rise can be achieved by lowering the onset without increasing the height of the offset. To answer the question whether the extension of the final rise or the raising of the final offset alone provides sufficient cues to interrogativity, additional perception experiments will be carried out. It further remains to be tested whether the differences in excursion size of the final rise become more prominent when there is no prenuclear accent for comparison.

5. References

- [1] Gussenhoven, C., On the grammar and semantics of sentence accents, Foris, 1984.
- [2] Pierrehumbert, J. B. and Hirschberg, J., "The meaning of intonational contours in the interpretation of discourse", in P. Cohen, J. Morgan and M. Pollack [Ed], Intentions in communication, 271-311, MIT Press, 1990.
- [3] Peters, J., Intonation deutscher Regionalsprachen, Walter de Gruyter, 2006.
- [4] Petrone, C. and Niebuhr, O., "On the Intonation of German Intonation Questions: The Role of the Prenuclear Region", Language and Speech, 0(0):1-39, 2013. [in press]
- [5] Gussenhoven, C., The phonology of tone and intonation, Cambridge University Press, 2004.
- [6] Pierrehumbert, J., The Phonology and Phonetics of English Intonation, MIT, 1980.
- [7] Ladd, D. R., Intonational Phonology, Cambridge University Press, 2008.
- [8] Palmer, H. E., English intonation with systematic exercises, Heffer & Sons, 1922.
- [9] de Groot, A.W., "De Nederlandse zinsintonatie in het licht der structurele taalkunde", De Nieuwe Taalgids, 37:30-41, 1943.
- [10] von Essen, O., Grundzüge der hochdeutschen Satzintonation, Henn, 1964.
- [11] Selting, M., Prosodie im Gespräch. Aspekte einer interaktionalen Phonologie der Konversation, Niemeyer, 1995.
- [12] Bartels, C., The intonation of English statements and questions: a compositional interpretation, Routledge, 1999

- [13] Truckenbrodt, H., "On rises and falls in interrogatives", in H. Y. Yoo and E. Delais-Russarie [Ed], Proceedings from IDP 2009, Paris, Septembre 2009, ISSN 2114-7612: 9-17, 2009.
- [14] Kügler, F., "Do we know the answer? – Variation in yes-no-question intonation", in S. Fischer, R. Vogel and R. van de Vijver [Ed], Experimental studies in linguistics, Potsdam Universitätsverlag, 9-29, 2003.
- [15] Kügler, F., "Dialectal variation in question intonation in two German dialects: the case of Swabian and Upper Saxon", in Proceedings of the second International Conference on Language Variation in Europe, 227-240, Uppsala University, 2004.
- [16] Kohler, K., "Pragmatic and attitudinal meanings of pitch patterns in German syntactically marked questions", in G. Fant, H. Fujisaki, J. Cao and Y. Xu [Ed], From traditional phonology to modern speech processing. Festschrift for Professor Wu Zongji's 95th Birthday, 205-214, Beijing Foreign Language Teaching and Research Press, 2004.
- [17] Cruttenden, A., "Falls and rises: meanings and universals", *Journal of Linguistics*, 17:77-91, 1981.
- [18] Peters, J., "Intonation", in Duden – Die Grammatik, Kap. 2 (DUDEN-Reihe Bd. 4), 95-128, Bibliographisches Institut Mannheim, 2009.
- [19] Hermann, E., Probleme der Frage. 2. Teil, Vandenhoeck & Ruprecht, 1942.
- [20] Bolinger, D. L., "Intonation across languages", in J. H. Greenberg [Ed], Universals of Human Language. Band 2 (Phonology), 471-525, Stanford University Press, 1978.
- [21] Ohala, J. J., "Cross-language use of pitch: An ethological view", *Phonetica*, 40:1-18, 1983.
- [22] Hadding-Koch, K. and Studdert-Kennedy, M., "An Experimental Study of Some Intonation Contours", *Phonetica*, 11:175-185, 1964.
- [23] Gårding, E., "A generative model of intonation", in A. Cutler and D. R. Ladd [Ed], *Prosody: Models and Measurements*, 11-25, Springer, 1983.
- [24] Iivonen, A., "Intonation in Finnish", in D. Hirst and A. Di Cristo [Ed], *Intonation Systems. A Survey of Twenty Languages*, 311-327, Cambridge University Press, 1998.
- [25] Thorsen, N., "A study of the perception of sentence intonation – Evidence from Danish", *Journal of the Acoustical Society of America*, 67(3):1014-1030, 1980.
- [26] Thorsen, N., "Intonation and text in Standard Danish", *Journal of the Acoustical Society of America*, 77(3):1205-1216, 1985.
- [27] Grønnum, N., "Superposition and subordination in intonation, a non-linear approach", *Proceedings 13th International Congress of Phonetic Sciences*, 2:124-131, 1995.
- [28] Vaissière, J., "Language-Independent Prosodic Features", in A. Cutler and D. R. Ladd [Ed], *Prosody: models and measurements*, 53-66, Springer, 1983.
- [29] Haan, J., *Speaking of Questions: An Exploration of Dutch Question Intonation*, LOT Graduate School of Linguistics, 2002.
- [30] Oppenrieder, W., "Deklination und Satzmodus", in H. Altmann, A. Batliner and W. Oppenrieder [Ed], *Zur Intonation von Modus und Fokus im Deutschen*, 245-266, Niemeyer, 1989.
- [31] Brinckmann, C. and Benz Müller, R., "The Relationship between Utterance Type and F0 Contour in German", *Proceedings 6th European Conference on Speech Communication and Technology (EUROSPEECH)*, Budapest, Hungary, 21-24, 1999.
- [32] Niebuhr, O., Bergherr, J., Huth, S., Lill, C. and Neuschulz, J., "Intonationsfragen hinterfragt - Die Vielschichtigkeit der prosodischen Unterschiede zwischen Aussage- und Fragesätzen mit deklarativer Syntax", *Zeitschrift für Dialektologie und Linguistik*, 77:304-346, 2010.
- [33] Hirst, D. and Di Cristo, A., "A survey of intonation systems", in D. Hirst and A. Di Cristo [Ed], *Intonation Systems. A Survey of Twenty Languages*, 1-44, Cambridge University Press, 1998.
- [34] Moraes, J. A., "Intonation in Brazilian Portuguese", in D. Hirst and A. Di Cristo [Ed], *Intonation Systems. A Survey of Twenty Languages*, 179-194, Cambridge University Press, 1998.
- [35] Gussenhoven, C., "Transcription of Dutch Intonation", in S.-A. Jun [Ed], *Prosodic typology: the phonology of intonation and phrasing*, 118-145, Oxford University Press, 2005.
- [36] Beckmann, M. E., Hirschberg, J. and Shattuck-Hufnagel, S., "The original ToBI system and the evolution of the ToBI framework", in S.-A. Jun [Ed], *Prosodic typology. The phonology of intonation and phrasing*, 9-54, Oxford University Press, 2005.
- [37] Grice, M., Baumann, S. and Benz Müller, R., "German Intonation in Autosegmental-Metrical Phonology", in S.-A. Jun [Ed], *Prosodic Typology: The Phonology of Intonation and Phrasing*, 5-83, Oxford University Press, 2005.