A PRESENTATION OF THE LUND MODEL FOR SWEDISH INTONATION

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The aim of this paper is threefold, to give a brief review of
a generative model for Swedish intonation which has been de-
veloped in Lund (Bruce & Gårding 1978, Gårding 1979), to in-
troduce a few modifications and finally to give some general
comments on its scope and nature.

The model originated from a study of fundamental frequency (Fo)
curves in an extensive material representing four Swedish dia-
lects. Its purpose is to generate such curves using only a few
linguistically relevant parameters.

Model

The following two pages, which were a handout at the sympo-
sium, summarize the model. It consists of a linguistic part,
an algorithmic part and a collection of prescriptions and con-
ventions. The linguistic variables are word accents (WA), sen-
tence accent (SA) or focus, and sentence intonation. The pro-
totypes of the dialects are Malmö (South), Dalarna (Central),
Stockholm (East) and Göteborg (West).

The accents, word accents as well as sentence accent, are re-
presented by high and low points which will become turning
points in the generated curves. The location of these points
is determined by the dialect. Stockholm, for instance, has a
HIGH in the preaccented syllable for A1 and a LOW in the ac-
cented one. Malmö, on the other hand, has a HIGH in the ac-
cented syllable, and a LOW in the postaccented one.

Common to all the dialects is that Accent 2 comes later than
Accent 1 and that sentence accent is manifested as a large
pitch interval.

The algorithm is a set of rules, the order of which is moti-
vated by practical considerations. A later rule is not permit-
ted to disturb the result of a rule applied earlier. The first

Swedish intonation model

Linguistic components

Dialectal representations

		1A South e.g. Malmö	1B Central e.g. Dalarna	2A East e.g. Stockholm	2B West e.g. Göteborg
Word prosody	A1	H ✪ L ✪	✪ ✪	✪ ✪	✪ ✪
	A2	H ✪ L ✪	✪ ✪	✪ ✪	✪ ✪
	Input string	▨ ▨▨ ▨ ▨ V C 'V C: V C V	▨ ▨▨ ▨ ▨ V C 'V C: V C V	▨ ▨▨ ▨ ▨ V C 'V C: V C V	▨ ▨▨ ▨ ▨ V C 'V C: V C V
Sentence prosody	SA (FO-CUS)	**Wide interval at A**		**Wide interval after A**	
		Higher H Lower L	**Higher H**	**H after A**	L at A H late after A
	SI	**L at onset and L at offset (statement)**			

Prescriptions and conventions

Auxiliary lines expressing sentence intonation

Topline and baseline are approximately straight lines. The topline
connects successive F_0 maxima outside the focus of a phrase. It
starts and ends with the phrase. Its slope depends on the length
of the phrase and the initial and final frequencies. These vary
with sentence intonation but are otherwise rather constant depend-
ing on the individual speaker's pitch range. The baseline connect-
ing successive F_0 minima is specified correspondingly. Focal lines
connect focal maxima or minima in different sentence positions.
These lines are nearly horizontal.

Conventions applying to the rules

WA Highs and Lows are on baseline and topline.

SA Highs and Lows are on focal line.

Example of an adjustment rule: If WA Low and SA High occur in
final syllable, give priority to SA High.

Concatenation including copy rule: Copy the High and Low of a
syllable onto the auxiliary line of the following syllable if
nothing else is indicated. Join neighbouring points by straight
lines.

Application of pitch rules

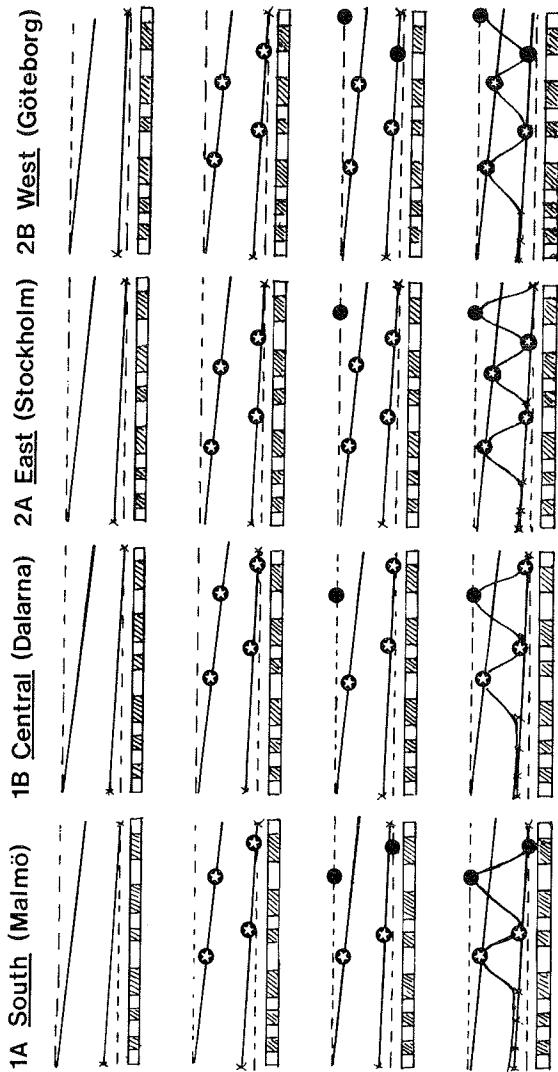Example of input phrase: [nɔra lɔŋːa nɛɳːɔr] Statement

Scheme

Rule 1. Apply SI. Draw topline and baseline fitting statement and focal lines. Start and end Low.

Rule 2. Apply WA.[1] Insert Highs and Lows.

Rule 3. Apply SA.[1] Insert Highs and/or Lows.

Concatenation[2] Concatenation including copy rule

1A South (Malmö) 1B Central (Dalarna) 2A East (Stockholm) 2B West (Göteborg)

1) here the adjustment rules are applied (See conventions)

2) See conventions

rule generates the frame of the sentence intonation. It consists of two interior slanting lines, i.e., a topline connecting the pitch peaks and a baseline connecting the pitch valleys of the accents outside focus. There are in addition two exterior hatched lines on which the HIGHS and the LOWS of sentence accent lie. These four lines give position-dependent pitch values to the HIGHS and LOWS of the accents. A statement like the example given in the algorithm is characterized by a global fall giving decreasing pitch values to the word accent HIGHS as well as the LOWS. The second rule inserts the word accents and the third rule the sentence accent. At the last stage a concatenation rule connects neighbouring points by straight lines.

With this model we can simulate observed pitch curves from different dialects in an acceptable way, as we have shown by LPC-synthesis carried out in Uppsala (Bruce & Gårding 1978). For the synthesis we used a carrier phrase made up of segments which do not differ very much across the dialects. Prosodically it is also very well suited to our purposes since it contains both accents, including A2 in a polysyllabic compound and unaccented syllables between the accented ones to show the maximal effect of the concatenation rule.(For different dialectal manifestations of compounds, see our other contribution to the proceedings.) The phrase was <u>Man anämmar lundamodellerna</u> 'One accepts the Lund models'.

Clarifications and modifications

The concatenation procedure as well as other dialect independent conventions are described under prescriptions and conventions.

Here we should like to make two clarifications.

The first concerns the domain of the baseline/topline construction. Recent work on text intonation in English (Lehiste 1975) and in Finland Swedish (Enkvist and Nordström 1978) suggests that the domain of intonation can be wider than the phrase or the sentence.

This has been confirmed also for South Swedish (Bruce, in press). Paragraphs consisting of two or three sentences are kept together by intonation, i.e. there is a successive down-drift in pitch covering the whole paragraph. The beginning of a new paragraph, e.g. a topic shift, appears to be signalled by a new downdrift from a reset pitch level.

A natural conclusion is therefore that the domain of the base-line/topline construction is at least the paragraph or the text unit.

The second comment concerns the range between the initial and final frequencies of a text unit. For a given intonation type we have assumed a constant Fo-range between the starting point and the end point irrespective of the length of the unit. This implies that the slope of the Fo-contour varies with the length of the text unit.

Recently Lehiste (1975) for English and Thorsen (1979) for Danish have shown that the range is not constant but increases with an increasing length of the unit.

In material containing text units with a varying number of stress-groups (Bruce, in press) it was found that for South Swedish the Fo-range between the starting point and the end point of each unit is practically constant, although the Fo-range between the first and the last accented syllable appears to increase with an increasing number of stress-groups. Some data that we have collected recently make us believe that al-though the range between the initial and final frequency ap-pears to be constant, the topline and the baseline are not nec-essarily straight lines as indicated by our model.

Scope and nature

We shall finally comment on some linguistic and phonetic prin-ciples that the model is based on and discuss its applicabili-ty and limitations.

The model is based on a linguistic analysis which separates word prosody from sentence prosody. This is reflected in the

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generative scheme. In this scheme sentence intonation comes
first and gives the frame within which the word prosodic part
can develop. The sentence accent, focus, breaks the frame by
widening the pitch interval.

Linguistically the HIGHS and LOWS of our model, suggest an in-
tonation system made up of four discrete pitch levels.

Since our analyzed sentences consist of sonorant segments
only, we can regard the turning points of the pitch curves as
indications of changes in the signals to the muscles which
control features of tone and accent. Given the positions on
the time and frequency axes of these turning points we can
derive the full intonation curve. This is reflected by the
concatenation rule. To make the algorithm applicable to other
segmental contexts as well, a certain amount of readjustment
will be needed (gaps for the voiceless consonants will have to
be inserted, local falls before voiced obstruents due to loss
of transglottal pressure will be introduced etc.).

The position of a HIGH-LOW relative to an accented syllable
varies from dialect to dialect. The model takes this into ac-
count but it should be borne in mind that such a shift may
change a tone movement involving an accented syllable to its
opposite, which of course gives a totally different perceptu-
al impression. It could be argued, then, that our model is
production oriented rather than perception oriented.

The model is general in so far as it can generate intonation
for a large part of the Swedish language area. Dialectal spec-
ifications seem to be needed only for one of the word accents.
From this we can derive the other word accent and for most of
the dialects also the sentence accent. We have regarded the
global expression of sentence intonation as common to all the
dialects.

Our model is a tool by which we can compare not only the into-
nation of different Swedish dialects but also the intonation
of other languages. It can also be used to study prosodic in-
terference between different dialects and between a primary

language and a secondary language (see our other contribution to this symposium).

Until recently we have concentrated on isolated phrases which have been elicited in a fixed situational frame. We started with statements and questions, the most firmly established types in the intonational system of a language, and varied the situations in such a way that the speaker was forced to focus various parts of the test sentence. Our next concern is intonation in a larger context. Such work is now underway.

References

Bruce G. in press. "Om prosodisk koppling i svenska." Svenskans beskrivning 12. Umeå University

Bruce G. and E. Gårding. 1978. "A prosodic typology for Swedish dialects." Nordic Prosody, E. Gårding et al. (eds), 219-228. Department of Linguistics. Lund University

Enkvist N.E. and H. Nordström. 1978. "On textual aspects of intonation in Finland-Swedish newscasts." Studia Linguistica XXXII:I-II, 63-79

Gårding E. 1979. "Sentence intonation in Swedish." Phonetica 36, 207-215

Lehiste I. 1975. "The phonetic structure of paragraphs." Structure and process in speech perception, A. Cohen and S.G. Nooteboom (eds), 195-203. Berlin

Thorsen N. 1979. "Intonation contours in declarative sentences of varying length in ASC Danish." Proceedings of the institute of acoustics. Institute of Acoustics. University of Copenhagen