ACOUSTIC-PHONETIC INVESTIGATIONS OF THE INTONATION OF
GERMAN AND DANISH: SIMILARITIES AND DIFFERENCES*

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INTRODUCTION

The past ten years have witnessed a growing interest in prosodic studies – phonological as well as phonetic ones. Today the emphasis is on the construction of theories and on empirical investigations, which interact and lead to models of prosody.

We present here the results of instrumental phonetic investigations of German and Danish intonation and account for the prosodic categories required in the description. This is followed by a comparison of the two languages, insofar as the prosodic categories and their manifestation is concerned. The presentation is descriptive rather than arguing. Discussions about intonation theories and models can be found in Bannert (1982) and Thorsen (1983a, 1983b, 1985a, 1985b). Our purpose here is to present to the reader the basic structures of German and Danish intonation and point out the more important similarities and differences. Such descriptions and comparisons may serve as point of departure for further comparative studies and for foreign language teaching. We would like to stress the fact at the outset that the research we each of us have conducted was not intended for comparative (Danish-German) purposes, and this paper thus represents a "rationalization after the fact". That also accounts for the somewhat different disposition of the two sections, which excludes a direct comparison of every aspect treated in Danish and German, respectively.


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TERMINOLOGY AND PROCEDURES

By intonation we mean speech melody, i.e. the fundamental frequency ($F_0$) variation or pitch course as it appears in $F_0$ curves. Other phenomena which in linguistic tradition are occasionally encompassed by intonation such as rhythm and voice quality, will not be dealt with here.

Our results derive from systematic, empirical and experimental acoustic investigations. Such investigations have certain intrinsic limitations. They often deal with sentences which have been read by speakers in sound treated rooms. Such is also the case here. The material is often composed of severely limited and manipulated utterance types. Such a procedure may seem inappropriate in view of the fact that the final goal is a description of the intonation of spontaneous speech. However, our methods may be defended on at least two grounds. Firstly, it is easier to investigate the course of $F_0$ in syntactically and pragmatically simple structures which have been produced under controlled circumstances. Secondly, you may expect that natural, spontaneous speech can be described with the same categories and prosodic structures as manipulated, read sentences. In other words, the intonation of non-manipulated, free speech will later be accounted for with the same descriptive devices as the controlled speech situation. The description of intonation in both languages is based on sentences of varying length and encompasses declarative as well as interrogative utterances.

THE BASICS OF DANISH INTONATION

The model in figure 1 derives from analyses of fairly short, simple sentences, read aloud by speakers of Copenhagen Standard Danish. The pragmatically neutral context as well as instructions to the speakers were intended to elicit neutral speech, i.e. speech which is not characterized by any particular emotions or emphases.

The model depicts the structure of intonational phenomena as a hierarchically organized system, where components of smaller temporal scope are superposed on components of larger temporal domain. In other words: global tendencies with more local modifications. For Standard Danish the following components can be discerned:

The text contributes an overall textual contour.
The sentence yields a sentence intonation contour.
The prosodic phrase adds a phrasal contour.
The prosodic stress group contributes a stress group pattern. The "stød" may involve a tonal modification on the stress group pattern.
Finally, individual segments have intrinsic $F_0$ characteristics (the microprosodic component).
A model for the course of fundamental frequency in short sentences in Standard Danish. (1) Syntactically unmarked questions. (2) Questions with word order inversion and/or interrogative particle; non-final declarative and interrogative clauses. (3) Terminal declarative statements. Large points denote stressed syllables, small points depict unstressed syllables. Full lines represent the Fo pattern of prosodic stress groups; broken lines indicate the sentence intonation contours.

Figure 1 only depicts the sentence and stress group components. If the utterance exceeds a certain length, the intonation contour is decomposed into shorter, falling phrasal contours, which together describe an overall falling contour (figure 2, see also Thorsen 1983a, 1983b). Sentences are coupled together into coherent texts in a similar fashion. Each sentence has its own intonation contour, but together these sentences describe an overall falling course (see figure 3 and also Thorsen 1985a, 1985b). In the following, only the sentences and stress group components are dealt with.

The prosodic stress group

Barsbøll (1977) defines a syntactic stress group in Danish as a group of words with one main stress which lies on the last word in the group (with certain exceptions: personal pronouns are unstressed also in final position). The prosodic stress group, on the contrary, consists of a stressed syllable and all succeeding unstressed syllables, i.e. the prosodic stress group boundary, or foot boundary, lies immediately before the stressed
Figure 2

Intonation contours (full/broken lines) and stress group patterns (dotted lines) in two groups of terminal declarative utterances, consisting of one to eight prosodic stress groups. Average over four speakers. Large points denote stressed syllables, small points unstressed syllables. Broken lines denote the boundaries between prosodic phrases.
Stylized model of the course of Fo in texts with three terminal declarative sentences (full lines) and three coordinate main clauses (broken lines). The lower lines connect the stressed syllables, i.e. they represent the intonation contours (cf. figure 1), the upper lines connect the first unstressed syllable in each stress group. The dotted lines represent the overall slope through the text. A text with two components is arrived at by leaving out the middle component. An isolated sentence arises when the dotted lines are suitably compressed in time.

 syllable, independently of the number and type of syntactic boundaries in the sentence. The parsing of an utterance into prosodic stress groups can be illustrated with the following example (/ depicts the boundaries between two main clauses and between verb phrase and complement within each clause; + denotes prosodic stress group boundaries, and − marks the stressed syllables):

Han lagde sig / på chaiselongen / og tændte / en Caminante.
Han + lægde sig på chaise + løngen og + tændte en Cami + nænte.

(He lay down on the sofa and lit a Caminante (a cheroot).)

The definition of the prosodic stress group as a stressed syllable plus all succeeding unstressed syllables (if any) within the same intonation contour derives from the analysis of tonal patterns. The prosodic stress group is the carrier of a recurring and fairly constant Fo contour consisting of a (relatively) low stressed syllable followed by a high-falling tail of unstressed syllables. Thus, the three capitalized sequences below are all realised with the same Fo pattern:
The interesting fact here is the non-isomorphic relation between syntax and prosody (in casu: intonation). Somewhere in the speech production process the utterance is re-structured, whereby a considerable number of word and higher syntactic boundaries are deleted in the course of Fo. (This is true at least of the type of monitored and fluently read speech which is the basis for the analysis.)

If tonal relations are accepted as criteria for locating boundaries, it is clear that the prosodic stress group cannot, e.g., end with the stressed syllable: the tonal relation between a stressed syllable and the preceding unstressed one is highly variable, as is apparent from figure 1. The preceding syllable may be higher than, on a level with, or lower than the stressed syllable, depending on how many unstressed syllables precede.

Stress group pattern variation

The prosodic stress group pattern is subject to a certain quantitative variation, depending on
1) its position in the utterance (the magnitude of the rise from stressed to post-tonic syllable decreases from beginning to end)
2) the intonation upon which the pattern rides (the rise is higher on less falling contours, cf. figure 1).

Furthermore, the number of unstressed syllables in a prosodic stress group may vary between zero and rather large numbers, which naturally influences both the Fo pattern and the time interval between the stressed syllables. If there are no unstressed syllables in the stress group, there is no material on which the pattern can rise (and fall), so the Fo pattern is truncated (rather than being compressed in time to be contained within the single, stressed syllable). Finally, there is an interspeaker variation in the magnitude of the low-to-high interval and in the steepness of the slope of the falling unstressed syllables. See further Thorsen (1984).

The slope of the intonation contour

When the stress group pattern is a recurrent, predictable, qualitatively constant LOW + HIGH-FALLING pattern, the intonation contour can be defined in terms of the stressed syllables alone. That is not to say that the course of the unstressed
syllables is irrelevant for the identification of intonation contours, only that they are redundant in the strict sense of the word (see further Thorsen 1980a). In short utterances the intonation contours approach straight lines whose slopes vary in close correlation with the type and function of the utterance, as shown in figure 1: terminal declarative utterances have the steepest slopes, syntactically and lexically unmarked questions have horizontal contours. In between we find other types of questions and non-terminal sentences, with a tendency towards a trade-off between syntax/lexicon and intonation: the more syntactic or lexical information about the interrogative or non-terminal function of the sentence, the more falling, i.e. the more declarative-like, is the intonation contour, and vice versa. Furthermore, it appears that, just like in German, the tonal course is the same in utterances with identical prosodic structure, independently of syntactic constituents. See also above under "The prosodic stress group".

Longer utterances

If a declarative utterance contains more than three or four stress groups, most speakers will decompose the contour into several, shorter phrase contours, each with its own declination - which together describe an overall falling slope (figure 2). The boundaries between prosodic phrases in an utterance are related, though not directly subordinated, to syntactic boundaries. The relationship between utterance length, prosody, syntax and semantics is rather complex. See further Thorsen (1983a).

Global signalling of sentence intonation

The description of intonation above implies that sentence intonation is signalled globally rather than locally, i.e. the difference between, e.g., a declarative and interrogative sentence does not reside in a special movement at the end of the sentence but is distributed over the whole utterance. In this matter, Danish is different from most of the related Germanic languages.

Sentence accent

Danish displays yet another peculiarity: it lacks an obligatory sentence accent, or focus, or nucleus. In pragmatically neutral speech all stressed syllables have the same weight or prominence. An extra prominence somewhere in the utterance is not present acoustically, nor perceptually. Pragmatically and prosodically neutral utterances are neither incomplete nor unnatural. Even if they do not occur very often in spontaneous speech, they are in no way unnatural and they are very easy to elicit in recordings. See further Thorsen (1983b).
Stylized tracings of the course of Fo in statements (S - left) and questions (Q - right), which are prosodically neutral (open circles and dotted lines) or have emphasis for contrast (stars, points and full lines) in initial position (top), medial position (mid), and final position (bottom). Stars denote the emphatically stressed syllables, large points denote other stressed syllables, and small points depict unstressed syllables.
Contrast

Emphasis for contrast is manifested in Standard Danish by a raising of Fo of the stressed syllable of the emphasized word, together with a shrinking of the Fo patterns in the neighbouring stress groups (figure 4 and further Thorsen 1980b). Thus, emphasis for contrast in Danish shares certain features with the sentence accent of other languages, without being identical with it. One difference remains, however: in pragmatically neutral utterances of Standard Danish there is no particular prominence attached to the last (or any other) stressed syllable.

In the description of Danish, as opposed to German, the following points should be noted: In German there is a distinction between emphasis as an expression of the speaker's involvement - which is signalled globally, i.e. with larger tonal movements throughout the utterance - and contrast, which emphasizes a particular word and which is expressed in and around the stressed syllable. In Danish the parameter "speaker involvement" has not yet been subjected to investigation. The German parameter 'contrast' corresponds to the Danish 'emphasis for contrast'.

Furthermore, in the description of German intonation a distinction is made between accented and stressed syllables. Accented syllables are those lexically stressed syllables which are associated with a tonal change, i.e. a skip (up or down) in frequency. Any German word may contain a stressed syllable; this is the word accent. In the sentence, however, words will often be de-accentuated due to the context, i.e. they will appear without any tonal movement. Such words, with their meanings, are not made prominent. This distinction in German corresponds, in the description of Standard Danish, rather to the difference between stressed syllables, which are signalled through a rise in Fo, and syllables with secondary stress which have no such rise and which we find, e.g., in prosodic stress groups which surround a word with emphasis for contrast. This is a point where the description of Danish may have to undergo a revision; but until the concept of accent is better understood in Danish, the present account will be maintained.

Finally, we wish to point out that certain phenomena, which are termed emphasis for contrast in Danish might correspond to the German sentence accent, insofar as the difference between sentence accent and contrast in German is not a categorical one, neither semantically nor phonologically/phonetically.
GERMAN INTONATION

The following description of German intonation is based on phonetic investigations of the speech of ten North German speakers, where the Fo course is attained through acoustic analysis and measurements. A more detailed description of the phonetic background can be found in the references.

Units of description

The basic units for the description of German intonation, apart from the whole text, are (1) the complete utterance, whose end is signalled by a very low Fo in answers and by a very high Fo in questions, tones which simultaneously reflect the terminal juncture, i.e. the boundary at the end of the utterance; (2) the phrase, the part of an utterance which is subordinated to it through tonal (and temporal) means (parentheses, subordinate clauses of various types); (3) the foot, i.e. the part of a phrase which begins with an accented syllable and encompasses all succeeding unstressed syllables. In certain cases units may merge. For instance, utterances like Es hat geklőpt, Ich doch nicht!, Jä, Wiesō? consist of phrases which are simultaneously feet.

The intonation, i.e. the Fo curves of utterances of varying length (1, 2, 3 and 8 accents), and the three utterance types: neutral answer, neutral information question, and surprised echo question by a North German speaker are shown schematically in figure 5. Every content word has the same weight. The time axis (horizontal) is normalized. The Fo rises in all accented syllables until the last one of the answer (declarative), where it falls. The two question types differ from the answer mainly at the end, through the rising versus falling tonal movement. The utterance with three accented syllables, in the three intonational versions is as follows:

ANSWER
Der Müller will die Männer immer Lümml
nennen.
(The miller always calls the men louts.)

ECHO QUESTION
Der Müller will die Männer immer Lümml
nennen??!!

INFORMATION QUESTION
Will der Müller die Männer immer Lümml
nennen?

The different utterance lengths are achieved by reduction and expansion, respectively, of these sentences.

For the production of intonation in an utterance in German, the following prosodic information is necessary and sufficient:
Figure 5

Normalized and superposed Fo tracings of answers, information questions, and echo questions of varying length. One to eight accents. The last accent is the line-up point.
1. Beginning and end of the utterance (initial and terminal junctures),
2. phrase boundaries, in case the utterance is decomposed into smaller elements,
3. the position of the accentuated syllables in the lexical items (words) of the utterance,
4. the semantic weight of the lexical units,
5. intonation type (utterance type): terminal in answers versus non-terminal in questions,
6. the speaker's involvement in what is being said: neutral versus involved, contrast through particular prominence of the contrasted element (word) and emphasis through prominence of a whole phrase or utterance, respectively.

Prosodic characteristics

In German, too, we may assume the stress accent or word accent to be primarily tonal in nature, i.e. the accent relies on a tonal change within the accentuated syllable or between two successive syllables and not on a greater articulatory force or a higher air pressure from the lungs. Therefore, it seems justified to speak only of accents or accentuated syllables in German, whose primary manifestation lies in the Fo movement of the syllable or in a skip up from the low Fo of the pre-accentuated to the high Fo of the post-accentuated syllable, respectively.

The tonal properties are partly independent, i.e. they do not rely on other properties, notably the rhythmical structure, of the utterance; but they are also partly connected with other properties and/or interact with them. So, for instance, intonation type (low final Fo in answers, high final Fo in questions) is independent of other properties, whereas accent is lexically associated with a stressed syllable.

Nucleus or main accent

The last of several accents, intended to be equally heavy semantically, in a German phrase will stand out from the others, and will be perceived as heavier or stronger. This accent is called the rhematic accent, the sentence accent, the main accent, the primary accent, or the nucleus ("Schwerpunkt") (e.g. by von Essen, 1956). Lately, the term (semantic) focus has become current. The semantic focus, which makes one lexical item stand out from others, is signalled prosodically through the main accent. This nucleus may occur with both intonation types: with terminal utterances it is manifested in the tonal fall (in the low end point), with non-terminal utterances it is signalled in the tonal rise (in the high end point). The stronger auditory impression of the main accent derives from two properties: firstly, from the tonal
change in the final accent itself, secondly, in the tonal course from the accent to the end of the utterance.

After the nucleus, no more accentuated syllables will appear (though there may be stressed syllables), i.e. after the tonal change associated with the primary accent the Fo curve runs smoothly towards the low or high end point. Thus, a phrase contains - besides possible accentuated syllables - only one nucleus or main accent. The nucleus is no independent unit: it can be predicted with semantic-pragmatic rules.

An example of nucleus displacement to the left, departing from an utterance with four accents which was pronounced as one phrase, is shown in figure 6, (a) as a terminal utterance type (an answer to a corresponding question or as a general statement) and as a non-terminal utterance type in two editions: (b) as information question with word order inversion and (c) as echo question, which expresses, inter alia, surprise and wonder. It is clear to see that the Fo curve, after the last, major change in the 4th, 3rd, 2nd, and 1st accentual position, respectively, runs smoothly low and high, respectively, to the end.

Special prominence

Intonation may also express the speaker's attitude towards the contents of his utterance, i.e. his involvement in what he is saying. A strongly participating, involved, emphatic attitude, e.g. surprise, wonder, indignation, is expressed tonally in a larger Fo range. The increase of the range, within which the pitch curve of the utterance varies, is primarily brought about by a raising of Fo maxima, but also by a lowering of the minima. This increase of the tonal range covers the whole phrase with all its accents. Figure 6 shows the echo question (c) in contrast to the information question (b) and to the answer (a).

Contrast, on the other hand, does have a semantic-lexical function, which is signalled tonally to the listener by the same means, namely an increased Fo range. However, its domain is limited to the lexical unit, the word. Contrast often expresses an opposition or the correction of an assumption. In phrases, which consist of only one foot, contrast and emphasis merge as far as the tonal manifestation goes. The difference lies, apart from the domain, in the function of the tonal expression. Contrast and nucleus are also different phenomena. This appears from figure 7. The curves derive from utterances which are of identical lexical, syntactic and phonological structure, but which occur in different prosodic contexts. The contrast appears tonally as prominent and marked peaks in each accent position.
Figure 6

Sentence accent in answers, echo- and information questions with four possible accents (arrows). Superposed tracings from four versions with the sentence accent in each of the four positions. The arrows along the horizontal time axis denote the boundaries between the initial consonant and the accentuated vowel. The respective accentuated words are underlined in the same type of line as the Po tracing. The sentence accent contains the last tonal change of the utterance.
Phrase intonation

Two junctures (boundary signals), the terminal (utterance final) and the non-terminal (phrase final), have their characteristic tonal expressions. While the former expresses itself through an extremely low or high Fo, respectively, the latter is manifested by an Fo in the middle to upper range of the utterance, the so-called phrase tone. The relation to the Fo course preceding and succeeding the juncture is also part of the total picture of these tonal-junctural phenomena.

Figure 8 shows the syntactically complex sentence "Männchmal aber, und dann ohne größe Ankündigung, blickte er sie finster unter einer gerunzelten Stirn an, dass sie beinahe das Furchten bekamen" (Often, however, and without particular warning, he looked severely at them, under dark and knitted brows, so that they were almost afraid.) as a part of a text. The utterance consists of four phrases. Each of the three non-final phrases ends in a high Fo which is reached either in the last syllable of the phrase ("Ankündigung, an") or already in the last accent ("aber"). The end of the last phrase is identical to the end of the utterance. The low Fo in the last syllable expresses simultaneously the terminal juncture and the intonation type 'answer' (statement). This figure also illustrates a natural Fo curve, as delivered by the acoustic analysis. The empty
Figure 8

Phrasal intonation and phrase tone. The syntactically complex utterance (declarative) consists of four prosodic phrases. The three non-terminal phrases end in a high, continuation phrase tone, which is denoted with a star.
spaces in the curve correspond to unvoiced segments and phona-
tory pauses. Both junctures may be, but are not necessarily, accompa-
nied by a physical pause. However that may be, we may assume that both junctures, beside their tonal manifestation, also involve a temporal lengthening of the last syllable, the so-called final lengthening, which has been demonstrated in other Germanic languages like Dutch, English and Swedish as well, but which is not a feature of Danish.

The intonational system

The course of Fo in phrasally identical utterances with equally prominent accents appears in German to be fairly simple and systematic. Apart from the last accent, the nucleus - which simultaneously expresses the intonation type - the tonal course of utterances with several accents appears, grossly simplified, as a repetition of the sequence Low-High(-Low) for each non-utterance final accent. This system for all three sentence types and for sentences with one to eight accents appears clearly from figure 5. The low points (Fo minima) of the accents in the three utterance types form a rather firm floor while the peaks in the utterances may be raised (so for instance in the echo question).

With unequally prominent accents, i.e. when an accent in the phrase, due to less semantic weight, appears weakened relative to a neighbouring one, the high and low points of this accent are displaced towards the middle of the range. The tonal move-
ments of this accent diminish. A complete loss of semantic weight of a lexical element leads to de-accentuation and there-
by also to the absence of Fo movements in the potentially ac-
centuated syllable.

The tonal course through an utterance, i.e. the Fo minima and maxima with rising and falling movements between them, is char-
acterized by an overall falling slope. As seen in figure 5, the Fo curve begins with a higher value of the minimum of the first accent than the one on which it ends. Intervening minima are distributed between these two values. This slope on the course of Fo is more or less identical for both utterance types and for the dimension 'involvement', although the echo question often begins with a lower Fo minimum in the first accent than the corresponding statement. Even when this difference is present, it should not be associated with utterance type dif-
fences, which are primarily signalled locally at the end of the utterance, but rather as an expression of involvement (in casu: surprise).

In the longest utterances, from five accents and upwards, Fo minima are not evenly distributed between the first and last minimum, as they are in shorter utterances. In the longest utterances a certain re-structuring appears to take place. The Fo minima of the penultimate and antepenultimate accent lie somewhat higher than the preceding ones. It is possible
that this upward displacement of the tonal movements - the
peaks, at least, are raised - takes place in anticipation of
the end of the utterance, which is so rich in tonal informa-
tion. Thereby it is assured that the tonal change of the last
accent may be really extensive and clear. A comparison with
figure 2 shows that the floor, i.e. the line which connects
the Fo minima, is clearly different from the corresponding
sentences in Danish. The interval between the first and last
Fo minimum in an answer is considerably smaller than in Danish.
This behaviour is a natural consequence of the different tonal
signalling of the intonation types answer and question, re-
respectively, in the two languages, as will appear from the next
section.

Intonation types

In German, answer and question differ very clearly and unam-
biguously with respect to their tonal manifestation. The dif-
ference between answer (terminal) and question (non-terminal)
appears locally at the end of the utterance. The terminal in-
tonation type ends with a low Fo. As a matter of fact, this
point represents the speaker's absolute low, which he repro-
duces fairly accurately and constantly. The non-terminal ut-
terance type ends high and may constitute the auditory pitch
peak of the utterance. As appears clearly from figure 5, the
Fo minima of the various sentence types practically coincide.
From this we may conclude that the overall slope of the pitch
curve, respectively the tonal floor (of the Fo minima), does
not, in German, constitute the signal for intonation type.
In Danish, on the contrary, where intonation type is not sig-
alled locally at the end, the global tonal difference of the
total utterance must serve to distinguish intonation types.

Tonal range

The course of the Fo curve, i.e. the timing of tonal minima and
maxima, signals linguistic categories, but apart from that the
speaker also exploits the possibility to change the range of
his tonal movements for communicative purposes. With the
speakers investigated so far the tonal movements in answers
and information questions had the same range. Both utterance
types were spoken with normal, neutral involvement. The in-
formation question is a true question, with which the speaker
seeks real, to him unknown information. By strong involvement,
as e.g. in the expression of surprise and wonder or incredulity
in the echo question, most speakers increased their tonal range,
though maintaining the basic structure of the tonal course.
Furthermore, the syllables of the total utterance will be con-
siderably lengthened in some cases. The tonal range is in-
creased primarily by the raising of the Fo maxima. Thereby the
Fo rises and falls in any given accent are increased. This
observation leads to the assumption that the tonal course rests
on a constant Fo bottom or floor, while the height of the ceiling
can be displaced upwards. These tonal relations express physiological-articulatory mechanisms and constraints.

Intonation and syntax

Prosody in general and intonation in particular have a double function in the grammar. They are associated with other grammatical components, on the one hand, but they lead separate lives, on the other. Accents occur only in lexically determined syllables; prosodic phrases often coincide with syntactic phrases, but not necessarily. The tonal course of phrases with the same prosodic structure is identical, whether the phrase be a nominal, a prepositional, or an adverbial one. Word boundaries have no influence on the Fo course, as is also the case in Danish.

SURVEY FOR COMPARISON

From the descriptions of German and Danish intonation above it appears that similarities and differences exist between the two languages. By way of conclusion they are summarized here:

Alike or similar are the following properties of German and Danish intonation: The basic units of description, namely text, utterance (sentence), phrase, foot, and syllable, which are hierarchically organized from the largest to the smallest unit. The (word-) accent is mainly realized through an Fo change in the accentuated syllable, or an Fo jump. Contrast and emphasis, i.e. a particular prominence of a word or an utterance, are expressed through greater Fo range, which is primarily achieved via a raising of the Fo peaks. Between prosody, in particular intonation, and syntax relations exist which, however, have not yet been investigated directly or to any great extent (but see Tropf 1984).

German and Danish intonation differ on the following points: In German, the last of several semantically equally prominent words in an utterance receives the nuclear or sentence or main accent; this is not so in Danish. In a neutral statement in Danish all accents sound equally prominent. The intonation types answer and question, respectively, demonstrate major differences. In German their tonal manifestation is located at the end of the utterance (from the last accent to the end) - the answer ends in a low Fo, the question in a high Fo. The preceding tonal course is identical. In Danish, on the contrary, answer and question differ globally, in the total course of Fo which is falling in terminal declaratives and horizontal in syntactically unmarked questions. At the end, both utterance types are alike tonally.

These similarities and differences are summarized in Table I:³
<table>
<thead>
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<th>Property</th>
<th>German</th>
<th>Danish</th>
<th>similar?</th>
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</thead>
<tbody>
<tr>
<td>Units of description</td>
<td>Text (period)</td>
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<td></td>
<td>Utterance (sentence)</td>
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<td>Nucleus (primary accent)</td>
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<td>non-compulsory</td>
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<td>Contrast</td>
<td>increased tonal range in the accentuated syllable and simultaneous tonal reduction in the neighbouring syllables</td>
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<td>yes</td>
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<tr>
<td>Intonation types</td>
<td>local signalling: lower final F0 in answers, higher final F0 in questions in otherwise similarly sloping pitch curves</td>
<td>global signalling: falling in terminal declaratives, less falling in other sentence functions</td>
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<td>Intonation and syntax</td>
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ACKNOWLEDGEMENT

We are very grateful to Hartmut Haberland for valuable comments and suggestions for improvement.

NOTES

1. The stress group or foot consists of the accentuated syllable and all succeeding unstressed syllables (if any).

2. The present description deals exclusively with the basic linguistic units of intonation, i.e. with the basic intonational structure of utterances with a purely linguistic function. Paralinguistic aspects, like emotions or irony as well as voice quality, are excluded. Note also, that as far as we know, the acoustic data on German intonation with their integration in an intonation or prosody model, are the first of their kind. Consequently, the statements made here about German intonation cannot be exhaustive. On the other hand, we assume that the description contains fundamentally valid observations and characteristic features of Standard German intonation. Further data and knowledge in this area are anticipated: due to a recent financial support for intonation research from the German Research Council, there is a lively activity in intonation research going on in the Federal Republic.

3. This comparison is, for various reasons, not complete.

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