INTRODUCTION

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

The results which are summarized below derive from systematic, empirical acoustic investigations of the speech of a total of ten speakers. My investigations have had certain intrinsic limitations. They deal with utterances which have been read by the speakers in a sound-treated room. The material is to a major extent composed of severely limited and manipulated utterance types, i.e. typical 'laboratory speech'. 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, the method may be defended on at least two grounds. Firstly, it is convenient to investigate the course of $F_0$ in syntactically and pragmatically simple structures which have been produced under controlled circumstances, because this allows you to single out the parameter under scrutiny without interference from other factors which may influence $F_0$. Secondly, you may reasonably expect that natural, spontaneous speech can be described, at least to a certain extent, with the same categories and prosodic structures which have been discovered in edited, read speech. In other words, the intonation of free speech ought later to be accounted for with the same descriptive devices as the controlled speech situation, although you may find that the inventory of parameters will have to be supplemented.

*) Contribution for a volume about intonation systems of various languages edited by Albert di Cristo and Daniel Hirst, to be published by Cambridge University Press.
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HIERARCHIES IN DANISH INTONATION

It is my basic assumption that Standard Danish intonational phenomena are structured in a hierarchically organized system, where components of smaller temporal scope are superposed on components of larger temporal domain. Such an organization creates global tendencies with more local modifications. The following components can be discerned:

1. the text contributes an overall textual contour
2. the sentence/utterance yields a sentence intonation contour
3. the prosodic phrase adds a phrasal contour
4. the prosodic stress group (or foot) contributes a stress group pattern
5. the 'stød' (see below) may involve a tonal modification of the stress group pattern
6. individual segments have intrinsic F0 characteristics (the microprosodic component).

These components are simultaneous, parametric, non-categorical and highly interacting in their actual production.

This view of intonation as a hierarchically organized, layered, system of components is not uncontroversial. Pierrehumbert 1980 and Liberman and Pierrehumbert 1984 take a different approach, and describe intonation in terms of a linear sequence of categorically different, non-interacting (high and low) tones. For a discussion of the relative merits of the two theories, see Ladd 1983a, 1983b, and Thorsen 1983a, 1983b, 1985, 1986, and 1987b.

Nos. (6) and (5) will not be dealt with any further in this chapter. The reader is referred to Thorsen 1979 and Fischer-Jørgensen 1987 for further treatment of microprosody and stød, respectively.

THE PROSODIC STRESS GROUP

Basbøll 1977 has defined a syntactic stress group in Danish as a group of words with one main stress, which is on the last word in the group (with certain exceptions - personal pronouns are unstressed even in stress group final position). The same definition is implicit in Andersen's 1954 description. The prosodic stress group, on the contrary, consists of a stressed syllable and all succeeding unstressed syllables (if any) - i.e. the prosodic stress group boundary, or foot boundary, lies immediately before the stressed syllable - independently of the number and type of syntactic boundaries in the utterance. 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 + lågde sig på chaise + lóngen og + tændte en Cami + nánte.

(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 F₀ pattern consisting of a (relatively) low stressed syllable followed by a high-falling tail of unstressed syllables. Thus, the three capitalized sequences below are all realized with the same F₀ pattern:

- - - • •
- - - • . • . • . . • . . . . . •

HANDBOLDSPIL ER meget ânstrengende
banÅNERNE I kåssen er rådne
allerGI ER EN INFåm sygdom

(Handball-playing is very strenuous. The bananas in the box are rotten. Allergy is an infamous disease.)

The interesting fact here is the non-isomorphous 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 F₀. (This is true at least of the type of monitored and fluently read speech which is the basis for the analysis.) See further Thorsen 1980a.

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. I have not investigated rhythmic structure, nor have I looked at segmental cues to syntactic boundaries, and the general relevance in speech production and perception of the prosodic stress group as defined here must be corroborated by investigations of timing.
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.

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, ceteris paribus, cf. figure 1)

(2) the intonation upon which the pattern rides (the rise is higher on less falling contours, cf. figure 1)

(3) within the realm of non-emphatic, non-contrastive stress there is apparently a certain margin for varying the degree of relative prominence, which is proportional to the rise in F0 from stressed to post-tonic syllable, cf. Thorsen 1987a.

Furthermore, the number of unstressed syllables in a prosodic stress group may vary between zero and rather large numbers, which naturally influences both the F0 pattern and the time interval between the stressed syllables. If, e.g., there are no unstressed syllables in the stress group, there is no material on which the pattern can rise (and fall), so the F0 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 1984a and 1984b.

ALIGNMENT OF SEGMENTS WITH F₀ PATTERNS

It is implicit in what has been said above, that Danish resembles the other Germanic languages where stress is concerned. I.e. stressed versus unstressed is a meaningful dichotomy in the phonology and phonetics of the language. Danish may even be an extreme case, when compared with its nearest (Swedish, Norwegian and German) neighbours where the reduction of unstressed syllables is concerned. Firstly, we have a vowel, /a/, which is exclusive to unstressed syllables. Secondly, on the surface, in fluent speech, this vowel assimilates to a neighbouring sonorant consonant, to the effect that the only trace left of an unstressed syllable may be in (duration and) the course of F₀. See further Brink and Lund 1975 and Thorsen 1984a. (This rather drastic phonetic reduction - compared to the full underlying forms (and the orthographical representation) - contributes much to make Danish difficult to understand for Swedes and Norwegians, in spite of the obvious similarities between the Scandinavian languages.)

Danish has a phonological distinction in stressed syllables between long and short vowels, without the complementary consonantal length, characteristic of Standard Swedish and Norwegian. Stressed syllables also carry a phonologically relevant stød/non-stød distinction, corresponding to the word tone distinction of Swedish and Norwegian. However, the manifestation of the stød, which exhibits a good deal of dialectal and individual variation, is not generally considered to be primarily tonal. In Standard Danish it may be described as a kind of creaky voice which attacks the final part of a long vowel or the succeeding consonant, if the preceding vowel is short (see further Basbøll 1985, Fischer-Jørgensen 1987, and Gårding 1977). Stress and stød, both, are to a very large extent predictable from the segmental composition of the underlying lexical forms (cf. Basbøll 1972 and Rischel 1969).

To the extent that stød has an influence upon the course of F₀, it will generally introduce a local falling tonal movement. Stress has a much more invariable and considerable effect upon F₀, as can be inferred from the stylized model in figure 1. In Standard Danish the stress group is associated with a low-high-falling tonal pattern, whose trough is timed to coincide approximately with the offset of the stressed vowel, if it is short, or else about halfway through a long vowel, see the example in figure 2. The peak of the pattern is aligned with the first post-tonic syllable, in general. It is entirely possible to view the F₀ pattern associated with prosodic stress groups in Standard Danish as a basically time- and frequency invariant pattern: Segments and syllables...
Fundamental frequency tracings (averages over 5 recordings) of two utterance medial words kugle and kulde [ˏkuˌlə, ˏkuˌlɛ]. The vowel-consonant boundary is indicated with a vertical stroke. Zero on the logarithmic frequency scale corresponds to 100 Hz. Male speaker.

are superposed on the wave in straight succession, like pearls of varying length onto an undulating string. Thus, the rise-fall is more or less complete, according as the prosodic stress group is longer or shorter, and may be lacking altogether in monosyllabic stress groups. See further Thorsen 1984a, 1984b.

There is a further phenomenon to be noted in the delimitation of prosodic stress groups: Figure 3 depicts the course of $F_0$ in the underlined sequence of 'Dén øl er lünken' (That beer is tepid), i.e. ['ˏøl ˏər ˏluŋken']. The initial [ˏ] in 'lünken' behaves very much as if it were part of the preceding prosodic stress group: together with the preceding stressed diphthong it performs the characteristic low + high-falling pattern.

Fundamental frequency tracing of the underlined sequence in the utterance Dén øl er lünken. Zero on the logarithmic frequency scale corresponds to 100 Hz. Female speaker.
STANDARD DANISH INTONATION

(The high consonant is not due to intrinsic F0 level differences between the [l] and the vowels, because, if anything, the consonant has an intrinsically lower F0.) In fact, the initial [l] in 'lunken' behaves qualitatively exactly as the final [l] in 'øl'. Its more ample rising movement is due to the longer total duration of the sequence [løn] versus [ø1], which allows for a more complete gesture before the downward course towards the next stressed vowel. In other words, the tonal syllabification seems to be VC-V rather than V-CV, irrespective of phonological and morphological/syntactic boundaries. To summarize: an initial voiced consonant in a stressed syllable will be dissociated tonally from the stressed vowel and continue the F0 pattern of the preceding context, if any. The perceptual relevance of the tonal association of an intervocalic consonant with the preceding or succeeding vowel has been tested, and it turned out that when vowel duration cues are ambiguous, the frequency location of the [l] alone can shift listeners' identification of synthetic stimuli between /'bilisd/ and /bi'lisd/. See further Thorsen 1984c. It seems, thus, that as far as its tonal manifestation goes, stress begins with the vowel. This matches observations from some tone languages that postvocalic consonants may carry the final part of the distinctive tonal course, but prevocalic consonants do not seem to be included, cf. Pike 1948, pp. 10, 30; Selmer 1928.

Prosodic segregation of initial consonants may not be a purely tonal phenomenon. Fischer-Jørgensen 1982, p. 159, presents evidence that under certain circumstances the pattern of segmental duration indicates a boundary between a prevocalic consonant and a stressed vowel. Recent experiments on Swedish indicate that the most reasonable account of rhythmic phenomena is achieved if the onset of the rhythmical unit is taken to be the onset of the stressed vowel rather than, say, the onset of the first prevocalic consonant. This was one of the conclusions drawn by Lubker et al. 1983 from data on articulatory compensation in bite-block experiments, and Strangert 1983 likewise found that the most appropriate segmentation for an account of inter-stress intervals is the onset of the stressed vowel.

DIALECTAL VARIATION IN STRESS GROUP PATTERNING

There is a great deal of variation across different Danish dialects, both in the shape of the F0 pattern associated with prosodic stress groups and in the alignment of segments and syllables with the tonal pattern. Work that I am presently doing on the regional languages of Bornholm and in South Zealand demonstrates rather radical differences from Standard Danish. However, this presentation will burst at its seams if it is not restricted to Standard Danish.
SENTENCE INTONATION CONTOURS

Although sentence accent and emphasis for contrast are phenomena at the level of the stress group, and thus below the sentence or utterance in the hierarchy, I shall deviate from the natural order because these phenomena are more reasonably presented in the context of the sentence or utterance.

When the stress group pattern is a recurrent, predictable, qualitatively constant unit, the intonation contour can be defined in terms of the stressed syllables alone (which is entirely in line with the theory of Standard Danish intonation where global tendencies carry more local modifications). That is not to say that the course of the unstressed syllables is irrelevant for listeners' identification of intonation contours, only that they are redundant in the strict sense of the word. See further Thorsen 1980b. 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 as well as 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 terminal declarative-like, is the intonation contour, and vice versa (a tendency also noted by Bo 1933, pp. 82-83, and Jespersen 1897-99, p. 592). A similar trade-off has been observed for other languages too, see e.g. Bolinger 1962, Cohen and 't Hart 1967, Danes 1960, von Essen 1956, Hadding-Koch 1961, and Mikos 1976. Furthermore, it appears that 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 - PROSODIC PHRASING

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, cf. figure 4. The discussion of the results which underlie figure 4 was a very involved one, cf. Thorsen 1983a, especially as far as the interplay between prosodic structure, syntactic structure and semantics was concerned. Suffice it here to summarize that there are fairly strong grounds for claiming that some prosodic categories (in casu: prosodic stress groups and prosodic phrases) are distinct entities in the phonology that do not have an isomorphous relation to syntactic structure. That is, prosodic boundaries will be affiliated (but not coterminous) with syntactic ones (prosodic boundary location is a combined result of balancing
Figure 4

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.
the length of the syntactic constituents in the utterance while taking into account their semantic content, but syntactic boundaries, inversely, need not leave any trace in the intonational structure of syntactically unambiguous, non-compound sentences. Whether syntactic boundaries can be traced in the time structure or in segmental cues is another question, and one that should be addressed.

How and to what extent this description would be applicable to spontaneous speech I cannot say. Spontaneous speech is rarely so fluent and so syntactically well structured as the edited, read speech which was investigated, and prosodic boundaries may be more evident (also when not accompanied by pauses) in free speech and may take more and different shapes than encountered in my 1983a material.

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

**Figure 5**

Fundamental frequency tracings (average over 6 recordings) of the utterance 'Torbens søster hedder Kamma' (Torben's sister's name is Kamma) by a male speaker from Bornholm (HP) and a male speaker from Copenhagen (NRP). Zero semitones corresponds to 60 Hz with NRP and 70 Hz with HP. (Note that NRP produced 'ter hedder' with continuous voicing, whereas HP paused very briefly before 'hedder'.)
It is also interesting to note that this feature is not shared by all Danish dialects. My studies on Bornholm (a Danish island off the coast of the southern part of Sweden) indicate that sentence intonation function is a matter more of a local, final movement than of differences in what precedes. Figure 5 is an example of average $F_0$ tracings of the same utterance, by a male speaker from Neksø on Bornholm, and a male speaker from Copenhagen. By far the most extensive $F_0$ movement is located within the last stress group ('Kamma') with HP, whereas the preceding $F_0$ variations are superposed on an only very moderately declining global trend. With NRP, on the contrary, local $F_0$ deflections, associated with the prosodic stress groups, are of approximately equal magnitude, but they ride on a slant whose slope is evenly distributed over the utterance. (You will also see that HP employs a far greater range than does NRP, which is another characteristic difference between the Bornholm region and Standard Danish. The considerable difference in utterance duration, however, is an individual feature.)

To what extent other Danish dialects will turn up with local sentence intonation function signalling, I cannot say. Possibly Southern Jutlandic, with its proximity to Germany, will deviate in the same manner that Bornholm does.

**SENTENCE ACCENT**

Standard 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 conspicuous and they are very easy to elicit in recordings. See further Thorsen 1983b.

Again, Bornholm (and possibly other Danish dialects) is more in line with our nearest neighbours. It seems that Bornholm does have a sentence accent, though it is probably not obligatory. (There is a good deal of work to be done yet on the prosodic system of this island.) Thereby it would resemble Skanian, i.e. the dialect of Southern Sweden (Gösta Bruce, Paul Touati personal communications). Figure 6 depicts averaged $F_0$ tracings of the same utterance as in figure 5, uttered under three different conditions: without a semantic context, and in answer to two questions which invite focus on the last and first items, respectively. (When these utterances are replayed without their context, they are easily identified, i.e. it is very easy to determine what their original context was, if any. - With the two Standard Danish speakers who recorded the same material as the seven Bornholm speakers, it is not possible to see any consistent differences between these conditions in the acoustic registrations, nor to auditorily
Fundamental frequency tracings (averages over 6 recordings) of the utterance 'Torbens søster hedder Kamma', uttered without a semantic context (full line); in answer to the question 'Hvad hedder Torbens søster?' (What's the name of Torben's sister?), i.e. with focus on the last item (wide broken line); and in answer to the question 'Hvem har en søster der hedder Kamma?' (Who has a sister named Kamma?), i.e. with focus on the first item (narrow broken line). Male speaker from Bornholm. Zero semitones corresponds to 70 Hz.

determine the context from which the (different) statements were taken, when replayed in isolation.) - Note that the principal difference between the neutral and final focus edition lies in the relation between the preceding unstressed syllables ('-ter hedder') and the onset of 'Kamma': the preceding F₀ pattern terminates higher than 'Kamma' in the neutral utterance, lower in the edition with focus on 'Kamma', besides a difference in the extent and complexity of movement within the final stress group, which is plainly falling in the neutral but rising-falling in the final focus edition.

With initial focus, the changes brought about, compared with the neutral utterance, are more radical: F₀ deflections after the focalized item are more or less deleted, and the whole tail of syllables after 'Tor-' runs smoothly from the high onset to the bottom of the speaker's range. - This is entirely
in line with descriptions of the tonal manifestation of focali-
ization in other languages, e.g. German (Bannert 1985) and
Swedish (Bruce 1977). Note the considerable shortening in-
volved when the utterance contains a sentence accent. This is
a general feature of all seven Bornholm speakers. It is inter-
esting because of the light it throws on the discussion about
the reason for 'final lengthening'. Several languages, among
them Swedish, are reported to have longer syllables preceding
an utterance boundary, ceteris paribus. This lengthening has
been taken by some (e.g. Lyberg 1979) to be a consequence of
the more elaborate F0 movements finally in the utterance,
where the sentence accent is located if nothing else is speci-
ified by the context. The explanation has been refuted by
Bannert 1982, and certainly its universal validity is flatly
denied by my data from Bornholm: 'Kamma' has a more elaborate
and more extensive F0 movement when focalized but it is shorter
than the non-focalized word in final position. (The difference
is often, but not invariably - with all utterances, or all
speakers - statistically significant.) Furthermore, when a
given item is compared over initial versus final positions
in the non-focalized editions, where the final movement - due
to the local signalling of sentence intonation - is far more
elaborate than the initial one (cf. figure 5), the item's
duration is generally significantly shorter in final position.

CONTRAST AND EMPHASIS

The semantic borderline between emphasis for contrast (whether
implicit in the context or explicitly stated) and other types
of emphasis cannot always be clear-cut. Likewise, there is
probably a grey zone between contrast emphasis and sentence
accent, in languages or dialects where this is a meaningful
concept. - It is outside the scope of this chapter to attempt
to weed out the muddiness in the classification of various
types of emphasis. The results presented summarily here are
derived from utterances where the contrasted item is explicit-
ly stated (e.g.: 'Sorry, what did you say? - Do the buses
leave from Tiflis or from Grosny?' -- 'There are many buses
out of Tiflis. - As far as I can see there is no connection
from Grosny at all.' or: 'Does pipipi have shorter syllables
or just shorter vowels? - 'pipipi has shorter syllables.'
You will see from the stylized tracings in figure 7 that em-
phasis for contrast in Standard Danish is achieved tonally
by making the stressed syllable of the emphasised word stand
out clearly from the surroundings, which is brought about by
raising it (except in initial position) and by lowering and
shrinking the F0 deflections in the surrounding stress groups,
in a manner so that the immediate surroundings - except the
first post-tonic syllable - fall away sharply from the empha-
sized syllable. (There are hints in my data that stress
groups further removed from the contrasted element do not
suffer a similar shrinking, which is what motivates the re-
striction of the following generalization to short utterances.)
Stylized tracings of the course of $F_0$ 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.
The changes induced by contrast, when compared with the prosodically neutral editions can be formulated thus: In short utterances with emphasis for contrast, the utterance reduces tonally to one prosodic stress group. That is, only one low + high-falling F0 pattern occurs in them. An informal experiment with LPC-analysis and re-synthesis which I had occasion to perform at the University of Uppsala showed that the perceptually salient feature of contrast emphasis resides in the shrinking of the surroundings, rather than in the upwards change of the emphasized syllable itself. Thus, in an utterance like 'Det er sidste bus til Tiflis.' (It is the last bus for Tiflis.) it is the shrinking of the F0 movements associated with 'sidste' and 'Tiflis', rather than a higher F0 location of 'bus', that will make 'bus' appear as the contrasted element.

TEXTUAL INTONATION

There are data from several languages that prove paragraphs or texts to have an overall intonational structure to which the constituent sentences are subordinated, cf. Bruce 1982 (Swedish), Lehiste 1975; Cooper and Sorensen 1981 (American English), Uyeno et al. 1980 (Japanese). So is also the case in Danish. (A 'text' here is a sequence of semantically but not necessarily syntactically coordinated sentences.) Figure 8 summarizes the analysis of texts consisting of one, two, or three sentences. These sentences were semantically coherent (they described what various members of a family were doing during their summer holidays). In one set of texts they were syntactically

![Figure 8](image)

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.
uncoordinated, i.e. each sentence was a terminal declarative, separated orthographically from its neighbours by periods.

In another set the same sentences occurred as coordinate main clauses, separated by commas and 'og' (and). For instance: 'Amanda skal afsted på camping. Hendes mor skal på kursus i Tyskland.' And: 'Hendes far skal vandre i Lapland, og Amanda skal afsted på camping, og hendes mor skal på kursus i Tyskland.' (Amanda is going away camping. Her mother is taking a course in Germany. -- Her father is going hiking in Lapland, and Amanda is going away camping, and her mother is taking a course in Germany.) Figure 8 should be read as follows. See e.g. the full lines. The lower line in each of the three pairs of lines corresponds to the broken lines in figure 1, that is it is the line which supports the stressed syllables of the sentence. The upper line, similarly, is the one which would carry the first post-tonic syllable in each stress group, i.e. the local 'highs' in the course of $F_0$. In other words, upper and lower lines delimit the space within which $F_0$ performs its undulating course through each sentence (disregarding the fact that with a sufficiently large number of post-tonic syllables, they may transgress the line connecting the stressed syllables). The full lines pertain to sequences of terminal declaratives, the broken lines depict syntactically coordinate main clauses. The dotted upper and lower lines describe the overall textual contour.

Clearly, each sentence is associated with its own declining sentence intonation contour, but together two or three such contours describe an overall downward trend, i.e. the onset and offset of upper and lower lines, respectively, decrease gradually through the text. Furthermore, the different syntactic arrangement is reflected in a difference of subordination to the overall contour: the broken lines, pertaining to syntactically coordinate structures, are less steep than the full lines describing syntactically uncoordinated sentences, i.e. the coordinate sentences deviate less from, are less slanted with respect to, the overall contour, than are the terminal declaratives. See further Thorsen 1985.

In a supplementary experiment, Thorsen 1986, where the number of terminal declaratives in a text was varied (between one and four) and where, furthermore, the length of individual sentences was varied (between two and four prosodic stress groups), it was proved that the overall trend described in figure 8 is not the result of a special 'initial high' and 'final low' effect: A sequence of four declarative sentences also shows a gradual decline. However, it appeared that the textual contour is sensitive, not only to the number of sentences that make up the text, but also to the length of individual sentences. This is due to the fact that, apparently, a declarative sentence must have a certain negative slope associated with it in order to serve appropriately as a declarative. This demand may conflict with a lowering of sentence onsets through the text: the longer the sentence, the higher its onset must be in order to preserve a suitable slope and simultaneously prevent the speaker from falling through the floor of his $F_0$ range.
INTONATION IN A NON-EDITED TEXT

It is worth pointing out, once more, that everything that has been said above is based on analyses of highly edited, read speech. The preliminary results (Thorsen 1987a) to be summarized in the following are based on a text which was read, but which was not edited for intonation analysis purposes. The investigation represents a first, cautious step on the road to analyse free, spontaneous speech. The text is the tape-recorded instruction to a language laboratory exercise, amounting to a total of five type-written pages. It was recorded once, by one speaker, the author of the programme.

Figure 9 shows F0 tracings of the first two sentences in the text. I have been particularly interested in the tonal pattern associated with prosodic stress groups: whether they would
appear in the same regular and predictable shape as in the pragmatically much more restrained texts analysed previously. The answer is both yes and no. The text contained 341 polysyllabic prosodic stress groups. Only 32 of those, or 9%, do not have an associated $F_0$ rise. So it appears justified to conclude that a sequence of stressed plus unstressed syllable(s) is normally accompanied by a rise in $F_0$. The magnitude of the rise, however, varies a good deal, and I cannot assert that it decreases in a monotonous and simple fashion through the phrase or utterance, as it does in short, pragmatically restricted sentences. Nor have I been able to disclose any other systematic trend in the vacillation of the low-to-high interval.

I venture to propose that varying the magnitude of the pitch rise from the stressed syllable - as this speaker does - serves pragmatic purposes in that it lends slightly varying degrees of prominence to the stressed syllables, without their falling out of the range of what may be termed neutral, non-emphatic, main stress. Thus, greater prominence would be associated with a higher rise after the stressed syllable.

It is important to note that rise in pitch from a stressed syllable to the post-tonic is not the only cue to its stressedness. (This is evident in the case of monosyllabic stress groups, where there are no post-tonics to carry such a rise.) Instead, I propose, the relation to surrounding stressed syllables may determine a syllable as stressed. That is, if a syllable falls into place in a rhythmic pattern and an intonational contour, established by preceding and/or succeeding stressed syllables, and if its duration, its vowel quality, and its lack of stop do not contradict it, such a syllable will be perceived as stressed. It may further warrant a characterization as ACCENTED if it is succeeded by one or more post-tonics and has an associated pitch rise; if there is no such pitch rise to post-tonics the stressed syllable is NON-ACCENTED. The distinction between accented and non-accented stressed syllables does not apply to monosyllabic stress groups.

The distinction, if it is tenable, between stress and accent, as outlined above, would bring Standard Danish on a par with German, as described by Bannert 1985, with British English, as described by O'Connor and Arnold 1961, and with Dutch, as described by 't Hart and Collier 1979, where a similar distinction can be made between stressed syllables which are tonally prominent (accented) and stressed syllables which are not (non-accented).

It appears then that in read speech in Danish, at least the speech I have analysed so far, stressed syllables are normally also accented. In the materials I had looked at before this one, this has been true without exception, which is why I have not thought to introduce a distinction between stress and accent before. In retrospect, the behaviour of stressed syllables surrounding an emphasis for contrast could have provoked a discussion of accented versus non-accented: stressed syllables which are neighbours to an emphasis for contrast suffer a reduction or deletion of their $F_0$ pattern, cf. figure 7.
However, I am not sure whether this reduction is not also a de-stressing (that is how it has been treated previously). This is clearly a point where empirical research is called for, both in terms of acoustic and perceptual studies.

There is one snag about the dichotomy accented/non-accented, if it is to apply to stressed syllables only. There are 104 syllables with secondary stress in the text. 95 of those are succeeded by unstressed syllables. 21 of those 95, i.e. 22%, are associated with a rise in F₀! Does this mean that secondary stresses may also be accented? Or does it mean that the stress reduction is only partial? Previously, secondary stresses have been characterized prosodically as lacking the pitch rise typical of main stress, but retaining all other stress cues (duration, quality, stress). If accented/non-accented is a relevant distinction in stressed syllables, then lack of pitch rise is not a feature confined to secondary stresses. Conversely, if there are secondary stresses with associated pitch rises, then accentuation is not confined to stressed syllables.

There is a vast amount of research to be done on stress and its (tonal) manifestation in Danish, not least perceptual experiments, before the descriptive categories can be definitively established.

**DANISH INTONATION IN INTERNATIONAL PERSPECTIVE**

It will be apparent from the preceding sections that Danish shares some features with its nearest Germanic neighbours, but differs from them in some important respects: The basic units of description are the same, or can be made to be identical across Danish, Swedish, German and English, namely text, utterance (sentence), phrase, foot or stress group, and syllable. (The data available on Norwegian at levels above the word are too scarce to allow a cross-language comparison.) It is also a common feature that prominence (stress or accent) is signalled with a tonal change associated with the stressed or accented syllable. (It is still an open question whether a distinction between stressed syllables and accented syllables, as it applies to German and English, should be postulated for Danish.) The acoustic manifestation of contrast is apparently alike in the four languages: increased tonal range associated with the stressed syllable of the emphasized item and a simultaneous tonal reduction in the neighbouring feet. Danish differs from the above languages in not having an obligatory sentence accent, or nucleus, and by not having any strong final lengthening. Furthermore, sentence intonation function in Standard Danish is signalled by the global trend exhibited by the undulating F₀ deflections through an utterance, as opposed to the more local, final F₀ movement in Swedish, German, and English.
NOTE

This manuscript was completed in December 1986. As you will see from my paper on Bornholm intonation in this volume, I have also had occasion to hypothesize a distinction between syntactically and/or prosodically conditioned sentence accents or default sentence accents versus the pragmatically conditioned focal sentence accents.

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