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Bruce, Gösta

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SWEDISH WORD ACCENTS IN SENTENCE PERSPECTIVE

AV
GÖSTA BRUCE
fil. kand., Hb

AKADEMISK AVHANDLING
som för avläggande av filosofie doktorsexamen
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Arbetet visar hur tonala variationer utnyttjas i stockholmsk svenska för att signalera ordprosodi och vissa aspekter av satsprosodi. Genom att jämföra tonförlopp (Fo) för de båda ordaccenterna, med och utan satsaccent, i final och icke-final position, har det varit möjligt att skilja ut olika prosodiska bidrag till tonförloppet: ordaccentfallet (tidigare för accent I än för accent II), satsaccentstigningen och terminalfallet. Samspelet mellan dessa prosodiska egenskaper resulterar i vissa kontextberoende justeringar av tonförloppen. Typisk är den temporala stabiliteten hos ordaccentförloppen och den temporala variabiliteten hos satsaccent- och terminalförloppen. Den akustiska analysen har kompletterats med perceptuell analys av syntetiserade tonförlopp. Testen visar, att tidpunkten för ordaccentfallet är viktig för distinktionen accent I/accent II, och att en extra tontopp gör en sammansättning till en tvåordsfras. Resultaten sammanfattas i en modell för svensk intonation i form av en samling regler som genererar de observerade tonförloppen.

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Gösta Bruce

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0 INTRODUCTION

0.1 Problem

The Scandinavian word accents have been examined from many different points of view in a number of studies. Important contributions to our understanding of the phonetic aspects of these word accents have been given by Selmer, Meyer, Haugen, Malmberg, Hadding-Koch, Öhman, Fintoft and Gårding (see references in bibliography). In spite of the great amount of work devoted to their study the description of the word accents is still far from complete. In the majority of the phonetic studies the word accents have been treated in isolated test words or in short carrier sentences. Very few authors have studied the word accents in a wider sentence perspective, notably Haugen & Joos (1952) and Gårding (1967). This lack of more complete descriptions has inspired me to deal with the Swedish word accents in a wider perspective. It is my conviction that it is important for their analysis to take into account the whole linguistic context - the sentence perspective - in which the accented words occur.

The variety of Swedish chosen for the present study is the Stockholm dialect. The thesis work forms a part of a research project called 'Swedish prosody', which is supported by the Swedish Humanistic and Social Sciences Research Council and is carried out in cooperation with Eva Gårding. The aim of the project is to analyze the prosody in some varieties of Swedish and to describe the prosodic properties in the form of strictly formulated, testable rules (cf. Gårding 1975a). Prosody refers here to the use of temporal and tonal features to convey linguistic information.

The present study will be restricted to the tonal aspects of the word accents. It has been convincingly demonstrated (Malmberg 1955, Jassem 1963, Fintoft & Mártony 1964, Fintoft 1970) that the word accent distinction is primarily a tonal phenomenon. It is therefore reasonable to assume that the word accents are an integral part of the intonational system of Swedish, and that it is necessary to take them into account in a more complete description of Swedish intonation. Intonation is used here to denote those aspects of the sound structure of a language, whose primary acoustic correlate is the time course of

voice fundamental frequency (henceforth Fo) and whose perceptual correlate is pitch.

During recent years prosody, in particular intonation, has received increasing attention and now occupies a central place in the study of linguistics and speech communication. It has been recognized that prosody is of primary interest for the understanding of linguistic behaviour. Prosodic facts have been found relevant for issues of linguistic theory. Prosody - at least certain aspects of it - is acquired very early by children learning their mother tongue (before the acquisition of segmental phonology) and it is believed that prosodic patterns play a key role in the marking of personality and of social identity.

It has been shown that prosody plays an important role in the identification of spoken utterances (for a review, see Svensson 1974, and Nooteboom, Brokx & de Rooij 1976). In particular, the fundamental frequency setting of an utterance carries important information about the message being transmitted from the speaker to the listener. In fact Fo fulfills several functions in its role as carrier of intonation in speech. It can have a distinctive function serving to distinguish between different lexical meanings of words with the same segmental structure. This is found in tone languages, e.g. Chinese, Thai, Vietnamese and in so called word accent languages like Swedish, Norwegian and Serbo-Croatian. Fo also has a syntactic function. In this function Fo helps the listener to mark the boundaries between parts of an utterance and between utterances and to tell what parts of an utterance belong together. Another important function of Fo is semantic. That word or part of an utterance, which is considered by the speaker to be the most important in a given context, receives a special Fo-marking and consequently becomes the focus of the listener's attention. Moreover, Fo conveys information about the speaker's attitude and feelings about what he is saying.

The Swedish word accents provide an interesting area of intonation study. Because of the word accents a Swedish speaker is assumed to be less free in his use of Fo to signal syntactic, semantic and attitudinal information than a speaker of a language without word accents, e.g. an English speaker. On the other hand he apparently has a greater freedom in this respect than e.g. a Chinese speaker with several lexical tones to manage.

How do speakers of Swedish place the diverse aspects of intonation in the Fo-contour of an utterance? In the Fo-contour of a word, phrase or sentence in Swedish, we expect to find contributions from word accent, sentence accent (semantic information) and different aspects of sentence intonation (syntactic and attitudinal information). An important task, therefore, is to separate the different contributions from one another. Such an analysis will make it possible to set up rules to predict the intonation of a given Swedish sentence. More precise knowledge of this kind is useful in language teaching, in the teaching of linguistically handicapped, e.g. hard of hearing and laryngectomized patients, and in so-called text-to-speech conversion or synthesis-by-rule (cf. Carlsson & Granström 1973). My work with the Swedish word accents may also have implications for a general model of intonation.

0.2 Goals

The main purpose of the thesis work is to determine how Fo is utilized in Swedish to signal word accent, sentence accent and terminal juncture. To achieve this goal I have attempted to isolate the Fo-contributions of each of these parameters and to investigate the interplay between them. Other aspects of sentence intonation such as statement/question and attitude have been held constant in this study. In order to gain a deeper understanding of how a Swedish speaker uses Fo in speech I found it important to examine certain aspects of the Fo-contours with respect to perception. For this purpose I have used synthetic simulation of Fo. The ultimate goal of my study is to construct a model of Swedish intonation, which will describe the behaviour of Fo for a basic subset of Swedish sentences.

0.3 Outline

The thesis consists of nine chapters. The first chapter gives a sketch of the prosodic phonology of Swedish. The relationship between stress, word accent and sentence accent is described, the word accent distribution in non-compound and compound words is treated in outline, and the sentence accent distribution is discussed from the view-point of the Functional Sentence Perspective.

The second chapter is the first of five chapters dealing

with the acoustic analysis of Fo-contours of a sample of Swedish sentences. It gives an account of the speech material, the informants and the general test procedure used for the investigation. Chapters three, four and five give a relatively detailed account of the behaviour of Fo in a number of Swedish sentences for one Stockholm speaker, the primary informant. In chapter three it is demonstrated how the prosodic contributions of word accent, sentence accent and terminal juncture to the Fo-contours of Swedish sentences can be isolated in single words, how they are distributed in certain two-word phrases and compounds and also in sentences where one, two or more words are in focus. In chapter four the basic Fo-contours for the features accent I, accent II, sentence accent and terminal juncture are described. Chapter five deals with the interplay of the basic contours, and the Fo-adjustments that take place in different contexts due to this interplay are discussed. Chapter six reports on a test of the validity of the main findings, based on the primary speaker, for a subset of the speech material produced by two secondary speakers.

Chapter seven gives an account of two perceptual experiments based on synthetic simulation of stimuli. The first experiment concerns the word accent distinction in non-focal position and the second experiment the distinction between compounds and two-word phrases.

In chapter eight a qualitative model of Swedish intonation based on the findings of the analysis and synthesis of the Fo-contours in the present study is presented. Chapter nine, finally, gives a summary of the main results of the thesis.

1 A SKETCH OF PROSODIC PHONOLOGY

The prosodic features that are relevant for my study are primarily stress, word accent, sentence accent and terminal juncture. In the present chapter these features will be defined and their interrelationships described. In the first part of the chapter the interconnection between word accents and stress levels is examined, and a system for interpreting the stress levels in Swedish as combinations of separate features is proposed. The second part contains an outline of the main regularities of the word accent distribution in Swedish non-compound and compound words. In the third part of the chapter factors governing the placement of sentence accent in Swedish sentences are surveyed, and a simple method of eliciting sentence accent is discussed.

1.1 Word accents and stress levels

In phonological analyses it has been claimed that the distinction between the two Swedish word accents - accent I (acute) and accent II (grave) - is maintained only at higher levels of stress (Malmberg 1959, 1964, Elert 1964, Lindau 1970, Linell & Anward 1971, Pettersson 1972, Gårding 1973). It is, however, not entirely clear nor is there complete agreement as to what level of stress is necessary for the distinction to be maintained. This is at least in part due to the fact that the number of stress levels in different analyses is not the same. Moreover the disagreement seems to be confined to stress levels outside the domain of the word.

1.1.1 Stress levels and prosodic features

Different systems have been used to account for stress levels in Swedish. For a survey of the most common systems see Elert (1964:15-16). Instead of the conventional analysis of stress as a one-dimensional category with a number of degrees I assume that the stress system of Swedish is multi-dimensional and built up of layers of prosodic properties. An interpretation of the stress levels in American English as combinations of different prosodic features made by Vanderslice (1968a, 1968b, 1971 with Ladefoged, 1972) is the inspiration of this analysis (for a Swedish version, see Linell & Anward 1971). In American English, where the stress system is comparable to the Swedish system,

four levels of stress have normally been distinguished (e.g. by Trager & Smith 1951). In this system 1-stress (primary stress) indicates the strongest stress, 2-stress and 3-stress the weaker stresses, while 0-stress (unstressed) is left unmarked. The stress system in Chomsky & Halle (1968) is based on this analysis, although their rules predict even finer degrees of stress. The main advantage of Vanderslice's re-analysis of the English stress system is that it makes it possible to separate different prosodic contributions to what is traditionally called 'stress'. His criticism of the system of multiple stress levels is mainly that it does not express the fact that a certain stress level, e.g. primary stress (1-stress) is the combination of prosodic dimensions with separate grammatical functions.

1.1.2 Definitions of prosodic features

The following features are proposed to account for the relevant prosodic distinctions in Swedish. There is a basic division into 'stressed' and 'unstressed' syllables. I assume that one syllable in every root and in certain affixes of a lexical unit - including compounds and lexicalized phrases - is associated with a kind of phonetic prominence, which is called stress and which may or may not be manifested in a particular utterance (cf. Bolinger 1961:313). Compounds and lexicalized phrases will contain at least two stressed syllables. The rules for the distribution of stress in Swedish words will not be dealt with here. For a treatment of these rules see e.g. Linell (1972:16ff.). The syllable preceding a stressed syllable is referred to as the pre-stress syllable, and the syllable following a stressed syllable is called the post-stress syllable. The phonetic correlate of stress is assumed to pertain to the time dimension. It is believed that a stressed syllable is distinguished from an unstressed syllable primarily by its greater relative length, aside from predictable variation such as inherent durational differences and utterance-final lengthening of segments (cf. Vanderslice's (op.cit.) feature [± STRONG]). A [+ STRESS] syllable in Swedish has either a long vowel followed by a short consonant (V:C) or a short vowel plus a long consonant (VC:) or a consonant cluster, i.e. it is characterized by the quantity distinction. In a [- STRESS] syllable the quantity distinction is neutralized, and both the vowel and the consonant

are short.

One [+ STRESS] syllable in every lexical unit is associated with another kind of phonetic prominence, namely one of the two word accents, denoted by the feature [+ WORD ACCENT]. In compounds this is normally the leftmost and in lexicalized phrases the rightmost [+ STRESS] syllable, i.e. the main stress syllable. Rules of this kind are discussed in Linell & Anward (1971). The phonetic correlate of word accent is a pitch obtrusion in connection with the stressed syllable. To account for the word accent distinction in Swedish an additional feature labelled [± ACCENT II] is introduced. The simultaneous specification of a syllable as [+ STRESS], [+ WORD ACCENT], [- ACCENT II] is to be interpreted as accent I (´), and consequently [+ STRESS], [+ WORD ACCENT], [+ ACCENT II] means accent II (`). The phonetic correlate of the feature [± ACCENT II] is "late vs. early timing of the pitch obtrusion". The motivation for having two features to describe the word accent distinction - [± WORD ACCENT] and [± ACCENT II] - and not just one - [± ACCENT II] - is that the specification of a syllable as [+ STRESS], [- ACCENT II] would be ambiguous. It can be interpreted either as an accent I-syllable or as a stressed syllable without word accent, i.e. the secondary-stress syllable in a compound or a lexicalized phrase. The latter kind of syllable is therefore defined as [+ STRESS], [- WORD ACCENT], [- ACCENT II] (ˌ) (see exemplification in section 1.1.4). Moreover in those Swedish dialects of Finland and in the far north of Sweden, where there is no word accent distinction [± ACCENT II], the feature [± WORD ACCENT] is probably still needed to account for the prosodic distinction between the secondary-stress syllable of a compound and the stressed syllable of a non-compound word. This analysis of the word accents is at variance with the view that only accent II is a true word accent and that accent I is merely stress plus sentence intonation (Sweet 1877:155, Haugen 1963:161, Elert 1964:33, Gårding 1970:41), but finds support in the perceptual experiment reported on in 7.1.

A third kind of prominence - sentence accent - will be attributed to one (or more) of the words in an utterance and is tied to the last stressed syllable of that word. In a non-compound word or in a lexicalized phrase this syllable is the [+ WORD ACCENT] syllable. But in a compound, [+ SENTENCE ACCENT]

would be assigned to the [+ STRESS] syllable in the last element of the compound, i.e. the so-called secondary-stress syllable. Rules for the placement of sentence accent in a sentence are discussed in the third part of this chapter. In Standard Swedish the phonetic correlate of sentence accent is a pitch rise after the pitch obtrusion for word accent in connection with the actual stressed syllable.

The final syllable of a word with sentence accent occurring in an utterance-final position may be assigned another prosodic feature termed [± TERMINAL JUNCTURE]. The phonetic correlate of terminal juncture (cf. Trager & Smith 1951:44) is "presence vs. absence of a pitch fall in the utterance-final syllable". The final pitch fall marks an utterance as demarcated from what may follow, while no fall indicates a connection with the following.

1.1.3 Stress, word accent and sentence accent

The three features stress, word accent, and sentence accent make it possible to account for five types of syllabic prominence, which are communicatively relevant in Swedish, in an intuitively and empirically satisfying way. The relationship between the conventional stress levels (cf. 1.1.1) and the prosodic features stress, word accent, and sentence accent is shown in the following matrix:

(1)	conventional stress levels	1	2	3	3	0
	stress	+	+	+	+	–
	word accent	+	+	–	–	–
	sentence accent	+	–	+	–	–

The distinction between the first and the third feature column can be exemplified by a pair consisting of a two-word phrase and a compound with identical segmental structure, e.g. <u>làma djúr</u> 'paralyzed animals' - <u>làmadjur</u> 'llamas'. The citation forms of this pair will have the following feature composition:

(2)	(a) làma djúr			(b) làmadjur		
stress	+	–	+	+	–	+
word accent	+	–	+	+	–	–
sentence accent	–	–	+	–	–	+

Although sentence accent is attributed to the corresponding syllable <u>djúr</u> in both members of the pair, there is still a

difference of word accent versus no word accent between the phrase and the compound for this syllable.

When the sentence accent is moved from the constructions in (2) to another phrase attached to them, the difference between the two-word phrase and the compound will still remain one of presence vs. absence of word accent. Differences between the forms of the syllable djúr in the pair làma djúr pà zóo 'paralysed animals in the zoo' - làmadjur pà zóo 'llamas in the zoo' illustrates this distinction (the second and fourth feature column in (1)):

(3)	(a)	làma	djúr	pà	zóo	(b)	làmadjur	pà	zóo
stress		+ –	+	–	+		+ –	+	–	+
word accent		+ –	+	–	+		+ –	–	–	+
sentence accent		– –	–	–	+		– –	–	–	+

A comparison of the feature specifications in (2) and (3) for the syllable djúr in the two-word phrase làma djúr on the one hand and in the compound làmadjur on the other exemplifies the distinction of sentence accent between the first and the second column in (1) above and also between the third and the fourth column. The latter distinction is not made in the conventional stress level system. Both feature columns are labeled 3-stress. The difference of sentence accent between (2b) and (3b) for the second element of the compound is not reflected as a difference in the last stressed syllable of the compound but has - incorrectly in my opinion - been attributed to the first stressed syllable of the compound (cf. Linell & Anward 1971).

Finally the distinction of stress only between the fourth and fifth feature column in (1) is evidenced by the following minimal phrase pair, where the first word is attributed sentence accent for the sake of exemplification: stòppa dànsskorna 'stop the dancing shoes' - stòppa dànskorna 'stop the Danish women'.

(4)	(a)	stòppa	dàns	skorna	(b)	stòppa	dànskorna
stress		+ –	+	+ –		+ –	+	– –
word accent		+ –	+	– –		+ –	+	– –
sentence accent		+ –	–	– –		+ –	–	– –

The difference is one of stress - defined here as relative syllable length - for the penultimate syllable of both phrases. This syllable contains a long vowel followed by a short consonant

in the first member of the pair, while there is a short vowel and a short consonant for the other member.

It should also be pointed out that the placement of stress - not only main stress but also secondary stress in a compound - can be distinctive. In the pair nàckaˌschacket i tópp 'the Nacka chess in the lead' - nàckajacˌkett i tópp 'Nacka morning-coat in the lead', where the last word is assumed to receive the sentence accent, the only difference is the place of the stressed syllable in the last element of the compound:

(5)	(a) nàckaˌschacket i tópp						(b) nàckajacˌkett i tópp					
stress	+	-	+	-	-	+	+	-	-	+	-	+
word accent	+	-	-	-	-	+	+	-	-	-	-	+
sentence accent	-	-	-	-	-	+	-	-	-	-	-	+

1.1.4 The word accent distinction

So far the word accent distinction has been left out of consideration. For the feature columns having a [+] for word accent - the first and the second column in (1) - but not for the other columns, the distinction between accent I and accent II is maintained. This is exemplified by a pair such as klàra stégen 'manage the steps' - klàra stègen 'manage the ladder' with sentence accent on the noun, where the only distinctive factor is the word accent of stegen. In a compound consisting of the same words as elements, the word accent distinction is neutralized in the last element, i.e. in secondary-stress position. This means that the compound klàraˌstegen is ambiguous and can be interpreted either as 'the steps of Klara' (Klara = city district in Stockholm) or as 'the ladder of Klara'. As is evident from the following matrices, the occurrence of stegen in the compound is prosodically distinct from both of the occurrences of stegen in the phrases. The product of the neutralization in the secondary-stress syllable of a compound will not be equivalent to accent I, as has been suggested (Öhman 1965:14, Lindau 1970: 43) (cf. 3.2 and 7.2).

(6)	(a) klàra stégen				(b) klàra stègen				(c) klàraˌstegen			
stress	+	-	+	-	+	-	+	-	+	-	+	-
word accent	+	-	+	-	+	-	+	-	+	-	-	-
accent II	+	-	-	-	+	-	+	-	+	-	-	-
sentence accent	-	-	+	-	-	-	+	-	-	-	+	-

If the constructions in (6) are placed in a sentence frame, where sentence accent is assigned to another constituent in the sentence, there will still be three distinct occurrences of stegen, e.g. vi brùkade klàra stégen 'we used to manage the steps', vi brùkade klàra stègen 'we used to manage the ladder' and vi brùkade klàra stegen 'we used the steps/the ladder of Klara'.

(7)	(a) vi	brùkade	klàra	stégen
stress	-	+ - -	+ -	+ -
word accent	-	+ - -	+ -	+ -
accent II	-	+ - -	+ -	- -
sentence accent	-	+ - -	- -	- -

	(b) vi	brùkade	klàra	stègen
stress	-	+ - -	+ -	+ -
word accent	-	+ - -	+ -	+ -
accent II	-	+ - -	+ -	+ -
sentence accent	-	+ - -	- -	- -

	(c) vi	brùkade	klàra	stegen
stress	-	+ - -	+ -	+ -
word accent	-	+ - -	+ -	- -
accent II	-	+ - -	+ -	- -
sentence accent	-	+ - -	- -	- -

The neutralization of the word accent distinction is found also in so-called lexicalized phrases, which are considered to have a stress pattern as in normal phrases but where only the rightmost stressed syllable carries word accent (cf. Linell & Anward 1971). For example, for the phrase anden-i-flàskan the potential distinction between accent I and accent II in the word anden - 'the duck' (accent I) or 'the ghost' (accent II) - may be neutralized, which could render the phrase ambiguous: either 'the-duck-in-the-bottle' or 'the-ghost-in-the-bottle'. An equivalent construction to the lexicalized phrase anden-i-flàskan is the compound flàskanden, which is also ambiguous: 'the bottle duck' or 'the bottle ghost'. But the phrase anden i flaskan may also be used as a normal phrase instead of a lexicalization. In this case the word accent distinction is maintained for anden. This means that three prosodically distinct occurrences of anden - like for stegen in (7) - may appear

in the actual phrase for example in the following sentence frame with sentence accent on the verb: han hörde ánden i flàskan 'he heard the duck in the bottle', han hörde ànden i flàskan 'he heard the ghost in the bottle' and han hörde anden-i-flàskan 'he heard the duck-/ghost-in-the-bottle':

(8)	han	hörde	ándén	i	flàskan
stress	-	+ - +	- -	+	-
word accent	-	+ - +	- -	+	-
accent II	-	+ - -	- -	+	-
sentence accent	-	+ - -	- -	-	-

	han	hörde	ànden	i	flàskan
stress	-	+ - +	- -	+	-
word accent	-	+ - +	- -	+	-
accent II	-	+ - +	- -	+	-
sentence accent	-	+ - -	- -	-	-

	han	hörde	anden-i-flàskan
stress	-	+ - +	- - + -
word accent	-	+ - -	- - + -
accent II	-	+ - -	- - + -
sentence accent	-	+ - -	- - - -

In summary, then, it has been demonstrated that a stressed syllable may occur with or without word accent independently of sentence accent. This means that the distinction between accent I and accent II may be maintained, even if the word in question has no sentence accent. A stressed syllable is associated with one of the two word accents, if it is the only stressed syllable in a non-compound word, the first stressed syllable in a compound or the last stressed syllable of a lexicalized phrase. A stressed syllable without word accent is found in the last element of a compound and in the first element of a lexicalized phrase. Also in an unstressed syllable the word accent distinction is absent. If sentence accent is attributed to a word in a sentence, it is tied to the last stressed syllable of the word. In a non-compound word or in a lexicalized phrase this is the word accent syllable and in a compound the secondary-stress syllable.

1.2 The word accent distribution

In most cases the occurrence of accent I and accent II in Swedish words is predictable by general rules relying on phonological and morphological information. For an exhaustive description of the word accent distribution, a few simple rules will not suffice, however. Such a description will have to take into account not only phonology and morphology but also syntactical and lexical information. Here I will briefly sketch the most important regularities in Central Standard Swedish (cf. 2.2). For more detailed information see Öhman 1966, Teleman 1969, Lindau 1970, Elert 1972 and Linell 1972.

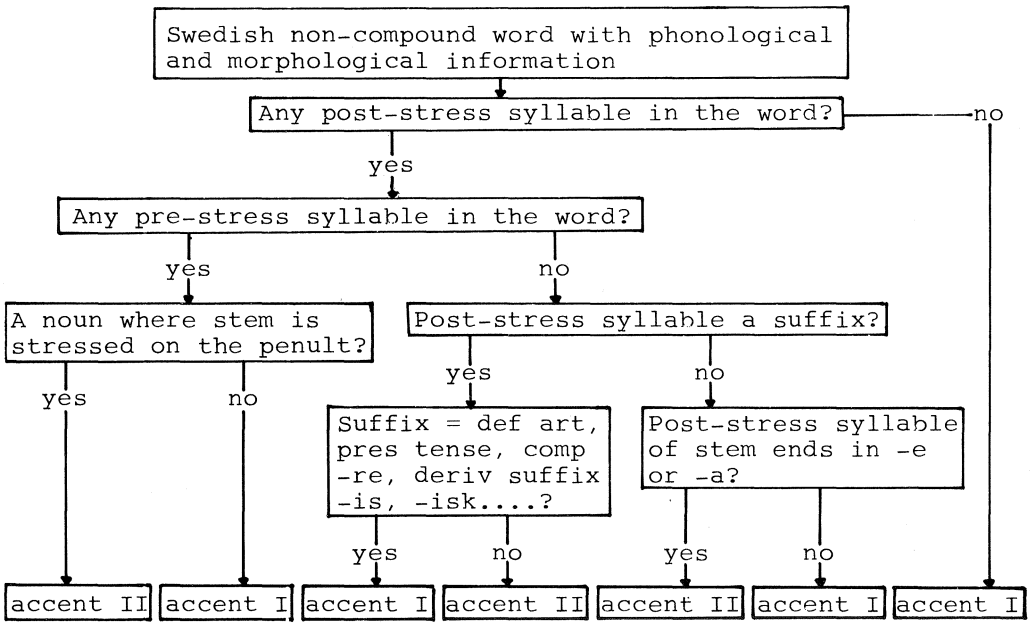
1.2.1 Non-compound words

The primary factor governing the distribution of the word accents in non-compound words is the placement of stress. For accent II to occur, there must always be a post-stress syllable in the word. When stress is on the last syllable, including monosyllabic words, accent I is obligatory, e.g. bíl 'car', banán 'banana', lemonád 'lemonade'. Among words containing both pre-stress and post-stress syllables both word accents occur. Accent II is assigned to nouns when the stem is stressed on the penult, e.g. vänìnna 'female friend', prinsèssa 'princess', kopìa 'copy'. Accent I is found in other cases, e.g. befálla 'to order', fundéra 'to ponder', egéntlig 'proper'.

For words with stress on the first syllable followed by one or more unstressed syllables the situation is somewhat more complex: A lexical word may have different word accents depending on the inflectional or derivational suffix. Therefore it is not always enough to identify the root or the stem of a word, nor is it necessary to take into account all the morphemes of the word in order to determine the word accent. The important thing is that the word accent is predictable if the morpheme occupying the post-stress syllable is known, as has been convincingly demonstrated by Rischel (1963) for Norwegian and which is equally true of Swedish. Certain suffixes, e.g. the plural and the infinitive suffix, can affect the word accent of the stem of a word while other suffixes, e.g. the definite final article and the present tense marker, do not. A monosyllabic stem like báck 'football back', followed by the definite

final article will have accent I: bácken, while bäck plus the plural suffix will have accent II: bäckar. Another example is the verb stem sítt 'sit' with accent II in the infinitive: sìtta, and accent I in the present tense:sítter. The word accent of a disyllabic stem with stress on the first syllable is already determined by the location of the post-stress syllable in the stem. Any suffixes added to the stem in this case will not affect the word accent, e.g. bäcke 'slope' plus the definite article = bäcken, bäcke plus the plural suffix = bäckar; fänrik 'ensign' plus the definite article = fänriken, fänrik plus the plural suffix = fänrikar. The difference in word accent between the last two examples can be accounted for by the following regularity: if the post-stress syllable of the stem ends in -e or -a, accent II will occur. In other cases of polysyllabic stems accent I will be assigned to the word. The following diagram summarizes the most important regularities of the word accent distribution discussed in this section. The input to the diagram is a transcription of any Swedish non-compound word with indication about its morphological and phonological structure:

Diagram for predicting the word accent of a Swedish non-compound word



The predictability of word accent by this diagram is, however, far from complete. Especially for words with a disyllabic stem stressed on the first syllable, the rules have to count a fair-sized number of exceptions. It is interesting to note that this very group of words, where the predictability of word accent is low, shows the greatest regional, social and individual variation.

1.2.2 Compound words

The word accent distribution in compounds appears to be straightforward. In Central Standard Swedish the majority of the compound words will receive accent II independently of whether the elements of the compound have accent I or accent II in isolation. Thus accent II will be found in a compound like tàxichaufför 'taxi-driver', where each of the simple words táxi and chaufför has accent I. Within the compound the stress distribution of each of the elements is preserved. The determining factor for accent II in a compound can be described as the presence of at least two stressed syllables within the same word regardless of their position in the word. Accent II is assigned to the stressed syllable of the first compound element, while the word accent of the stressed syllable of other compound elements is neutralized. Exceptions to the highly productive compound rule in Central Standard Swedish are primarily specific lexicalized compounds, i.e. the names of the days of the week, e.g. mándag 'monday', certain place names, e.g. Märsta, Täby (suburbs of Stockholm), and personal names, e.g. Bérgman, Lúndgren, and some other words, such as ríksdag 'parliament', vérkstad 'workshop', trädgård 'garden'. In some other Swedish dialects, notably dialects of south Swedish, the word accent distribution in compounds appears to be quite different from that of Central Standard Swedish (Bruce 1973, 1974).

1.3 The sentence accent distribution

It has been noted for a number of languages that there is a tendency for the sentence accent to be placed late in a sentence (cf. Bolinger 1958, Chomsky, Halle & Lukoff 1956 and Chomsky & Halle 1968 for English, Kiparsky 1966 for German, Gårding 1964 for Swedish and Daneš 1960, 1967 for Slavic languages). It is, however, still debated, whether the place-

ment of sentence accent is mainly syntactically or semantically conditioned. See discussion in Bresnan 1971, 1972, Lakoff 1972, Berman & Szamosi 1972, Bolinger 1972, Stockwell 1972, Crystal 1975, O'Shaughnessy 1976. Most of the work devoted to the study of the sentence accent distribution seems to indicate that an exclusively syntactic conditioning of the placement of sentence accent is weakly supported and that it is mainly semantically conditioned.

1.3.1 The Functional Sentence Perspective

The view that the location of sentence accent is primarily semantically or contextually conditioned is advocated, for example, in works by Daneš (1960, 1967), Gunter (1966, 1972), Halliday (1967) and Vanderslice (1968a, 1968b). The theoretical background of Daneš's work is the notion of the Functional Sentence Perspective developed in the Prague school. The basic idea is that a sentence is divided from a contextual view-point into a 'theme' and a 'rheme', the theme representing roughly the given (or old) information of the sentence and the rheme containing the greatest amount of new information (or Communicative Dynamism) in the sentence (see Firbas 1964, 1966, 1971). The theme is normally located in the beginning and the rheme in the end of a sentence. The rheme may either add to or contrast with the information assumed by the speaker to be available to the listener. With this approach a sentence is regarded not as an isolated whole but as a part of a discourse. The sentence accent is associated with the rheme, i.e. the new information. This means that the normal place for the sentence accent is in the final part of the sentence. In the generative literature the terms 'presupposition' and 'focus' are used to refer to concepts similar to 'theme' and 'rheme' respectively (cf. Chomsky 1971, Jackendoff 1972).

Daneš (op.cit.) has demonstrated that word order and location of sentence accent are different means of expressing the contextual organization of a sentence. In languages with a relatively free word order, e.g. Russian, the rheme - and consequently the sentence accent - will be located at the end of the sentence, whereas in languages with a more fixed word order like English, the rheme is not necessarily moved towards the end of the sentence but can be signalled by the location of sentence

accent alone. This point is illustrated by the following examples cited from Worth (1964:50) by Daneš:

	Russian	English
(a)	Krovati stojali v jego KOMNATE.	The beds were in his ROOM.
(b)	V jego komnate stojalí KROVATI.	There were BEDS in his room.

In the English version of (b) the sentence accent - represented orthographically by capital letters - and consequently the rheme is located relatively early in the sentence, although there is no emphatic or contrastive accent involved. It seems to me that the Functional Sentence Perspective - the theme/rheme distinction - can account for a great deal of what has conventionally been attributed to emphasis and contrast. By 'contrast' a particular lexical item is distinguished from other items that might occur in the same position, while 'emphasis' is either equivalent to contrast or distinguishes a proposition from its negation (Bierwisch 1966). It is not always clear, however, whether emphatic and contrastive accent can in fact be distinguished from normal sentence accent (cf. Bolinger 1961).

1.3.2 Contextual organization and sentence accent

A sentence is usually related to other sentences, normally most closely to the immediately preceding sentence in the discourse - the context sentence (cf. Gunter 1972:194). Therefore almost every sentence can be regarded as a possible response to a context and as relevant to this context. This approach plays a major role in the elicitation of sentence accent in different positions of the sentences used in my speech material, which will be presented in the following chapter (cf. 2.1). In the following presentation it is assumed that each sentence constitutes one cohesive phonological phrase, so that only one sentence accent occurs in each sentence. In spontaneous speech, however, a sentence may often be divided into two or more phrases, so that more than one lexical item in the sentence may receive "sentence accent". This possibility will not be considered here, since it is not relevant for my presentation.

Consider the Swedish sentence Dom vill låna några gula gardiner 'They want to borrow some yellow curtains'. A possible

context sentence is the following wh-question.

Vad vill dom låna för några gula saker? Context
'What yellow things do they want to borrow?'

Dom vill låna några gula GARDINER. Response
'They want to borrow some yellow CURTAINS.'

In this response GARDINER is the rheme and the rest of the sentence the theme. The sentence accent will be located in the rheme at the end of the sentence. The repeated context - the theme - is devoid of any sentence accent. But it is of course not necessary to repeat the whole context in the response sentence. The response may also be elliptical. Possible alternative responses are:

Vad vill dom låna för några gula saker? Context
'What yellow things do they want to borrow?'

Några gula GARDINER. Response
'Some yellow CURTAINS.'

GARDINER. Response
'CURTAINS.'

With another context the sentence accent in Swedish may be shifted to an earlier constituent of the response sentence, although the syntactic structure (word order) of the response sentence remains the same.

Vad vill dom låna för några gardiner? Context
'What curtains do they want to borrow?'

(Dom vill låna) några GULA gardiner. Response
'(They want to borrow) some YELLOW curtains.'

In this response GULA is the rheme carrying the sentence accent, while the rest of the sentence - with a possible partial ellipsis - constitutes the theme. A third possible context for the actual response sentence will shift the sentence accent still earlier in the sentence.

Vad vill dom göra med några gula gardiner? Context
'What do they want to do with some yellow curtains?'

(Dom vill) LÅNA några gula gardiner. Response
'(They want to) BORROW some yellow curtains.'

Yet another possibility of response is to pronominalize part of the context.

Vad vill dom göra med några gula gardiner? Context
'What do they want to do with some yellow curtains?'

(Dom vill) LÅNA dom. Response
'(They want to) BORROW them.'

Vanderslice (1968b:14) has pointed out that repetition of the context without sentence accent - accent deletion -, pronominalization and ellipsis are three equivalent kinds of reduction applying to sentences under certain semantic conditions. The choice between the alternatives is to some extent optional.

It is also possible to choose another syntactic form for the response sentence without resorting to pronominalization or deletion, e.g. by clefting.

Vad är det för några gula saker dom vill låna? Context
'What yellow things do they want to borrow?'

Det är några gula GARDINER dom vill låna. Response
'It is some yellow CURTAINS they want to borrow.'

In a sentence like this, the rheme - and the sentence accent - is contained in the clefted phrase. In this case the rheme is the last element of the clefted phrase, but this is not obligatory, as illustrated by the following situation.

Vad är det för några gardiner dom vill låna? Context
'What kind of curtains do they want to borrow?'

Det är några GULA gardiner dom vill låna. Response
'It is some YELLOW curtains they want to borrow.'

In all the response sentences so far the rheme has consisted of one word only. This has been due to the context sentences whose construction elicits only one rhematic element. It is interesting to note, however, where the sentence accent will be located if the rheme of the response sentence consists of more than one word. Consider the following situation.

Vad vill dom låna? Context
'What do they want to borrow?'

Dom vill låna några gula GARDINER. Response
'They want to borrow some yellow CURTAINS.'

Although both gula and gardiner belong to the rheme in this case, the sentence accent will be placed on gardiner, i.e. the last word of the rheme. Also when the whole verb phrase constitutes the rheme, i.e. when both låna, gula and gardiner provide new

information, the sentence accent will be placed on the last word of the rheme: gardiner.

Vad vill dom göra? Context

'What do they want to do?'

Dom vill låna några gula GARDINER. Response

'They want to borrow some yellow CURTAINS.'

From the examples above we can conclude that the rule for the placement of sentence accent in Swedish is roughly as follows: Sentence accent is placed on the last element of the rheme. Since the rheme is often located at the end of a sentence, sentence accent will consequently appear in the final position of a sentence more frequently than in any other position.

2 PROCEDURE

The second chapter contains a description of the test procedure used for the investigation of Fo-contours of Swedish sentences reported on in chapters 3-6. In the first part of the chapter the speech material is described. The syntactic, prosodic and segmental composition of the test sentences are treated, and the different sets and subsets of test sentences are presented. In subsequent parts a short presentation of the informants and their dialect is given, and the recording of the test material and the registration and measurements of the Fo-contours are described.

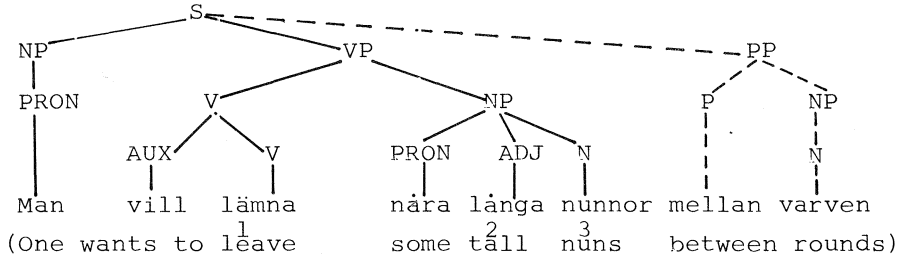
2.1 Test material

The test material designed for the analysis of Fo-contours consists of a large number of meaningful Swedish sentences. For the same sentence frame the following parameters are systematically varied: 1) the word accent in different positions of a sentence, 2) the placement of sentence accent and for a subset of sentences the domain of focus, 3) for one position the number of syllables and the placement of stress in the test words and consequently also the number of syllables between the stressed syllables, 4) final vs. non-final position for the same word, 5) the phrase structure of a part of the sentence containing either one word (a compound) or two words.

2.1.1 Syntactic composition of the test sentences

A typical test sentence in my speech sample has the form of an answer to a question. The idea is to keep the response sentence - the real test sentence - constant and vary its context. In each case, then, the syntactic form of the response sentence is the same. The context sentence - the question - is formulated in different ways in order to make the speaker choose one of several possible parts of the sentence as the focus and carrier of sentence accent (cf. 1.3.2).

A basic type of Swedish sentences is used in my speech material. The syntactic structure of these test sentences is shown in the tree diagram below:



The numbers in the diagram denote focus locations. Maximally three of the possible focus locations in the test sentences have been used. They are all located in the verb phrase of the test sentence. It was considered convenient that the verb phrase, which contains the possible focus locations, be syntactically relatively cohesive. Moreover the semantic relation of the verb to the object noun phrase is not one of implication, so that either the main verb, the adjective or the noun can equally well attract the sentence accent (cf. 1.3.2). In order to evaluate the effect on Fo of final versus non-final position in the sentence for the same word some of the test sentences also have a version with an added prepositional phrase (broken lines in the tree diagram above), which does not, however, attract the sentence accent. These test sentences all have the sentence accent in the third focus position.

Each test sentence in my speech material is uttered as a neutral statement. Although the location of sentence accent is systematically varied, the degree of emphasis within each focus position is meant to be constant. No variation of the statement/question dimension or differences in speaker attitude have been included in the study.

2.1.2 Prosodic composition of the test sentences

In each focus position there are words with accent I and accent II. It has not been found necessary to have minimal pairs in these positions but only to require that the words with different word accents are segmentally equivalent and comparable. Nor has it been considered important to have the same accent I-word and the same accent II-word occur in the different possible positions of a test sentence. The requirement is that the different accent I-words and accent II-words should be segmentally and prosodically equivalent and therefore comparable. In focus

positions 1 and 2 the test words are stressed on the penult. This means that the disyllabic words are stressed on the first syllable, while the only trisyllabic word is stressed on the second syllable. In focus position 3 the number of syllables and the position of stress are varied for both the accent I- and the accent II-words. The number of unstressed syllables between the first and the second stressed syllables in a test sentence is kept constant, while there is a varying number of unstressed syllables between the second and the third stressed syllables. This has been done in order to evaluate the possible effect on Fo of a difference in the number of unstressed syllables between the stressed syllables.

2.1.3 Segmental composition of the test words

The following conditions on the segmental structure of the test words have been established. Test words with sonorant consonants have been chosen as far as possible in order to have continuous, fairly undisturbed Fo-contours of the utterances (cf. Meyer 1937). Obstruent consonants - both stops and fricatives - have been systematically avoided, because they cause disturbances of the ideal Fo-contours particularly of following vowels. Voiceless obstruents are known to have a raising effect on the Fo of the following vowel, while voiced obstruents have instead a lowering effect on Fo (House & Fairbanks 1953, Lehiste & Peterson 1961, Mohr 1971, Lea 1973, Gandour 1974, Löfqvist 1975, Hombert 1976, I. Johansson 1976). This effect is greatest in the beginning of the following vowel but appears to be traceable to a central part of the vowel (Lea 1973:43, Löfqvist 1975: 243, Hombert 1976:24). Sonorant consonants - nasals and liquids - tend to have the least influence on Fo.

For three words in the test sentences: vill, lavemång and várven the principle of choosing sonorant consonants has not been maintained. In all cases the voiced fricative v, which in Swedish may be better described as a voiced approximant, has been used instead of a sonorant consonant. Three out of four of these v's occur in an unstressed position, so the disturbing effect - Fo-lowering - of the v is assumed to be marginal.

Vowels with approximately the same degree of opening - non-high vowels - have been chosen to avoid differences in intrinsic Fo, which might complicate the interpretation of the con-

tours. It has been shown in a number of investigations of different languages that the differences in intrinsic Fo between high and low vowels can be as great as 20-30 hz (Peterson & Barney 1952, House & Fairbanks 1953, Lehiste & Peterson 1961, Magdics 1969, Atkinson 1973, Lea 1973, I. Johansson 1976, Petersen 1976), i.e. sizeable differences. By choosing vowels with nearly the same degree of opening possible differences in intrinsic Fo are minimized. The only high vowel in my speech material is the vowel of the word vill, which occurs in an unstressed, non-critical position of the sentence. It has been shown that the differences in intrinsic Fo between vowels are less in an unstressed than in a stressed position (I. Johansson 1976, Petersen 1976), so the negative effect of incorporating this word into the speech material is only marginal.

As it was found necessary to restrict the test material, vowel length is not varied in the test words. All the stressed vowels - as well as the unstressed - are phonologically short. By choosing short vowels followed by long consonants instead of long vowels followed by short consonants in the stressed syllable it is assumed that the relevant intonational information is captured and that the Fo-contours of the consonants and of the final portion of the long vowel do not substantially add to this information but merely fill out the contours (cf. the 'truncation hypothesis' in Eriksson & Alstermark 1972 and Bannert & Bredvad-Jensen 1975).

All these conditions on the segmental structure of the test words mean, however, rather severe restrictions in the choice of existing Swedish words for the test sentences, which explains the somewhat peculiar semantic composition of the test material. An alternative method would have been to use test sentences consisting of Swedish nonsense words. Although optimal segmental structure of the test words can be obtained in this way, the method has certain obvious drawbacks. In a pilot experiment it was found that the subjects had difficulties in producing fluent test utterances with correct word accents and the correct number of syllables when repeating the same type of syllable, e.g. na. This also happened, when they were imitating a test sentence with real words. Moreover as my method of eliciting the sentence accent in different positions of a test sentence involves the responding meaningfully to a context,

the use of nonsense words in this situation imposes heavy demands on the subjects. Therefore I have preferred to choose existing Swedish words for the test sentences in spite of the problems of finding suitable words, because of the restrictions on segmental structure.

2.1.4 Test sets

There are three sets of test sentences in the speech material. Set A contains disyllabic test words - except for the trisyllabic accent I-verb in the absence of disyllabic accent I-verbs in Swedish - all stressed on the penult and with contrasting word accent in the three focus positions (marked 1, 2 and 3). The following test sentences are included in set A (=24):

Set A 1 2 3
Man vill {aŋámma / lämna} nära {lǎngre / långa} {númmer / nùnnor}. [man vil {anám:a / lɛ̀mna} nɔra {lɛ́ŋre / lɔ̀ŋ:a} {núm:ɛr / nùn:ɔr}]

(One wants to {accept / leave} some {longer / long / tall} {numbers / nuns}.)

For sentences belonging to set A either the verb, the adjective or the noun may occur in focus. But for set A the Fo-response has also been tested for sentences in which the domain of focus is extended to cover either the noun phrase or the whole verb phrase (=16). The subset of test sentences from set A with an additional prepositional phrase mellan várven is the following (=2):

1 2 3
Man vill lämna nära långa {númmer / nùnnor} mellan várven. [mɛlan várven]

(One wants to leave some {long / tall} {numbers / nuns} between rounds.)

For these sentences only the accent II-verb and the accent II-adjective are used in the first and second position respectively, and the sentence accent is restricted to the third position.

The test sentences in set B have the same basic structure as in set A. In set B, however, the syllabic composition of words in the third position is different from that of set A. The disyllabic nouns are replaced by monosyllabic or trisyllabic nouns. The position of stress is varied among the trisyllabic accent I-nouns, while the only trisyllabic accent II-noun is stressed on the first syllable. Only the accent II-verb is

used in the first position. Each of the words occurring in the three focus positions can attract the sentence accent. Set B consists of the following test sentences (=30):

Set B

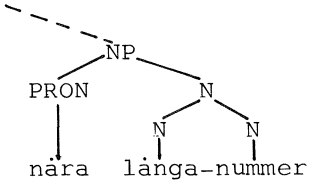
1	2	3	
Man vill lämna nära	{långre / länga}	{lámm / lémmonar / laméller / lavemáng / làngare} .	[{lám: / lém:ɔnar / lamél:ɛr / lavemáŋ: / làŋ:are}]

(One wants to leave some {{longer / {long / tall}} / {lambs / lemmons / disks / enemas / boot-leggers}} .)

Also for set B a subset of the test sentences has a version with the prepositional phrase added. In this subset only the accent II-adjective is used in the second position and sentence accent is attributed to the third position (=5):

1	2	3	
Man vill lämna nära	länga	{lámm / lémmonar / laméller / lavemáng / làngare}	mellan várven.

In set C one word - a compound - is used instead of the two words - adjective and noun - occupying position 2 and 3 in sets A and B. This means that there are only two focus positions in set C. The first element of the compound: Länga, which has the same segmental structure as the accent II-adjective, is to be interpreted as a place name. The noun phrase of the sentences containing a compound has the following syntactic structure:



The first element of the compound when it is used as a single word - as well as the compound itself - has accent II. The second element of the compound has in five out of six cases accent I in isolation. One compound with an accent II-word (nunnor) as the second element was incorporated in order to determine whether accent II is actually neutralized in secondary-

stress position. Set C contains the following test sentences (=12):

Set C

1 2

Man vill lämna nära { långalamm / länganummer / långalemmonar / långalameller / långalavemang / länganunnor } . [{ lˈɔŋ:aˌlam: / lˈɔŋ:aˌnʉm:ɛr / lˈɔŋ:aˌlɛm:ɔnar / lˈɔŋ:alaˌmɛl:ɛr / lˈɔŋ:alaveˌmaŋ: / lˈɔŋ:aˌnʉn:ɔr }]

(One wants to leave some { "Långa-lambs" / "Långa-numbers" / "Långa-lemons" / "Långa-disks" / "Långa-enemas" / "Långa-nuns" } .)

All of these test sentences, except the one containing a compound with a second accent II-element nunnor, also have a version with the additional prepositional phrase mellan várven. As for the corresponding subsets of sets A and B, the sentence accent has been restricted to the last focus position - in this case the second position. The sentences of this subset are (=5):

1 2

Man vill lämna nära { långalamm / länganummer / långalemmonar / långalameller / långalavemang } mellan várven.

The total number of test sentences is 94 (cf. 2.2).

In the sentences where the placement of focus has been varied we find different Fo-contours for each test word. In sets A and B there are three Fo-contours for each test word: one when the word is in focus carrying sentence accent (focal) and the other two when the word has no sentence accent (non-focal), i.e. when the sentence accent is in one of the other two positions of the sentence. Naturally in the first position test words without sentence accent only occur before focus (pre-focal) - either 1 or 2 before focus -, in the second position either 1 before or 1 after focus, and in the third position only after focus (post-focal) - either 1 or 2 after focus. In set C there are two Fo-contours for each test word: in the first position a pre-focal and a focal contour, and in the second position a focal and a post-focal contour.

2.2 Informants

Although the rules for the distribution of accent I and accent II in Swedish show some variation interdialectally, it appears that the Fo-realizations of the word accents vary even more. Evidence that this variation can still be shown to involve only a few basic types is given in the tentative accent typology proposed by Gårding & Lindblad (1973:44-48) and based on E.A. Meyer's data on isolated disyllabic words spoken with statement intonation. The typology takes into account the number and relative location of the tone peaks in a word. Disregarding those dialects which have no word accent distinction (0-dialects), the Swedish dialects can be divided into two main types: dialects having one-peaked accent I and accent II, where the relative location of the peak is decisive (1-dialects), and those having a one-peaked accent I and a two-peaked accent II (2-dialects). Each main type can be subdivided into two subtypes. Figure 1 from Gårding & Lindblad (op.cit.) shows the regional distribution of the different accent types. The variety of Swedish chosen for my investigation is the Stockholm dialect belonging to type 2,subtype (A),typical of the eastern and northern parts of Sweden. The reason for choosing the Stockholm dialect is that it represents a wide-spread variety of Central Standard Swedish and that it turned out to be particularly interesting from the point of view of intonation. I am also making a parallel study - not yet completed - of the Malmö dialect (South Swedish) representing type 1, subtype (A), in figure 1. A preliminary report of my work with the word accents in the Malmö and the Stockholm dialect is found in Bruce (1975).

Three speakers representing the Stockholm dialect and judged to speak the same sociolect were used in my investigation. My primary informant was a female student of logopedics in Lund - 21 years old at the time of the recording - born and brought up in Stockholm to the age of 19. She recorded the whole speech material five times, i.e. 470 utterances in total. Two secondary informants from Stockholm - both female logopeds and research students in phonetics at Lund University, 29 years of age at the time of the recording - recorded a minor part of the speech sample. Subsets from sets A and B and one sentence from set C were included in their recordings, making up a total of 145 utterances each. Thus this study is based on 760 utterances.

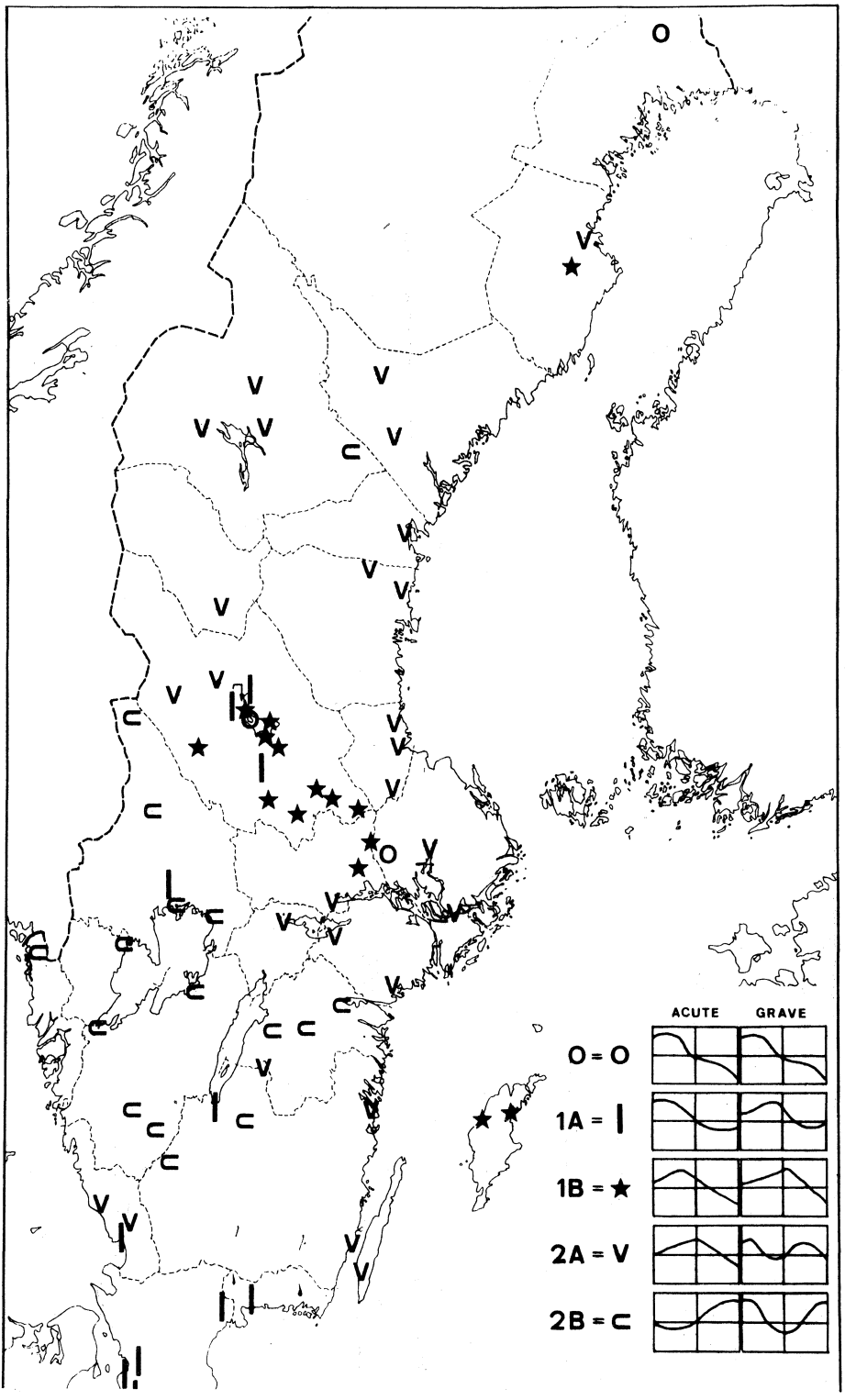


Figure 1. Geographical distribution of the accent types (from Gårding & Lindblad 1973).

2.3 Recording

The recordings took place in the sound studio of the phonetics laboratory in Lund. The context sentences and the test sentences were typed on cards. For each card the speakers read aloud the context sentence and the response to it - the real test sentence -, e.g.:

Vad vill man lämna för nåra nunnor? (What nuns does one want to leave?)

Man vill lämna nåra långa nunnor. (One wants to leave some tall nuns.)

No special marking of focus occurred on the cards. The position of focus was elicited by means of the context sentence. The speakers were trained before the recording session and instructed to answer the questions in a friendly but determined manner. Each test sentence appeared five times in different order arrangements in each set: A, B and C. The speech material was recorded in one recording session, which was divided into a number of subsessions with pauses in between, during which the speakers and the experimenter controlled the recordings. A Sennheiser microphone was used with a microphone distance to the speaker of about 30 cm. The speech material was recorded on a STUDER tape recorder with a tape speed of 19 cm/sec.

2.4 Registration and measurements

The recordings were fed into a FONEMA pitch extracting device from a TANDBERG tape recorder and were registered on a SIEMENS oscillomink with a paper speed of 100 mm/sec. The fundamental frequency contours (Fo-contours) obtained in this way constituted the raw material for the acoustic analysis of the word accents. The Fo-contours were expanded for each speaker's frequency range so that a measurement accuracy of 5 hz was obtained. In the time domain the measurement accuracy was 10 ms. A duplex oscillogram and a full frequency range intensity curve from a FONEMA analysis assembly were used for the segmentation of the Fo-contours. Although the test utterances consist of sonorant segments throughout, there were no severe problems of segmentation. The boundary between a sonorant consonant and a vowel was often visible even in the Fo-contour. Tracings of typical Fo-contours, which out of several repetitions of the

same test item are judged to represent the average case, are presented in the figures.

Measurements of the fundamental frequency were made by hand. Fo-maxima and Fo-minima in connection with the major changes in the Fo-contours of the test utterances were measured in hz. The timing of each of the major turning-points in the Fo-contours, i.e. starting-points and end-points of rises and falls connecting these Fo-maxima and Fo-minima, was determined and is given in ms relative to the closest CV-boundary (normally) and also in percent of the segment in which the turning-point is normally located. A negative value indicates that the turning-point is located before the segment boundary in question. The timing values in ms for a particular turning-point are related to the same CV-boundary for the two word accents and are therefore comparable. The percentage values of a turning-point, on the other hand, are for words with different word accents often related to different segments and therefore only permit direct comparisons for the same word accent in different positions.

It should also be noted that the percentage values for the turning-points located in the stressed vowel or in the following consonant would be different, if a long vowel followed by a short consonant were chosen instead of a short vowel followed by a long consonant in the stressed syllable of the test words (2.1.2). Differences in the inherent durations of segments may also complicate comparisons of the percentage values to some extent. In spite of these limitations on the usefulness of the percentage values, it can still be maintained that it is reasonable to have a relational complement to the absolute timing values in ms and that the percentage values serve this purpose.

The duration of the rises and falls in ms have also been measured. Values for the frequency range of an Fo-change have been determined by subtracting the Fo-minimum from the Fo-maximum mean values for the same word accent and position. Approximate values for the gradient of an Fo-change have been obtained by dividing these range values by the mean duration values of the fall or rise and are given in hz/100 ms.

Since the Fo-maximum, minimum and timing values for the same word in the same position in most cases turn out to be similar regardless of the context, they have normally been pooled. If an apparent context-dependence for a certain variable is

suspected, the values for different environments are also presented separately. Means and standard deviations for the Fo-maxima, Fo-minima and for the timing and duration of the rises and falls have been calculated on a COMPUCORP 325 Scientist and are presented in the tables, the means rounded to whole numbers and the standard deviations to one decimal place.

3 PROSODIC CONTRIBUTIONS TO THE Fo-CONTOURS

> "... in dem wirklich vorliegenden Intonationsverlauf sind die ideelle Wortton- und die ideelle Satztonkurve zu einer Einheit vermählt. Eine empirische Intonationskurve in die beiden Komponenten, aus denen sie zusammengesetzt ist, mit Sicherheit zu zerlegen, ist nun freilich kaum möglich."
> (Meyer 1937:41)

The quotation shows that Meyer was well aware of the complex nature of an Fo-contour, although he did not consider it feasible to separate its prosodic components. It will be demonstrated in this chapter, how it is in fact possible to separate the different prosodic contributions to the Fo-contour from each other.

In the Fo-contour of an utterance prosodic and segmental contributions are merged. In the present investigation it has been attempted to minimize the effects of segmental influence on the Fo-contour (cf. 2.1.3) and to vary only the prosodic context. By comparing Fo-contours of words in final and non-final position, in and out of focus and with contrasting word accent out of focus, the individual Fo-contributions of terminal juncture, sentence accent, and word accent (accent I and accent II) could be isolated. This will be dealt with in the first main section of this chapter. The second section contains a comparison of these Fo-contributions in certain two-word phrases and compounds, and the third section finally shows how they are distributed in sentences where the domain of focus is extended to cover more than one word.

3.1 Single words

The Fo-contours of the word accents that are regarded as typical of the Stockholm dialect are illustrated in figure 2. These Fo-contours are in agreement with those shown by earlier investigations (Meyer 1937 and 1954, Öhman 1965 and 1967, Gårding 1967 and 1973, Alstermark & Eriksson 1971, Gårding & Lindblad 1973; cf. also figure 1, type 2 A). It will be argued that these Fo-contours for accent I and accent II are specific and are found in this material only when words in focus occur in the final position of a sentence which is uttered as a statement. In the Fo-contour of a disyllabic word like <u>nùmmer</u> or <u>nùnnor</u> above there are reflexes of word accent, sentence accent, terminal juncture and other aspects of sentence intonation, all realized

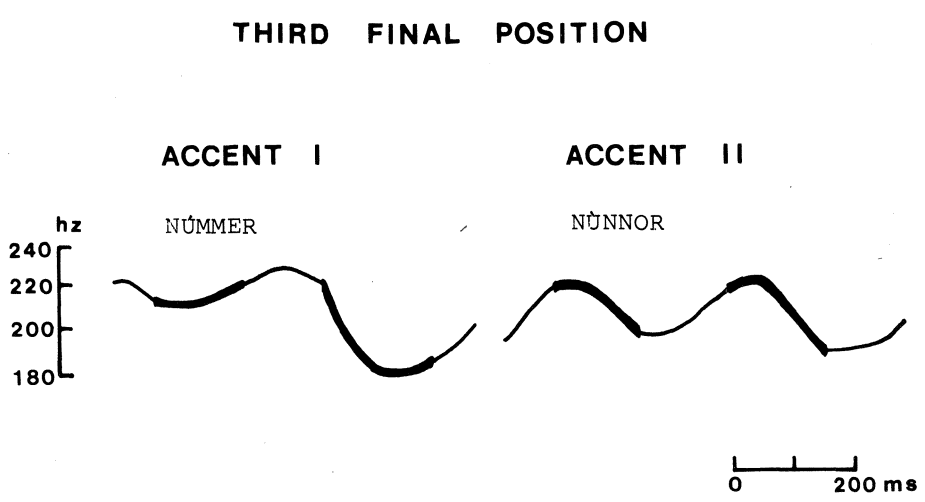


Figure 2. The citation forms of the word accents. Fo-contours of one accent I- and one accent II-word. Vowel segments are drawn in thick lines and consonant segments in thin lines in the figures. Focus is indicated by capital letters and non-focus position by small letters.

during the pronunciation of this particular word. This Fo-contour is only partly similar to the Fo-contours for the same word in other contexts.

3.1.1 Terminal juncture

In order to isolate the Fo-contribution of terminal juncture, Fo-contours of words carrying sentence accent in final and non-final position have been compared. In figure 3 are found typical Fo-contours of the same accent I- and accent II-words in a final and a non-final position of the sentence. The typical lengthening of segments - particularly of unstressed vowels and consonants - when they occur in utterance-final position (cf. Lindblom, Lyberg & Holmgren 1976), is apparent in figure 3 and should be remembered, when comparisons are made between the Fo-contours in final and non-final position.

The main difference between the Fo-contours of the same word in figure 3 is the Fo-fall, which occurs in the last syllable of a word in final position but is totally absent in non-final position. This is true of both accent I- and accent II-words regardless of the number of syllables in the word and the position of stress. Figure 4 shows corresponding Fo-contours for

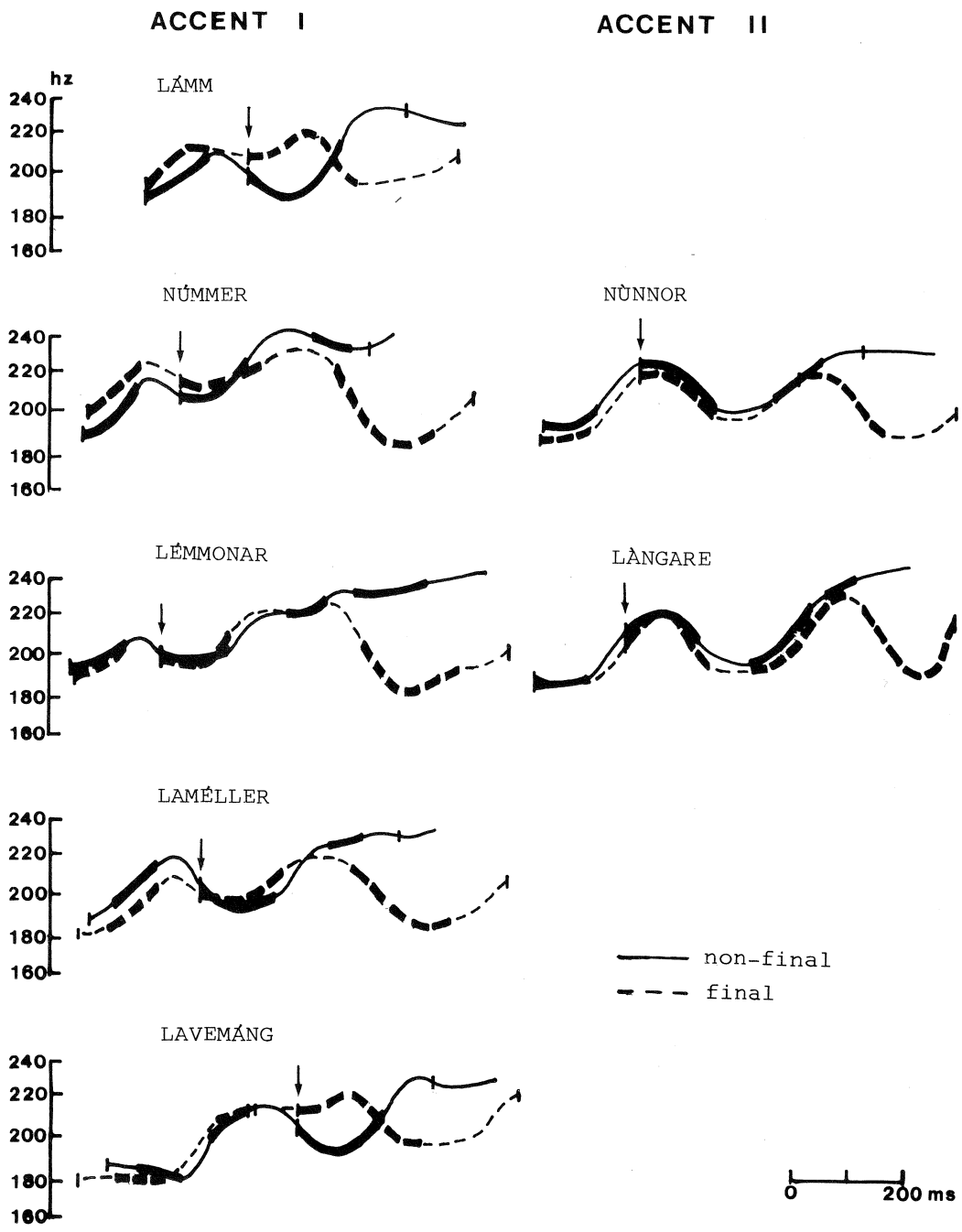


Figure 3. The effect of terminal juncture. Fo-contours of the same accent I- and accent II-words with sentence accent in final and non-final position. The arrow is the line-up point at the CV-boundary of the stressed syllable.

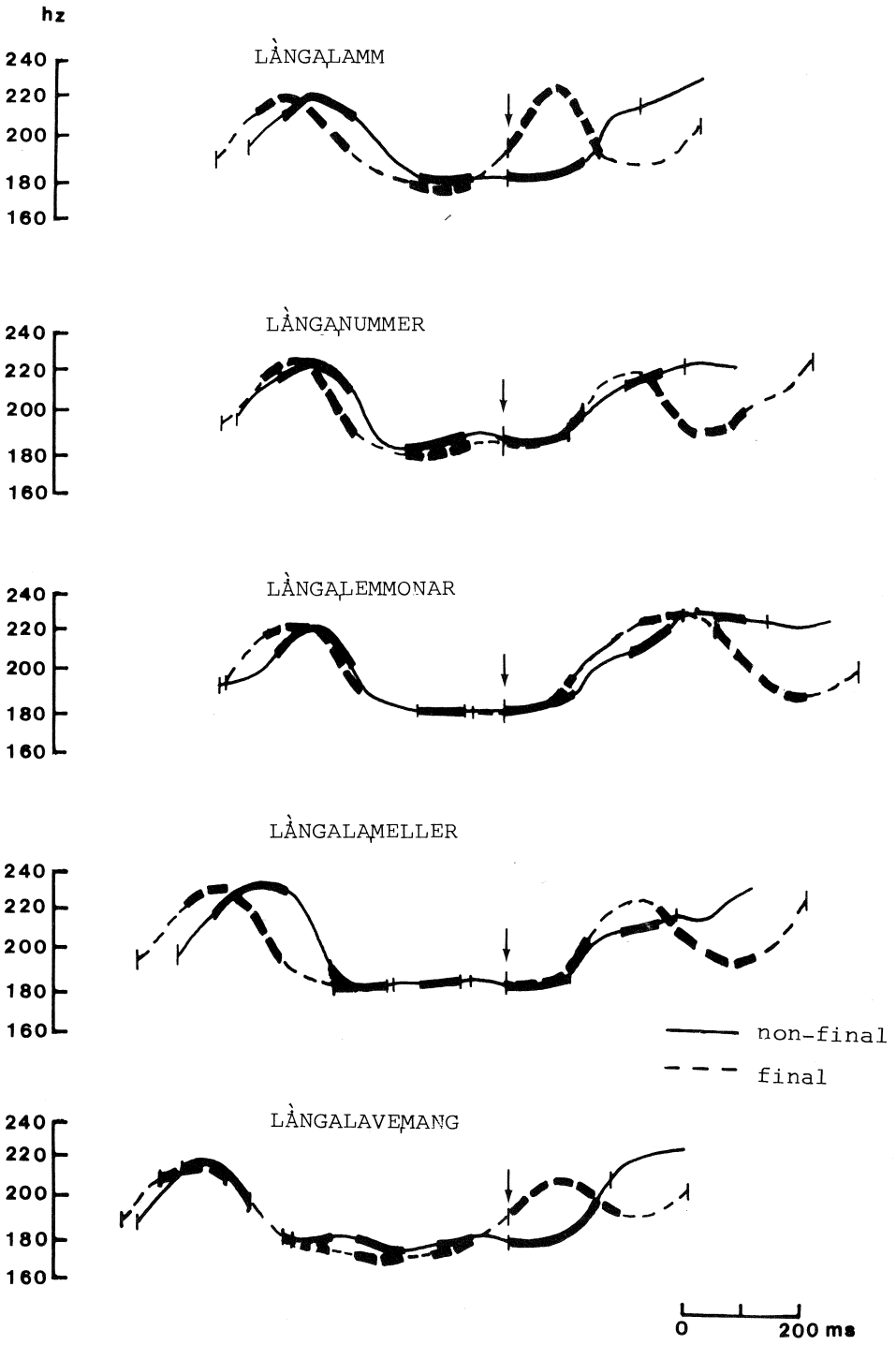


Figure 4. The effect of terminal juncture. Fo-contours of compounds with sentence accent in final and non-final position. The line-up point is at the CV-boundary of the secondary-stress syllable.

compounds. Similarly for compounds the primary difference between final and non-final position is the presence vs. absence of an Fo-fall in the last syllable of the word. All this clearly shows that terminal juncture manifests itself as an Fo-fall in the last syllable in utterance-final position.

From the Fo-tracings in figures 3 and 4 we can observe that for eight out of twelve words there is a rather close match of the Fo-contours in final and non-final position except for the presence vs. absence of the terminal Fo-fall. In the four remaining words, namely those where the stressed syllable is the final syllable, the Fo-contours differ in respects other than terminal Fo-fall. These phenomena are discussed in later sections (cf. 5.4 and 5.5), where the more exact properties of the terminal juncture fall and its interaction with other prosodic features are treated.

3.1.2 Sentence accent

By comparing the Fo-contours of the same words with and without sentence accent it was possible to factor out the Fo-contribution of sentence accent. Figure 5 shows Fo-contours of two sentences, where the place of sentence accent has been varied. One sentence contains only accent I-words and the other only accent II-words, in the three positions that can attract sentence accent. Thus for each of the sentences there are three Fo-versions, each reflecting a different placement of sentence accent. There are clear differences between the three Fo-contours of the same sentence. This is true of both the sentence with accent I-words and the sentence with accent II-words. There are also apparent similarities between the Fo-contours of the two sentences that have the corresponding word in focus.

For each test word in the three positions we can find three different Fo-contours: one when the word carries sentence accent and the other two when the word has no sentence accent, i.e. when the sentence accent is in one of the other two positions of the sentence. Naturally test words without sentence accent only occur before focus when they occupy the first position (i.e. either one or two positions before focus); they occur either before or after focus in the second position, and only after focus in the third position (either one or two positions after focus).

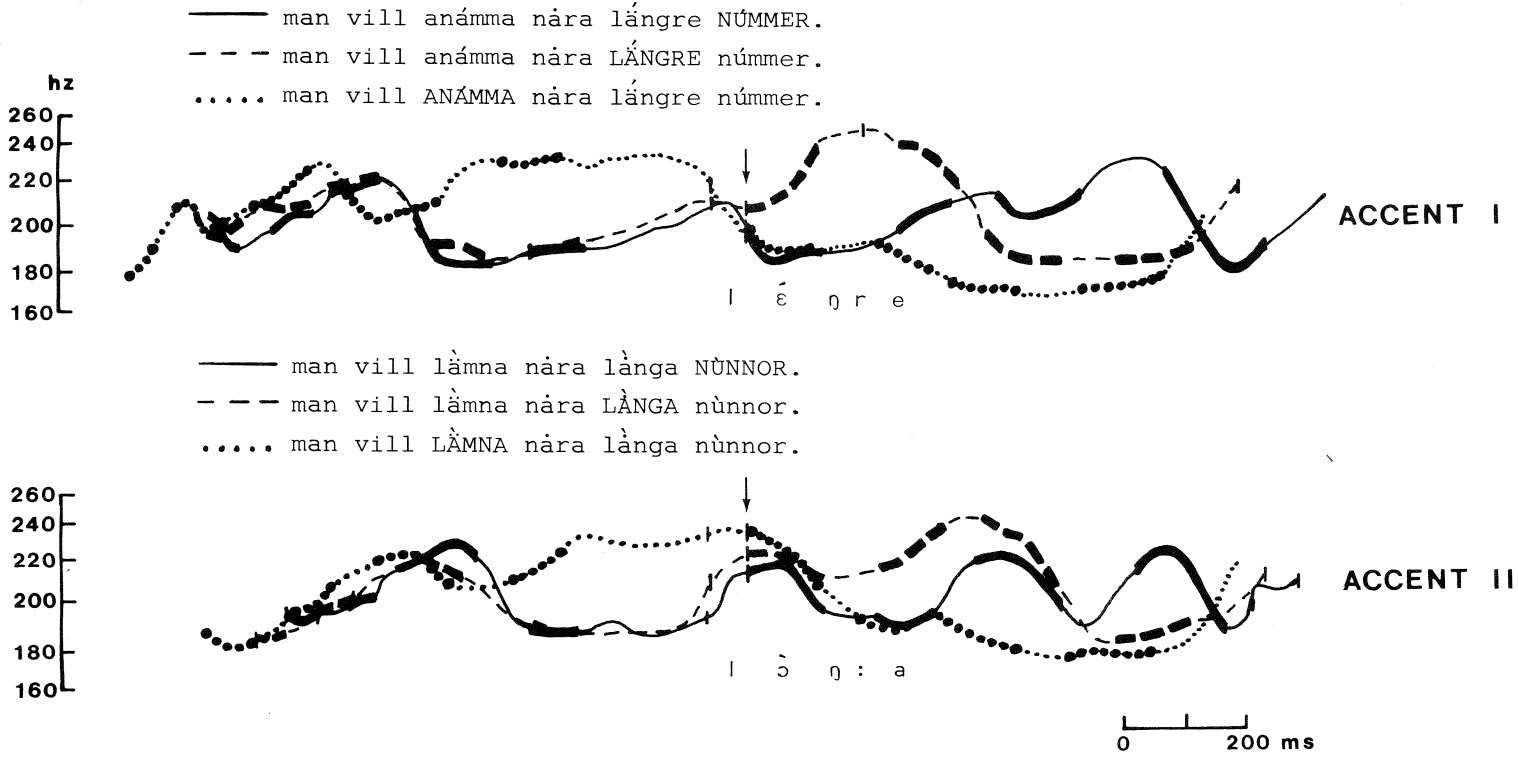


Figure 5. The effect of the placement of sentence accent. Fo-contours of full sentences, one with accent I-words and another with accent II-words. The line-up point is at the CV-boundary of the stressed syllable in the second position.

Figure 6 shows Fo-contours of accent I- and accent II-words with and without sentence accent in the three non-final positions in the sentences. For both word accents the Fo-contours in the non-focus positions appear to be only partly similar to the Fo-contours in focus. The Fo-contour of an accent I-word in non-focus position is radically different from the corresponding focus contour. Only the very first part of the Fo-contour in the pre-stress syllable of e.g. anámma is the same for both non-focus and focus position. The rise in the stressed syllable and the following Fo-maximum - features which are regarded as typical of accent I in the Stockholm dialect - are found only in focus position. In non-focus position a low Fo is maintained through the stressed and the following unstressed syllable of the word.

The Fo-contour of an accent II-word in non-focus position is partly similar to the corresponding focus contour. In lämna, for example, the Fo-contour in the stressed vowel is practically the same in both non-focus and focus position. But the Fo-rise in the second, unstressed syllable of the word, when it is in focus, is totally absent in non-focus position. Here we find a low Fo instead.

Corresponding Fo-differences between focus and non-focus positions are found for accent I-words and accent II-words in the other positions. In the second position the situation is parallel to the one in the first position. The Fo-rise, which is found for both the accent I-word lángre (in the stressed syllable) and the accent II-word länga (in the unstressed, post-stress syllable) when they are in focus, are missing in the non-focus positions. In non-final positions Fo remains high after the Fo-rise until the following stressed syllable (see figure 5).

Figure 7 shows corresponding Fo-contours in the third final position for accent I- and accent II-words with a varying number of syllables and varying stress placement. Here the Fo-rise, which appears to be typical of a word in focus, as well as the terminal juncture fall, occur in the Fo-contours in focus but not in the non-focus contours. As was noted in the preceding section, the Fo-contours for words where the stressed syllable is also final are somewhat special. This will be treated in a later section (cf. 5.5).

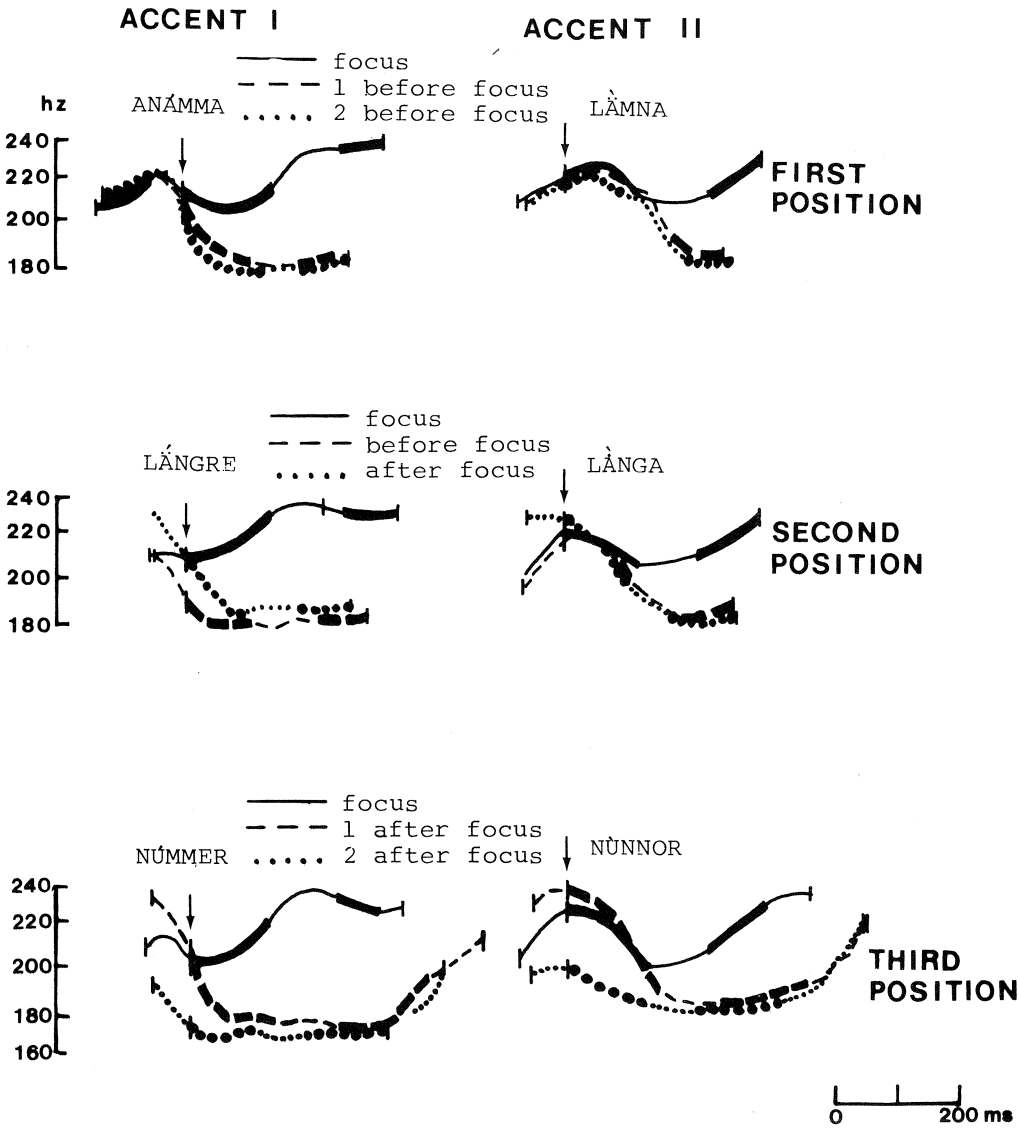


Figure 6. The effect of sentence accent. Fo-contours of accent I- and accent II-words in the first, second and third, non-final position. The line-up point is at the CV-boundary of the stressed syllable.

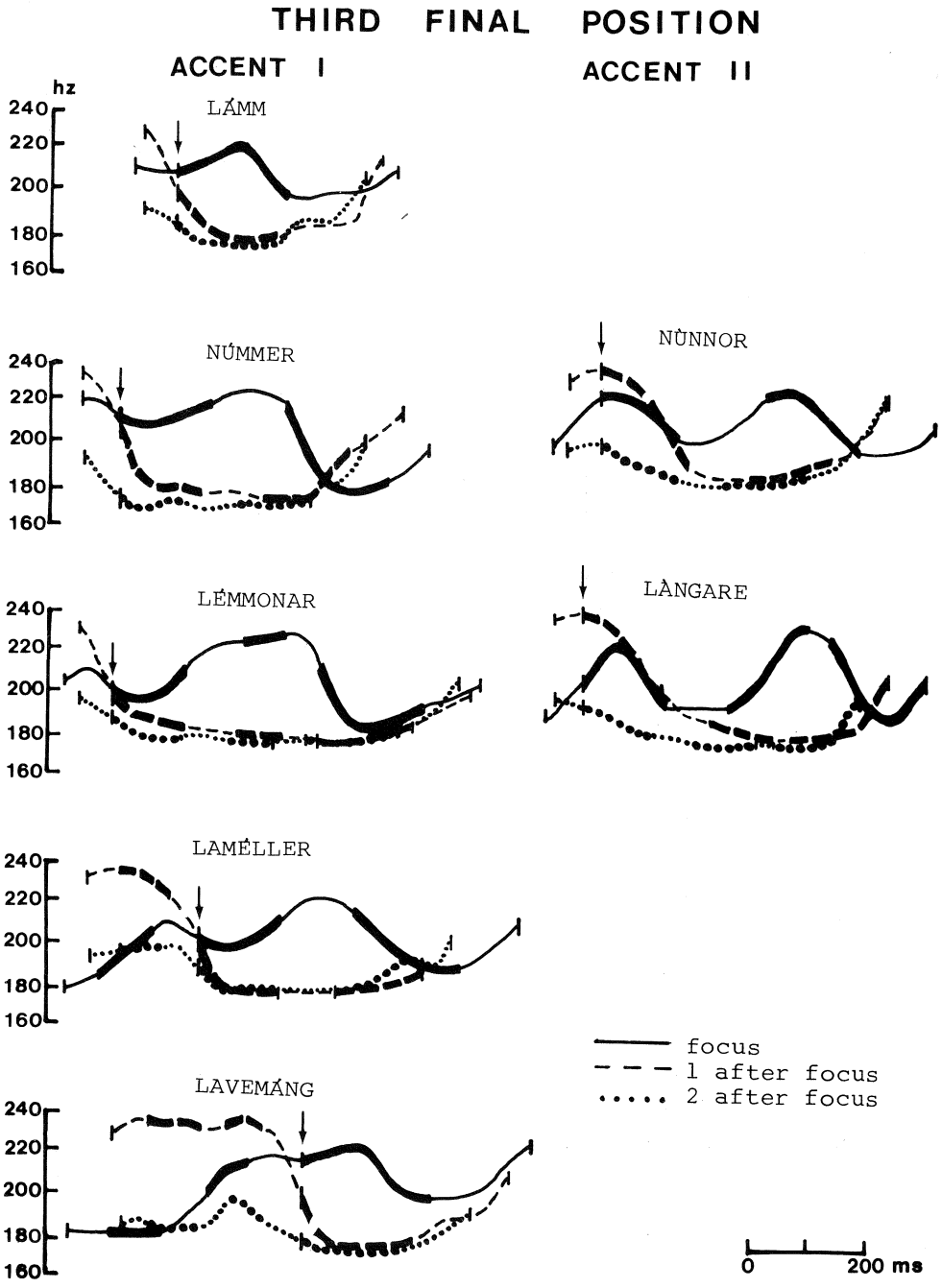


Figure 7. The effect of sentence accent. Fo-contours of accent I- and accent II-words in the third, final position. The line-up point is at the CV-boundary of the stressed syllable.

In figure 8 corresponding Fo-contours of compounds are illustrated. The sentences containing compounds have only two possible focus locations; either the verb or the compound receives the sentence accent. This means that the compound occurs either in or after focus. Like non-compound accent II-words compounds in focus have two Fo-peaks. These two Fo-peaks in a compound with sentence accent are, however, often well separated. The first peak appears in the first stressed syllable and the second peak in connection with the secondary-stress syllable, the separation between them being dependent on the number of unstressed syllables between the two stressed syllables. When the compound occurs after focus (i.e. without sentence accent), only the first Fo-peak is present, as for a non-compound accent II-word. After focus the Fo-rise in the secondary-stress syllable and the terminal Fo-fall in the final syllable in focus are replaced by a low Fo-level.

From what has been shown above it can be concluded that the Fo-rise in connection with the last stressed syllable of a word in focus is the true Fo-manifestation of sentence accent. It is evident that it is the same tonal phenomenon that is found in both accent I- and accent II-words and compounds, although the timing of the Fo-rise varies.

3.1.3 Word accent

When the contributions of terminal juncture and sentence accent to the Fo-contour have been separated, it should be possible to detect the contribution of word accent more easily. It is assumed that the Fo-contour that is found, when an accented word occurs without sentence accent and terminal juncture in a sentence, represents word accent proper. Figure 9 compares Fo-contours of accent I- and accent II-words, when they occur without sentence accent in different but not unstressed positions (cf. figure 5).

It appears that the word accent distinction - as far as the Fo-contours are concerned - is retained even when the word has no sentence accent. The main difference is in the timing of the whole Fo-contour in connection with the stressed syllable. Both an accent I-word and an accent II-word, when they occur without sentence accent in a sentence, are characterized by the presence of an Fo-peak. For the accent I-word the peak occurs as early

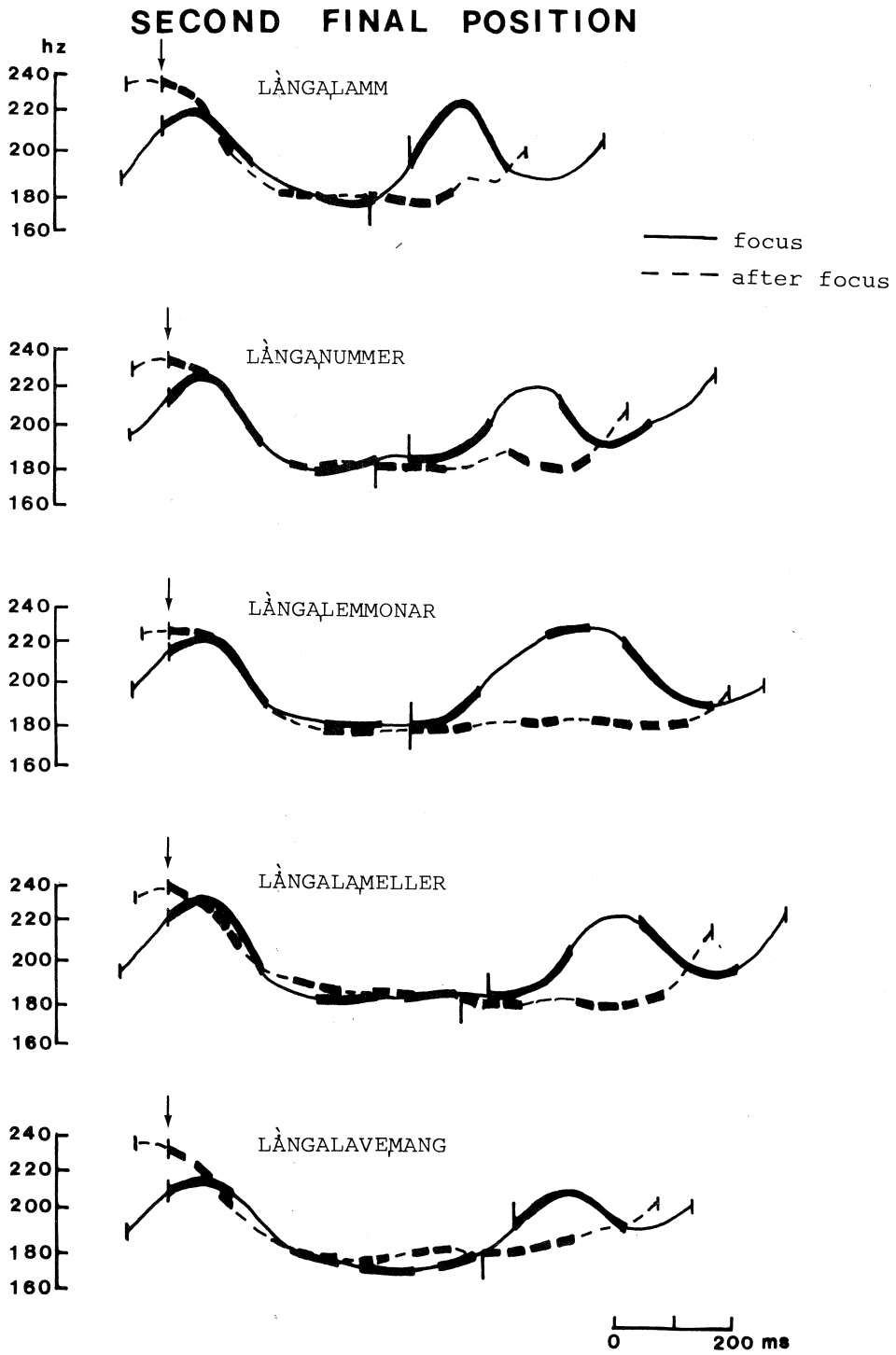


Figure 8. The effect of sentence accent. Fo-contours of compounds in the second, final position. The line-up point is at the CV-boundary of the primary-stress syllable and the vertical bar indicates the CV-boundary of the secondary-stress syllable.

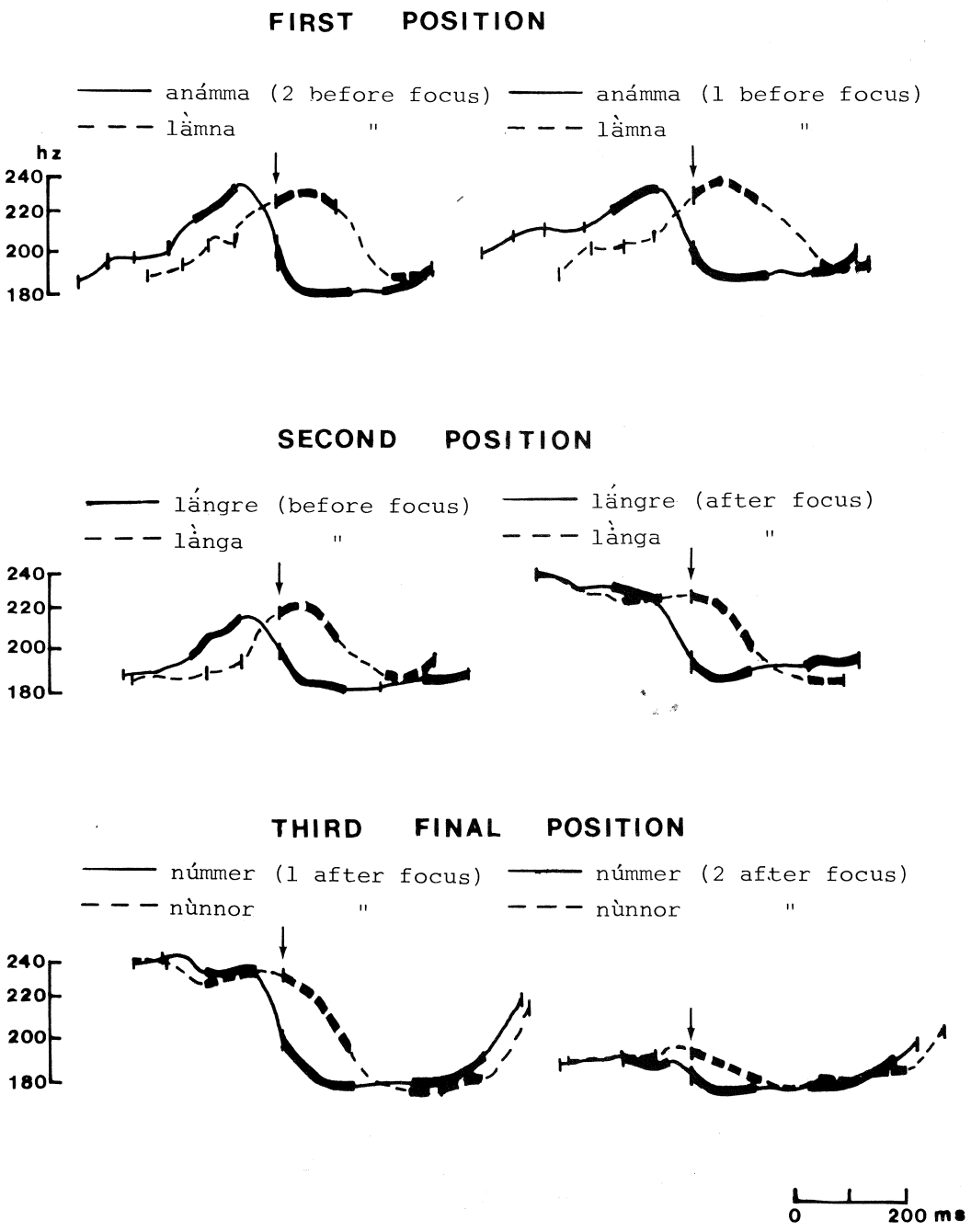


Figure 9. The word accent distinction in non-focal position. Fo-contours of accent I- and accent II-words in the first and second non-final and in the third final positions. The line-up point is at the CV-boundary of the stressed syllable.

as in the pre-stress syllable, even if this syllable belongs to a preceding word, while in the accent II-word the peak is located in the stressed syllable. This is a first indication that the prosodically relevant Fo-contributions do not necessarily relate to the domain of the word. In a position before focus the Fo-peak - in the stressed vowel of accent II and in the pre-stress vowel of accent I - is normally reached by a directly preceding rise, while in a position after focus the Fo-peak is the final part of a plateau and has no directly preceding rise (see also figure 5). The fall from the Fo-peak in the accent I-word occurs in the prevocalic consonant of the stressed syllable, whereas in the accent II-word the fall normally starts in the stressed vowel. The timing difference results in an Fo-minimum for accent I and an Fo-maximum for accent II in the stressed vowel, although the frequency range may vary considerably depending on position in the sentence, as is evident from figure 9 (see also figures 5 and 7).

Apart from the timing difference a difference in the gradient of the Fo-fall between accent I and accent II can also be detected. It appears from figure 9 that accent I has a somewhat steeper fall than accent II for the same position. Although there appear to be systematic Fo-differences between accent I and accent II in the non-focus positions, it cannot be taken for granted that these differences represent a perceptual, as well as an acoustic, reality (cf. Gårding 1967:69). This was tested in a perceptual experiment reported on in 7.1.

Summarizing the findings so far we have demonstrated that the Fo-contour of an accent I-word or an accent II-word (including compounds) in focus in utterance-final position is composed of contributions from different prosodic sources. It was possible to separate the word accent fall with an earlier timing for accent I than for accent II in connection with the stressed syllable, the subsequent sentence accent rise also with a different timing for accent I and accent II and for compounds, and the terminal juncture fall in the final syllable. These Fo-contributions are illustrated in the following schematized figure.

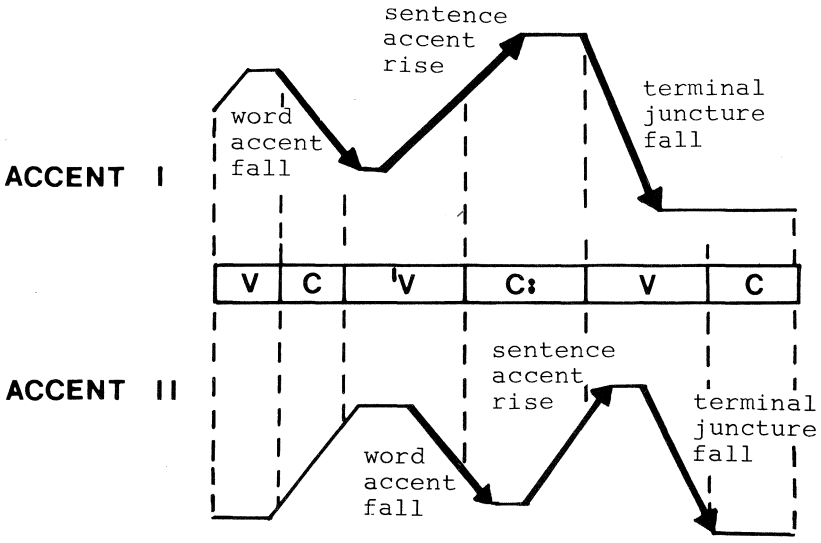


Figure 10. The Fo-contributions of word accent, sentence accent and terminal juncture. Schematized contours of one accent I- and one accent II-word. The arrows, drawn in thick lines, indicate word accent fall, sentence accent rise and terminal juncture fall.

3.2 Two-word phrases and compounds

In this section the discussion will be extended to encompass also certain phrases. Primarily the Fo-contributions in phrases consisting of an accent II-word followed by an accent I-word compared to those in corresponding compounds will be dealt with.

Alstermark & Eriksson (1971) tried to synthesize Fo-contours of compounds by using the first part of an accent II-word combined with the whole Fo-contour of an accent I-word (figure 11). The result of this synthesis procedure was that the synthesized Fo-contour matched fairly closely the actual Fo-contour of the compound. Therefore they interpreted the Fo-contour of a compound as a combination of one accent II-part and one accent I-part (see also Öhman 1965:14 and Lindau 1970:44). This would imply that a compound like <u>làmadjur</u> 'llamas' has the same Fo-contour as a two-word phrase like <u>làma djúr</u> 'paralyzed animals', which is at variance with the phonological interpretation proposed in 1.1.4.

However, an inspection of actual Fo-contours of both two-word phrases and compounds with the same composition in my study

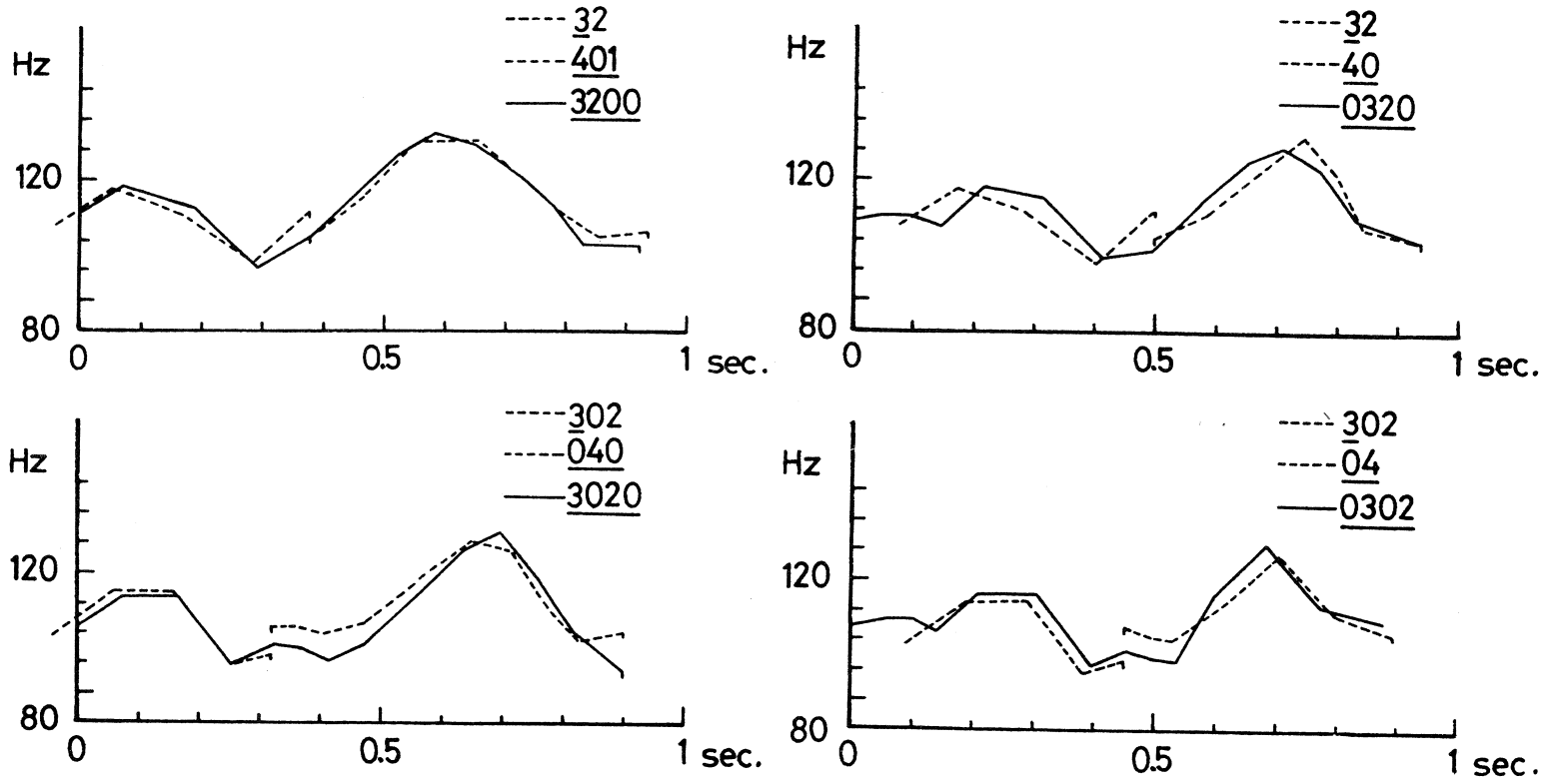


Figure 11. Synthesis of compound Fo patterns 3200, 3020, 0320, 0302 (from Alstermark & Eriksson 1971). 4 denotes main stress and accent I, 3 main stress and accent II, 2 secondary stress and 0 no stress.

indicates that there are systematic Fo-differences between these two types of construction. Figure 12 shows Fo-contours of compounds and two-word phrases with the last word in focus in final position. In the two-word phrases as well as in the compounds we recognize the word accent fall in the first stressed syllable (accent II), the sentence accent rise in the last stressed syllable and the terminal juncture fall in the final syllable. But the two-word phrase, as distinguished from the compound, has an additional Fo-contribution - an Fo-peak between the two other peaks. At first glance this peak may seem to belong to the Fo-contour of the accent II-word signalling sentence accent, as the peak is present in the second syllable of lànga in both lànga LÁMM, lànga NÚMMER and lànga LÉMMONAR. But a more thorough examination of the examples in figure 12 reveals that the peak occurs in the syllable preceding the stressed syllable with accent I, which is not always the second syllable of lànga. This makes the interpretation of this peak as deriving from accent I more plausible. In the preceding section it was demonstrated that the position for an accent I-peak is in fact the pre-stress syllable regardless of whether it is located in a preceding word or in the accent I-word. That the Fo-peak under discussion does not signal sentence accent but rather accent I, is further substantiated by the following circumstance: In two-word phrases consisting of two accent II-words like lànga NÙNNOR and lànga LÀNGARE or in phrases consisting of an accent I-word plus an accent II-word like lángre NÙNNOR and lángre LÀNGARE (figure 13) there appears to be no peak whatsoever in the unstressed syllables of lànga and lángre, which would have been expected if the peak were actually signalling sentence accent.

Figure 14 compares Fo-contours of phrases consisting of an accent II-word plus and accent I-word, where either the first or the second word is in focus. The two Fo-contours of the "same" phrase turn out to be clearly distinct. In the Fo-contour of a phrase where the first word is in focus, we recognize the word accent fall (accent II) in the first stressed syllable, the sentence accent rise always in the post-stress syllable of lànga in spite of some variation in its timing, and the word accent fall (accent I) from the pre-stress to the last stressed

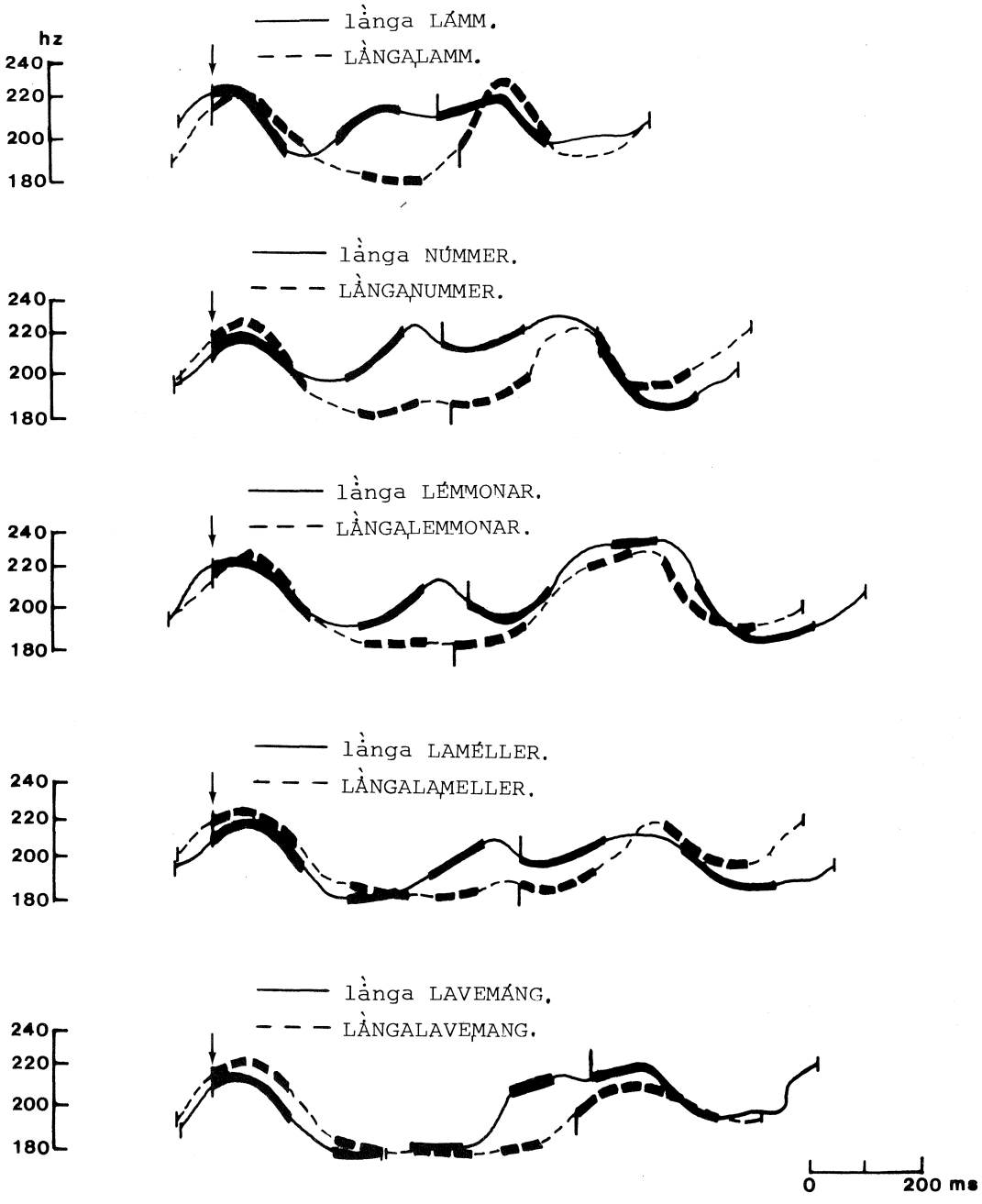


Figure 12. The effect of phrase structure. Fo-contours of two-word phrases consisting of an accent II-element followed by an accent I-element with the last word of the phrase in focus, and contours of corresponding compounds. The line-up point is at the CV-boundary of the first stressed syllable and the vertical bar indicates the CV-boundary of the second stressed syllable.

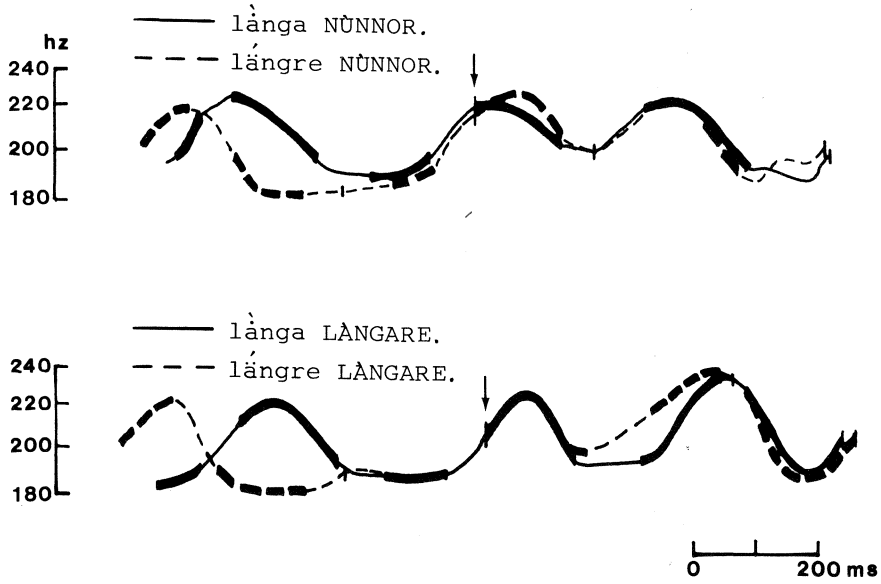


Figure 13. The effect of accent II in two-word phrases. Fo-contours of two-word phrases consisting either of an accent I-word or an accent II-word, followed by an accent II-word in focus. The line-up point is at the CV-boundary of the last stressed syllable.

syllable. Even when there is an Fo-peak in the same syllable in both contours of the same phrase, as in the second, unstressed syllable of lànga in, for example, the phrase lànga númmer, these peaks do not coincide (figure 14). More important than the specific shape of this Fo-peak is probably the overall Fo-contour of the phrase. When, for example, the peak in the second syllable of lànga is followed by no other peak in númmer, this signals unambiguously that the first word in the phrase is in focus. When instead there is another peak present in númmer, the second word in the same phrase will be attributed focus.

The Fo-contours of compounds are distinct from those of two-word phrases also when no sentence accent is involved (figure 15). In post-focal position, when the sentence accent is on the preceding verb in the sentence, a compound like lànganummer is characterized merely by an Fo-fall from the stressed to the post-stress syllable typical of accent II-words. After that the same low Fo-level is maintained during the rest of the compound. A corresponding two-word phrase like lànga númmer also has an Fo-fall signalling accent II in connection with the stressed syllable of the first word. But the Fo-contour

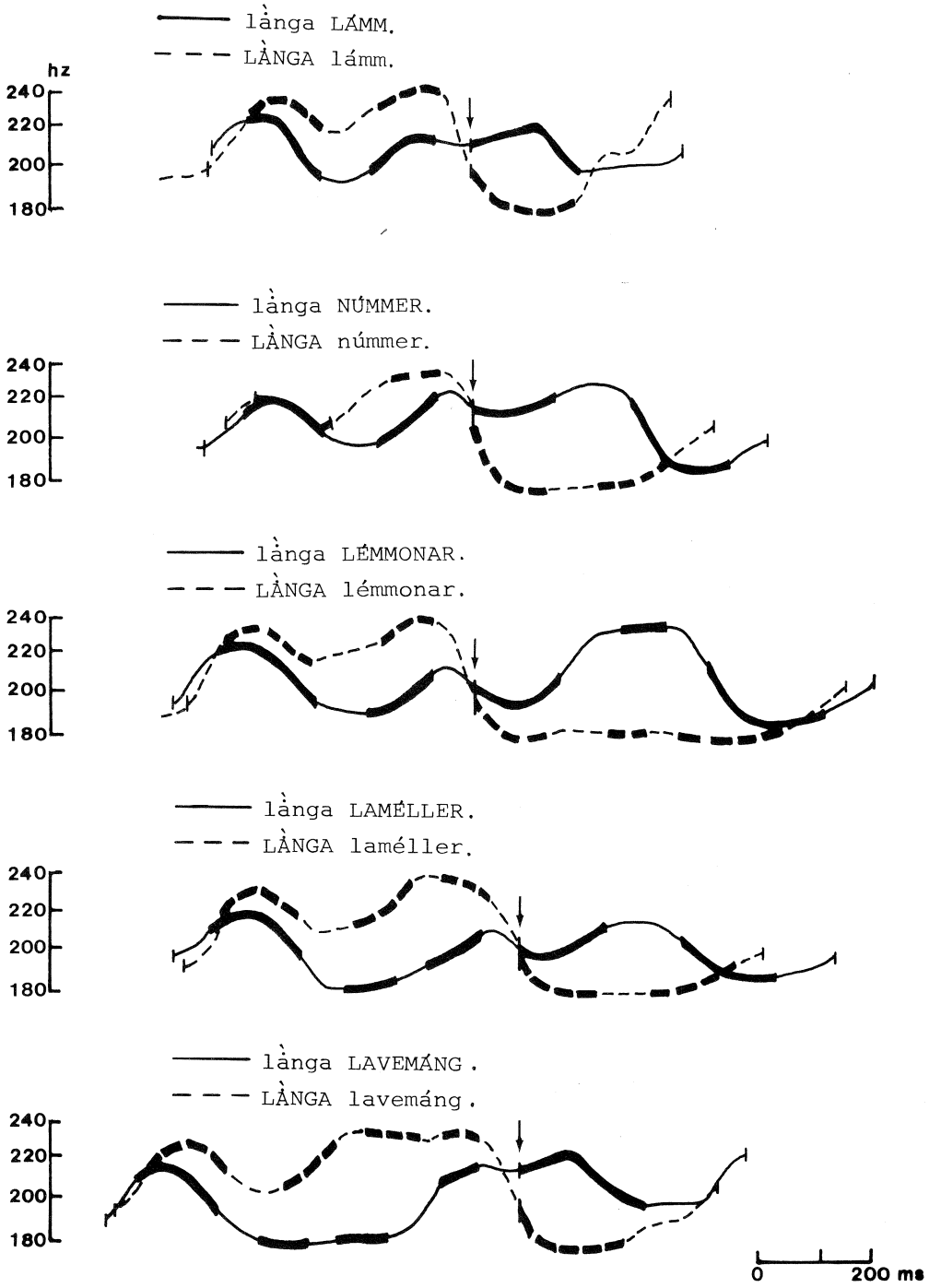


Figure 14. The effect of placement of sentence accent. Fo-contours of two-word phrases consisting of an accent II-word followed by an accent I-word with either the first or the last word of the phrase in focus. The line-up point is at the CV-boundary of the last stressed syllable.

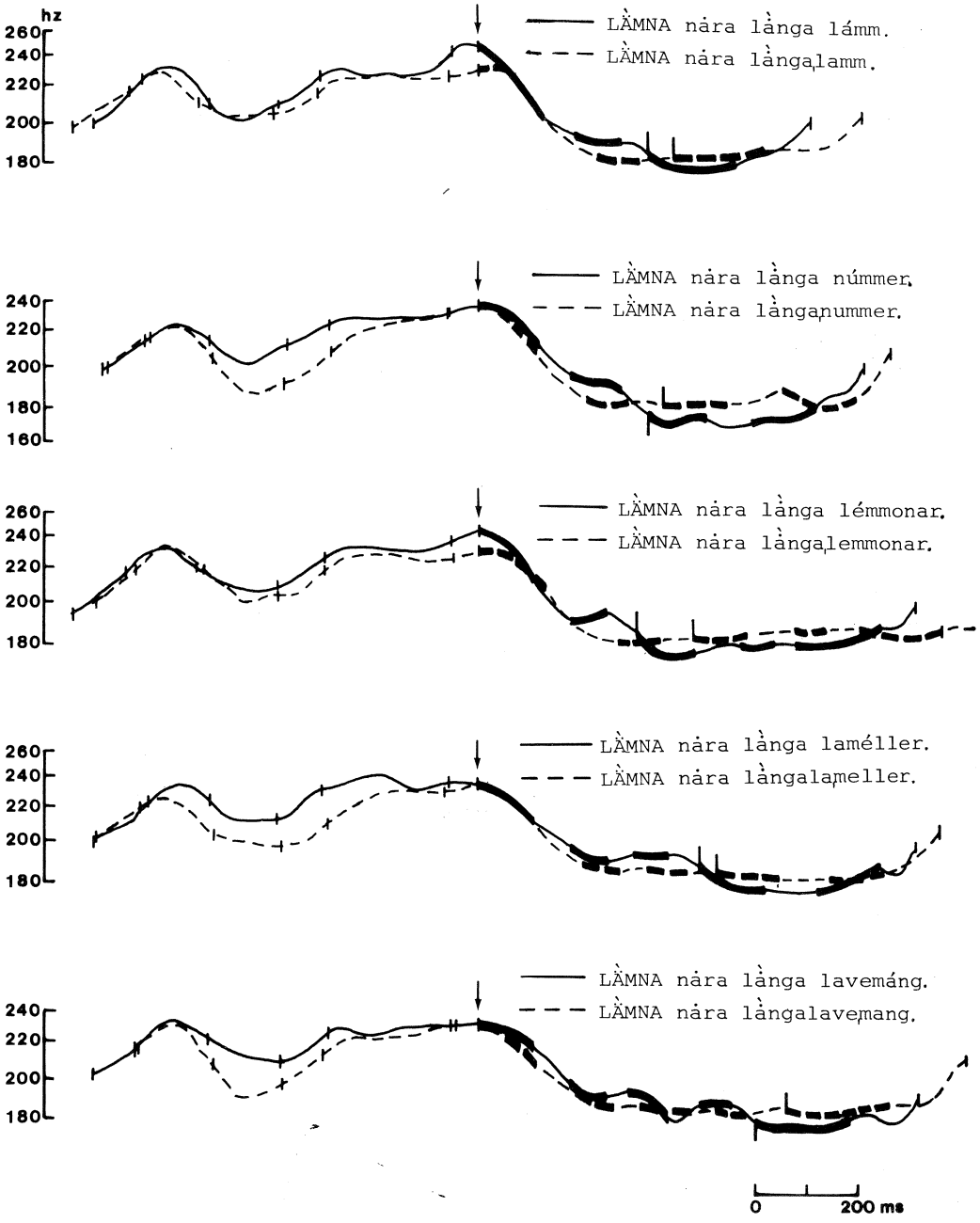


Figure 15. The effect of phrase structure. Fo-contours of verb phrases containing a two-word phrase consisting of an accent II-element followed by an accent I-element, or a corresponding compound, with the verb in focus. The line-up point is at the CV-boundary of the stressed syllable in the second position and the vertical bar indicates the CV-boundary of the last stressed syllable.

of the two-word phrase contains an additional Fo-modification in connection with the stressed syllable of the second word. The Fo-fall from the pre-stress to the last stressed syllable - in spite of the very narrow frequency range - signals accent I and consequently two words.

It has been demonstrated in this section that the Fo-contour of a two-word phrase consisting of an accent II-element plus an accent I-element is clearly distinguished from the Fo-contour of a corresponding compound with accent II. The distinguishing factor is an Fo-peak in the syllable preceding the last stressed syllable signalling accent I and two words. Although this peak can therefore be said to have a constructive function, it does not mark the exact location of a word boundary. The possibility of signalling two words - instead of one word - by the introduction of an Fo-peak between two other Fo-peaks in constructions of the type discussed above was investigated in a perceptual experiment, which will be reported on in 7.2.

3.3 Extended domain of focus

So far we have been considering Fo-contours of sentences, where only one word is in focus. The possibility of having two words or even a whole phrase in focus was discussed in section 1.3.2. It was proposed that when the sentence accent in a sentence like Man vill lämna nära länga nùnnor is placed on the last word, nùnnor, either only the noun nùnnor alone, the noun phrase länga nùnnor, or the whole verb phrase lämna nära länga nùnnor is in focus, conveying new information. Some test sentences were included in the speech material in order to determine, whether the Fo-contours of the same sentence turn out to be the same, when the noun, the noun phrase, or the verb phrase is elicited as the focus of the sentence.

Figure 16 shows Fo-tracings of two verb-phrases, one with only accent I-words and another with accent II-words in the three possible focus positions. There are three Fo-versions representing responses to different contexts, which elicit utterances with either the noun, the noun phrase, or the verb phrase as the focus. It appears from a superficial inspection of the Fo-contours that there are striking similarities between the three Fo-versions of the same sentence. For words in the

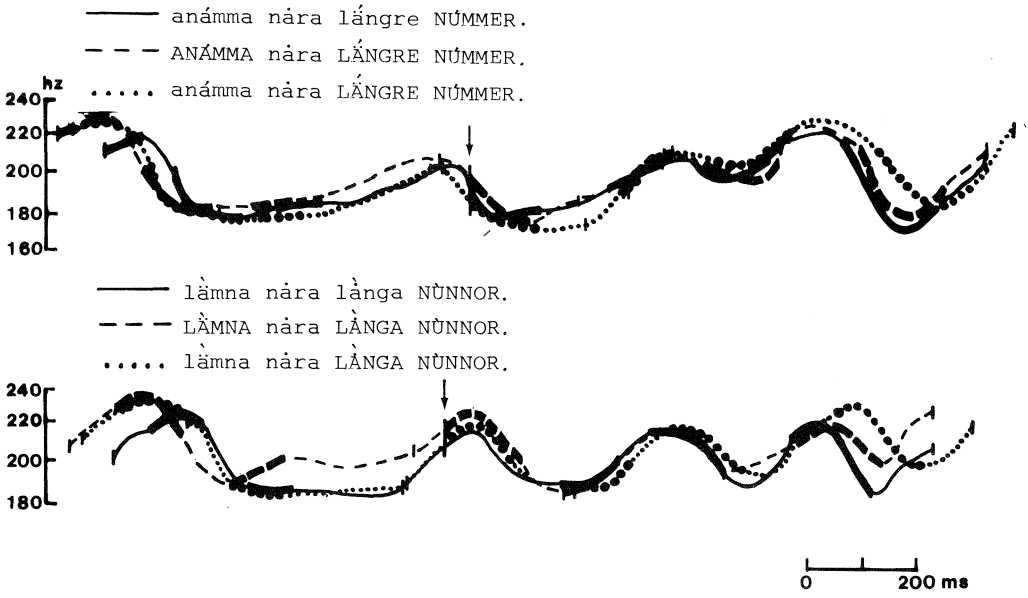


Figure 16. The effect of the domain of focus. Fo-contours of verb phrases, one with accent I-words and another with accent II-words. Either the noun, the noun phrase or the verb phrase is in focus. The line-up point is at the CV-boundary of the stressed syllable in the second position.

first and second position of the sentence we can detect only the Fo-contribution of word accent - either accent I or accent II - in all three versions, while in the third position there are also the contributions of sentence accent and terminal juncture. We can conclude that the prosodic features seem to be manifested in the same way in the Fo-contour of a sentence regardless of whether the noun alone, the noun phrase, or the entire verb phrase is in focus, i.e. sentence accent will be attributed to the last possible item.

Finally it should be noted that in final position the Fo-contour of an utterance normally ends with a rise (see figures in chapter 3), which can vary considerably in frequency range. The exact prosodic status of this terminal rise is unclear. It is conjectured, however, that it might express the speaker's positive attitude to the listener (cf. Hadding-Koch 1961:119ff, Bolinger 1964:292). Compare also the "non-prominence lending rise" in Dutch ('t Hart & Cohen 1973:314).

4 THE BASIC Fo-CONTOURS

Having isolated the separate contributions of terminal juncture, sentence accent and word accent to the Fo-contour, we are now ready to study them in more detail. In the first section of the present chapter the concept of 'basic contour' is defined, and in the three following sections the basic contours for each of the prosodic features word accent (accent I and accent II), sentence accent, and terminal juncture are described.

4.1 Basic contour

A fundamental assumption underlying my analysis of the Fo-contours is that each of the tonal features, accent I, accent II, sentence accent and terminal juncture has a basic Fo-contour. This basic contour is to be found in a context where the tonal command representing a particular tonal feature can be considered to be minimally influenced by other tonal commands, i.e. where it can be manifested in its full form. A tonal command corresponds to the neural program assumed to underlie each basic contour (cf. chapter 8). Thus the basic contours represent canonical Fo-forms. Each basic contour contains one Fo-minimum target and one Fo-maximum target connected by an Fo-rise or fall. The normal interaction of tonal commands often results in adjustments of the basic contours, which will be described in chapter 5. The Fo-maximum and Fo-minimum target values and the timing values for each basic contour will serve as reference points for the discussion of this interplay of the basic contours.

4.2 Basic word accent

The basic contour for accent I and accent II is to be looked for in a context, where the test word has no sentence accent and no terminal juncture, i.e. in non-focal position. Fo-contours of accent I- and accent II-words in this position were illustrated in figure 9. The difference between accent I and accent II manifests itself mainly as a difference in the timing of the Fo-contour - particularly the Fo-fall - in connection with the stressed syllable (3.1.3). From the Fo-tracings in figure 9, roughly three distinct non-focal word accent contours can be distinguished: 1) a pre-focal contour with a preceding rise and a relatively wide range of the word accent fall, 2) a first post-

focal contour (1 after focus) with a preceding Fo-plateau and a wide range of the fall, and 3) a second post-focal contour (2 after focus), also with a preceding plateau but with a very narrow range. It can be argued that for the first post-focal contour there is an influence from the preceding sentence accent command on the word accent command (cf. 5.2.3), while for the second post-focal word accent contour there is an influence of the two adjacent word accent commands on one another (cf. 5.3.2). The pre-focal contour, on the other hand, does not show any apparent influence from other tonal commands, provided there is no other directly adjacent word accent command (cf.5.3.1). Both the first (1 before focus) and the second (2 before focus) pre-focal contours have the same overall shape with no indication of any interaction among them. The prefocal contour has therefore been chosen as the basic contour for word accent, i.e. for both accent I and accent II.

4.2.1 Timing of word accent fall

Timing values for the starting-point and the end-point of the word accent fall for one accent I-word and one accent II-word in pre-focal position are included in table I. For accent I the timing of the starting-point of the fall varies very little between positions. The starting-point is located at or shortly after the boundary between the pre-stress and the stressed syllable, i.e. in the beginning of the consonant preceding the stressed vowel. The starting-point of the fall for accent II, which is located in the stressed vowel, varies more. In the first position (1 or 2 before focus) the fall starts towards the end of the stressed vowel, while in the second position the starting-point is in a central part of the vowel.

The end-point of the fall for accent I - like the starting-point - shows little variation for different positions. It is located in the initial part of the stressed vowel. This means that the fall for an accent I-word is executed mainly in the consonant preceding the stressed vowel. For accent II the end-point of the fall shows a variation similar to that of the starting-point. In the first position the fall is completed right at the CV-boundary of the post-stress syllable, while in the second position the end-point of the fall occurs in the middle of the consonant following the stressed vowel. Thus in

Table I. Timing of the word accent fall for accent I (A I) and accent II (A II) in non-focal positions. Values for the starting-point and end-point, in ms relative to the CV-boundary of the stressed syllable, and in % of the duration of the relevant segment (prevocalic C, stressed 'V or postvocalic C:), and values of the duration of the fall in ms. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n). Approximate values of the gradient of the fall are given in hz/100 ms.

	STARTING-POINT OF FALL					END-POINT OF FALL					DURATION			GRADIENT
	ms			%		ms			%		ms			hz/100 ms
1st position 2 before focus	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	
A I aṇámma	-48	6,5	28	18/C	11,8	38	16,9	27	30/'V	13,6	86	16,1	27	49
A II lämna	88	31,4	23	81/'V	31,0	198	18,8	26	101/C:	17,6	110	35,6	23	34
1 before focus														
A I aṇámma	-43	9,0	20	23/C	14,0	39	13,3	18	29/'V	10,5	81	13,9	19	54
A II lämna	82	27,9	19	75/'V	26,0	206	29,0	20	87/C:	25,6	124	32,2	18	28
2nd position 1 before focus														
A I lą́ngre	-51	15,8	24	19/C	26,9	28	24,9	23	26/'V	19,8	82	25,6	23	35
A II lànga	64	12,8	27	51/'V	10,3	163	28,9	26	43/C:	29,7	100	26,5	27	29
1 after focus														
A I lą́ngre	-55	20,4	17	-3/C	43,4	28	18,0	19	25/'V	18,6	80	22,9	17	60
A II lànga	43	18,7	20	39/'V	17,3	176	20,0	19	92/C:	30,4	134	28,1	20	32
3rd position 1 after focus														
A I nú̇mmer	-64	26,3	20	-16/C	57,9	45	20,4	20	34/'V	14,7	109	27,7	20	55
A II nùnnor	24	31,8	19	19/'V	25,0	167	25,2	19	36/C:	30,2	146	43,3	19	40
2 after focus														
A I nú̇mmer	-46	30,4	17	16/C	65,6	24	28,2	18	22/'V	26,2	72	36,8	15	21
A II nùnnor	23	32,9	18	23/'V	26,0	154	25,4	16	39/C:	35,0	127	21,3	16	11

the first position, the fall for accent II is realized almost entirely in the consonant segment between the stressed and the post-stress vowel, while in the second position the fall is executed partly in the stressed vowel and partly in the following consonant.

A comparison of the mean values of the starting-point on the one hand and of the end-point of the fall on the other for accent I and accent II (table I), shows that the timing difference between accent I and accent II is greater for the end-point than for the starting-point of the fall. Consequently the duration of the fall is longer for accent II than for accent I as can be seen from the calculated values for the duration of the fall (table I). As the frequency range of the fall appears to be approximately the same for the two word accents in each position (cf. table II), this means that the gradient of the word accent fall is steeper for accent I than for accent II for the same position (cf. table I).

4.2.2 Word accent maxima and minima

In table II are presented values (in hz) for the word accent maximum (before the word accent fall) and word accent minimum (after the fall) of accent I- and accent II-words in pre-focal positions. For accent I the Fo-maximum occurs in the pre-stress vowel and for accent II in the stressed vowel. A comparison of the Fo-maximum values for accent I and accent II in the same position (table II) shows generally small, negligible differences. Therefore the Fo-maximum target for accent I and accent II can be regarded as the same for a given position.

For an accent I-word the Fo-minimum is located in the stressed vowel and for an accent II-word in the post-stress vowel. A comparison between accent I and accent II for the same position reveals that the difference in Fo-minimum is negligible in all cases but the second position, which will be commented on in section 5.3.1. It is assumed that the Fo-minimum target is the same for both word accents.

The word accent maxima as well as the word accent minima - apart from the accent II-minima in the second position (cf. 5.3.1) - tend to be somewhat higher in the first than in the second position, before focus (cf. table II and figure 5).

Table II. Word accent maxima and minima for accent I (A I) and accent II (A II) in non-focal positions. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n) in hz.

NON-COMPOUND WORDS	WORD ACCENT MAXIMUM						WORD ACCENT MINIMUM					
	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n
1st position	2 before focus			1 before focus			2 before focus			1 before focus		
A I aṇámma (set A)	227	5,7	28	229	7,8	20	185	3,6	28	185	4,4	20
A II läṃna (set A)	225	5,3	26	224	4,9	20	188	2,9	26	189	3,6	20
" läṃna (set B)	228	9,2	50	233	6,0	50	185	3,6	50	187	2,5	50
2nd position	1 before focus			1 after focus			1 before focus			1 after focus		
A I lángre (set A)	212	9,3	27	237	6,3	20	183	4,2	27	189	2,2	20
" lángre (set B)	215	5,6	25	242	6,1	25	181	3,9	25	190	3,7	25
A II lànga (set A)	220	5,5	27	233	4,4	20	191	3,9	27	190	3,6	20
" lànga (set B)	218	6,1	25	238	5,6	25	185	5,1	25	191	4,3	25
3rd position	1 after focus			2 after focus			1 after focus			2 after focus		
A I lámm	242	5,4	10	190	4,7	10	181	3,7	10	173	2,6	10
" núṃmer	239	5,5	20	192	4,0	20	179	4,0	20	177	3,7	20
" lémmonar	244	7,1	10	194	3,4	10	181	1,6	10	177	2,6	10
" laméller	239	3,9	10	191	3,9	10	178	2,6	10	177	3,4	10
" lavemáng	243	7,9	10	191	3,9	9	179	2,4	10	177	3,4	10
A II nùnnor	239	7,6	20	192	2,9	20	180	4,0	20	178	2,9	20
" làngare	241	5,2	10	193	3,5	10	179	2,4	10	174	4,1	10
COMPOUND WORDS												
2nd position	1 after focus						1 after focus					
A II làṇgaḷamm	237	2,7	5				183	2,7	5			
" làṇgaṇummer	233	5,7	5				182	2,7	5			
" làṇgaḷemmonar	234	4,2	5				182	2,7	5			
" làṇgaḷaṃeller	237	2,7	5				182	2,7	5			
" làṇgalaveṃang	237	7,6	5				182	2,7	5			
" làṇgaṇunnor	237	5,7	5				183	2,7	5			

This is taken as a sign of a slight down-drift in frequency of the overall contour of the utterance. This means that the word accent maximum and minimum target values are somewhat higher in an early position of the utterance than in a later position. A comparison of the mean word accent maximum and minimum values in table II, for the same word accent and position, gives the approximate values for the frequency range of the word accent fall. The frequency range in pre-focal positions varies between approximately 30 and 45 hz.

In summary, the basic accent I-contour is characterized by a fall from an Fo-maximum in the pre-stress vowel to an Fo-minimum in the stressed vowel, while the basic accent II-contour contains a fall from an Fo-maximum in the stressed vowel to an Fo-minimum in the post-stress vowel. The fall appears to be somewhat steeper for accent I than for accent II. For both word accents the fall is preceded by a rise from the vowel preceding the pre-stress and the stressed vowel respectively. The Fo-maximum as well as the Fo-minimum target are assumed to be the same for accent I and accent II. The main characteristics of the two basic contours for word accent are illustrated in the following schematized figure (figure 17).

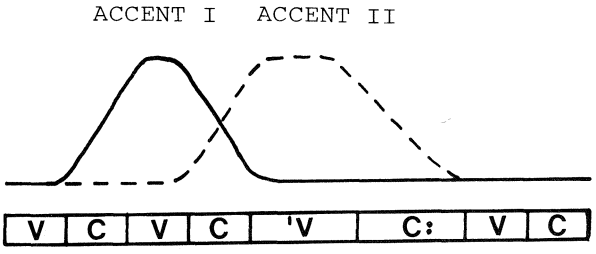


Figure 17. The basic contours of the two word accents. Schematized Fo-contours of accent I (unbroken line) and accent II (broken line) in pre-focal position.

4.3 Basic sentence accent

Finding a context for sentence accent where the influence from other tonal commands can be assumed to be minimal is not as easy as it is for word accent. Word accent can occur alone in a word, whereas sentence accent is necessarily tied to the preceding word accent in the same word. The possible influence from a following word accent or from the terminal juncture is more

easily controlled by choosing a non-final position, where the following word accent does not occur immediately after the sentence accent. There exists, however, one context where the sentence accent can be optimally separated from the preceding word accent, namely in compounds (cf. 1.1.3).

In figures 6 and 7 we can observe that the word accent fall in a non-compound word does not reach the same low Fo-minimum immediately before the sentence accent rise as when there is no such rise in non-focal position. It is apparent from figure 8 that for compounds, there is no corresponding difference between focal and non-focal position for the Fo-minima after the word accent fall; here the sentence accent rise is well separated in time from the word accent fall. This suggests that there is no influence between the word accent and the sentence accent commands in compounds, while in non-compound accent I- and accent II-words this seems to be the case (cf. 5.2). Hence, the sentence accent rise in compounds is the basic contour for sentence accent.

4.3.1 Timing of sentence accent rise

Fo-contours of compounds with sentence accent in non-final position are presented in figure 4. Timing values, for the starting-point and the end-point of the sentence accent rise in non-final positions, are given in table III. The sentence accent rise in compounds (accent II) usually starts in the second half of the last stressed vowel, i.e. the secondary-stress vowel. The timing of the end-point of the sentence accent rise shows a greater variation. But the end-point normally occurs in the post-stress vowel of the secondary-stress syllable and only occasionally in the consonant segment between the secondary-stress and the post-stress vowel. Consequently the main part of the sentence accent rise in non-final position is realized in this consonant segment.

The exact starting-point or end-point of the sentence accent rise is not always easily definable; this is true also for the corresponding turning-points for word accent and terminal juncture. The rise may start or level off slowly, so that there is no pronounced turning-point. I have excluded the most problematic cases from the calculations, but some uncertain values are probably still included. The difficulties in defining the exact location of the starting-points and end-points are reflected to

Table III. Timing of the sentence accent rise for accent I (A I) and accent II (A II) in non-final positions. Values for the starting-point and the end-point of the rise, in ms relative to the CV-boundary of the stressed syllable (starting-point) and the post-stress syllable (end-point) and in % of the duration of the relevant segment (stressed 'V or ˌV, post-vocalic C: or post-stress V). Values for the duration of the rise are given in ms. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n).

	STARTING-POINT OF RISE					END-POINT OF RISE					DURATION OF RISE		
NON-COMPOUND WORDS	ms			%		ms			%		ms		
1st position	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n
A I anámma (set A)	93	28,2	13	64/'V	18,8	-52	21,7	19	48/C:	22,3	106	23,4	15
A II lȁmna (set A)	212	34,8	19	64/C:	27,9	108	32,3	17	122/V	30,4	150	48,7	17
" lämna (set B)	233	29,2	44	82/C:	27,1	120	35,6	44	141/V	37,6	149	53,1	43
2nd position													
A I lą́ngre (set A)	48	20,7	16	40/'V	16,6	-107	34,2	15	18/C:	16,9	97	29,8	15
" lą̈ngre (set B)	54	23,3	24	40/'V	17,0	-77	52,1	23	44/C:	26,4	142	38,0	22
A II lȁnga (set A)	165	31,1	17	40/C:	27,3	80	26,1	20	85/V	25,4	141	25,9	16
" lȁnga (set B)	189	30,6	25	55/C:	30,3	94	42,6	23	96/V	43,2	140	32,3	24
3rd position													
A I lámm	76	11,1	4	48/'V	6,2	-43	50,6	4	65/C:	41,6	160	52,1	4
" nú̇mmer	56	28,4	4	43/'V	19,3	-55	40,2	4	58/C:	31,2	144	40,7	4
" lémmonar	93	23,6	5	70/'V	18,9	-49	19,3	4	58/C:	16,4	115	28,6	4
" laméller	75	21,8	5	58/'V	16,4	-25	15,4	5	75/C:	14,7	138	28,0	5
" lavemáng	81	26,6	4	53/'V	12,3	-81	22,7	5	45/C:	16,0	134	36,1	5
A II nùnnor	204	39,0	5	42/C:	33,9	121	30,0	5	166/V	49,8	160	37,4	5
" làngare	265	32,2	5	134/C:	31,4	200	34,5	5	170/V	36,6	167	63,1	5
COMPOUND WORDS													
2nd position													
A II lànga‿lamm	71	26,6	5	53/ˌV	18,8	22	64,6	5	124/C:	64,2	180	49,0	5
" lànga‿nummer	76	8,5	4	64/ˌV	5,7	13	38,8	4	117/C:	39,8	138	36,9	5
" lànga‿lemmonar	86	10,3	4	67/ˌV	7,5	63	60,0	4	156/C:	60,1	163	81,5	4
" lànga‿laméller	81	14,7	5	69/ˌV	9,7	51	62,8	4	164/C:	73,3	170	67,0	4
" lànga‿lavemang	74	42,3	5	53/ˌV	28,2	-45	24,2	5	65/C:	15,6	131	53,2	5

Table IV. Word accent maxima, word accent minima (= sentence accent minima) and sentence accent maxima for accent I (A I) and accent II (A II) in non-final positions. Means ($\bar{x}$) and standard deviations (s) in hz of the indicated number of repetitions (n).

NON-COMPOUND WORDS	WORD ACCENT MAXIMUM			WORD ACCENT MINIMUM			SENTENCE ACCENT MAXIMUM		
1st position	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n
A I aṇámma (set A)	222	4,7	20	206	3,9	20	235	3,8	20
A II lạ̈mna (set A)	231	4,2	20	206	5,6	20	238	5,3	20
" lämna (set B)	236	5,5	50	206	7,5	50	240	6,2	50
2nd position									
A I lạ́ngre (set A)	213	8,4	15	210	5,0	15	238	7,0	20
" lạ̈ngre (set B)	214	7,9	25	207	5,4	25	244	7,1	25
A II lạ̀nga (set A)	225	8,3	20	210	5,3	20	240	6,1	20
" lànga (set B)	230	4,8	25	210	6,0	25	239	4,3	25
3rd position									
A I lámm	222	8,4	5	192	5,7	5	241	6,5	5
" númmer	220	5,0	5	197	2,7	5	238	6,7	5
" lémmonar	211	6,5	5	196	4,2	5	235	5,0	5
" laméller	223	5,7	5	192	5,7	5	234	2,2	5
" lavemáng	226	6,5	5	194	4,2	5	236	4,2	5
A II nùnnor	230	7,1	5	193	6,7	5	237	2,7	5
" làngare	225	7,1	5	194	4,2	5	243	8,4	5
COMPOUND WORDS									
2nd position									
A II làngaṛamm	223	6,7	5	179	2,2	5	234	9,6	5
" làngaṇummer	226	8,2	5	183	2,7	5	232	4,5	5
" làngaḷemmonar	229	8,9	5	180	0,0	5	229	5,5	5
" làngalạ̈meller	232	6,7	5	181	2,2	5	231	2,2	5
" làngalavẹmang	224	8,2	5	181	2,2	5	232	9,1	5

some extent in the relatively high standard deviation values for the timing of these turning-points (cf. tables I, III and V). (They are high in relation to the standard deviations of the Fo-maximum and Fo-minimum values (cf. tables II, IV and VI).) But there is also a great deal of actual variation in the timing of the starting-points and end-points. This may mean that the timing of the starting-point or the end-point of an Fo-change (rise or fall) is critical only within a certain time range, indicated by the standard deviation values.

4.3.2 Sentence accent minima and maxima

Values for the sentence accent minimum (before the rise) and the sentence accent maximum (after the rise) are given in table IV. The sentence accent minimum is identical to the word accent minimum for the same word in focus. The sentence accent minima in compounds, which ideally represent the Fo-minimum target for sentence accent, appear to have approximately the same values as the prefocal word accent minima in the corresponding second position (cf. table IV). It is notable also that the values for the sentence accent minimum in final position (table VI) and the word accent minimum in compounds after focus (table II) are equivalent. The sentence accent maxima for compounds in non-final position, representing the Fo-maximum target for sentence accent, have somewhat higher values than the corresponding "basic" word accent maxima (cf. table II). Therefore also the range of the sentence accent rise (50-55 hz) is wider than the range of the word accent fall.

The main characteristics of the basic contour for sentence accent may be summarized as a rise from an Fo-minimum in the last stressed vowel (the secondary-stress vowel) to an Fo-maximum in the post-stress vowel. This is illustrated in the following schematized figure (figure 18).

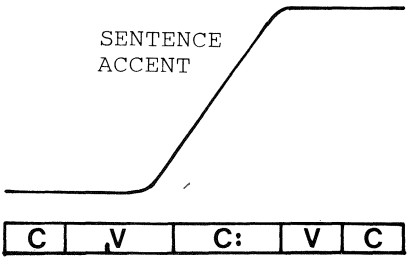


Figure 18. The basic contour of sentence accent. Schematized Fo-contour of sentence accent in the secondary-stress syllable of a compound in non-final position.

4.4 Basic terminal juncture

Terminal juncture is necessarily associated with the final syllable of an utterance. The basic contour of terminal juncture is to be found when it is not immediately preceded by the sentence accent and the word accent commands. This occurs most apparently in an accent I-word or a compound, where the stress - main stress and secondary stress, respectively - is on the antepenult (or earlier), i.e. where the stressed and the final syllable are separated by one syllable (see lémmonar and lànga,lemmonar in figures 3 and 4, respectively). For these words the terminal juncture means primarily the addition of an Fo-fall in the final syllable, while the rest of the Fo-contour of the word is practically the same as in non-final position (cf. figures 3 and 4). Also for the penult-stressed accent I-words and compounds, and for the antepenult-stressed accent II-word the influence of the sentence accent command on the terminal juncture command is assumed to be marginal.

4.4.1 Timing of terminal juncture fall

Table V presents values for the timing of the starting-point and the end-point of the terminal juncture fall relative to the last CV-boundary of the final word, and for the duration of the fall. The normal case is that the terminal juncture fall starts close to the CV-boundary of the final syllable. For the three non-oxytonic (= with no final stress) accent I-words the starting-point of the fall occurs in the consonant before the CV-boundary, at the same distance from this boundary. But as in the penult-stressed accent I-words (númmer and laméller) this consonant

Table V. Timing of the terminal juncture fall for accent I (A I) and accent II (A II). Values for the starting-point of the fall, in ms relative to the CV-boundary of the final syllable and in % of the duration of the relevant segment (prevocalic C or final V), and values for the duration of the fall in ms. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n).

NON-COMPOUND WORDS	STARTING-POINT OF FALL					END-POINT OF FALL					DURATION OF FALL		
	ms			%		ms			%		ms		
3rd position	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n
A I lámm	119	14,3	10	57/V	6,3	205	20,7	10	98/V	4,8	86	16,2	10
" númmer	-27	14,8	26	80/C	10,1	73	14,8	26	46/V	8,4	100	19,8	26
" lémmonar	-34	12,9	10	47/C	17,1	54	22,0	10	26/V	10,4	87	25,4	10
" laméller	-26	23,6	10	79/C	13,5	72	27,6	10	45/V	14,8	98	22,8	10
" lavemáng	114	19,6	10	52/V	7,1	223	44,7	10	102/V	18,1	110	29,1	10
A II nùnnor	79	12,5	27	51/V	8,6	162	31,4	27	105/V	20,6	80	31,0	27
" làngare	8	9,5	10	4/V	4,5	104	33,7	10	52/V	15,6	98	27,6	10
COMPOUND WORDS													
2nd position													
A II làngalamm	110	5,0	5	61/V	6,9	180	23,2	5	98/V	9,5	70	21,5	5
" lànganummer	3	26,8	5	2/V	17,3	103	24,9	5	71/V	13,2	100	12,5	5
" làngalemmonar	2	9,1	5	1/V	5,1	95	19,0	5	56/V	14,3	93	18,2	5
" làngalameller	-1	12,4	5	99/C	9,6	105	37,9	5	70/V	21,6	106	36,5	5
" làngalavemang	158	31,7	5	78/V	20,1	256	41,4	5	125/V	25,0	98	45,9	5

has a relatively long duration due to the stress, the fall starts in the final part of the consonant, whereas in the antepenult-stressed lémmonar, where the consonant belonging to an unstressed syllable has a relatively short duration, the starting-point is in the middle of the consonant. For the corresponding non-oxytonic compounds and also the trisyllabic accent II-word (làngare) the starting-point of the fall is approximately right at the CV-boundary. The end-point of the terminal juncture fall usually occurs in a central part of the final vowel with lémmonar at one extreme (at ca. 25 % of the vowel) and làngaṇummer and làngalaṃeller at the other (at ca. 70 %). There is no apparent variation in the duration of the fall for the actual words.

4.4.2 Terminal juncture maxima and minima

Table VI shows values (in hz) for the terminal juncture maximum (before the terminal fall) and terminal juncture minimum (after the fall). The terminal juncture maximum is identical to the sentence accent maximum in final position. For the non-oxytonic words the terminal juncture maximum values appear to be more or less the same. These Fo-maxima in final position - the terminal juncture maximum target - are found to be somewhat lower than the corresponding target values for sentence accent maximum in non-final position (cf.4.3.2). The terminal juncture minimum values for the non-oxytonic non-compound words appear to be somewhat lower than for the corresponding compound words. The terminal juncture minimum values in these non-compound words, representing the terminal juncture minimum target, turn out to be similar to the corresponding word accent minimum and sentence accent minimum target values (cf. 4.2.2 and 4.3.2). The frequency range for the terminal juncture fall is widest for the non-compound words (45 hz) and somewhat less wide for compounds (30-40 hz).

In summary, the main features characterizing the basic contour for terminal juncture is a fall from an Fo-maximum in the next to the last vowel to an Fo-minimum in a central part of the final vowel of an utterance. This is illustrated in the following schematized figure.

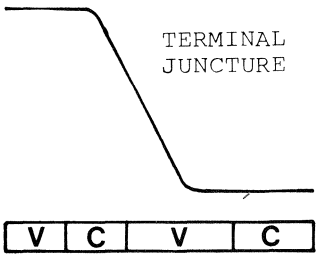


Figure 19. The basic contour of terminal juncture. Schematized Fo-contour of terminal juncture in the utterance-final syllable of a non-oxytonic word.

In my speech material it is possible to find an Fo-contour of a single word, in which all the three basic contours of word accent, sentence accent and terminal juncture are represented, namely of the compound làngaˌlemmonar (cf. figure 8). Here the word accent fall (accent II) in connection with the main stress syllable, the sentence accent rise in the secondary-stress syllable, and the terminal juncture fall in the final syllable are optimally separated from one another. Figure 20 summarizes in a schematized form the basic contours of word accent (accent II), sentence accent and terminal juncture combined in the Fo-contour of a compound word.

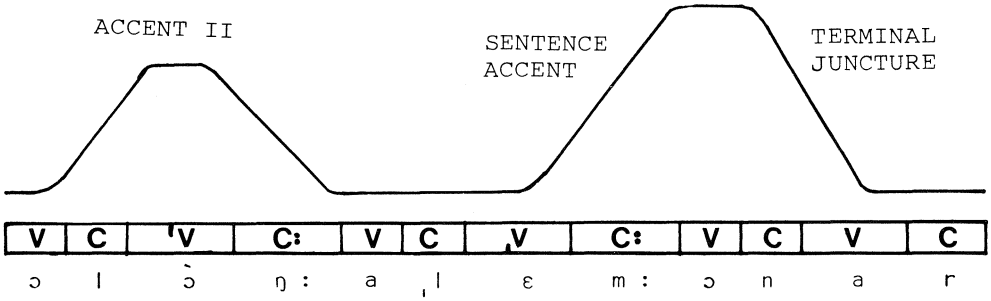


Figure 20. The basic contours of accent II, sentence accent and terminal juncture combined in a compound word. Schematized Fo-contour of the compound làngaˌlemmonar.

Table VI. Word accent maxima, word accent minima (= sentence accent minima), sentence accent maxima (= terminal juncture maxima) and terminal juncture minima for accent I (A I) and accent II (A II) in final position. Means ($\bar{x}$) and standard deviations (s) in hz of the indicated number of repetitions (n).

NON-COMPOUND WORDS	WORD ACCENT MAX.			WORD ACCENT MIN.			SENTENCE ACC. MAX.			TERMINAL JUNC. MIN.		
3rd position	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n
A I lámm	215	5,0	10	213	5,9	10	219	5,2	10	193	4,2	10
" númmer	216	4,5	27	205	5,3	27	229	4,9	27	182	3,7	26
" lémmonar	208	5,9	10	197	4,1	10	226	6,6	10	182	2,4	10
" laméller	212	5,3	10	201	6,0	10	227	8,2	10	184	3,2	10
" lavemáng	218	5,4	10	218	7,1	10	222	5,9	10	192	5,3	10
A II nùnnor	217	6,9	27	196	6,1	27	221	6,3	27	194	6,2	27
" làngare	215	9,7	10	193	3,4	10	224	7,8	10	187	3,5	10
COMPOUND WORDS												
2nd position												
A II làngaˌlamm	224	5,5	5	179	4,2	5	219	12,0	5	193	7,6	5
" làngaˌnummer	228	5,7	5	180	3,5	5	216	6,5	5	192	2,7	5
" làngaˌlemmonar	223	4,5	5	182	2,7	5	223	6,7	5	186	5,5	5
" làngalaˌmeller	228	6,7	5	181	2,2	5	223	5,7	5	192	2,7	5
" làngalaveˌmang	225	3,5	5	179	4,2	5	211	4,2	5	194	4,2	5
" làngaˌnunnor	225	9,4	5	180	3,5	5	222	4,5	5			

5 INTERPLAY OF THE BASIC CONTOURS

When a sequence of tonal commands is to be executed it is not to be expected that the Fo-consequences of these commands will be a mere juxtaposition of basic Fo-contours. Instead it is reasonable to assume that these commands like those involving other aspects of speech production and causing coarticulation will influence each other more or less. This means that certain context-dependent adjustments of the basic contours take place. These adjustments involve a displacement in the time and/or frequency domain of Fo-maximum and Fo-minimum targets. More specifically the "basic" falls and rises that have been described may be anticipated, delayed, compressed in time, interrupted or omitted, and Fo-maximum and Fo-minimum targets may be undershot or overshot.

The interplay between the basic contours seems to be of two kinds. The first and most common kind of interaction involves adjustments due to time restrictions on the execution of tonal commands. When two or more commands apply to the same syllable, a temporal overlapping of these commands is assumed to take place, which will result in certain adjustments of the basic contours to each other. This kind of adjustment will be called time-dependent. The other kind of adjustment is also context-dependent but has apparently nothing to do with time. For a sequence of two commands, which can be well separated in time, a particular context may involve adjustments of basic contours, although no time restrictions are present. This kind of adjustment will be called position-dependent.

In the present chapter the interplay of basic contours involving the following combinations of tonal features will be described in the order indicated: 1) word accent + sentence accent 2) sentence accent + word accent 3) word accent + word accent 4) sentence accent + terminal juncture 5) word accent + sentence accent + terminal juncture.

5.1 Word accent + sentence accent

In this section we consider the interplay between word accent and sentence accent in non-final positions, in cases where there is no apparent interference from the following word accent command. When the sentence accent rise immediately

follows the word accent fall in non-compound words in focus (cf. figure 6) certain adjustments of the basic contours of word accent and sentence accent may occur. This affects mainly the timing of the word accent fall and of the sentence accent rise, and the Fo-minimum values between the fall and the rise.

5.1.1 Timing of word accent fall

Table VII shows values for the starting-point and the end-point of the word accent fall, in focus, as well as the duration of this fall. The timing values for one accent I-word and one accent II-word in the first position and for one accent II-word in the second position will be considered here. (For the accent I-word in the second position it was in most cases impossible to measure the starting-point and the end-point of the fall due to the minimal range of the fall, - 5 hz on average (cf. table IV).) The timing of the starting-point of either word accent fall is more or less the same in and out of focus - except for a somewhat earlier timing of the fall, in focus, for the accent II-word in the first position -, but the end-point of the fall often comes earlier in focus position (cf. tables VII and I). The end-point for the accent I-word in focus occurs only slightly earlier than in non-focal position, but for the accent II-words the timing of the end-point is considerably earlier in focus than before focus.

The earlier timing of the end-point of the fall in focus is accompanied by a shorter duration of the word accent fall (table VII), and a narrower range of the fall together with a higher word accent minimum (cf. 5.1.2). All this points to the following interpretation: The word accent fall has been interrupted by the sentence accent rise.

There is no apparent difference in the gradient of the fall in focus between accent I and accent II, like that found in non-focal position (cf. table I). The gradient values for the accent II-words in focus are, however, almost identical to the corresponding values in non-focal position, while accent I is less steep in focus than in non-focal position.

5.1.2 Word accent maxima and minima

A comparison between the word accent maximum values for the same word accent and the same position in and out of focus

Table VII. Timing of the word accent fall for accent I (A I) and accent II (A II) in focus. Values for the starting-point and end-point of the fall, in ms relative to the CV-boundary of the stressed syllable and in % of the duration of the relevant segment (prevocalic C, stressed 'V or postvocalic C:), and values for the duration of the fall in ms. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n).

	STARTING-POINT OF FALL					END-POINT OF FALL					DURATION		
	ms			%		ms			%		ms		
1st position	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n
A I anámma	-41	13,6	9	30/C	15,6	22	15,5	7	15/V	10,5	64	14,6	7
A II làmna	73	10,1	19	58/V	7,7	166	26,6	20	29/C:	20,9	90	25,1	20
2nd position													
A I lángre	-	-	-	-	-	-	-	-	-	-	-	-	-
A II lànga	65	11,9	17	52/V	11,0	119	19,8	16	-6/C:	19,4	56	21,0	16
3rd final position													
A I númmer	-55	13,3	11	21/C	7,4	16	7,9	8	11/V	5,8	73	13,4	8
A II nùnnor	71	18,4	27	51/V	12,7	166	20,4	20	20/C	17,4	96	27,3	20

(tables IV and II) shows that the word accent maxima in focus are directly comparable to those before focus (apart from minor differences). This is exactly what can be seen also in figures 5 and 6. In focus, as before focus, the word accent maximum is always directly preceded by an Fo-rise. Therefore the basic word accent contour - for both accent I and accent II - appears to be partly preserved.

The most obvious modification of the basic Fo-contour for both accent I and accent II concerns the word accent minimum. The word accent minimum values in non-compound accent I- and accent II-words turn out to be clearly higher in focus (table IV) than in non-focal position (table II). The difference varies between 15 and 30 hz. This is interpreted as an undershooting of the word accent minimum target. The word accent fall is interrupted by the sentence accent rise, which starts from a level intermediate between the word accent maximum and word accent minimum target. The word accent minimum values in focus for accent I and II in the same position are practically identical. This is true of all three positions, although in the third position the values for non-compound words are 10-15 hz lower than in the other positions. In compounds the Fo-minimum values are yet another 15 hz lower than for non-compound words in the third position. For compounds the difference between the Fo-minima in and out of focus (cf. section 4.3.2 and tables IV and II) turns out to be non-existent. This means that in a compound with sentence accent there will be no undershooting of the Fo-minimum target. As in a non-compound accent II-word in non-focal position, Fo in a compound will fall to reach the word accent minimum target at the CV-boundary of the post-stress syllable. Fo will then stay at the lowest level until the secondary-stress syllable, where the rise towards the sentence accent maximum starts. This suggests that it is the small time separation between word accent and sentence accent in a non-compound word that causes the word accent minimum target not to be reached (time-dependent adjustment).

A comparison between the word accent maximum and minimum values in table IV gives the approximate values for the frequency range in focus. The fact that the Fo-minima are clearly higher in focus, and that the Fo-maxima before focus are approximately the same, means that the frequency range is

narrower in focus than in non-focal position except for compounds (cf. table II).

5.1.3 Timing of sentence accent rise

As in the case of the word accent fall, there appears to be a clear timing difference between accent I and accent II for the sentence accent rise. In accent I-words as in compounds, representing the basic contour, the sentence accent rise usually starts in the middle of the last stressed vowel, which for accent I-words is the main-stress vowel (cf. table III). For non-compound accent II-words the starting-point of the rise comes later than the stressed vowel; typically in the middle of the consonant following the stressed vowel but occasionally even in the beginning of the post-stress vowel.

There is a concomitant difference in the timing of the end-point of the rise. For accent I-words the sentence accent rise normally ends in a central part of the consonant segment following the stressed vowel, i.e. earlier than in compounds (cf. table III), which is to be expected for the same gradient of the rise and with a narrower range to cover (cf. 5.1.4). For accent II-words the end-point of the rise is usually later than the post-stress vowel, not seldom in the vowel following the post-stress vowel. For a disyllabic accent II-word this means that the rise ends beyond the word itself. (It would seem that the accent II-word in the second position is an exception with its earlier end-point of the rise. This will be discussed in section 5.2.1.) Compared to the basic case, therefore, the sentence accent rise in non-compound accent II-words can be said to occur with a time delay. This delay is due to the relatively late timing of the word accent fall for accent II.

The timing difference for the end-point of the rise between accent I and accent II appears to be greater than for the starting-point of the rise. This reflects differences in the duration of the rise. There is a tendency for accent II-words in each position to have a longer duration of the rise than accent I-words (cf. table III). Among the compounds there is a considerable variation in the duration of the rise. In most cases it is, however, comparable to that of non-compound accent II-words.

5.1.4 Sentence accent maxima

The sentence accent maximum values for accent I- and accent II-words are very much the same for the same position and also for different positions. They are even somewhat higher than for compounds (cf. table IV). The frequency range between the sentence accent maximum and the preceding sentence accent minimum (= word accent minimum) is approximately the same for accent I- and accent II-words. In the first and second position the range is 30-35 hz and in the third position somewhat wider: 40-50 hz. This is less wide than for compounds, where particularly the sentence accent minimum values are considerably lower than in non-compound words (cf. 4.2.2).

Finally, a schematized figure (figure 21) summarizes the

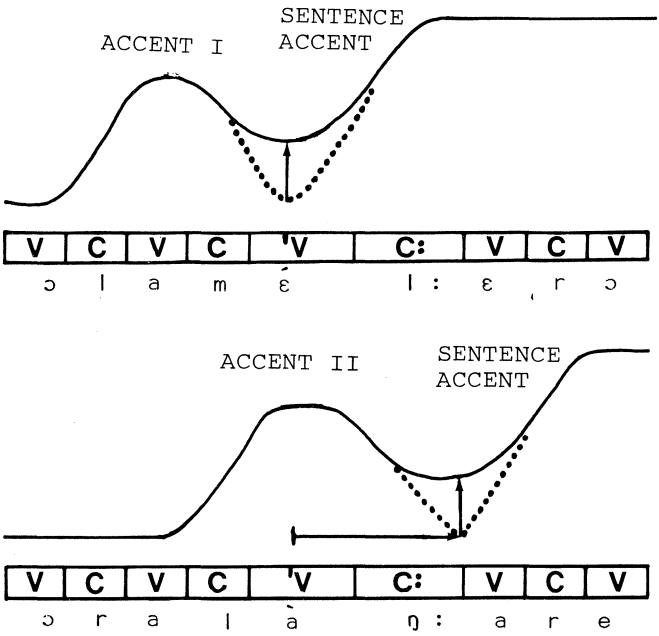


Figure 21. Interplay of word accent and sentence accent in non-compound words. Schematized Fo-contours of accent I with sentence accent (upper part) and accent II with sentence accent (lower part). The extent of the undershooting of the word accent minimum is indicated by the arrow pointing upward, and the extent of the delay of the sentence accent rise for accent II by the arrow pointing to the right. The dotted line represents contours prior to adjustment.

time-dependent adjustments that take place, when word accent and sentence accent occur in the same non-compound word: the shorter duration and the earlier end-point of the word accent fall, the undershooting of the word accent minimum target, and for accent II-words the delay of the sentence accent rise.

5.2 Sentence accent + word accent

In this section the interplay between sentence accent and a following word accent will be dealt with. What is important here is mainly the timing of the sentence accent rise and the word accent maximum values.

5.2.1 Timing of sentence accent rise

The accent II-word in the second position was shown to be a possible exception to the general tendency of the end-point of the sentence accent rise to be located beyond the word itself (cf. 5.1.3). A closer examination of the timing values of the sentence accent rise for accent II in this position reveals a context-dependence due to the prosodic structure of the word - i.e. of word accent and stress placement - in the first post-focal position.

Table VIII shows timing values of the sentence accent rise for accent II in the second position in different contexts. It appears that an early timing of stress and accent I with its

Table VIII. Timing of the sentence accent rise for the accent II-word <u>lànga</u> in different contexts. Values for the starting-point and the end-point of the rise, in ms relative to the CV-boundary of the stressed syllable (starting-point) and the post-stress syllable (end-point) and in % of the duration of the relevant segment (C: or V). Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n).

	STARTING-POINT OF RISE					END-POINT OF RISE				
	ms			%		ms			%	
2nd position	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	$\bar{x}$	s
A II lànga /-										
A I lámm	171	15,6	5	40/C:	16,1	69	45,9	4	61/V	42,1
" númmer	159	27,5	10	28/C:	18,7	57	12,1	10	62/V	12,5
" lémmonar	178	14,8	5	28/C:	17,1	51	24,6	4	56/V	24,1
" laméller	202	31,9	5	58/C:	38,6	96	45,6	5	98/V	45,5
" lavemáng	191	46,4	5	64/C:	34,4	119	28,8	5	136/V	20,1
A II nùnnor	169	16,4	7	57/C:	30,5	104	9,7	10	108/V	5,6
" làngare	197	33,3	5	65/C:	32,7	120	31,0	5	116/V	27,5

earlier timing of the word accent fall in the word following focus position favours a somewhat earlier timing of the starting-point of the rise. The most apparent context-dependence, however, concerns the end-point of the rise. When followed by a word with stress on the initial syllable and accent I, the end-point of the rise is in the second part of the post-stress vowel, while words with accent II or a later placement of stress give a later end-point location, usually beyond the post-stress vowel (see also figure 14). What governs the timing of the sentence accent rise is of course not the placement of stress or the word accent in itself, but rather the timing of the word accent fall, which is dependent on the placement of stress and the word accent.

5.2.2 Sentence accent maximum

In non-final position Fo remains high after the sentence accent rise until the word accent fall in connection with the following stressed syllable (cf. 3.1.2). This means that the sentence accent maximum will not seldom form an Fo-plateau, which may be of considerable length (compare the so-called 'hat pattern' in Dutch in Cohen & 't Hart 1967). The length of the plateau is - for a given speech tempo - determined by the word accent of the word in focus, the number of unstressed syllables before the following stressed syllable and the word accent tied to this syllable (see figures 5 and 14). For the same number of syllables between the two stressed syllables the widest plateau will be formed by an accent I-word in focus position (early rise) followed by an accent II-word in the next position (late fall), while the narrowest plateau - sometimes merely a peak - will be formed by accent II (late rise) plus accent I (early fall) in the corresponding positions.

5.2.3 Word accent maxima and minima

The Fo-peak or plateau formed between the sentence accent rise and the word accent fall functions both as sentence maximum and word accent maximum. Therefore the word accent maximum values in the first post-focal position appear to be the same as the sentence accent maximum values (cf. tables II and IV). In this position the word accent maxima are higher than in pre-focal positions - the basic case (cf. table II). It can be argued that in the first post-focal position the word accent command

is influenced by the preceding sentence accent command. This is the only position where the word accent maxima are so high. The sentence accent maxima are almost as high also in final position, where terminal juncture occurs, but no following word accent is involved (table VI). This is considered to be a position-dependent adjustment of the basic word accent contour, as the high word accent maximum values are found regardless of whether the sentence accent and the word accent occur closely or well separated in time (cf. table II). Moreover the sentence accent rise can be said to replace the pre-focal word accent rise.

The word accent minimum values in the first post-focal position appear to be approximately the same as in pre-focal positions, except for the values in the second position, which will be commented on in section 5.3.2 (cf. table II). Because of the high sentence accent maxima the frequency range of the word accent fall in the first post-focal position is clearly wider (45-60 hz) than in pre-focal position.

5.2.4 Timing of word accent fall

For accent I the starting-point of the word accent fall occurs slightly earlier in the first post-focal position than in pre-focal position (cf. table I), while the end-point values are practically the same. For accent II the fall starts in the first half of the stressed vowel, i.e. earlier than in pre-focal position. In the third but not in the second position the end-point of the accent II-fall is likewise earlier than in pre-focal position. Also in the first post-focal position the fall is steeper for accent I than for accent II (cf. table I). But there is no constancy for the gradient of the same word accent across positions. For both word accents there is a tendency for the duration of the fall to be longer and the gradient to be steeper in positions where there is a wider range of the fall to cover, i.e. directly after focus (cf. table I).

It has been demonstrated in this section that an early timing of the word accent fall directly after focus may cause an anticipation of the sentence accent rise - particularly of its end-point (time-dependent adjustment). Moreover it was proposed that the sentence accent maximum will influence the immediately following word accent maximum: the word accent will have the same Fo-maximum values as the sentence accent (position-dependent

adjustment). The following schematized figure (figure 22) illustrates these adjustments.

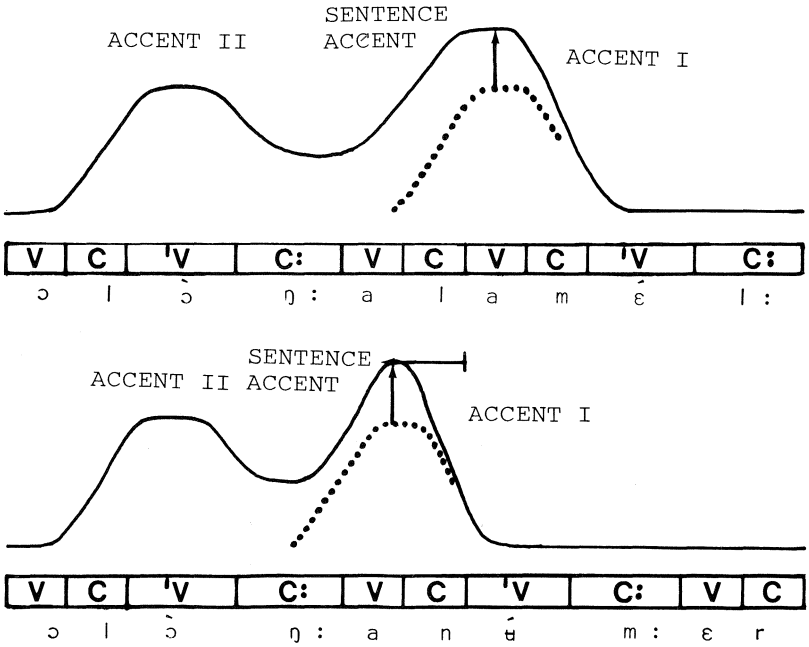


Figure 22. Interplay of sentence accent and word accent. Schematized Fo-contours of accent II with sentence accent followed by accent I, with a late stress placement (upper part) and with an early stress placement (lower part). The extent of the "overshooting" of the word accent maximum is indicated by the arrow pointing upward, and the extent of the anticipation of the sentence accent rise, particularly the end-point, by the arrow pointing to the left. The dotted line represents contours prior to adjustment.

5.3 Word accent + word accent

In this section we shall consider two instances of interplay between two adjacent word accent commands: one in pre-focal position affecting mainly the word accent minimum and one in post-focal position causing adjustments of the word accent minimum and the following word accent maximum.

5.3.1 Pre-focal word accents

The word accent minimum values for accent II in the second position before focus were shown to be higher than the corresponding

values for accent I (4.2.2). These Fo-minimum values for accent II vary, however, to some extent with the immediate context (cf. table IX). The highest word accent minimum values for the accent II-word are found, when it is followed by a word with initial stress and accent I (lámm, númmer and lémmonar). In other contexts the Fo-minimum for accent II is normally as low as for accent I. Fo-tracings of lànga in some of the above mentioned contexts will serve as illustrations (figure 12). When there is an early rise towards the word accent maximum in the following word as in lámm, númmer and lémmonar, the word accent fall in lànga does not reach the same low Fo-minimum, as when the word accent rise comes later due to the stress placement as in laméller and lavemáng. This is interpreted as an instance of undershooting of the word accent minimum target (time-dependent adjustment): When accent II in pre-focal position is directly followed by an accent I-syllable, the word accent minimum target will not be reached. However, the effect is smaller than before the sentence accent rise (cf. 5.1.2), which can be ascribed to the lower Fo-maximum target of word accent as compared to sentence accent.

Table IX. Word accent minima for the accent I-word lángre and the accent II-word lànga in different contexts. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n).

	WORD ACCENT MINIMUM		
2nd position	$\bar{x}$	s	n
A I lángre /-			
A I númmer	184	4,2	13
A II nùnnor	183	4,3	14
A II lànga /-			
A I lámm	189	4,2	5
" númmer	194	2,7	14
" lémmonar	189	2,2	5
" laméller	181	4,2	5
" lavemáng	182	2,7	5
A II nùnnor	188	2,4	13
" làngare	183	5,7	5

5.3.2 Post-focal word accents

After focus in the second position the word accent minimum values for accent I- and accent II-words are found to be higher than for compounds in the corresponding position and also higher than for accent I and accent II directly after focus in the

third position. They are in fact as high as the word accent maximum values in the following second post-focal position, i.e. the third position 2 after focus (cf. table II). Apparently, when two word accents after focus are to be realized in a sequence, Fo decreases in two steps, the first step covering a considerably wider range than the second one (cf. figure 15 and table II). A plateau is formed between the word accent minimum in the first post-focal position and the word accent maximum in the second post-focal position. The word accent maximum values in the latter position are by far the lowest of all positions, and the frequency range of the word accent fall is narrow, only about 15 hz. This is interpreted as adjustments of the word accent minimum and the following word accent maximum after focus. These adjustments are typically position-dependent, as they occur in this environment regardless of the prosodic structure - word accent and stress placement - of the words involved (cf. table II). With only one word accent command to be executed after focus, as in a compound in the second position or in a non-compound word in the third position, Fo will reach the Fo-minimum target level directly (cf. table II and figure 15).

The timing values of the word accent fall in the second post-focal position agree with the values in the first post-focal position (cf. table I) in spite of the much narrower range of the fall. The gradient difference between accent I and accent II is also maintained.

The following schematized figure (figure 23) illustrates the time-dependent adjustment of the word accent minimum in pre-focal position, and the position-dependent adjustments of the word accent minimum and the following word accent maximum in post-focal position.

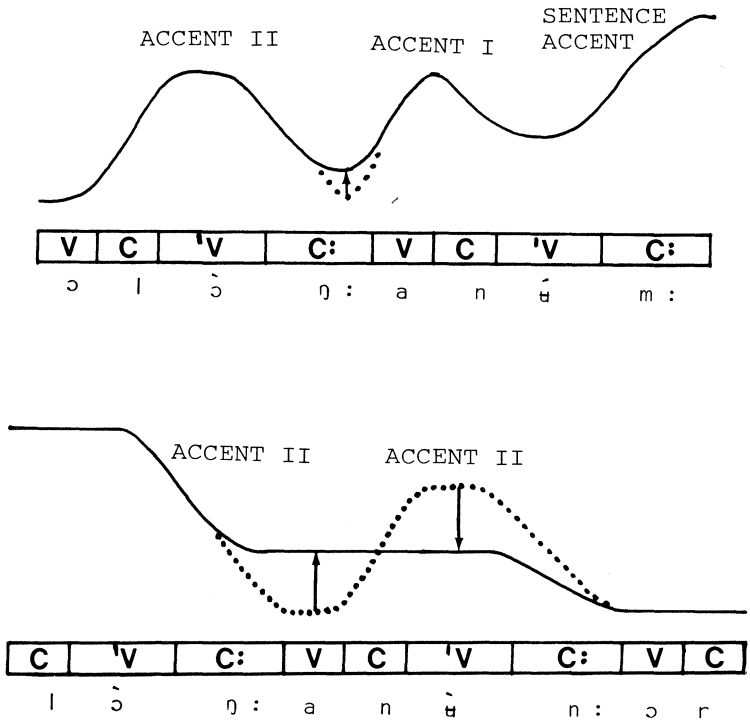


Figure 23. Interplay of word accent and word accent in non-focal position. Schematized Fo-contours of accent II in pre-focal position followed by accent I (upper part), and accent II followed by accent II in post-focal position (lower part). The extent of the undershooting of the word accent minimum is indicated by the arrow pointing upward, and the undershooting of the word accent maximum by the arrow pointing downward. The dotted line represents contours prior to adjustment.

5.4 Sentence accent + terminal juncture

When the utterance-final syllable of a word in focus is stressed, we can expect to find Fo-contributions from different sources concentrated to this syllable. In this section we shall consider the situation in compounds, where an interplay between sentence accent and terminal juncture is assumed to take place, resulting in adjustments of the timing of the sentence accent rise and of the terminal juncture fall.

5.4.1 Timing of sentence accent rise

Table X includes timing values for the sentence accent rise in compounds in final position. The starting-point of the sentence

Table X. Timing of the sentence accent rise for accent I (A I) and accent II (A II) in third final position. Values for the starting-point and the end-point of the rise, in ms relative to the CV-boundary of the stressed syllable (starting-point) and the post-stress syllable (end-point) and in % of the duration of the relevant segment (prevocalic C, stressed 'V or ˌV, postvocalic C: or post-stress V), and values for the duration of the rise in ms. Means ($\bar{x}$) and standard deviations (s) of the indicated number of repetitions (n).

	STARTING-POINT OF RISE					END-POINT OF RISE					DURATION OF RISE		
NON-COMPOUND WORDS	ms			%		ms			%		ms		
3rd position	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n	$\bar{x}$	s	$\bar{x}$	s	n
A I lámm	13	11,0	5	6/'V	5,6	86*	15,5	4	43/'V	8,3	73	15,0	4
" númmer	73	26,6	18	53/'V	20,1	-113	17,1	24	19/C:	10,8	98	31,4	18
" lémmonar	66	18,0	10	48/'V	13,1	-77	21,2	10	27/C:	19,5	101	33,0	10
" laméller	66	18,2	9	49/'V	18,1	-111	18,3	9	19/C:	13,9	108	14,4	9
" lavemáng	-	-	-	-	-	-	-	-	-	-	-	-	-
A II nùnnor	205	18,5	27	49/C:	12,3	35	20,4	27	24/V	13,1	104	20,0	27
" làngare	211	27,2	10	52/C:	26,9	112	21,1	10	83/V	14,5	163	31,4	10
COMPOUND WORDS													
2nd position													
A II làngaˌlamm	-54	20,4	5	17/C	27,9	74*	4,2	5	41/ˌV	6,5	128	19,9	5
" làngaˌnummer	53	11,5	5	40/ˌV	9,1	-89	44,6	5	36/C:	21,4	120	29,4	5
" làngaˌlemmonar	58	4,5	5	47/ˌV	5,5	11	29,5	4	110/C:	27,1	184	29,3	4
" làngalaˌmeller	84	7,4	5	64/ˌV	8,6	-54	19,3	4	59/C:	17,1	119	27,2	4
" làngalaveˌmang	-43	28,7	4	32/C	45,8	86*	28,8	5	43/ˌV	18,5	124	39,2	4
" làngaˌnunnor	61	22,9	4	46/ˌV	17,8	-74	20,6	4	47/C:	15,3	140	36,7	4

* For oxytonic words the end-point values are related to the CV-boundary of the stressed syllable

accent rise for non-oxytonic compounds in final position occurs only slightly earlier than in non-final position. However, the rise in oxytonic (=with final stress) compounds (lànga̤lamm and lànga̤lave̤mang) starts considerably earlier - even clearly before the CV-boundary of the stressed (final) syllable - in final as compared to in non-final posi̇tion (cf. tables X and III and figure 4). The end-point of the rise in the non-oxytonic compounds in final position is - unlike the situation in non-final position - normally before the CV-boundary of the post-stress syllable. For the oxytonic compounds in final position the end-point of the rise occurs already before the middle of the final, stressed vowel. Therefore, according to my interpretation, there is a temporal anticipation of the whole sentence accent rise in oxytonic compounds in final position due to the influence of the following terminal juncture command. For non-oxytonic compounds particularly the end-point of the rise is anticipated in final relative to non-final position. In final position, where the time restrictions on the realization of the sentence accent rise are heavier than in non-final position, the duration of the rise is also shorter, in general (cf. tables X and III).

5.4.2 Timing of terminal juncture fall

While the terminal juncture fall in non-oxytonic compounds (basic contour) is realized mainly in the first half of the final vowel, there is clearly a later timing of the fall in oxytonic compounds (cf. table V). Here the terminal juncture fall will not set in until after the middle of the final vowel and will be realized primarily in the second half of the final vowel (cf. table V and figure 4). This is interpreted as a temporal delay of the terminal juncture fall in oxytonic compounds under the influence of the directly preceding sentence accent command.

Moreover, there is a tendency, albeit weak, for the oxytonic compounds to have a lower sentence accent maximum than the non-oxytonic compounds (table VI), which is not found in non-final position (table IV).

Therefore in final position, when the stressed and the final syllable coincide, there will be a mutual influence between the sentence accent and the terminal juncture commands, resulting

both in an anticipation of the sentence accent rise and in a delay of the terminal juncture fall and in an undershooting of the intervening Fo-maximum. This is illustrated in the following schematized figure (figure 24).

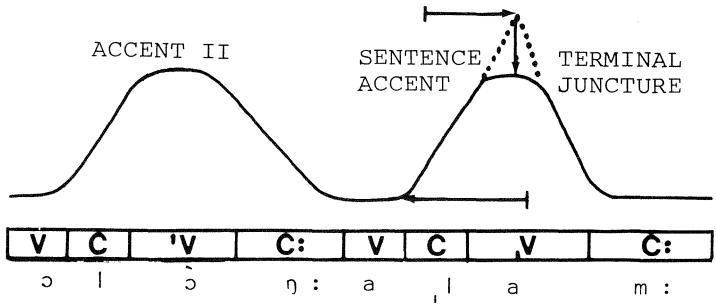


Figure 24. Interplay of sentence accent and terminal juncture in compounds. Schematized Fo-contour of an oxytonic compound. The extent of the anticipation of the sentence accent rise is indicated by the arrow pointing to the left, and the delay of the terminal juncture fall by the arrow pointing to the right, and the undershooting of the sentence accent maximum by the arrow pointing downward. The dotted line represents contours prior to adjustment.

5.5 Word accent + sentence accent + terminal juncture

In this section the interplay between the basic contours of word accent, sentence accent and terminal juncture for accent I- and accent II-words (non-compound words) in final position will be treated. Particularly for oxytonic words (accent I) the interference of tonal commands is assumed to be maximal, causing adjustments of the word accent fall, the sentence accent rise and the terminal juncture fall.

5.5.1 Timing of word accent fall

Table VII presents timing values for the word accent fall for one accent I-word (nú̀mmer) and one accent II-word (nùnnor) in final position. (In a number of cases it was difficult to define exactly the starting-point and the end-point of the fall in the accent I-word because of the narrow frequency range (cf. 5.5.2). These cases have been left out of consideration here.)The timing values of the word accent fall in final position appear to be very similar to those in non-final position for the same word

accent (cf. table VII), i.e. the fall for accent I is realized mainly in the consonant preceding the stressed vowel and for accent II in the second half of the stressed vowel and in the first part of the following consonant (cf. also table I). The duration of the fall for accent I is shorter than for accent II, but due to the narrower range of the fall for accent I, the gradient of this fall (15 hz/100 ms) still appears to be less steep than for accent II (21 hz/100 ms). This means that accent II shows a relatively stable gradient of the fall across positions (cf. 4.2.1 and 5.1.1), while for accent I the gradient varies more.

5.5.2 Word accent maxima and minima

Table VI shows word accent maximum and minimum values for non-compound words in focus in final position. There are only small differences for the word accent maxima between accent I and accent II in final position. Comparing the word accent maximum values in the third final and non-final position (cf. tables VI and IV), we find approximately the same values in both positions. Also the word accent maximum values in the second, pre-focal position are similar (cf. table II). In final as in non-final position the word accent maximum is directly preceded by a word accent rise (see figure 3).

Unlike the situation for word accent maxima, there appears to be a wide range of variation for the word accent minima. At one extreme we find the accent II-words and the antepenult-stressed accent I-word, for which the Fo-minimum in final position is as low as in non-final position (cf. table IV), while for the oxytonic words at the other extreme, the word accent minima are markedly higher in final position and in many cases even as high as the preceding word accent maxima (cf. figure 3 and table VI). In some cases there is a slight word accent fall and a subsequent sentence accent rise, but in most cases we find an Fo-plateau extending from the pre-stress to the stressed syllable until the terminal juncture fall. For the non-oxytonic words the frequency range of the word accent fall varies between 10 and 20 hz (cf. table VI).

5.5.3 Timing of sentence accent rise

As was mentioned in the preceding section, the sentence accent rise is minimal for the oxytonic accent I-words in final position. Where we find such a rise - in a few cases for lámm -, the timing of the rise is clearly earlier compared to non-final position (cf. tables X and III). The starting-point of the rise is in the very beginning of the final vowel, and the end-point occurs before the middle of the same vowel. For the non-oxytonic accent I-words there is no apparent difference in the timing of the starting-point of the rise between final and non-final position, while there is a somewhat earlier location of the end-point of the rise in final position (cf. tables X and III).

Apart from the influence of the word accent command, the situation for the sentence accent rise in oxytonic non-compound words is parallel to that of oxytonic compound words (cf. 5.4.1). The earlier timing of the rise in oxytonic words in final position is interpreted as an anticipation due to the influence of the terminal juncture command. But in addition, the word accent and the sentence accent commands will interfere, causing a more complete form of undershooting of the word accent minimum target than for non-oxytonic words (5.5.2) and for non-compound words in non-final position (cf. 5.1.2).

For the disyllabic accent II-word the sentence accent rise starts at approximately the same point in time in final and non-final position, while for the trisyllabic accent II-word the starting-point of the rise is earlier in final position. But although the starting-point of the rise for the disyllabic accent II-word is the same in final and non-final position, the end-point of the rise occurs considerably earlier in final position. For the disyllabic nùnnor the rise ends in an initial part of the post-stress vowel, while for the trisyllabic làngare it ends in the final part of the post-stress vowel, which is still earlier than in non-final position (see figure 3).

In the case of the accent II-word nùnnor the post-stress syllable is the final syllable, which in final position has to contain the terminal juncture fall. This will obviously create a conflict of commands. The solution of this conflict seems to involve an interruption of the sentence accent rise by the

terminal juncture fall (see figure 3), resulting in an anticipation of the end-point location of the rise. (Compare the shorter duration of the rise in final than in non-final position, tables X and III.) In the trisyllabic accent II-word the sentence accent rise and the terminal juncture fall will not be realized in the same syllable. Consequently the interference of tonal commands will not be as strong as for the disyllabic accent II-word. But there will still be an anticipation of the sentence accent rise.

5.5.4 Timing of terminal juncture fall

Table V shows timing values of the terminal juncture fall for non-compound words. While the normal case for the non-oxytonic words is that the fall starts somewhat before or at the CV-boundary of the final syllable (cf. 4.4.1), the starting-point of the fall for the oxytonic words and the disyllabic accent II-word comes later, in a central part of the final vowel. For the oxytonic words and the disyllabic accent II-word, the terminal juncture fall is realized in the second half of the final vowel. Compare the timing values of the terminal juncture fall for the oxytonic compounds (table V). Therefore, besides the temporal anticipation of the sentence accent rise in the oxytonic accent I-words and in the disyllabic accent II-word, there will also be a delay of the terminal juncture fall for these words.

5.5.5 Terminal juncture maxima and minima

Table VI presents values of the sentence accent maximum (= terminal juncture maximum) and the terminal juncture minimum for non-compound words. It appears that the oxytonic accent I-words and the disyllabic accent II-word, which have a relatively earlier sentence accent rise and a later terminal juncture fall, also tend to have somewhat lower terminal juncture maximum values as well as higher terminal juncture minimum values than the other non-oxytonic words. The terminal juncture minimum values for the non-oxytonic words turn out to be comparable to the corresponding word accent minimum values in non-focal position (cf. table II).

In summary, there appears to be a fair degree of agreement between the Fo-contours of the same word in final and non-final

position (cf. 5.1) - apart from the presence of the terminal juncture fall - in all cases but two. The two cases are words in which the stressed syllable is also the final one, i.e. lámm and lavemáng. In this situation the three tonal commands, word accent, sentence accent, and terminal juncture are to be executed within one and the same syllable, which will apparently create a conflict of commands. The conflict is solved in the following way. Priority is given to the word accent rise and to the terminal juncture fall (cf. Gårding & Lindblad 1973:59), which occurs with a delay, while the sequence of word accent fall and sentence accent rise is partly or completely omitted, replaced by an Fo-plateau. Also for the disyllabic accent II-word there is an interference of tonal commands, causing a partial anticipation of the sentence accent rise, an undershooting of the sentence accent maximum and a delay of the terminal juncture fall. All this is illustrated in the following schematized figures (figures 25 and 26).

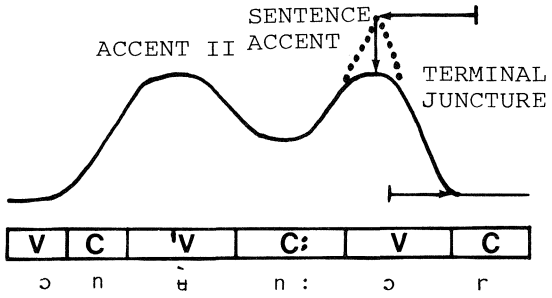


Figure 25. Interplay of sentence accent and terminal juncture for accent II. Schematized Fo-contour of a disyllabic accent II-word. The extent of the anticipation of the sentence accent rise, particularly the end-point of the rise, is indicated by the arrow pointing to the left, the undershooting of the sentence accent maximum by the arrow pointing downward, and the delay of the terminal juncture fall by the arrow pointing to the right. The dotted line represents contours prior to adjustment.

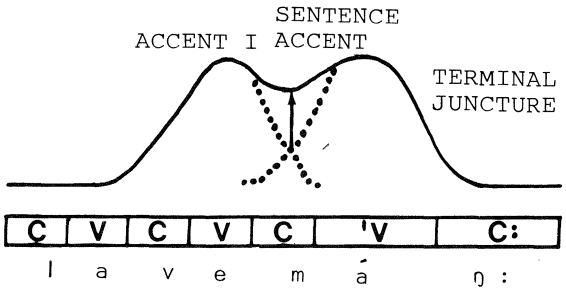


Figure 26. Interplay of word accent, sentence accent and terminal juncture for accent I. Schematized Fo-contour of an oxytonic accent I-word. The anticipation of the sentence accent rise, the undershooting of the sentence accent maximum, and the delay of the terminal juncture fall illustrated in figure 24 for the oxytonic compound are all presupposed in the present figure. The extent of the undershooting of the word accent minimum is indicated by the arrow pointing upward. The dotted line represents contours prior to adjustment.

5.6 Conclusion

The interplay of the basic contours involves time-dependent and position-dependent adjustments. The most typical time-dependent adjustments are the following:

1) Interruption of the word accent fall by an immediately following Fo-rise. This adjustment occurs both in focus between word accent fall and sentence accent rise (cf. 5.1) and to a lower degree in pre-focal position between word accent fall and a subsequent word accent rise (cf. 5.3.1). This interruption results in an undershooting of the intervening Fo-minimum target, which in final position may be so complete that the sequence of word accent fall and sentence accent rise is replaced by an Fo-plateau (5.5.2).

2) Anticipation of the sentence accent rise because of a directly following Fo-fall. This adjustment occurs both in non-final position before the word accent fall (cf. 5.2.1) and in final position before the terminal juncture fall (5.5.3), and can affect just the end-point or the whole rise.

3) Delay of the terminal juncture fall because of the preceding sentence accent rise (cf. 5.4.2 and 5.5.4). The simultaneous anticipation of the sentence accent rise and the delay of the

terminal juncture fall may cause an undershooting of the intervening Fo-maximum target (cf. 5.5.5).

There are two instances of position-dependent adjustments of basic contours. Both occur in post-focal position and involve the omission of the word accent rise. In the first post-focal position (1 after focus) the word accent maxima are adjusted to the sentence accent maxima (5.2.3). In the second case, the word accent maxima in the second post-focal position (2 after focus) and the preceding word accent minima are adapted to each other (5.3.2).

Let us finally consider the context-dependent adjustments described in this chapter by summing up the effects on the basic contours in different environments. This is shown in the following diagram.

	BASIC CONTOUR	ADJUSTED CONTOUR	
		Focal	Post-focal
Accent I	rise-fall	rise-interrupted fall rise	fall
Accent II	rise-fall	rise-interrupted fall	fall

		Non-final	Final
Sentence accent	rise	rise anticipated rise	rise anticipated rise no rise
Terminal juncture	fall		fall delayed fall

The temporal pattern of the word accent contours (accent I and accent II) appears to be stable. When they are influenced by a following sentence accent in focus, the word accent fall may be interrupted or even omitted (in final position) but not temporally displaced. In post-focal position the word accent rise is omitted, and the timing of the word accent fall remains the same. The word accent maximum can therefore be regarded as a temporal fix-point (cf. Gårding 1975:73). The sentence accent rise, on the other hand, is temporally variable. Apart from the word accent dependent variation in the timing of the sentence accent rise, the rise can be anticipated under the influence of a following accent I or terminal juncture. In a sequence of accent I plus sentence accent plus terminal juncture in an utterance-final syllable, the sentence accent rise may even be completely

omitted with only a high Fo-level left between the word accent rise and the terminal juncture fall. The terminal juncture fall is also temporally variable. The fall may be delayed because of a preceding sentence accent, but it is always realized in its full shape. Consequently, what belongs to sentence prosody, i.e. sentence accent and terminal juncture, appears to be temporally more flexible than the lexical prosody, i.e. the two word accents.

6 VALIDITY TESTING

The first part of the present chapter touches upon questions such as representativity, choice of informants and size of the test material in phonetic investigations. The subsequent parts of the chapter give an account of a test of the validity of the results obtained for my primary informant (cf. chapters 3-5). The prosodic contributions to the Fo-contours, the basic Fo-contours and their interplay, respectively, are checked for a subset of the speech material for two secondary informants.

6.1 Procedure

In a phonetic investigation - particularly in pilot and exploratory studies but also in those of more definitive character - it is not uncommon to make use of only one speaker. The choice is often between a relatively extensive speech material recorded by perhaps one single speaker and a less extensive material tested on more speakers. In the present investigation a combination of these approaches has been attempted, which may be of some methodical interest. In order to limit the amount of data but still have a varied and representative speech sample I had one primary informant make a record of a rather extensive speech material, while a subset of the same material was recorded by two secondary informants.

6.1.1 Speakers

The following considerations have governed the choice of speakers for the present study. To avoid problems of normalization, speakers of the same sex - in this case female - with an auditively determined similarity in voice registers have been chosen. The speakers do in fact have approximately the same mean value for their voice registers, but two of the speakers - the secondary informants (HS and UN) - use a wider frequency range than the third speaker - the primary informant (EH) (see figure 26). Moreover the speakers are judged to speak the same social dialect of Stockholm Swedish.

6.1.2 Speech material

In order to be able to determine the prosodic contributions to the Fo-contour and to investigate the interplay of the basic

contours it was considered important to vary the following parameters in the subset of the speech material selected for the two secondary informants:
1) placement of sentence accent for two positions - the second and the third - in sentences from sets A and B;2) word accent for the second and third positions (in the first position only the accent II-word is used);3) word structure (number of syllables and the placement of stress) for the test words in the third position;4) phrase structure of the noun phrase (one or two words) by including one sentence from set C (for this sentence the placement of sentence accent is restricted to the second position, i.e. to the compound). The subset of the speech material consists of 29 sentences. With five repetitions of each test sentence the control sample contains 145 utterances, which were recorded by each of the secondary informants following the same procedure as described in 2.3.

6.1.3 Measurements

In order to check the agreement of certain central aspects of the interplay of the basic contours with the primary speaker, measurements have been made of the following Fo-points (cf. 2.4): 1) Fo-maximum and Fo-minimum values have been measured for the noun phrase in the sentences included in the subset of the speech material, i.e. a) word accent maximum and minimum values for words in the second, pre-focal and focal positions and the third, focal and post-focal positions, b) sentence accent maximum values for both the second, non-final and third, final positions, c) values for the word accent minimum in the first position and d) for the terminal juncture minimum in the third, final position. 2) Timing values have been determined a) of the word accent fall for the word accent pair <u>núm̀mer</u>/<u>nùnnor</u> in post-focal position, b) of the sentence accent rise in non-final position for <u>lǎngre</u> and <u>làǹga</u> in two different environments and for <u>núm̀mer</u> and <u>nùnnor</u> in final position, and c) of the terminal juncture fall for the pair <u>núm̀mer</u>/<u>nùnnor</u>.

6.2 Prosodic contributions to the Fo-contours

6.2.1 Two-word phrases and compounds

The same prosodic contributions to the Fo-contours as for my

primary informant can be isolated for the two secondary informants. Figure 27 shows typical Fo-contours for the three speakers for the phrase consisting of the accent II-element làngа and the accent I-element númmer uttered either in a two-word phrase or a compound. Two versions of the two-word phrase with either the first or the second word in focus, and one version of the compound in focus are presented. In the Fo-contour of the compound we can isolate the word accent fall (accent II) in the first stressed syllable, the sentence accent rise in the second stressed syllable and the terminal juncture fall in the final syllable (cf. 3.2). The Fo-version of the two-word phrase with the second word in focus has an additional Fo-peak - word accent rise and fall reflecting accent I - instead of the low Fo-level in the pre-stress syllable of númmer. For the two-word phrase, where the first word is in focus, the sentence accent rise occurs in the post-stress syllable of làngа and is directly followed by the word accent fall (accent I). The figure shows that for all three speakers the Fo-contour of the compound is clearly distinct from either of the Fo-contours of the two-word phrase.

6.2.2 Word accent distinction

There is a clear timing difference of the Fo-contour in relation to the stressed syllable between accent I and accent II in non-focal position for all three speakers. This is illustrated in figure 28 for the word accent pair lángre/làngа before focus and the pair númmer/nùnnor after focus. For the latter pair timing values for the word accent fall are given in table XIII for the two secondary speakers (cf. table I for the primary speaker). The starting-point of the fall for accent I is located in the beginning of the consonant preceding the stressed vowel, and the end-point occurs in a central part of the stressed vowel for both secondary speakers. For accent II the starting-point of the fall is in the middle of the stressed vowel, while the end-point is normally located in the final part of the consonant following the stressed vowel. For speaker UN the timing difference between accent I and accent II is approximately the same for both the starting-point and the end-point of the fall (140 ms), hence there is no word accent dependent difference in gradient. But for speaker HS as for

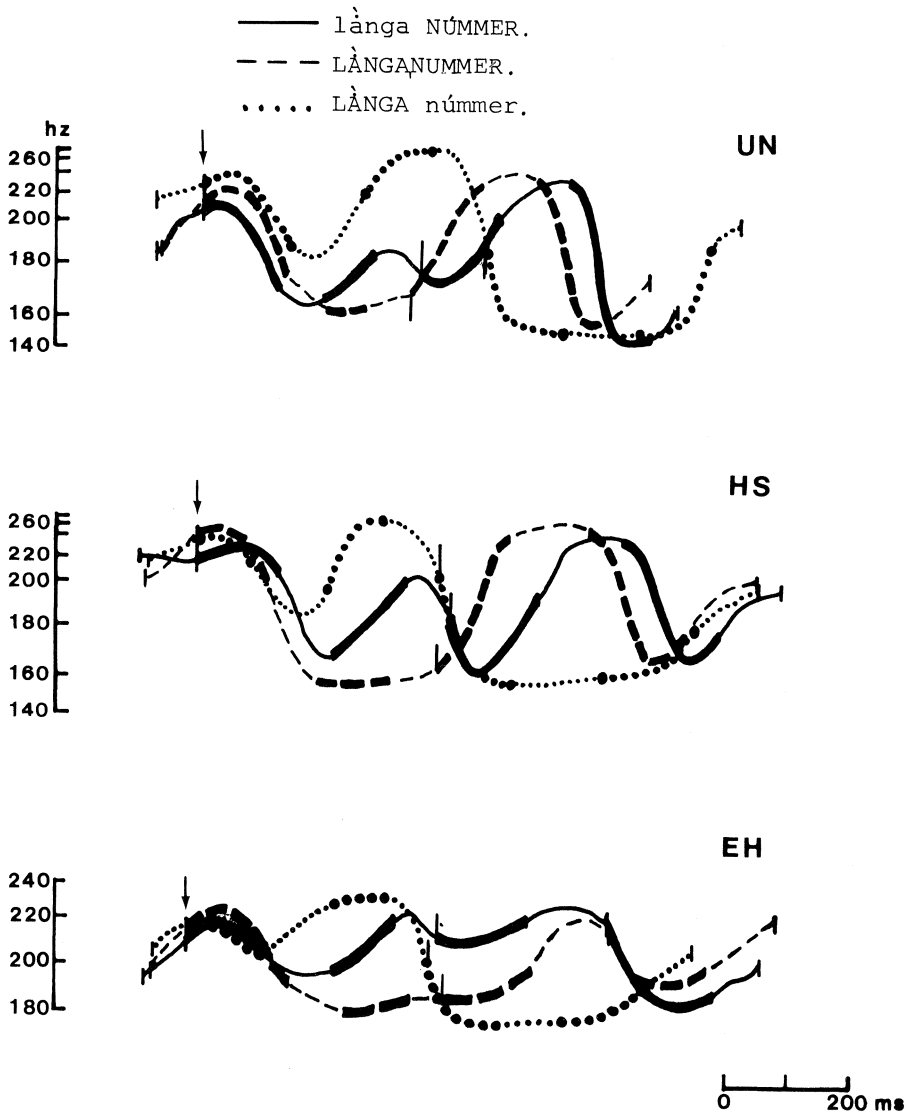


Figure 27. The effect of phrase structure and placement of sentence accent. Fo-contours of two-word phrases consisting of an accent II-word followed by an accent I-word with either the first or the last word of the phrase in focus, and contours of corresponding compounds for three speakers. The line-up point is at the CV-boundary of the first stressed syllable and the vertical bar indicates the CV-boundary of the second stressed syllable.

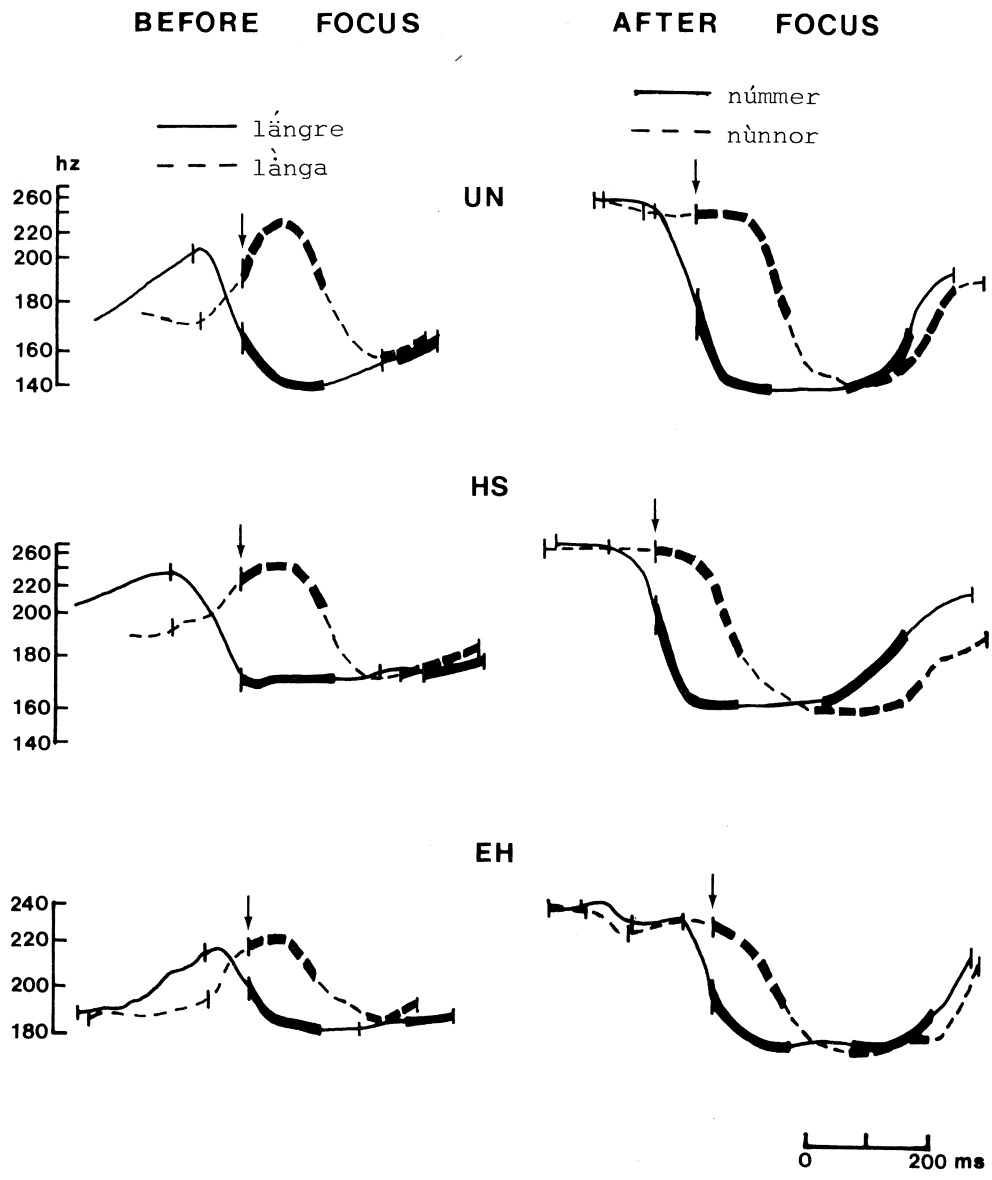


Figure 28. The word accent distinction in non-focal position. Fo-contours of accent I- and accent II-words in the second and third positions for three speakers. The line-up point is at the CV-boundary of the stressed syllable.

the primary speaker (cf. table I) the difference is less for the starting-point (125 ms) than for the end-point of the fall (185 ms). Consequently the gradient of the fall is steeper for accent I than for accent II for these two speakers.

It is clear that essentially the same characteristics of the word accent contours in non-focal positions as for the primary speaker (cf. 4.2.1, 5.1.1 and 5.5.1) are found also for the secondary speakers: The clearly earlier timing of the word accent fall for accent I as compared to accent II, the tendency for the fall to be steeper for accent I, the non-existent, or in some positions small, differences in word accent maximum and minimum values (tables II, XI and XII), the wider frequency range after, as compared to before focus are typical features of all three speakers.

6.3 The basic Fo-contours

For the two secondary informants the same basic contours of accent I, accent II, sentence accent and terminal juncture are assumed, although the speech sample tested on these two speakers does not allow such a complete documentation of this as for my primary speaker (cf. chapter 4). This means that for accent I and accent II the pre-focal contour is considered basic, for sentence accent the compound contour and for terminal juncture the non-oxytonic compound (or accent I) contour. In the Fo-contour of the compound <u>lànganummer</u> (figure 27) the three basic contours of accent II, sentence accent and terminal juncture are represented. Here the word accent fall (accent II), the sentence accent rise and the terminal juncture fall are clearly separated and therefore minimally influenced by each other.

6.4 Interplay of the basic contours

6.4.1 Word accent + sentence accent

The present section deals with the interplay between word accent and sentence accent in non-final position affecting mainly the word accent minima (= sentence accent minima) (cf. tables XI and XII). The word accent minimum values for both secondary speakers are usually higher in focus than before focus. It is interesting to note that for both speakers the word accent minimum values for the compound <u>lànganummer</u> in

focus, where there is a relatively clear time separation between the word accent fall and the sentence accent rise (cf. figure 27), are lower than the corresponding values for the word <u>lànga</u> in focus, where the sentence accent rise occurs directly after the word accent fall. This supports the interpretation, which was advanced in connection with the primary informant, that a small time separation between a fall and a rise is likely to cause an undershooting of the intervening Fo-minimum target, whereas a larger time separation favours attainment of this target (cf. 5.1.2).

6.4.2 Sentence accent + word accent

The interplay between sentence accent in the second non-final position and word accent in the third position also appears to be similar to that of my primary informant (cf. 5.2.2). For both secondary speakers the sentence accent rise is connected with the subsequent word accent fall by a plateau of varying length, functioning both as sentence accent maximum and post-focal word accent maximum. These post-focal word accent maximum values, which are the same for accent I and accent II in different environments, are markedly higher than the pre-focal word accent maximum values (cf. tables XI and XII). As for the primary speaker it is assumed that the higher values are caused by the preceding sentence accent (position-dependent adjustment).

The timing of the sentence accent rise is dependent both on the word accent of the word in focus and on the placement of the following stressed syllable and its word accent, which determines the timing of the word accent fall. For the accent I-word the starting-point of the rise occurs in the first part of the stressed vowel, and the end-point is in a central part of the consonant segment following that vowel (table XIII). For the accent II-word the rise starts in a central part of the consonant following the stressed vowel (speaker UN) or close to the boundary of the post-stress vowel (speaker HS). The end-point of the rise displays a clear context-dependent variation for both speakers. When the next syllable is stressed, the rise ends in the final part of the post-stress vowel, while a more distant location of the following stressed syllable favours a later end-point of the rise, often in the vowel following the post-stress vowel. Roughly the same timing characteristics of

the sentence accent rise in non-final position were found for the primary speaker (cf. 5.2.2).

6.4.3 Word accent + word accent

There is some indication of an influence between two successive word accent commands in pre-focal position for one of the secondary speakers. For the word accent minimum in the second position there is no apparent difference between accent I and accent II for speaker HS, but for speaker UN the word accent minimum values appear to be higher for accent II, where there is a smaller time separation between the word accent fall and the following word accent rise (time-dependent adjustment), than for accent I (cf. 5.3.1). This was also found in certain contexts for the primary speaker (cf. 5.3.1).

6.4.4 Word accent + sentence accent + terminal juncture

The two secondary speakers often have rather different Fo-contours in final position, which is interpreted as a difference in the execution of the word accent, sentence accent and terminal juncture commands. While for speaker HS there is always a clear sequence of word accent rise, word accent fall, sentence accent rise and terminal juncture fall even in oxytonic words, this is the case for speaker UN usually only in the accent II-words. In her accent I-words the word accent fall is often replaced by a plateau between the word accent rise and the sentence accent rise (cf. 6.4.1) or - in oxytonic words - is omitted altogether, so that the word accent rise and the sentence accent rise may even be combined to form a single rise. While the word accent maximum values are approximately the same as in non-final focus position for both speakers (tables XI and XII), the difference between the speakers is reflected particularly in the word accent minimum values. For speaker HS there is no difference between the word accent minimum values in focal and non-focal position except for the oxytonic lavemáng (table XI). For speaker UN the word accent minima in the non-oxytonic accent I- and accent II-words have approximately the same values as in non-final focus position - i.e. they are higher than in non-focal position (table XII) -, while there is no distinct word accent minimum in the oxytonic words. This is also roughly the case for the primary speaker

(cf. 5.5.2).

Apart from the difference in the timing of the sentence accent rise depending on the word accent of the word in focus there is also a dependence of the sentence accent rise in final position on the terminal juncture fall (cf. 5.5.3 for the primary speaker). Timing values of the sentence accent rise for one accent I-word (nú̀mmer) and one accent II-word (nù̀nnor) in final position are given in table XIII. For the disyllabic accent I-word the timing of the rise is roughly the same as in non-final position, whereas for the disyllabic accent II-word the rise occurs clearly earlier - for UN particularly the end-point of the rise - in final position. As for my primary speaker (cf. 5.5.3) this is interpreted as an anticipation of the sentence accent rise in final position because of the terminal juncture fall, which is to be realized in the post-stress syllable of the accent II-word.

The timing of the terminal juncture fall is similarly dependent on the timing of the sentence accent rise. In the accent I-word the terminal juncture fall starts at or slightly before the last CV-boundary and ends in the second half of the final vowel for the two speakers, while in the accent II-word the starting-point of the fall is in the middle of the final vowel and the end-point at the very end of the final vowel or sometimes even in the final consonant (cf. table XIII). These timing values agree with those of the primary speaker (table V). Therefore the interpretation of this timing difference for my primary speaker (cf. 5.5.4) is applicable also for the two secondary informants. For the disyllabic accent II-word in final position the interference of the sentence accent and the terminal juncture will cause an anticipation of the sentence accent rise relative to non-final position and a delay of the terminal juncture fall in relation to the timing of the fall in a non-oxytonic accent I-word (basic contour).

The sentence accent maxima in final position appear to be lower than in non-final position for all three speakers. For speaker HS as for my primary speaker (cf. 5.5.5), but not for speaker UN, the sentence accent maximum values in final position tend to vary systematically with the prosodic structure of the word. For oxytonic words and for the disyllabic accent II-word, which have a relatively earlier timing of the sentence

accent rise and a later timing of the terminal juncture fall than corresponding words with an earlier stress placement, these maxima tend to be lower than for the other words (cf. tables XI and XII). For the two secondary speakers the terminal juncture minima turn out to have approximately the same values regardless of the prosodic structure of the test words (cf. 5.5.5 for the primary speaker), and they are also similar to the values of the corresponding post-focal word accent minima.

Finally it should be noted that the Fo-minimum values in an early position of the sentence appear to be higher than in a later position of the sentence for both secondary speakers (cf. tables XI and XII). This downdrift in frequency through an utterance is more marked than for the primary speaker (cf. 4.2.2).

6.5 Conclusion

As has been demonstrated in this chapter there are obvious similarities in most respects between the three speakers as to their use of Fo in speech. The temporal stability of the word accent contours and the temporal variability of the sentence accent and terminal juncture contours appear to be features characteristic of all three speakers (cf. 5.6). Also the relationships between Fo-maxima and Fo-minima for each speaker are roughly the same in most contexts.

The most obvious differences between the speakers pertain to the actual realization of a sequence of word accent, sentence accent and terminal juncture, particularly in accent I-words. At one extreme we can find the full realization of the word accent rise and fall, the sentence accent rise and the terminal juncture fall even in oxytonic words, while at the other extreme there is only a single rise - a combination of word accent and sentence accent rise with omission of the word accent fall - and the terminal juncture fall. It appears that in the given situation even one and the same speaker may vary considerably as to the realization of these contours - the speaker may either perform the maximal Fo-movements or have Fo take a short-cut. It may be speculated that different means of realizing the Fo-contours have some attitudinal significance. In this connection it is interesting to note that Atkinson (1973) in a study of intonation in American English found an intra-speaker variability, which was nearly as great as the inter-speaker variability.

Table XI. Word accent maxima (WA-MAX) and minima (WA-MIN), sentence accent maxima (SA-MAX) and terminal juncture minima (TJ-MIN) for accent I and accent II in two-word phrases and one compound in final position a) with the first word in focus and b) with the second word in focus. Standard deviations are shown under each mean value (hz). Speaker HS. [n = 5 (4)]

a)

	PRE-FOCAL 1st position	FOCAL 2nd position		POST-FOC 3rd pos	
	WA-MIN	WA-MAX	WA-MIN	SA-MAX	WA-MIN
lángre lámm	194	205	176	281	149
	13.9	12.7	8.2	14.3	4.2
lángre númmer	195	222	174	284	156
	9.4	5.7	6.5	16.7	4.2
lángre lémmonar	188	206	177	282	155
	16.0	11.9	12.5	10.4	3.5
lángre laméller	188	208	174	286	154
	10.4	18.2	5.5	5.5	4.2
lángre lavemáng	187	197	172	274	156
	5.7	11.0	5.7	6.5	5.5
lángre nùnnor	182	220	169	287	160
	7.6	17.0	4.2	14.0	0.0
lángre làngare	189	223	169	286	157
	17.8	14.4	10.8	8.9	2.7
lànga lámm	190	231	170	276	156
	9.4	11.9	3.5	13.9	4.2
lànga númmer	192	237	184	274	156
	7.6	5.7	21.0	11.4	5.5
lànga lémmonar	188	246	184	276	158
	9.6	11.1	13.1	4.8	2.9
lànga laméller	190	228	175	273	153
	10.0	13.5	5.0	18.9	8.4
lànga lavemáng	188	231	170	284	157
	10.4	5.5	6.1	15.2	2.7
lànga nùnnor	186	234	175	277	157
	8.2	11.4	6.1	14.8	4.5
lànga làngare	190	238	171	280	154
	11.7	2.7	6.5	7.1	2.2
lànga‿nummer					

b)

	PRE-FOC 1st pos	PRE-FOCAL 2nd position		FOCAL 3rd final position			
	WA-MIN	WA-MAX	WA-MIN	WA-MAX	WA-MIN	SA-MAX	TJ-MIN
lángre lámm	178	233	161	217	164	249	159
	11.5	17.9	4.2	12.5	10.8	13.9	4.2
lángre númmer	186	225	167	219	158	252	157
	13.9	7.9	6.7	12.4	2.7	14.0	9.1
lángre lémmonar	191	230	167	216	160	250	159
	14.7	9.4	8.4	16.7	5.0	9.4	2.2
lángre laméller	188	233	167	224	157	246	161
	11.0	13.5	7.6	13.9	2.7	7.4	5.5
lángre lavemáng	187	229	165	212	177	234	161
	9.7	7.4	6.1	13.0	13.0	12.9	4.2
lángre nùnnor	185	225	163	222	163	234	160
	7.9	12.2	4.5	9.7	5.7	6.5	7.9
lángre làngare	190	236	171	239	158	256	163
	7.1	12.9	4.2	10.2	2.7	11.4	9.1
lànga lámm	181	237	166	194	160	239	157
	13.9	4.5	2.2	2.2	8.7	15.6	2.7
lànga númmer	179	245	167	210	157	253	159
	13.9	15.0	6.7	15.8	4.5	17.9	9.5
lànga lémmonar	184	237	168	200	159	234	152
	10.8	9.1	5.7	3.5	4.2	6.5	7.6
lànga laméller	177	245	166	217	156	255	162
	11.5	15.4	9.6	18.2	4.2	20.6	8.4
lànga lavemáng	180	241	167	217	188	237	161
	7.9	7.4	2.7	11.0	19.6	9.1	6.5
lànga nùnnor	183	240	169	229	163	246	164
	5.7	9.4	4.2	6.5	5.7	14.7	4.2
lànga làngare	185	244	170	225	159	245	168
	8.7	12.9	6.1	5.0	6.5	10.0	2.7
lànga‿nummer	173	242	153	-	-	262	164
	6.7	5.7	5.7	-	-	11.0	6.5

Table XII. Word accent maxima (WA-MAX) and minima (WA-MIN), sentence accent maxima (SA-MAX) and terminal juncture minima (TJ-MIN) for accent I and accent II in two-word phrases and one compound in final position a) with the first word in focus and b) with the second word in focus. Standard deviations are shown under each mean value (hz). Speaker UN. [n = 5 (4)]

a)

	PRE-FOCAL 1st position	FOCAL 2nd position		POST-FOC 3rd pos	
	WA-MIN	WA-MAX	WA-MIN	SA-MAX	WA-MIN
lángre lámm	172	199	-	273	138
	10.4	9.6	-	17.9	2.7
lángre númmer	169	205	-	273	139
	7.4	13.5	-	17.9	4.2
lángre lémmonar	168	203	170	276	142
	11.0	23.3	16.6	20.7	2.7
lángre laméller	173	203	189	276	139
	4.5	7.6	13.9	4.2	2.2
lángre lavemáng	175	200	-	270	140
	12.2	20.8	-	10.0	6.1
lángre nùnnor	168	193	184	267	141
	4.5	10.4	10.8	14.4	4.2
lángre làngare	165	193	-	260	142
	10.0	16.6	-	15.4	2.7
lànga lámm	173	216	168	276	140
	10.4	17.8	9.7	22.7	3.5
lànga númmer	171	226	173	280	144
	15.6	15.2	12.0	0.0	4.2
lànga lémmonar	171	222	169	284	146
	6.5	18.2	13.9	15.6	6.5
lànga laméller	169	221	167	280	142
	12.9	14.7	9.1	3.5	4.5
lànga lavemáng	172	222	169	279	139
	12.0	16.0	5.5	14.7	6.5
lànga nùnnor	166	206	162	263	138
	5.5	6.5	4.5	12.0	2.7
lànga làngare	167	212	165	269	142
	9.1	15.6	11.7	9.6	2.7

b)

	PRE-FOC 1st pos	PRE-FOCAL 2nd position		FOCAL 3rd position			
	WA-MIN	WA-MAX	WA-MIN	WA-MAX	WA-MIN	SA-MAX	TJ-MIN
lángre lámm	169	214	148	196	-	248	145
	6.5	9.6	6.7	4.2	-	7.6	3.5
lángre númmer	174	230	153	205	197	250	140
	7.4	22.4	7.6	13.2	21.7	18.7	7.1
lángre lémmonar	166	209	145	197	198	249	139
	5.5	10.2	6.1	5.7	12.0	12.4	2.2
lángre laméller	175	221	152	214	-	254	137
	12.2	26.8	10.4	11.9	-	13.9	4.5
lángre lavemáng	177	220	156	218	-	260	140
	16.0	13.7	8.9	7.6	-	6.1	0.0
lángre nùnnor	165	210	147	226	164	241	150
	9.4	12.7	12.0	11.4	20.4	24.3	12.2
lángre làngare	174	222	149	228	165	241	151
	6.5	12.5	7.4	10.4	10.6	14.7	8.9
lànga lámm	165	219	165	202	-	238	144
	7.9	8.9	7.9	10.4	-	7.6	4.2
lànga númmer	163	217	161	197	178	237	142
	5.7	14.4	8.2	9.7	19.4	8.4	2.7
lànga lémmonar	177	232	168	210	160	242	144
	20.8	18.2	13.5	17.7	18.4	14.8	6.5
lànga laméller	168	226	160	202	196	247	141
	2.7	12.4	5.0	6.7	2.2	8.4	2.2
lànga lavemáng	170	225	160	214	-	255	141
	12.7	15.0	10.0	14.3	-	12.7	2.2
lànga nùnnor	166	232	158	229	174	242	146
	11.9	10.4	7.6	7.4	9.6	11.0	12.5
lànga làngare	173	228	162	224	161	243	143
	8.4	8.4	5.7	10.2	4.2	12.5	2.7
lànganummer	174	241	154	-	-	249	147
	16.4	19.2	8.9	-	-	11.4	5.7

Table XIII. Timing of the word accent fall in post-focal position, the sentence accent rise in non-final and final position, and the terminal juncture fall for accent I (A I) and accent II (A II) for the two secondary speakers. Values for the end-point for each word are shown below the values for the starting-point: For the word accent fall, in ms relative to the CV-boundary of the stressed syllable; for the sentence accent rise in ms relative to the CV-boundary of the stressed (sp) and the post-stress syllable (ep); for the terminal juncture fall in ms relative to the CV-boundary of the final syllable; and for each fall or rise in % of the duration of the relevant segment (prevocalic C, stressed 'V, postvocalic C:, post-stress V or final V). Means ($\bar{x}$) and standard deviations (s).

	SPEAKER UN					SPEAKER HS				
WORD ACCENT FALL										
3rd position post-focal	ms $\bar{x}$	s	n	% $\bar{x}$	s	ms $\bar{x}$	s	n	% $\bar{x}$	s
A I núm̀mer	-78	19,7	10	7/C	24,1	-62	26,9	10	25/C	31,5
" "	72	24,3	10	53/'V	18,6	53	19,9	10	40/'V	14,0
A II nùnnor	60	15,5	10	42/'V	10,8	65	14,7	10	46/'V	10,3
" "	211	17,3	10	67/C:	11,8	237	19,4	10	80/C:	23,6
SENTENCE ACCENT RISE										
2nd position non-final										
A I lá́ngre /-										
A I lámm	-	-	-	-	-	29	15,6	5	22/'V	10,4
" "	-85	76,5	4	41/C:	57,4	-85	35,9	5	38/C:	23,0
A I laméller	44	50,6	4	25/'V	28,5	32	14,8	5	25/'V	12,2
" "	-75	90,8	4	49/C:	59,8	-47	14,8	5	62/C:	11,5
A II là̀nga /-										
A I lámm	219	23,0	5	50/C:	9,6	203	18,2	5	82/C:	14,9
" "	75	15,8	5	71/V	10,7	83	14,4	5	73/V	4,6
A I laméller	253	12,5	5	69/C:	14,8	234	10,8	5	112/C:	20,4
" "	114	26,8	5	118/V	37,5	162	21,1	5	157/V	25,1
3rd position final										
A I núm̀mer	52	37,3	10	34/'V	24,6	64	19,4	10	45/'V	13,0
" "	-115	57,6	10	15/C:	43,1	-78	32,2	10	50/C:	20,0
A II nùnnor	209	19,1	10	43/C:	7,9	254	23,1	10	44/C:	18,0
" "	14	15,2	10	10/V	10,2	51	9,1	10	32/V	8,3
TERMINAL JUNCTURE FALL										
3rd position										
A I núm̀mer	-33	40,0	10	76/C:	27,1	13	19,0	10	7/V	12,0
" "	74	22,5	10	58/V	21,4	111	20,4	10	69/V	12,1
A II nùnnor	64	14,9	10	47/V	10,0	90	9,3	10	56/V	10,2
" "	146	18,9	7	96/V	40,4	182	9,4	9	112/V	16,3

7 PERCEPTION OF SYNTHESIZED Fo-CONTOURS

A necessary complement to the acoustic analysis of Fo-contours in the pursuit of tonal regularities is the use of perceptual analysis of synthesized Fo-contours. In order to find a satisfactory answer to the question of what in an Fo-contour is perceptually and linguistically relevant, the obvious approach is to systematically vary different aspects of synthesized Fo-contours (cf. for example Malmberg 1955, Gårding & Abramson 1960, Hadding-Koch & Studdert-Kennedy 1963, 1964, 1974). Perceptual comparisons of these synthetic Fo-contours with internally represented pitch patterns of native listeners will then determine the "perceptually relevant pitch movements" ('t Hart & Cohen 1973:310). It is known from studies of synthesized Fo-contours that there may be a great perceptual tolerance for certain extensive changes in Fo, while other relatively small changes in the Fo-contours may cause a total reversal of identification (cf. 't Hart & Cohen op.cit.).

In the present study two aspects of Swedish intonation have been investigated in this way and are reported on in this chapter. In the first part of the chapter a perceptual test of the word accent distinction in non-focal position is described. The second part of the chapter gives an account of another perceptual experiment concerning the distinction between compounds and two-word phrases.

7.1 Perception of the word accent distinction in non-focal position

7.1.1 Background

The perceptual relevance of the systematic Fo-differences which were found to exist between accent I and accent II in non-focal position was tested in an experiment with synthetic speech. As has been shown in the analysis of the Fo-contours in sections 3.1.3, 4.2.1 and 6.2.2, there appears to be a clear difference in the timing of the Fo-fall in connection with the stressed syllable between the two word accents, so that the fall occurs earlier for accent I than for accent II. Furthermore a tendency for the Fo-fall in an accent I-word to be steeper than in an accent II-word was observed, while the Fo-maximum and Fo-minimum values before and after the fall

respectively were found to be more or less identical for both word accents. It was suggested that the timing difference of the Fo-fall is the constant, basic difference between accent I and accent II in Stockholm Swedish.

Therefore the question arises 1) whether such differences in the timing of just the Fo-fall, which are found in non-focal position in the Stockholm dialect, are also perceived as different word accents. Also, if these differences in the timing of the Fo-fall are perceived as different word accents, 2) how critical is this timing: is the shift of identification abrupt or do we find a more gradual transition from one word accent category to the other? Moreover 3) do the differences in the gradient of the Fo-fall, which can be observed when comparing accent I and accent II, play any role in the perception of the word accents? These questions formed the basis of the perceptual experiment.

7.1.2 Procedure

The synthesis was made at the Phonetics laboratory of the university of Umeå with the aid of an Ove IIIc speech synthesizer controlled by a Nova 820 computer.* The control program was an OVCON - Ove IIIc Control program, prepared by J. Liljencrants, Stockholm, and adapted for the use at the laboratory in Umeå by P. Asplund. The fundamental frequency could be varied from 55-315 hz in steps of 3 % and the duration from 1-255 ms in steps of 0,5 ms.

For the synthesis I chose a phrase consisting of an accent II-word in focus followed by a word in non-focal position, which might be either an accent I- or an accent II-word: INGA malmer, which may be interpreted either as a woman's name - the first name Ìnga and the surname Málmer -, when the latter word has accent I, or as 'no ores', when màlmer carries accent II. The first name Ìnga and the plural of the negative, indefinite pronoun ìnga are homophonous. The version of this phrase with the first word in focus is of course not the neutral one but presupposes a certain context.

The upper part of figure 29 shows the Fo-contour and the segment durations of this phrase. In the synthesis all factors

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* I am indebted to C.-C. Elert for letting me use the synthesis equipment.

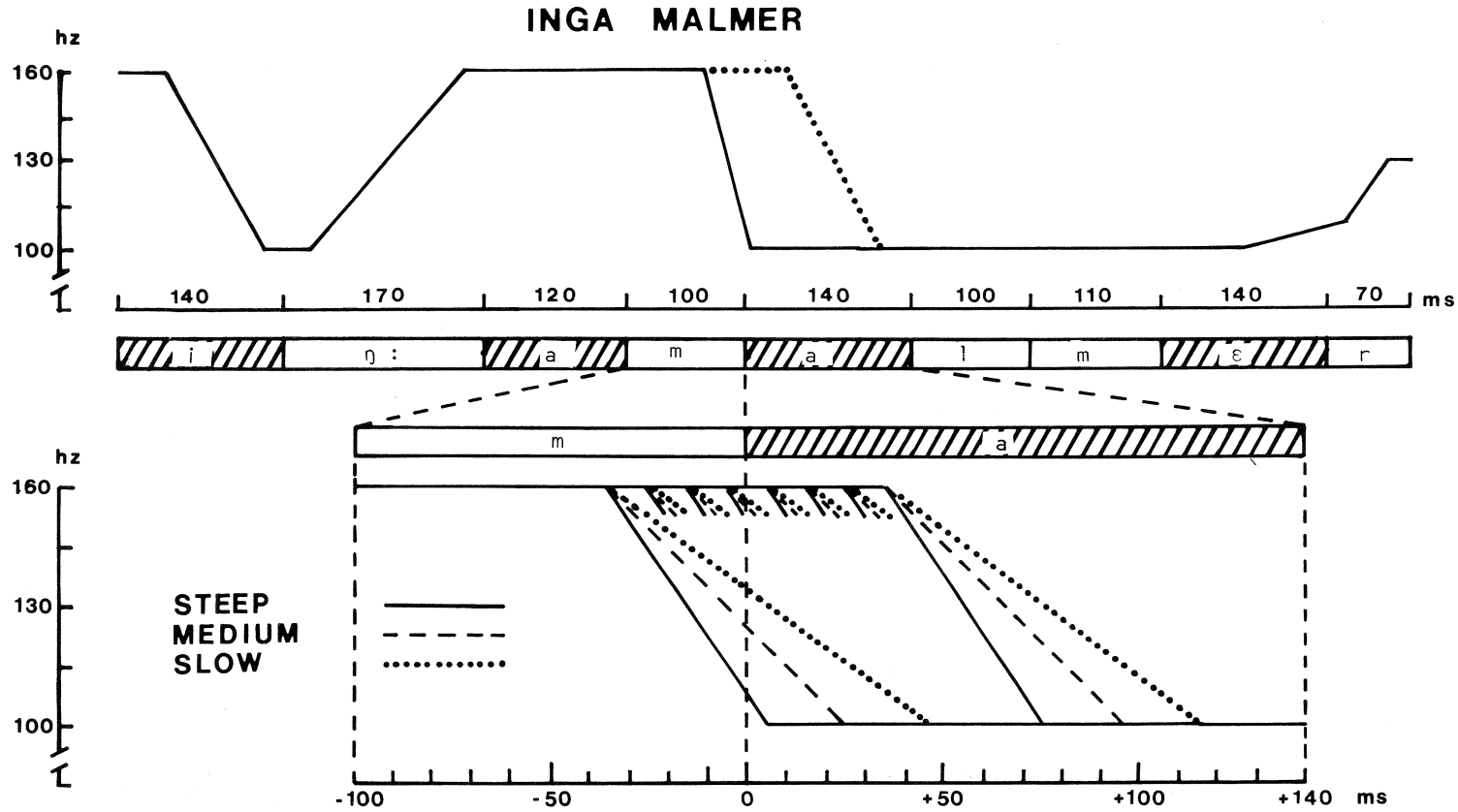

Figure 29. Synthesis of the word accent distinction in non-focal position. Fo-contour and segment durations of the phrase INGA malmer; the whole phrase (upper part) and the critical interval enlarged (lower part): Fo-falls with 8 different starting-points and 3 gradients. Only the first and last falls are represented in full.

were held constant except the Fo-contour within an interval in the second stressed syllable. In this interval (enlarged in the lower part of figure 29) the timing of the Fo-fall and the gradient of the fall are systematically varied. After a pilot test with a few Stockholm listeners eight different starting-points of the Fo-fall and three different gradients of the fall were chosen, 24 different stimuli altogether for the perception test. The starting-point of each fall differs from the preceding one by 10 ms. Of the eight starting-points four come before and four after the boundary between the consonant and the vowel (m and a). Each starting-point of the fall is combined with three different gradients. Thus Fo falls from 160 hz to 100 hz in 40, 60 or 80 ms, i.e. a steep, a medium and a slow gradient. This gives 12 different end-points for the fall, all of which are located in the vowel. There is an interval of 70 ms which separates the starting-point of the earliest fall from that of the latest, while the interval separating different stimuli relative to the end-points of the fall is 110 ms.

20 Stockholm listeners participated in the perception test. The group of listeners consisted of staff members at the Linguistics Institute and the Speech Transmission Laboratory, and first term students of phonetics at the University of Stockholm. Each of the 24 test stimuli appears three times in the test. These 72 stimuli were randomized on the test tape and were preceded by an initial buffer of eight stimuli. The buffer was not included in the results. For the whole test group of 20 Stockholm listeners there were, therefore, 60 judgements for each stimulus.

All the listeners heard the test tape through head-phones - Sennheiser HD 414. They were exposed to a few practice stimuli before the test. The 80 stimuli were presented in 10 series, of 8 stimuli in each, with a pause of 5 seconds between the stimuli of each series and longer pauses (10 seconds) between the series. The test lasted about 9 minutes. The test was of the forced choice type, and the choice was semantic, i.e. to determine which of the phrases 'woman's name' or 'no ores' was heard.

7.1.3 Results

Figure 30 shows for the whole listener group the scores obtained for each stimulus. The identification curves are lined up with

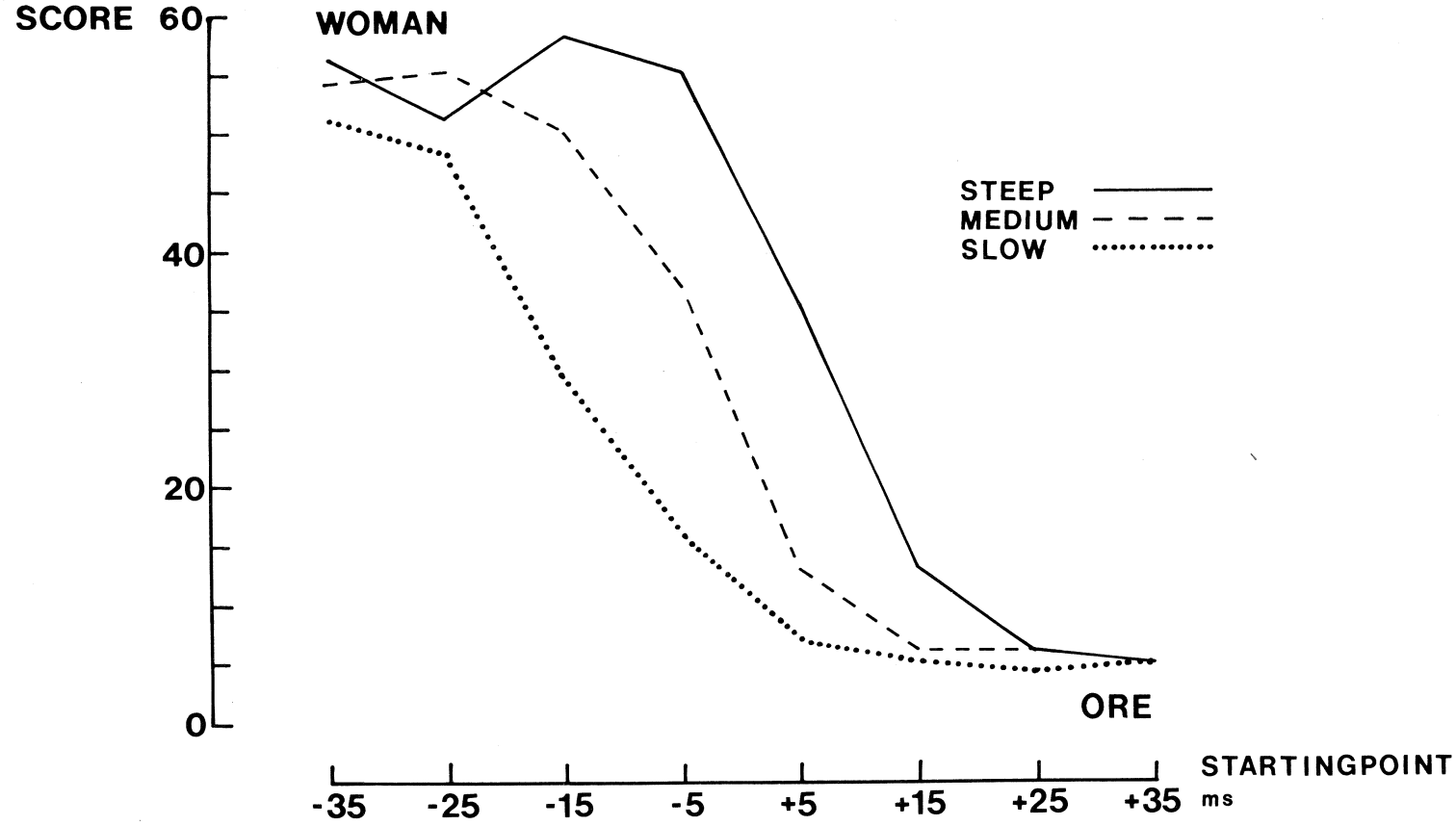

Figure 30. Identification curves for the synthetic phrase INGA malmer. Responses from 20 Stockholm listeners for 3 repetitions of each of 24 stimuli. The curves are lined up with reference to the starting-point of the fall for each stimulus.

reference to the starting-point of each fall.

In the steep series, the first four stimuli were heard as 'woman's name', i.e. accent I, stimulus no. 5 was ambiguous, while the three remaining stimuli were identified as 'no ores', i.e. accent II. In the medium series, the first three stimuli were heard as 'woman's namé', no. 4 received divided responses, and the four remaining stimuli were perceived as 'no ores'. For the slow series we find that only the first two stimuli were heard as 'woman's name', no. 3 was ambiguous, while all the remaining stimuli were identified as 'no ores'. In each series, then, there is one stimulus in the crossover region. For the other stimuli there is a rather clear predominance of the scores of either 'woman's name' or 'no ores'. In each series with the same gradient there is an obviously critical zone of 20 ms, where a crossover of identification takes place (figure 30). In critical cases the gradient of the fall seems to be decisive for the identification. The fourth stimulus in each series has the same starting-point for the Fo-fall but different gradients. The scores show that no. 4 with a steep fall was identified as 'woman's name', no. 4 with a medium fall received divided responses and no. 4 with a slow fall was judged as 'no ores' in most of the cases.

It is evidently not enough in all cases to know the starting-point of the Fo-fall in order to decide, whether the stimulus is accent I or accent II. Nor is the end-point of the fall a sufficient cue. In the left-hand part of figure 31 two stimuli with the same end-point of the fall but with different gradients are compared. The stimulus with the slow fall (sp = -25, ep = +55) was heard as 'woman's name', while the steep variant (sp = +15, ep = +55) was identified as 'no ores' (cf. figure 30). Instead we need a measure which takes into account that both the starting-point and the end-point of the fall play a role in the identification. One expression for this is the mid-point of the fall (suggested to me by S. Nooteboom), i.e. the point in time at which half of the range of the fall has been covered. In the right-hand part of figure 31 it can be seen that two stimuli, which are in the crossover region according to the perception test (figure 30), have exactly the same mid-point.

In the light of this finding the identification curves of figure 30 are rearranged with the mid-point of the fall as the

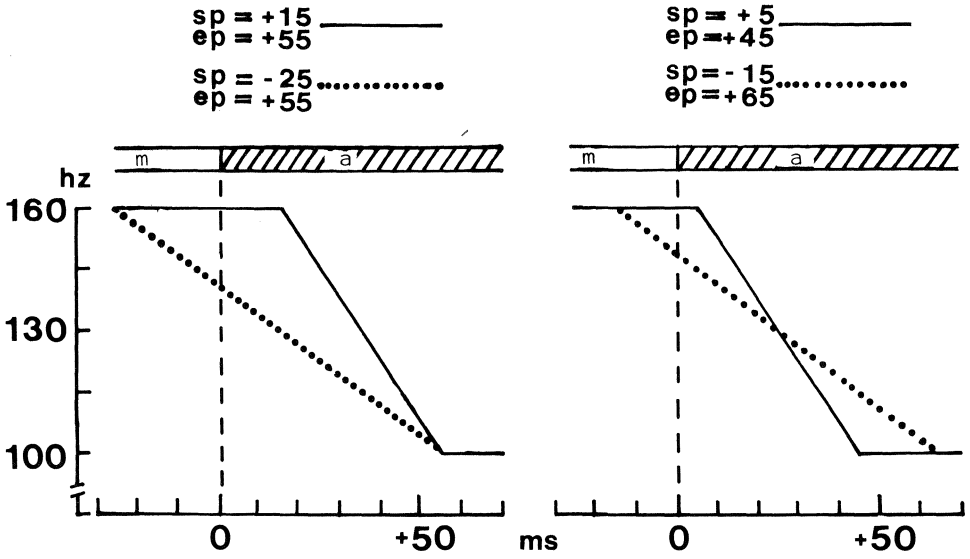

Figure 31. Fo-falls of synthetic stimuli with different gradients. Left: Falls with different starting-points and same end-point. Right: Falls with different starting- and end-points but same mid-point.

line-up point. This is illustrated in figure 32. It can now be seen that the three identification curves representing different gradients more or less coincide for the six mid-points which are common to the stimuli from the different gradient series. The obvious interpretation of this is that the gradient of the fall is irrelevant for the identification and that the timing of the fall determines the identification of the two word accents. More precisely, when the mid-point of the fall is located 15 ms - 10 % of the vowel duration - after the vowel onset or earlier, the stimuli are identified as accent I, but as early as 20 ms later - 35 ms after the vowel start or 25 % of the vowel duration - a shift of identification has taken place. This occurs regardless of whether two stimuli with the same mid-point have a relatively early starting-point and a relatively late end-point of the fall or the starting-point is late and the end-point is early. It seems possible to rotate the Fo-fall around a mid-point with a fixed time-location without shifting the identification, at least within certain limits. But different gradients of the Fo-fall are not equally represented in production. There

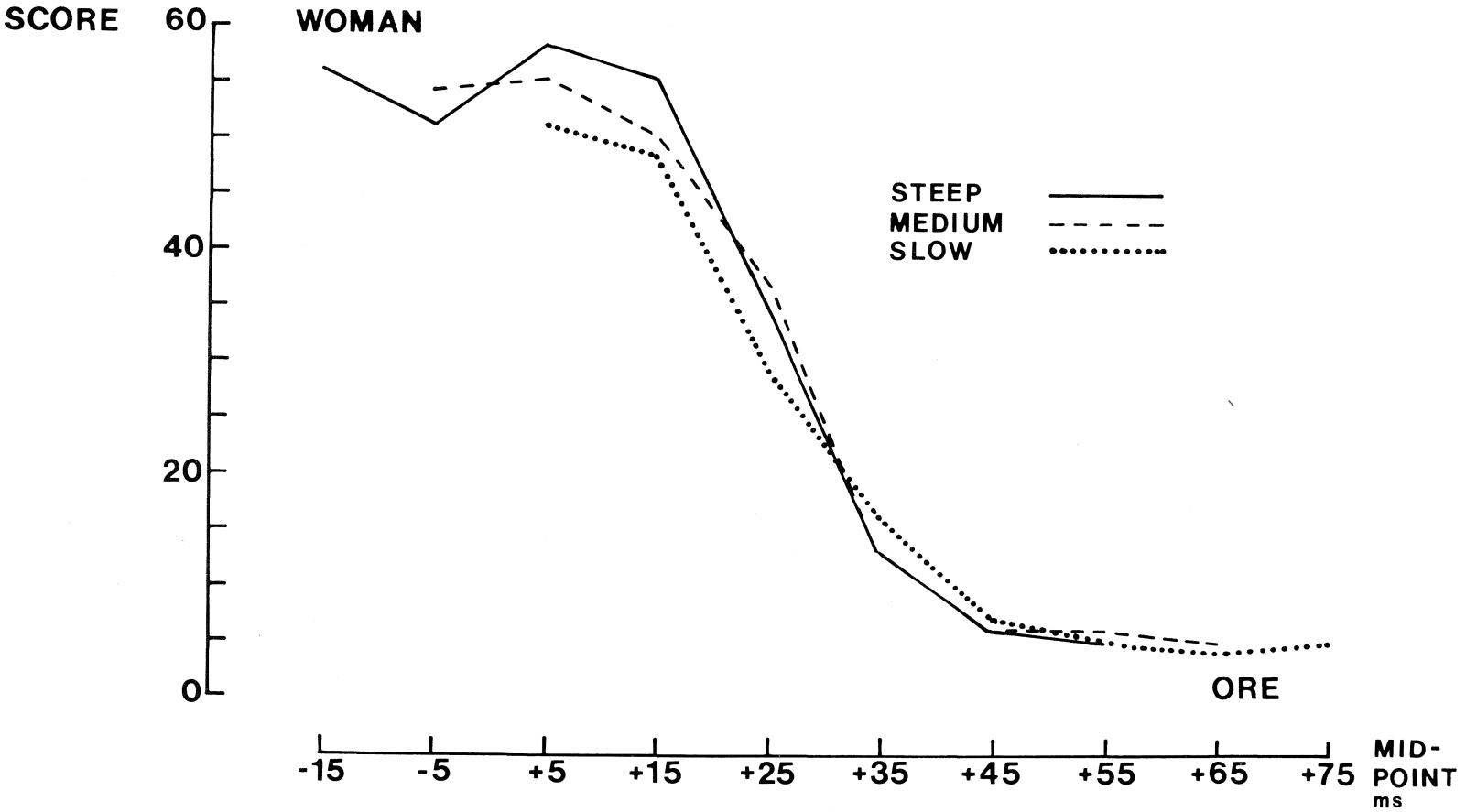

Figure 32. Identification curves for the synthetic phrase INGA malmer. Responses from 20 Stockholm listeners for 3 repetitions of each of 24 stimuli. The curves are lined up with reference to the mid-point or the fall for each stimulus.

seems to be a preferred gradient for a speaker depending on factors such as the word accent and the frequency range to cover (cf. 4.2.1).

The possibility of an order effect on the responses was checked, as it is possible that the response for a stimulus may be influenced by the immediately preceding stimulus. For example a preceding stimulus, which is unequivocally perceived as accent I, might elicit an accent II-response for a following ambiguous stimulus, while the same stimulus preceded by a clear accent II-response might be perceived as accent I. However, no systematic order effect could be detected. The variation in the response depending on the preceding stimulus did not appear to be greater for stimuli in the uncertainty region than for stimuli, which are clear instances of accent I or accent II.

7.1.4 Discussion

Our experiments indicate that the pitch relationships between the stressed and the surrounding syllables are important clues to the perception of word accents. This means that for an accent I-word in the context used - directly after focus - the relevant pitch levels for the pre-stress, stressed and post-stress syllables would be high-low-low, while for an accent II-word in the same context it would be high-high-low. An early timing of the Fo-fall relative to the stressed syllable - as expressed by the timing of the mid-point of the fall - will give the predominant impression of low pitch for the stressed syllable in e.g. malmer, as opposed to the high pitch of the pre-stress syllable, and will consequently be identified as accent I. For an accent II-response to result, the Fo-fall does not have to occur late in the stressed syllable, however. It seems to be enough that an impression of high pitch - in the given context not lower pitch than for the pre-stress syllable - is evoked for the first part of the stressed vowel. Apparently the only requirement is that the fall is not realized in the very beginning of the stressed vowel.

That the timing of the Fo-contour might be the important difference between accent I and accent II has been suggested by Haugen (1949): 'In those Scandinavian dialects which have tonal systems, the difference between two significantly contrastive tones may consist of nothing more than a different

timing of the tonal curve in relation to the syllabic stress'. In experiments with synthetic Fo-contours in meaningful Swedish words Malmberg (1955) found that a listener from the south of Sweden perceives accent I, if the Fo-peak is located within the first 50 ms from the onset of the stressed vowel, but accent II, if the Fo-peak is 75 ms or later in the vowel. If the Fo-peak is between 50 and 75 ms from the vowel onset, the identification is not clear.

My own experiment with synthetic simulation of the word accents reveals that the timing difference is important also for Stockholm Swedish, where the word accent distinction is usually described in terms of one versus two tone peaks (cf. the typology in 2.2). It could be assumed then that the common denominator of the word accent distinction in those Scandinavian dialects where it has a tonal manifestation - not only dialects with one-peaked word accents (cf. 2.2) -, is that the timing of the Fo-contour relative to the stressed syllable is earlier for accent I than for accent II. The absolute timing of the Fo-contour for the same word accent, however, can vary with dialect (cf. Bruce 1975).

Variation in the timing of the Fo-contour relative to certain segment boundaries seems to be a simple and efficient way of manifesting a tonal contrast. It has been recognized for other languages as well. In Serbo-Croatian, which has a distinction between so called falling and rising accents, the timing of the Fo-contour relative to the stressed syllable can be decisive for the identification. In an experiment with synthetic speech Purcell (1976) systematically varied the pitch peak location in the stressed vowel of a disyllabic Serbo-Croatian word. Native listeners identified stimuli with an early or central pitch peak as having a falling accent, while a pitch peak location in the end of the stressed vowel was perceived as a rising accent. The shift of identification from falling to rising accent appeared to be abrupt.

Also for Japanese it has been demonstrated that the timing of certain aspects of the Fo-contour is an essential feature for the distinction between word accent types. Fujisaki & Sugito (1976), in a study of the four word accents of two-mora words in the Osaka dialect, found that the timing of the underlying accent command relative to certain segment boundaries is of

primary importance in perception. In an identification test they showed that listeners based their word accent judgements on the relative timing of the onset and the offset of the accent command.

Summarizing the most important results of this perceptual experiment we can conclude 1) that the word accent distinction appears to be maintained in nón-focal position and 2) that the timing of the Fo-fall in connection with the stressed syllable - as expressed by the timing of the mid-point of the fall - is decisive for the identification of the word accents, but 3) the gradient of the fall turns out to be irrelevant. An early timing of the fall is interpreted as accent I and a late timing of the fall as accent II with a sharp shift of identification.

7.2 Perception of compounds and two-word phrases

7.2.1 Background

According to my analysis the constant, basic difference between a phrase consisting of an accent II-word followed by an accent I-word and a corresponding compound in Stockholm Swedish (and probably typical of the whole type 2 area (cf. 2.2)) is the presence of an Fo-peak in the syllable preceding the second stressed syllable (cf. section 3.2). A higher Fo in the pre-stress than in the beginning of the stressed vowel signals accent I and consequently two words. In the compound this peak is absent.

The perceptual relevance of the acoustic difference between these two types of construction was investigated in a perception test. The following questions should be answered. 1) Will the presence versus absence of such an Fo-peak - everything else being equal - in the syllable preceding the second stressed syllable favour the identification 'two-word phrase' instead of 'compound'? 2) If this is so, what is the minimal value of this peak for the response 'two-word phrase' to be evoked? 3) Is the minimal value of this Fo-peak for the perception of 'two-word phrase' dependent on the value of the preceding Fo-peak - the accent II-peak -, or is it perhaps dependent on the value of the following Fo-peak - the sentence accent peak, or some combination?

7.2.2 Procedure

The same synthesis equipment as in the experiment reported on in section 7.1 was used.

For the synthesis I chose a phrase, where the first part mèllan carried accent II as an independent word and the second part málen accent I. This phrase can be interpreted either as a one-word phrase mèllanmàlen, which is the definite plural form of the compound mèllanmàl 'between-meal snack', or as a two-word phrase mèllan málen, consisting of the preposition mèllan 'between' and the definite plural form of mál 'meal'. The phrase was synthesized in such a way that it simulated the Fo-contours derived from sentences with the second part of the phrase in focus in Stockholm Swedish. In the two-word phrase mèllan málen the preposition mèllan may occur stressed or unstressed in natural speech. Here, the stressed version of mèllan in the phrase was chosen for the synthesis, in order to minimize the difference between the two-word phrase and the compound. In the synthetic version of the phrase all parameters were held constant except the Fo-contour, where certain factors (specified below) were systematically varied.

Figure 33 shows Fo-contours and segment durations for the stimuli used in this perceptual experiment. The segment durations, which are found in the lower part of the figure, are the same for all stimuli, although in natural speech main-stress and secondary-stress vowels may differ in duration (cf. Lindblom & Rapp 1973). There are four series of stimuli. In each of these series the value of the medial Fo-peak, occurring at the end of the second, unstressed vowel in mèllan is varied in steps of approximately 5 hz. The way Ove IIIc sets Fo - variation in steps of 3 % - does not permit a constant frequency interval of exactly 5 hz. The description in this section will, however, follow the convention of giving the values in equal 5 hz steps.

In series 1, consisting of nine stimuli (figure 33, upper part), the Fo-peaks in the two stressed syllables are both 40 hz above the lowest Fo-level between the peaks and at the end (= 100 hz). In this series stimuli with eight different values of the medial Fo-peak and one stimulus without a medial peak (0-40 hz) are represented. In series 2, the surrounding Fo-peaks are instead both 20 hz (figure 33, second row). This series

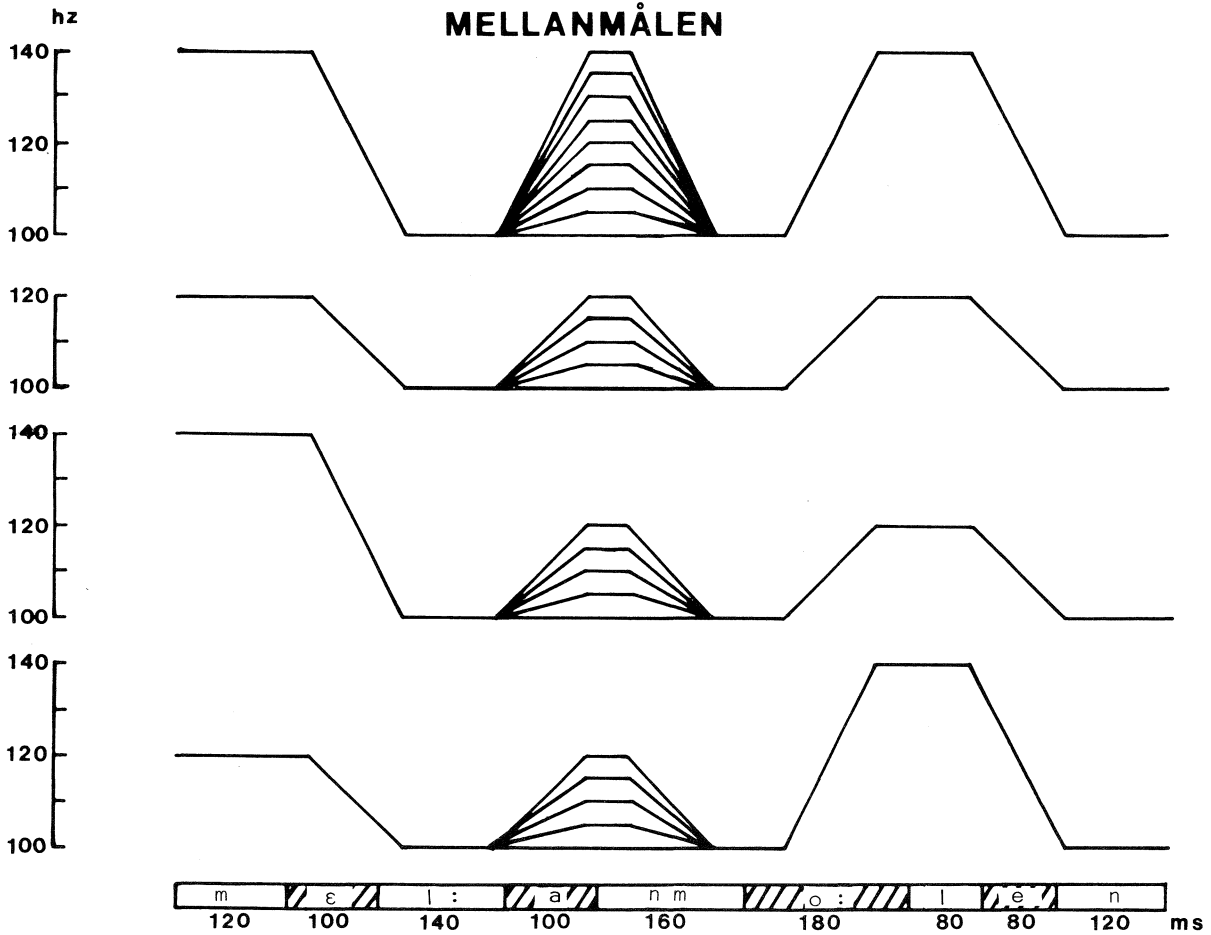

Figure 33. Synthesis of compounds and two-word phrases. Fo-contours and segment durations of 4 series of the synthetic phrase mellanMÅLEN, each series having two fixed, surrounding peaks and one variable, medial peak.

contains stimuli with five different medial Fo-peak values (0-20 hz). In series three and four, which are illustrated in the lower part of figure 33, the surrounding Fo-peaks are not of equal height. In series three the first Fo-peak is 40 hz and the last Fo-peak 20 hz with five values of the medial peak (0-20 hz). In series four the first Fo-peak is instead 20 hz and the last one 40 hz. Also in this series there are five different medial Fo-peak values. This makes a total of 24 different stimuli for this perception test.

The starting-point of an Fo-rise or fall as well as the corresponding end-point, has the same timing regardless of the Fo-range (see figure 33), which means that the gradient of a rise or fall varies with the range. Moreover the Fo-value at the end of the first vowel is higher (ca. 5 hz) for stimuli with a first peak of 40 hz than for stimuli with a first peak of 20 hz. An informal test had shown, however, that the Fo-value at this point is not decisive for the perception of the phrase as consisting of one or two words.

20 listeners from the Stockholm area took part in the perception test. The group of listeners consisted of staff members at the Linguistics Institute and first term students of phonetics at the University of Stockholm. Each of the 24 different stimuli is represented three times in the test. These 72 stimuli were randomized and were preceded on the test tape by an initial buffer of 8 stimuli, which were excluded from the results. As each stimulus appears three times in the test, 60 judgements were given for each stimulus by the whole test group. The test procedure used for the second perceptual experiment was practically identical to that of the first experiment (see 7.1.2). The listeners were instructed to choose one of the two alternatives mèllanmålen (one word) or mèllan málen (two words) - forced choice - for each test stimulus.

7.2.3 Results

Figure 34 shows the results of the test for the whole group of listeners. The scores obtained for one or two words as a function of the absolute value (in hz) of the medial Fo-peak in the stimuli are illustrated.

For stimuli in series 1 with both surrounding Fo-peaks at 40 hz, the synthetic phrase was perceived exclusively as one

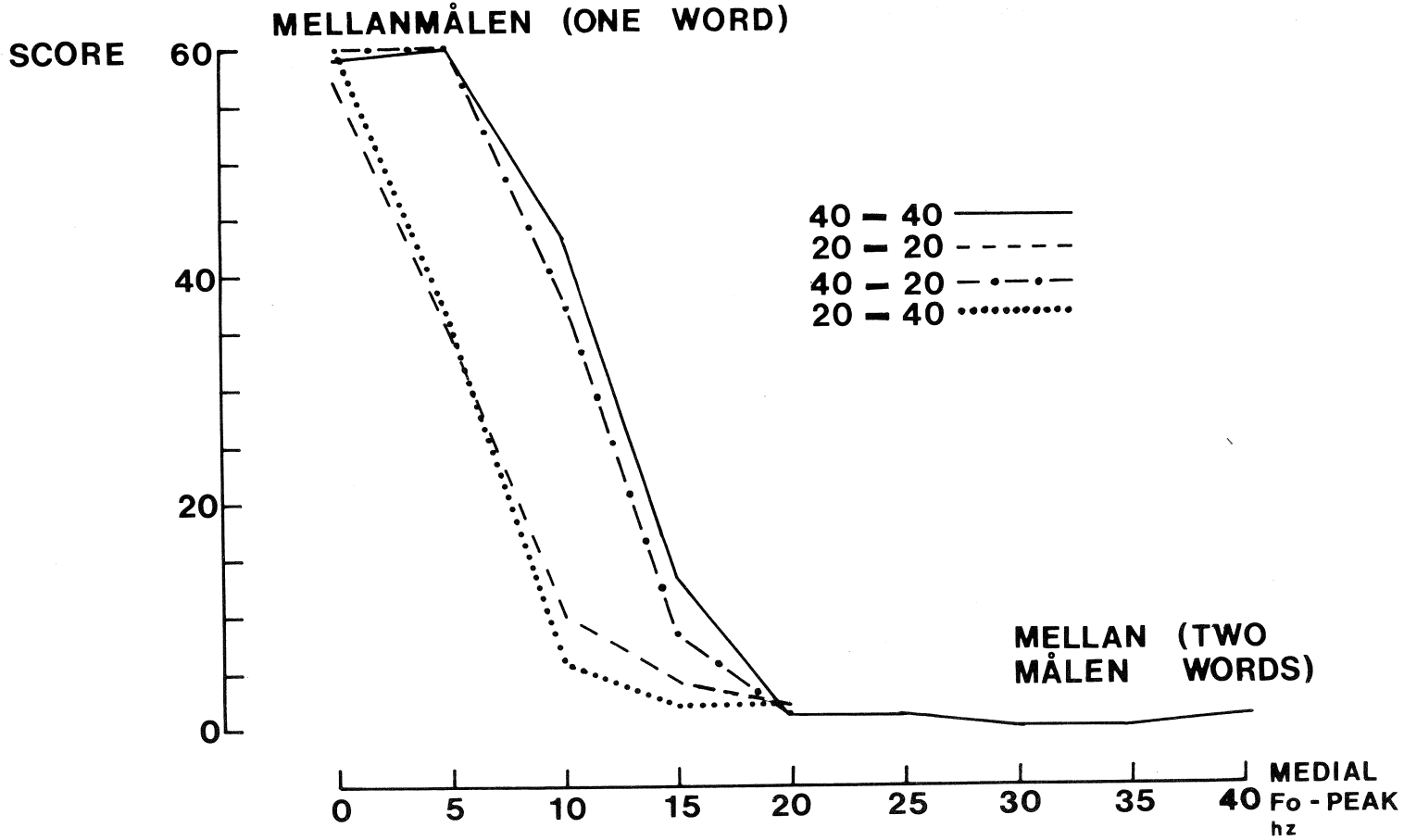

Figure 34. Identification curves for the synthetic phrase mellanMÅLEN. Responses from 20 Stockholm listeners for 3 repetitions of each of 24 stimuli. The curves are lined up with reference to the absolute value (in hz) of the medial peak.

word (mèllanmålen), when there was no medial Fo-peak (0 hz) or when the medial peak was 5 hz. But with a medial peak of 10 hz there was a tendency towards a shift in identification. When the medial Fo-peak was 15 hz, a total shift of identification occurred, so that most of the responses were for two words. From a value of the medial Fo-peak of 20 hz onwards, practically all responses were for two words. For stimuli in series 2, when the surrounding Fo-peaks were both 20 hz, there was a crossover of identification with a medial Fo-peak of only 5 hz. Only the stimulus without a medial Fo-peak was unambiguously perceived as one word. When the medial Fo-peak was 10 hz, there was a clear predominance of responses for two words, which was further reinforced for stimuli with a higher medial Fo-peak (15 and 20 hz). For the stimuli in series three, where the first Fo-peak was higher, the identification curve follows the one in which the two surrounding Fo-peaks were equally high (40 hz), whereas for stimuli in series four, with a lower first Fo-peak, the identification curve follows the one with equally low peaks (20 hz).

Thus we can conclude that in a phrase like that used in the test the presence of a medial Fo-peak in the syllable before the last stressed one is perceptually important and favours the identification 'two words'. The resulting tonal pattern signals that the construction consists of two words and not of one word. It is also evident that even a minor Fo-peak between the Fo-peaks in the two stressed syllables is all that is required for the identification of a stimulus as a two-word phrase.

The Fo-value of the medial peak required for a two-word response seems to be dependent on the value of the first Fo-peak. If the first peak is relatively high, a somewhat higher medial Fo-peak is required for a two-word phrase to be heard, than if the first peak is relatively low. On the other hand the value of the last Fo-peak in relation to the value of the first Fo-peak does not seem to play any role in the identification.

The results suggest that a certain ratio of the medial Fo-peak to the first Fo-peak has to be maintained in order for a phrase of the given type to qualify as a two-word phrase. It is hypothesized that the perceptual "boundary" between a one-word phrase and a two-word phrase is located at some point where the value (in hz) of the medial Fo-peak is equal to one fourth of the value (in hz) of the initial Fo-peak (I). In figure 35

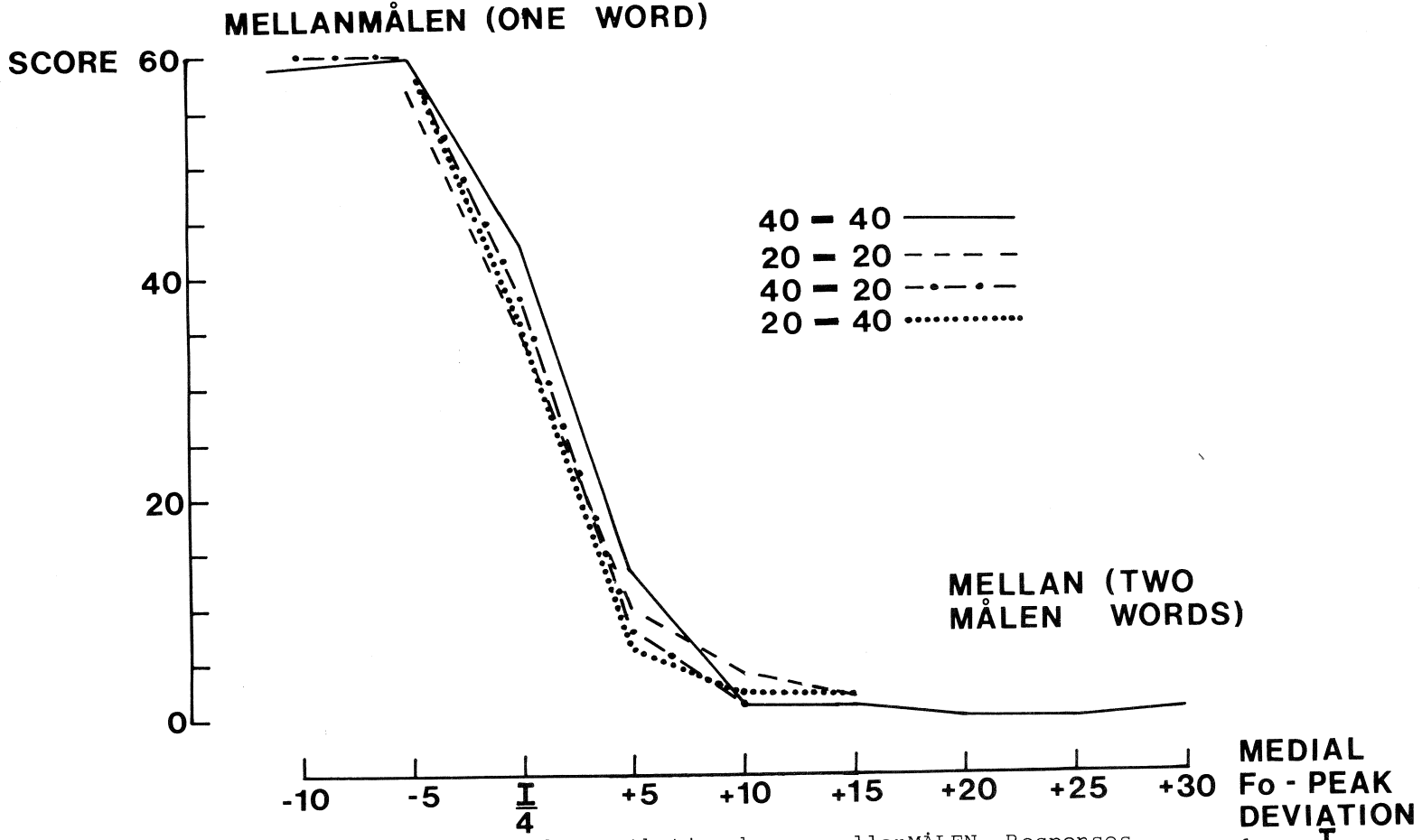

Figure 35. Identification curves for the synthetic phrase mellanMÅLEN. Responses from 20 Stockholm listeners for 3 repetitions of each of 24 stimuli. The curves are lined up with reference to the deviations of the medial peak from I/4.

the same identification curves as in figure 34 are lined up with reference to the deviations of the medial Fo-peak from I/4 instead of to the absolute value of the medial Fo-peak. With this arrangement all four identification curves more or less coincide. When for a stimulus the value of the medial Fo-peak falls below I/4, we can see that the phrase is identified as one word. On the other hand, when the value of the medial Fo-peak exceeds I/4 the stimulus is identified as a two-word phrase. This relationship between the first and the medial Fo-peak should be tested also for wider Fo-ranges and other voice registers.

It appears from an examination of the scores obtained for each individual listener in the perception test that all listeners respond to the stimuli in more or less the same way. As with the first perceptual experiment (cf. section 7.1.3), it does not seem possible to predict any systematic order effect on responses of ambiguous stimuli in the second test either.

7.2.4 Discussion

The results of this perception test show that in order for a listener to perceive the phrase as consisting of two words a certain minimal value of the ratio of the medial Fo-peak to the first peak has to be maintained. Now how do we explain this relativity? A plausible interpretation is the following. The listener expects a speaker to use approximately the same fundamental frequency range during a whole utterance. It is assumed that the range in the beginning of the utterance sets the reference. Therefore, if the speaker begins with a relatively wide frequency range in connection with the first Fo-peak, the listener will disregard minor changes in Fo like a small, medial Fo-peak. But if the speaker starts with a relatively narrow range, the same absolute value of the medial Fo-peak will be an integral part of the intonation pattern of that utterance, and the listener will pay attention to it.

Relativity of perception has been demonstrated also for other aspects of intonation. In a number of experiments, Hadding-Koch & Studdert-Kennedy (1963, 1964, 1974) tested the role of a terminal Fo-rise, in relation to other parameters, for the perception of statement and question in Swedish and American English. By synthetic manipulation of the Fo-contour of a test phrase they varied the values of the Fo-peak in the stressed syllable,

the turning-point before the terminal rise, and the end-point of the rise. Listening tests showed the importance of the entire Fo-contour. Not only the value of the end-point of the Fo-rise but also the preceding peak and turning-point appeared to be relevant for the identification of statements and questions. Both their tests and my own compound/two-word phrase experiment seem to involve the same perceptual strategy. The perception of one section of an Fo-contour is dependent on other parts of the same contour.

In summary, then, it has been shown that the presence of a sufficiently high medial Fo-peak in the actual construction clearly favours two-word responses, while a minimal Fo-peak or no peak at all will elicit compound responses with a narrow uncertainty region inbetween. The lowest value of the medial Fo-peak for the perception of two words appears to be proportional to the value of the preceding Fo-peak: A higher first Fo-peak requires a higher medial Fo-peak.

8 A QUALITATIVE MODEL OF SWEDISH INTONATION

In this chapter I will present a qualitative model of intonation in the form of a set of preliminary rules for generating Fo-contours of Swedish sentences. These rules concern primarily word accent, sentence accent and terminal juncture, and are based on the findings from the analysis and synthesis of Fo-contours reported on in the preceding chapters. It is believed that the rules are valid not only for Stockholm Swedish but are applicable in essential parts to the Central Standard Swedish area in general (cf. 2.2). The rules are intended to be used in a system of synthesis-by-rule (cf. Carlsson & Granström 1973).

The chapter contains five main sections. The first section gives a brief survey of previous models of Swedish intonation, in the second section the model components of the present model are outlined and in the subsequent sections the three kinds of rules - pitch rules, Fo-rules and join rules - are described.

8.1 Previous models of Swedish intonation

Öhman (1967) described a quantitative larynx model, which is in principle capable of generating Fo-contours of any language but which is primarily used to generate Fo-contours typical of the word accents in different Scandinavian dialects. The inputs to the model are step functions representing neural commands for sentence intonation and word intonation. These step functions are transformed into Fo-contours by a smoothing procedure. By the appropriate timing of one negative word intonation pulse in relation to one positive sentence intonation step, Fo-contours of accent I and accent II are simulated.

Gårding (1970) criticized Öhman's model and also proposed a revision of it. The criticism concerned mainly the weak empirical evidence for the postulated negative pulse. To generate Fo-contours of the Swedish word accents Gårding used only positive pulses with appropriate amplitudes, onset times and durations.

Carlsson and Granström (1973) presented a system of rules for predicting simplified Fo-contours of Swedish sentences. Statement intonation is marked by a linear fall in Fo of the base line, and word stress is marked by locating an Fo-minimum in the stressed vowel of an accent I-word and an Fo-maximum in the stressed vowel of an accent II-word. Fo-minima are also

located in the beginning and at the end of a sentence. Fo-contours are then generated by connecting these Fo-minima and/or Fo-maxima by suitable portions of a cosine wave.

My model of Swedish intonation ties in with models presented in Gårding & Lindblad (1973) and Gårding (1977a, b). Rules for generating pitch contours of one-word phrases in some Swedish dialects were sketched in Gårding & Lindblad (op.cit.). In their material a number of prosodic parameters were systematically varied: number of syllables, location and type of stress (neutral/emphatic), sentence intonation (statement/question) and word accent (accent I/accent II). The rules are output-oriented and specify pitch movements in utterance-final and stressed syllables with reference to four pitch levels. The range and the direction of the movement are indicated. Join rules fill out those parts of the contours which are not specified by the rules. In this way the rules are applicable to constructions of varying length.

In Gårding (1977a, b) with some cooperation from the present author, the rules were extended to cover also two-word phrases. Prominence (= focus) was included among the prosodic parameters. Some changes were made, e.g. three instead of four pitch levels were used, but the principal arrangement of the model remains the same. In some essential features the model to be presented below agrees with Gårding's model and constitutes a further elaboration of it.

8.2 Outline of model components

There are three kinds of rules in my model: pitch rules, Fo-rules and join rules. The input information to the pitch rules is a phonetic transcription, where the important points of information are the prosodic features: stress, word accent (accent I and accent II), sentence accent, initial juncture and terminal juncture. The pitch rules represent the tonal commands induced by the prosodic features in terms of two pitch levels, which are considered to be linguistically relevant: a LOW and a HIGH. There are two kinds of pitch rules, basic and context-dependent. The output of the pitch rules is a representation where tonal points are defined in terms of relative pitch (HIGH/LOW) with indications about their relative temporal locations. These tonal points can be viewed as ideal Fo-targets and give a rough picture of the essential tonal characteristics of an

utterance. But this tonal representation has to be further elaborated to fit actual Fo-data. The output of the pitch rules will be modified by the operation of Fo-rules. These rules specify the relative pitch levels as four different Fo-levels depending on the context. In order to receive a continuous Fo-contour of an utterance the points defined by the pitch rules and Fo-rules pass on to the join rules, which state how to interconnect these points and provide as the end-product the actual Fo-contour of an utterance. The model components are summarized in the following diagram.

8.3 Pitch rules

8.3.1 Input information

As was mentioned in the preceding section, the input to the pitch rules consists of a transcription with information about the location of unstressed and stressed syllables - secondary-stress as well as main-stress -, word accent (accent I/accent II) for a main-stress syllable, placement of sentence accent, initial juncture for an utterance-initial syllable and terminal juncture for an utterance-final syllable (see chapter 1). It should be noted that indication about the location of word boundaries does not seem to be necessary, when the position of main-stress and secondary-stress syllables is known. Besides the information given in the transcription it is assumed that the temporal rules of Central Standard Swedish (cf. Lindblom, Lyberg & Holmgren 1976) have assigned the correct durational values to the segments of the actual utterance.

8.3.2 Ordering

The pitch rules apply in a left-to-right order. In the transcription two or all of the features word accent, sentence accent and terminal juncture may occur in the same syllable. In a situation like this, where the transcription does not specify the order of the features, the tonal commands are to be executed in the order: word accent, sentence accent and terminal juncture.

8.3.3 Pitch levels

I have preferred to formulate the pitch rules in terms of pitch levels (HIGH/LOW) (cf. Malmberg 1961) rather than pitch movements (RISE/FALL), as for example in Gårding (1977a, b). This reflects the view that reaching a certain pitch level at a particular point in time is the important thing, not the movement (rise or fall) itself. In this way the rise or fall becomes a mere transition, which is necessary in order to go from one level to another. The transitions, then, are taken care of by the join rules (cf. 8.5). It is hypothesized that the interrelations in terms of relative pitch (HIGH/LOW) between successive syllables are of primary importance for the perception of word accent, sentence accent and terminal juncture (cf. 7.1). The rises and falls are often - at least partly - being executed during consonant segments, which can be voiceless and consequently cannot signal a pitch change. Instead the pitch change has to be inferred from a comparison of pitch levels in successive vowels, which are assumed to carry the primary intonational information.

8.3.4 Temporal reference

The rules specify the locations of HIGHs and LOWs with reference to the syllable. This choice is partly a matter of convenience. The following conventions are assumed to apply to the temporal location of tonal points in the syllable. It is believed that particularly the onset of the vowel segment is important for tonal events. Therefore, when a syllable is indicated as the temporal reference for a single tonal point, this means that the HIGH or LOW will be placed in the initial part of the vowel. When two tonal points - representing different pitch levels and belonging to the same or adjacent commands - occur in the same syllable, the first of these tonal points will be placed in the initial part of the vowel and the other one in the final part of the same syllable, which may be in a vowel or a consonant depending on the syllable structure. Occasionally, in an utterance-final stressed syllable, even three tonal points may occur in one and the same syllable: at the vowel onset, in the middle and at the end. When two tonal points of the same pitch level from adjacent commands occur in the same syllable, only one tonal point (representing both commands)

will be specified. As has been shown in my analysis of Fo-contours (cf. 3.1.3 and 3.2), word boundaries do not seem to be relevant temporal references for tonal events. It is immaterial, if a pre-stress or post-stress syllable functioning as the temporal reference for a tonal point belongs to the same or to another word than the stressed syllable.

8.3.5 Basic pitch rules

A basic pitch rule represents the tonal command for a prosodic feature, when it is not influenced by other tonal commands (cf. the basic Fo-contours, chapter 4). For each prosodic feature (except for word accent) the basic pitch rule specifies one tonal point - one HIGH or one LOW. For word accent (accent I and accent II) the basic pitch rule will specify two tonal points - one HIGH and one LOW. The tonal points prescribed by the basic pitch rules are distributed over successive syllables.

The basic pitch rules are the following. (They are exemplified in figure 36.)

ACCENT I: HIGH in the pre-stress syllable, LOW in the stressed syllable.

ACCENT II: HIGH in the stressed syllable, LOW in the post-stress syllable.

SENTENCE ACCENT: HIGH in the post-stress syllable.
(Accent I,
Compounds)

SENTENCE ACCENT: HIGH in the syllable following the post-stress
(Accent II) syllable.

INITIAL JUNCTURE: LOW in the utterance-initial syllable.

TERMINAL JUNCTURE: LOW in the utterance-final syllable.

The important difference between the word accents is one of timing of the tonal points relative to the stressed syllable. What the pitch rules for accent I and accent II give is essentially the common denominator for each word accent in different sentence positions. The timing of the sentence accent command is different for an accent I-word and an accent II-compound, on the one hand, and for a non-compound accent II-word on the other. In a compound the sentence accent command is tied to the secondary-stress syllable and in an accent I-word to the main-stress syllable, i.e. in both cases to the last stressed syllable of the word. Relative to accent I-words and compounds the sentence accent

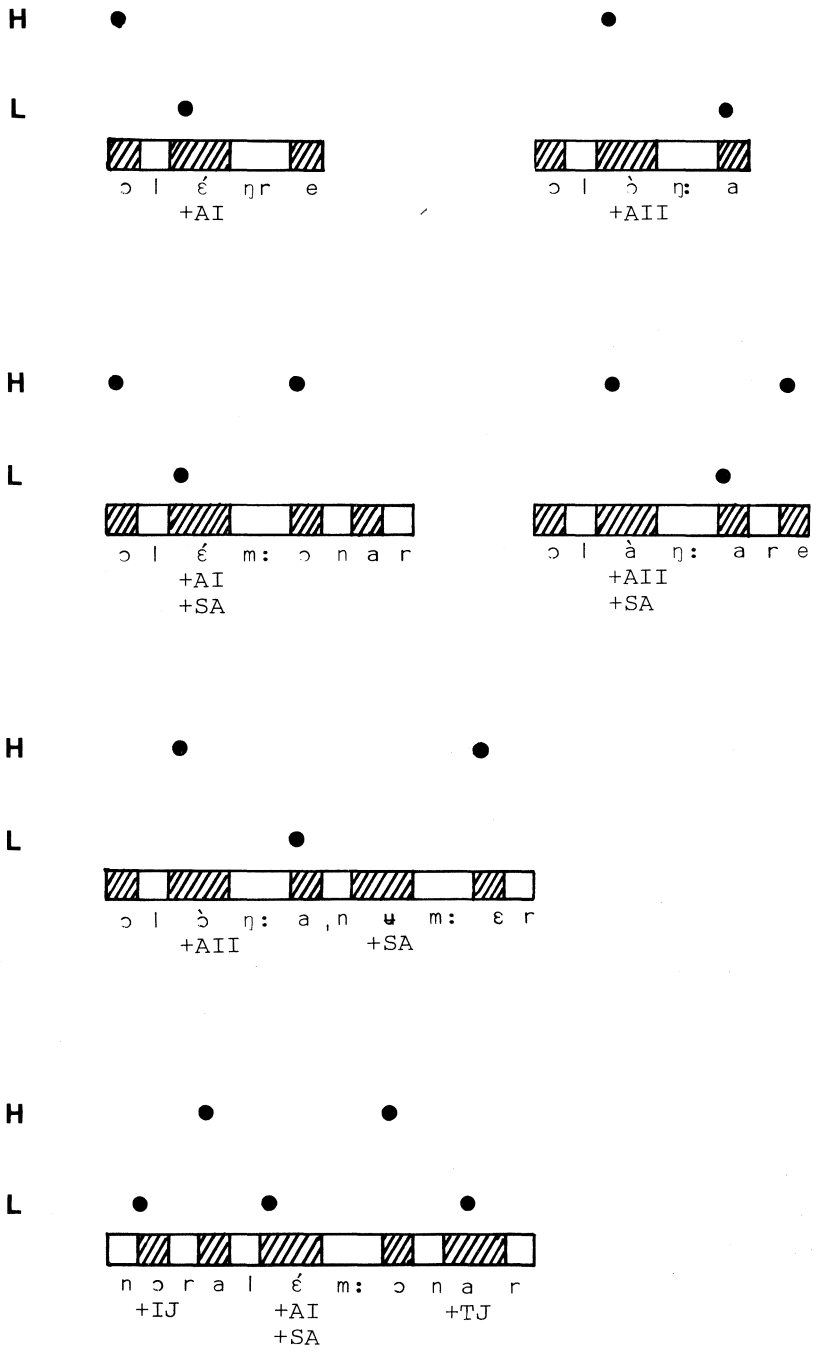

Figure 36. The effect of basic pitch rules. Tonal points with reference to two pitch levels - HIGH (H) and LOW (L) - with indications about their relative temporal locations. Accent I (AI), accent II (AII), sentence accent (SA), initial juncture (IJ) and terminal juncture (TJ).

command for non-compound accent II-words occurs with a delay of one syllable. For both accent I and accent II the HIGH for sentence accent occurs in the syllable following the word accent LOW.

8.3.6 Context-dependent pitch rules

When tonal commands occur adjacent to each other, they will normally influence each other (cf. the interplay, chapter 5). This influence often involves a temporal displacement of the tonal point of a command relative to the basic pitch rule, depending on the particular context. The context-dependent pitch rules replace the basic pitch rules in certain, specified contexts. Thus the basic pitch rules will apply to those contexts not specified by the context-dependent pitch rules.

The following context-dependent pitch rules are assumed to complement the basic pitch rules. (They are exemplified in figure 37.)

SENTENCE ACCENT: (Accent I, Compounds)	HIGH in the stressed syllable, if the post-stress syllable has accent I or terminal juncture (LOW), or if there is no post-stress syllable.
SENTENCE ACCENT: (Accent II)	LOW in the stressed syllable, HIGH in the post-stress syllable, if the following syllable has accent I or terminal juncture (LOW), or if there is no following syllable.

The timing of the tonal commands for word accent appears to be stable. The HIGHs for accent I and accent II seem to be temporally fixed points, which are not displaced in a situation with conflict of commands (cf. 5.6). Only the LOW for accent II may be anticipated to the final part of the stressed syllable (see convention in 8.3.4). The context-dependent rules mainly concern the HIGH for sentence accent, which appears to be temporally variable (cf. 5.6), always involving an anticipation. The LOW for terminal juncture is also temporally variable to some extent. This does not have to be expressed in a special rule, however. When the HIGH for sentence accent occurs in the utterance-final syllable the LOW for terminal juncture will automatically - according to the convention in 8.3.4 - occur later than when the HIGH for sentence accent precedes the final syllable.

The interaction between initial juncture and other tonal commands remains to be studied. It is therefore not fully accounted for in the model.

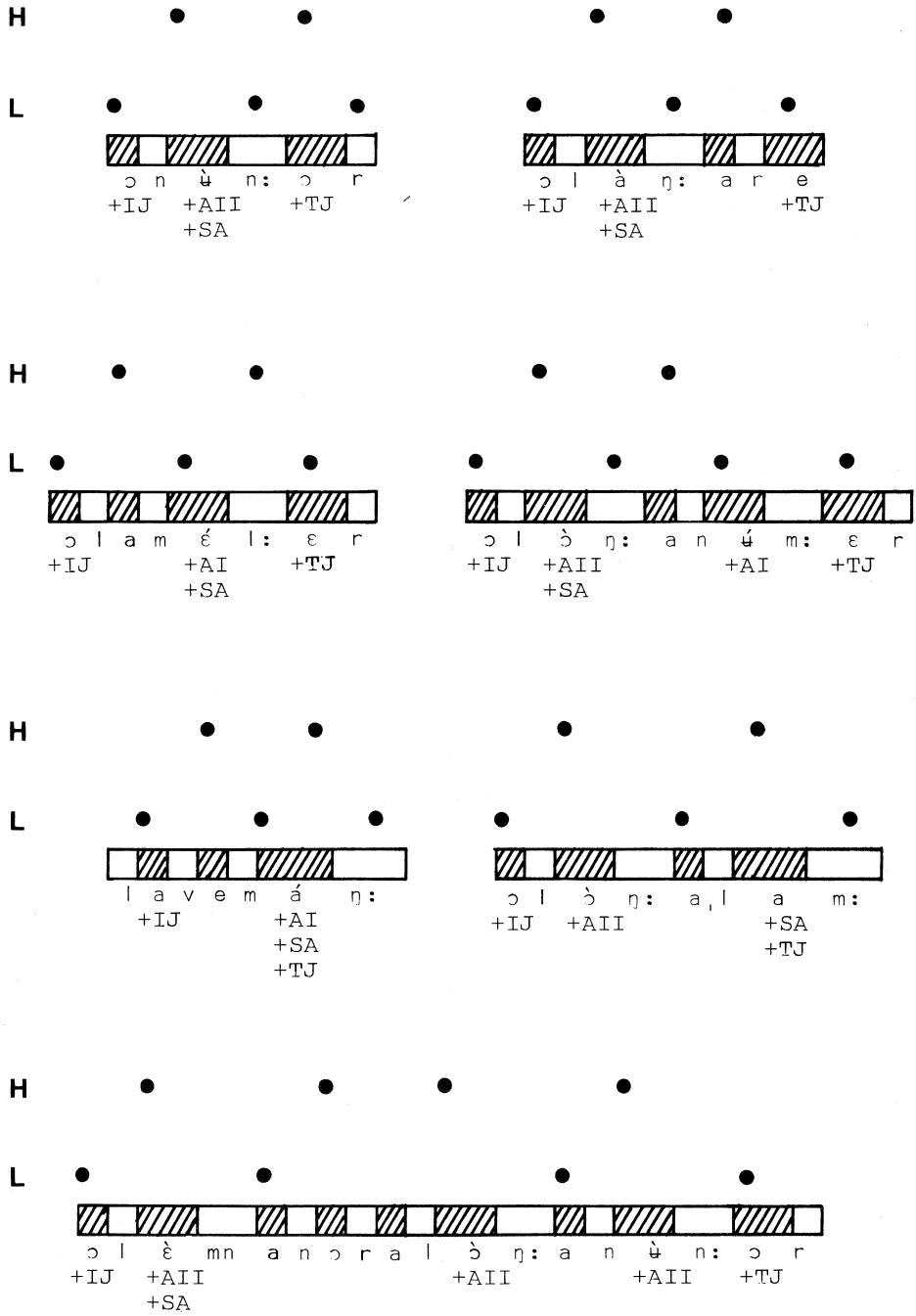

Figure 37. The effect of basic and context-dependent pitch rules. Tonal points with reference to two pitch levels - HIGH (H) and LOW (L) - with indications about their relative temporal locations.

8.4 Fo-rules

To account for the relationship between relative pitch levels and actual Fo-levels with a fair degree of accuracy, I have chosen here to let four Fo-levels correspond to the two pitch levels. These Fo-levels are referred to as 1, 2, 3 and 4 respectively from the lowest to the highest. The Fo-levels are assumed to constitute an ordinal scale with no necessary equidistance between them, although a constant frequency interval between the Fo-levels will be maintained, when they are represented in the figures. Fo-level 1 is considered to be the base level and is the true representative of the LOW pitch level. The Fo-movements can roughly be described as positive deviations in frequency from the base level in connection with accented syllables. Fo often returns to this level rather directly after such a positive deviation. A notable exception is the situation after the HIGH for sentence accent, where Fo can remain high in several unaccented syllables. In certain contexts the LOW pitch level will also be specified as Fo-level 2 (and occasionally as Fo-level 3). The HIGH pitch level can be specified as Fo-levels 2, 3 or 4, depending on the context. This means that Fo-level 2 can represent both a HIGH and a LOW pitch level, which may seem paradoxical. But the pitch levels HIGH and LOW are to be conceived of as relative and contextually specified for each case as a particular Fo-level.

8.4.1 Base line

I assume, for the sake of simplicity, a flat base line (Fo-level 1). There is some evidence for a downdrift in frequency for utterances in my speech material (cf. 4.2.2 and 6.4.4). This is also what has been found in a number of investigations and has been proposed in intonation models of different languages (Öhman 1967, Cohen & 't Hart 1967, Gårding & Lindblad 1973, Carlsson & Granström 1973, Maeda 1975, Thorsen 1976). It is likely that different slopes of the base line - rising or falling - reflect differences in sentence intonation, i.e. along the statement/question or certainty/uncertainty dimension (cf. suggestions in Bolinger 1964, Carlsson & Granström 1973, I. Johansson 1975, Thorsen 1976) and will probably have to be incorporated in the model to account for different sentence intonations.

8.4.2 Basic and context-dependent Fo-rules

The Fo-rules, like the pitch rules, can be divided into basic and context-dependent cases. A basic Fo-rule represents the normal case, which applies to all contexts except those stated in context-dependent Fo-rules. In this section both kinds of Fo-rules will be treated together.

For the specification of the two pitch levels as four Fo-levels I assume the following rules. (They are exemplified in figure 38.)

HIGH will be specified as Fo-level:

4 for word accent, when it directly follows HIGH for sentence accent

for sentence accent

3 for word accent

for sentence accent, when it occurs in the same syllable as LOW for terminal juncture

2 for word accent, when it directly follows LOW for word accent after focus

LOW will be specified as Fo-level:

1 for word accent

for initial juncture

for terminal juncture

2 for word accent, when it directly precedes HIGH for sentence accent

for word accent, when it directly follows HIGH for sentence accent plus HIGH for word accent and directly precedes HIGH for word accent

The word accent HIGH will be converted into one of the Fo-levels 2, 3 or 4. Fo-level 3 is the typical representative of the HIGH for word accent (accent I or accent II) in and before focus. The specification of the word accent HIGH as 4 and 2 represents two cases of position-dependent adjustment (cf. 5.2.3 and 5.3.2). The sentence accent HIGH will normally be specified as Fo-level 4. The only situation when the HIGH for sentence accent will be specified as Fo-level 3 is when it occurs in an utterance-final syllable before LOW for terminal juncture. This represents an instance of time-dependent adjustment (undershooting of an Fo-maximum target).

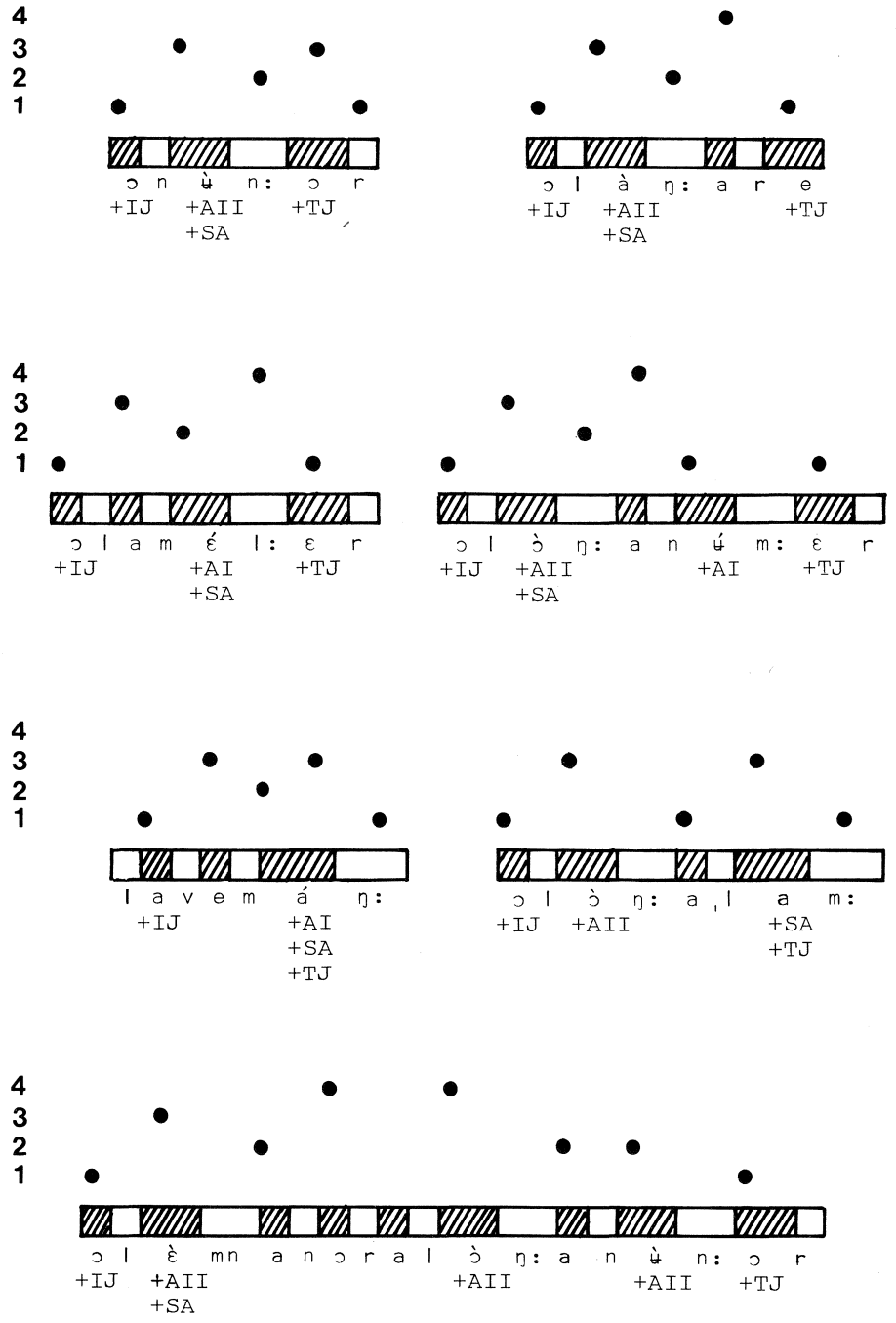

Figure 38. The effect of Fo-rules. Fo-points with reference to 4 Fo-levels with indications about their relative temporal locations.

Normally the LOW for word accent, initial juncture and terminal juncture will be specified as Fo-level 1. The specification of the word accent LOW directly after focus as Fo-level 2 represents a position-dependent adjustment to the following word accent HIGH, also specified as Fo-level 2. In a non-compound word in focus the LOW for word accent directly precedes the HIGH for sentence accent and will be specified as Fo-level 2. This represents a typical case of time-dependent adjustment (undershooting of an Fo-minimum target).

8.5 Join rules

In order to receive a continuous Fo-contour of an utterance the Fo-points defined by the pitch rules and the Fo-rules have to be interconnected. This is taken care of by the join rules. By these rules the rises, falls, plateaus and troughs of the Fo-contours will be filled out. The following join rules will be used. (The output of the join rules is exemplified in figure 39.)

Copy rule: Copy the Fo-level of a syllable on to the following syllable, if nothing else is indicated.

Join rule: Connect the Fo-points by a linear interpolation.

The copy rule will provide certain Fo-turning-points, which are not defined by the pitch rules or the Fo-rules. The join rule will then simply connect the Fo-points by a basically linear interpolation. There seems to be no apparent constancy for the gradient of an Fo-change. The rise/fall appears to be considerably steeper, when there is a wide range to cover. This is automatically accounted for by the join rule. In this connection it is interesting to note that the shorter distance between the HIGH and LOW for accent I than for accent II - due to differences in the duration of the intervening segments - will give rise to a steeper gradient of the Fo-fall for accent I as specified by the join rule (cf. 4.2.1).

Rules for microprosody, i.e. the segmental influence on the Fo-contour (cf. 2.1.3), are presupposed but not accounted for here.

Finally the whole derivation of a sentence from the phonetic transcription via pitch rules, Fo-rules and join rules to the Fo-contour is exemplified in figure 40.

A qualitative model - like the one presented here - is of course not merely an instrument of summarizing in a condensed

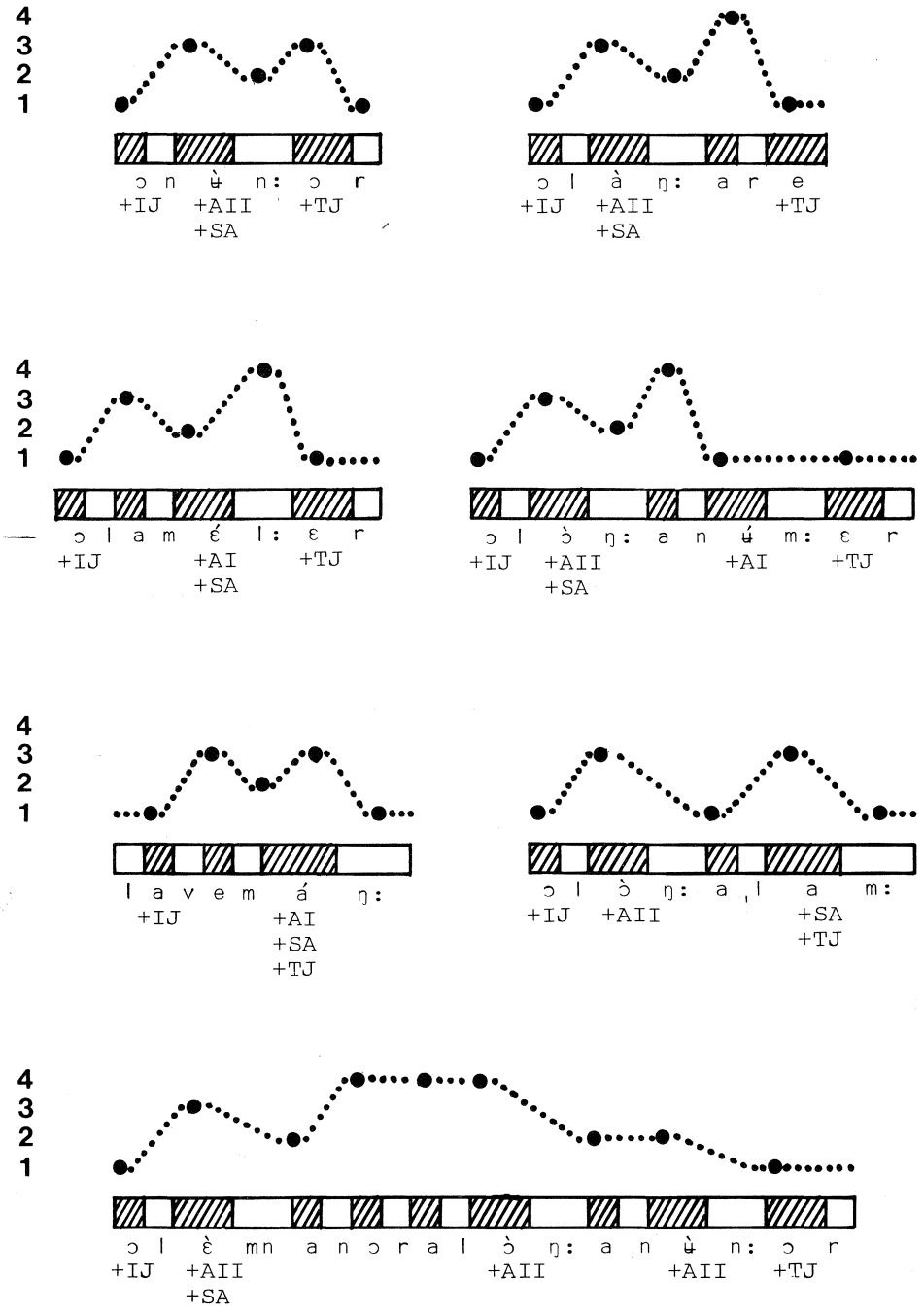

Figure 39. The effect of join rules. Fo-contours (dotted) containing Fo-points with reference to 4 Fo-levels with indications about their relative temporal locations.

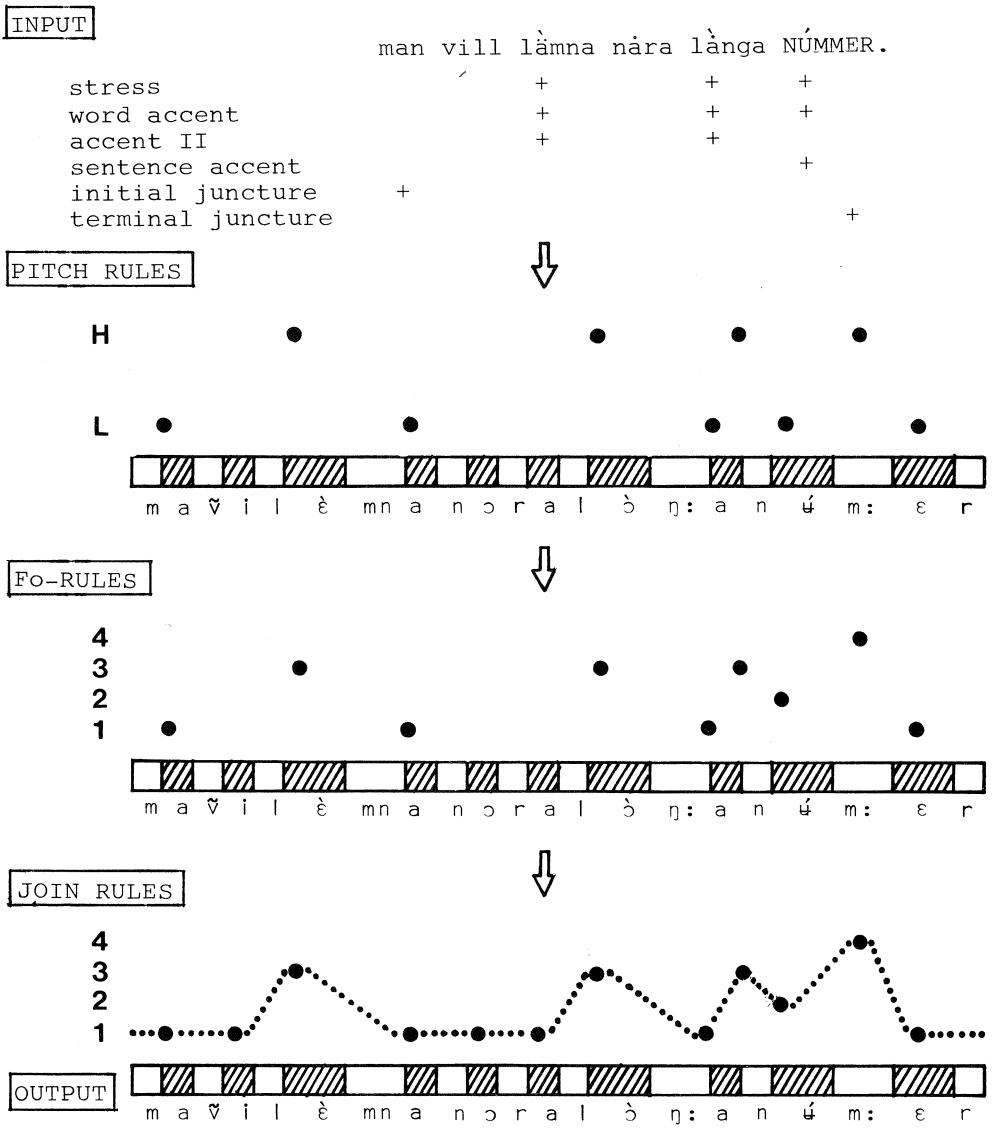

Figure 40. Derivation of the sentence man vill lämna nära länga NUMMER according to the model.

form the main results of an investigation. It should at the same time be looked upon as a hypothesis about the system underlying the observed Fo-contours. The present model is to be regarded as a tool, by which new, more explanatory models of Swedish intonation can be developed. This means that new experiments may be designed to test certain aspects of the model. Thereby, hopefully, we can arrive at new, deeper insights into Swedish intonation and intonation in general.

9 SUMMARY

The main object of this thesis is to determine how Fo is utilized in Stockholm Swedish to signal lexical prosody - the two word accents - and certain aspects of sentence prosody - sentence accent and terminal juncture.

A phonological analysis of Swedish prosody shows that a stressed syllable may occur with or without word accent independently of sentence accent, i.e. the distinction between accent I and accent II can be maintained, even if the word in question has no sentence accent. A stressed syllable is associated with one of the two word accents, if it is the only stressed syllable in a non-compound word or the first stressed syllable in a compound. A stressed syllable without word accent is found in the last element of a compound. If sentence accent (focus) is attributed to a word in a sentence, it is tied to the last stressed syllable of the word. In a non-compound word this is the main-stress syllable, and in a compound it is the secondary-stress syllable.

The test material designed for the analysis of Fo-contours consists of a large number of meaningful Swedish sentences. A typical test sentence in my speech sample has the form of an answer to a question. The idea is to keep the response sentence - the real test sentence - constant and vary its context. The context sentence - the question - is formulated in different ways in order to make the speaker choose one of several possible parts of the sentence as the focus and carrier of sentence accent. The investigation is based on the recordings of three Stockholm speakers, one primary and two secondary informants.

In the Fo-contour of an utterance, prosodic and segmental contributions are merged. Here an attempt has been made to minimize the effects of segmental influence on the Fo-contour and to vary only the prosodic context. By comparing Fo-contours for different word accents, with or without sentence accent and in final or non-final position in a sentence, the various prosodic contributions to the Fo-contour can be separated from each other. In this way it is possible to isolate the word accent fall (with an earlier timing for accent I than for accent II relative to the stressed syllable), the subsequent sentence accent rise (also with a different timing for accent I and

accent II and for compounds), and the terminal juncture fall, in the utterance-final syllable. For example, the characteristic double-peaked Fo-contour of an accent II-word in Stockholm Swedish can be shown to consist of a word prosody part - the first peak - and a sentence prosody part - the second peak. The Fo-contour of a two-word phrase consisting of an accent II-element plus an accent I-element appears to be clearly distinguished from the Fo-contour of a corresponding compound. The distinguishing factor is an Fo-peak, in the syllable preceding the last stressed syllable, which signals accent I and (thus) two words.

A fundamental assumption underlying my analysis of the Fo-contours is that each of the prosodic features - word accent, sentence accent and terminal juncture - has a basic Fo-contour. The basic contour is to be found in a context where there is minimal influence from other prosodic features. Each basic contour contains one Fo-minimum target and one Fo-maximum target. For word accent - accent I and accent II - the basic contour is assumed to occur in a position, where the word has no sentence accent. More specifically the pre-focal contour is chosen as basic. Accent I is characterized by an Fo-maximum in the pre-stress syllable and an Fo-minimum in the stressed syllable, while for accent II the corresponding Fo-maximum occurs in the stressed syllable and the Fo-minimum in the post-stress syllable. The fall connecting the Fo-maximum with the Fo-minimum tends to be steeper for accent I than for accent II. There are negligible or non-existent differences in Fo-maximum and Fo-minimum values between accent I and accent II for the same position in the sentence. The basic contour for sentence accent is found in a compound in a non-final position. Here the sentence accent rise occurring in connection with the last stressed syllable is often well separated in time from the preceding word accent fall (accent II) in the first stressed syllable and therefore easily extractable. Typically Fo rises from a minimum in the last stressed syllable to a maximum in the post-stress syllable. After reaching the Fo-maximum for sentence accent, Fo stays at a high level, until a word accent or terminal juncture command causes Fo to decrease. This means that the Fo-plateau formed between the sentence accent rise and the subsequent fall may be of considerable length, if a sufficient number of unstressed

syllables intervene. The basic contour for terminal juncture occurs in a context where the sentence accent rise does not immediately precede the terminal juncture fall. This is found for a word in final position, where the stressed syllable is separated from the final syllable by one or more unstressed syllables, e.g. a trisyllabic ´accent I-word with initial stress or a compound with the antepenult as the last stressed syllable. In this case Fo falls from a maximum in the second final syllable to a minimum in the final syllable.

When a sequence of tonal commands is to be executed it is not to be expected that the consequences of these commands will be a mere juxtaposition of basic Fo-contours. Instead certain adjustments of the basic contours, depending on the particular context, will take place. The interplay of the basic contours involves time-dependent and position-dependent adjustments. The most typical time-dependent adjustments are: 1) Interruption of the word accent fall by an immediately following Fo-rise - sentence accent rise or word accent rise. This interruption results in an undershooting of the intervening Fo-minimum target.
2) Anticipation of the sentence accent rise because of a directly following word accent fall or terminal juncture fall.
3) Delay of the terminal juncture fall because of the preceding sentence accent rise. The simultaneous anticipation of the sentence accent rise and the delay of the terminal juncture fall may cause an undershooting of the intervening Fo-maximum target. There are two instances of position-dependent adjustments of basic contours. In the first post-focal position the word accent maxima are adjusted to the sentence accent maxima. If two successive word accents are to be executed after the sentence accent, Fo decreases in two steps, the first step covering a much wider Fo-range than the second one. In the second post-focal position the word accent maxima and the preceding word accent minima are adapted to each other.

The temporal stability of the word accent contours and the temporal variability of the sentence accent and terminal juncture contours appear to be features characteristic of all three speakers. The most obvious differences between the speakers pertain to the realization of a sequence of word accent, sentence accent and terminal juncture, particularly in accent I-words.

At one extreme we can find the full realization of the word accent rise and fall, the sentence accent rise and the terminal juncture fall even in oxytonic words, while at the other extreme there is only a single rise (a combination of word accent and sentence accent rise with omission of the word accent fall) and a terminal juncture fall. Even one and the same speaker may vary considerably as to the realization of these contours; the speaker may either perform the maximal Fo-movements or have Fo take a short-cut.

In the search for tonal regularities, the use of perceptual analysis of synthesized Fo-contours is an important complement to the acoustic analysis of Fo-contours. In order to find a satisfactory answer to the question of what is perceptually and linguistically relevant in an Fo-contour, the obvious approach is to systematically vary different aspects of synthesized Fo-contours. In the present study two aspects of Swedish intonation have been investigated in this way. One experiment concerns the perceptual importance of the apparent timing difference and the possible gradient difference between the Fo-fall for accent I and accent II in non-focal position. The results show that the word accent distinction is maintained in non-focal position, and that the timing of the Fo-fall in connection with the stressed syllable - as expressed by the timing of the mid-point of the fall - is decisive for the identification of the word accents. The gradient of the fall, however, turns out to be irrelevant. An early timing of the fall is interpreted as accent I and a late timing of the fall as accent II with a sharp shift of identification. The second experiment concerns the perceptual importance of a medial Fo-peak, between the accent II-peak and the sentence accent peak, for the identification of compounds vis à vis two-word phrases. The results indicate that a construction with a sufficiently high medial Fo-peak is identified as two words, while one with a minimal Fo-peak or no peak at all is heard as a compound with a narrow uncertainty region in between. The lowest value of the medial Fo-peak for the perception of two words appears to be dependent on the value of the initial Fo-peak: A higher initial peak requires a higher medial peak.

Based on the findings from the analysis and synthesis of Fo-contours in the present thesis a qualitative model of Swedish

intonation was constructed, modifying and refining an earlier model by Gårding. There are three kinds of rules in the model: pitch rules, Fo-rules and join rules. These rules convert a phonetic transcription of a sentence, with indication about location of unstressed and stressed syllables, word accent (accent I/accent II) and placément of sentence accent, initial juncture and terminal juncture, into Fo-contours. The pitch rules transform the prosodic feature labels in the transcription into tonal points defined in terms of relative pitch (HIGH/LOW) with indication about their temporal location relative to the syllable. This will give a representation of the essential tonal characteristics of an utterance. But this tonal picture has to be further elaborated to fit actual Fo-data. The Fo-rules specify the relative pitch levels as one of four Fo-levels depending on the context. In order to receive a continuous Fo-contour for an utterance, the points defined by the pitch rules and the Fo-rules in combination have to be connected with each other. This is taken care of by the join rules, which state how to interpolate between the Fo-points.

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