

A COMPARATIVE STUDY OF SWEDISH, GREEK AND FRENCH INTONATION

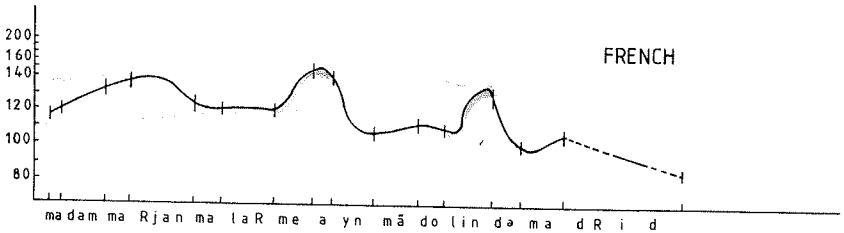
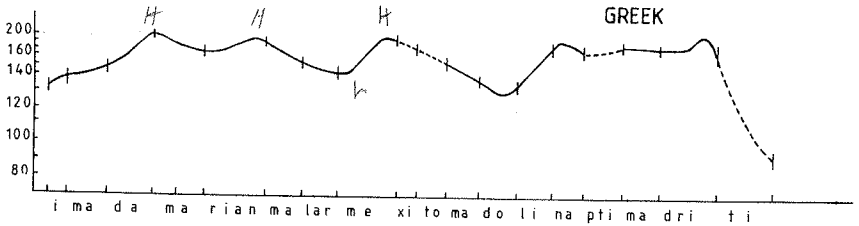
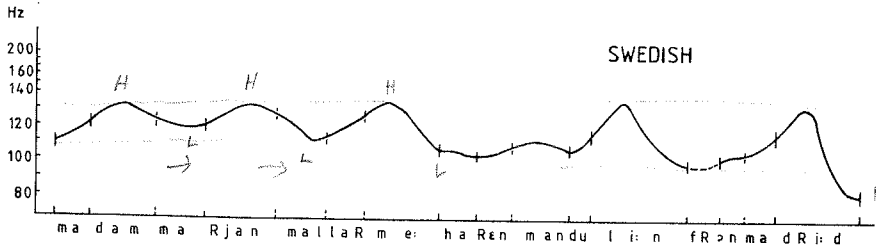
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AN INTONATION MODEL

Most intonation contours look very complex at first sight. Experience shows, however, that we can get simple descriptions by indicating the important turning points, their pitch values and their positions in the sentence. The contour is then obtained by connecting the turning points with a smooth curve over the voiced segments.

What are then these important turning points? With an appropriate material, consisting of sonorant segments that do not disturb the local pressure conditions at the glottis, it can be shown that the turning points cooccur with crucial communicative events, such as lexical accents, focal accents at phrase and sentence level, morphological and phrasal boundaries. All of these linguistic variables are embedded in one and the same curve.

A model based on these general observations has been developed for Swedish dialects, (e.g. Gårding & Lindblad 1973, Gårding 1977, 1979, Bruce 1977, Bruce & Gårding 1978, 1981) and in this paper we shall demonstrate how it can be used to describe the intonation of other languages as well. For the demonstration we shall use one particular sentence for which the intonation will be generated in Swedish, Greek and French. The sentence is 'Madame Marianne Mallarmé' which has been uttered in a narrative style with equal semantic weight given to the words *Mallarmé*, *mandolin* and *Madrid* as if it had been the first sentence of a short story. Typical observed sentences are shown in Figure 1. The corresponding inputs to the model are given in the lower part of the figure. There are markings for word accents (A), for Swedish only one of the two existing accents is used (A1), phrase accents (PA) and sentence accent (SA).



Swedish St^{A1 A1 PA PA SA}_{A1 A1 A1 A1 A1}[madam: marian: malar me://har en manduli:n/frøn madri:d]St

Greek St^{A A PA/A PA SA}[i madam marian malar me//exi to mandolino/apo tin madriti]St

French St^{PA PA SA}[madam marian/malar me/a yn mädölin/dæ madri:d]St

word boundaries: spacing

phrase boundaries: / /

sentence boundaries: []

A : word accent

A1: acute word accent

PA: phrase accent

SA: sentence accent

St: statement

Figure 1. Statement intonation in observed sentences above.
Inputs to the model below. From Gårding 1981.

*it is not an
extra boundary.*

Brackets and slashes show three kinds of syntactic boundaries, for the sentence, the major phrases and the phrase internal constituents. In this example we have tried to find a complete correspondence between syntactic and prosodic boundaries, which of course is very unusual in spontaneous speech. Nevertheless, the French speaker has put in an extra boundary before Mallarmé. The sentence boundary is labelled *St* for statement. Figure 2 presents the stages of the model (for a fuller account see Gårding 1981).

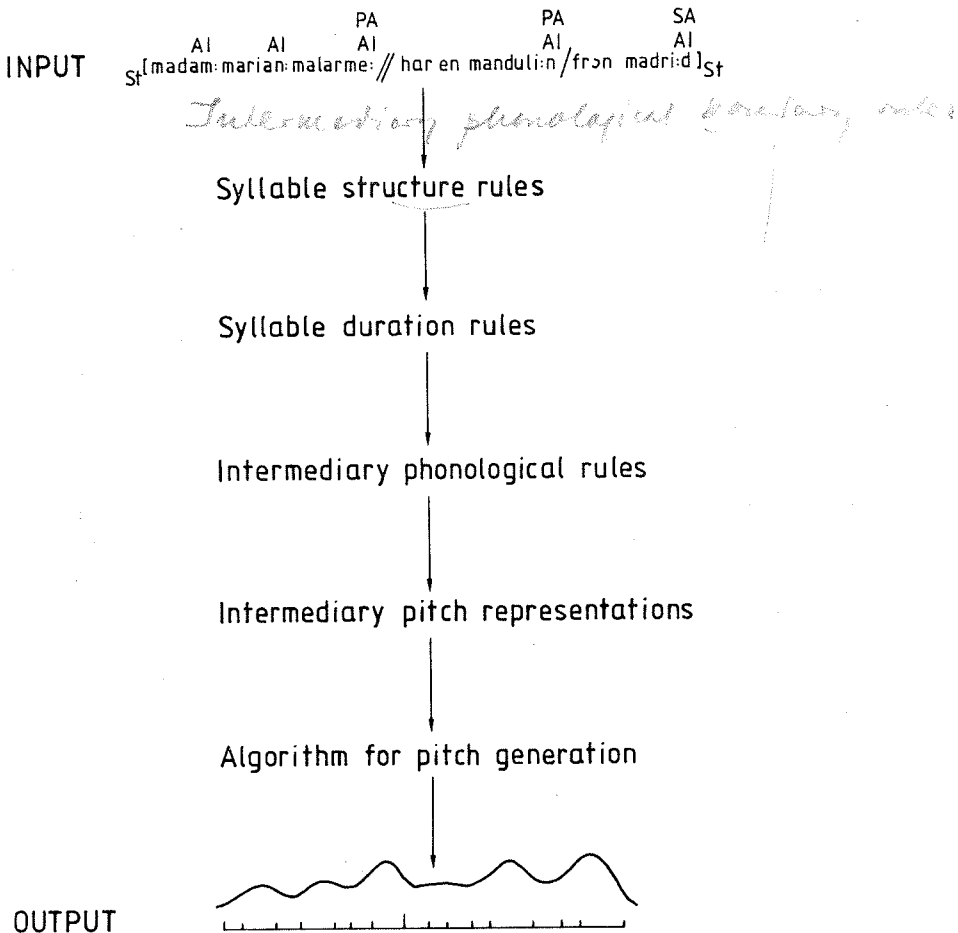


Figure 2. Model for prosody. From Gårding 1981.

Here we shall assume that the input phrase has passed through the first two stages of the model, the syllable structure rules and the syllable duration rules, the effects of which have been demonstrated earlier (Gårding 1981). These rules give syllable durations and total durations consistent with the observed data. The French sentence is short mainly due to the lack of long accented syllables, the Swedish sentence is long because of the presence of such syllables.

Provided with the correct durations, the demonstration phrase is ready for pitch assignment. At the third stage, the intermediary phonological rules adjust context dependent symbols. One phenomenon which is fairly general across languages is that there are no pitch obtrusions in connection with accents after focus. Hence the word accent symbol which has already produced the duration appropriate for an accented syllable will here be deleted by an intermediary phonological rule. It is in this rule among others that our three compared languages differ. The pitch obtrusions characteristic of accents are not present after focus in Greek and French. They occur in Swedish, however (see examples in Figure 3).

The rules of the fourth stage, the intermediary pitch representations, transform the abstract symbols into more concrete ones. Global features, i.e. features connected with sentence and phrase, are expressed as a Rise, a Fall or a Level. Local features, those that pertain to syllables or words, are expressed as Highs and Lows which are going to become turning points in the final pitch contour.

The algorithm for pitch generation (Figure 4) works on this new notation. It has the following rules:

RULE 1 produces a tonal grid which represents the overall plan for sentence intonation. For a declarative sentence of the given structure it looks like the grid of Figure 5. The interior solid lines represent the bounds of not weakened accents within a phrase. The exterior hatched lines

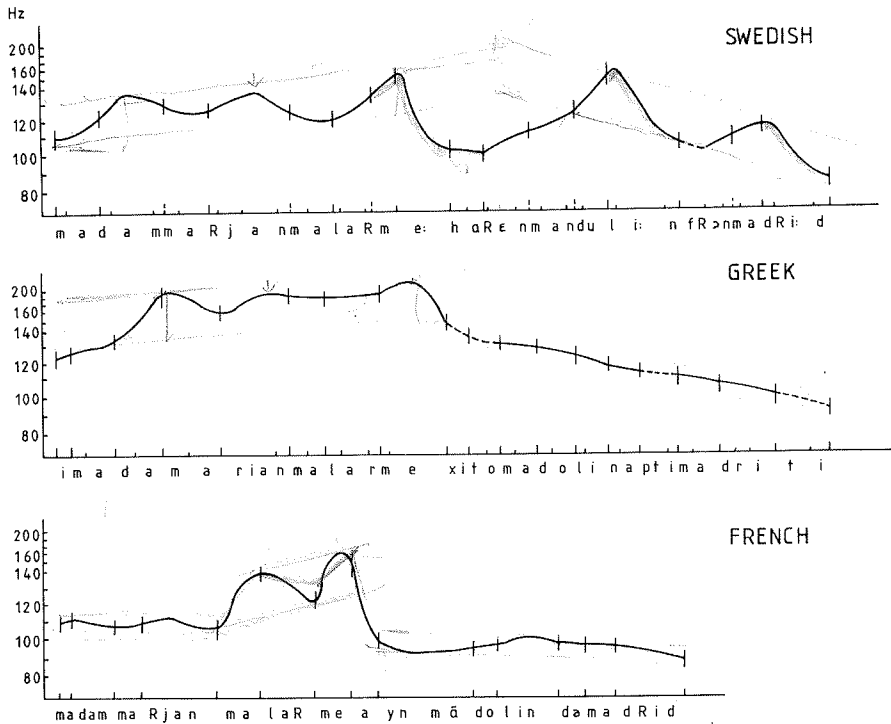


Figure 3. Different treatment of pitch after focus. From Gårding 1981.

are used for pragmatic effects, e.g. for strengthened accents as in combination with focus, here called sentence accent (SA). To construct this grid we use knowledge that we have gathered from studying the same intonation contour in sentences with different phonetic and grammatical structure, uttered by different speakers. Results of interest for this grid will be found in Bruce's work (1982).

RULE 2 inserts Highs and Lows for sentence and phrase boundaries.
 RULE 3 inserts the Highs and Lows of the sentence and phrase accents.

In focus.

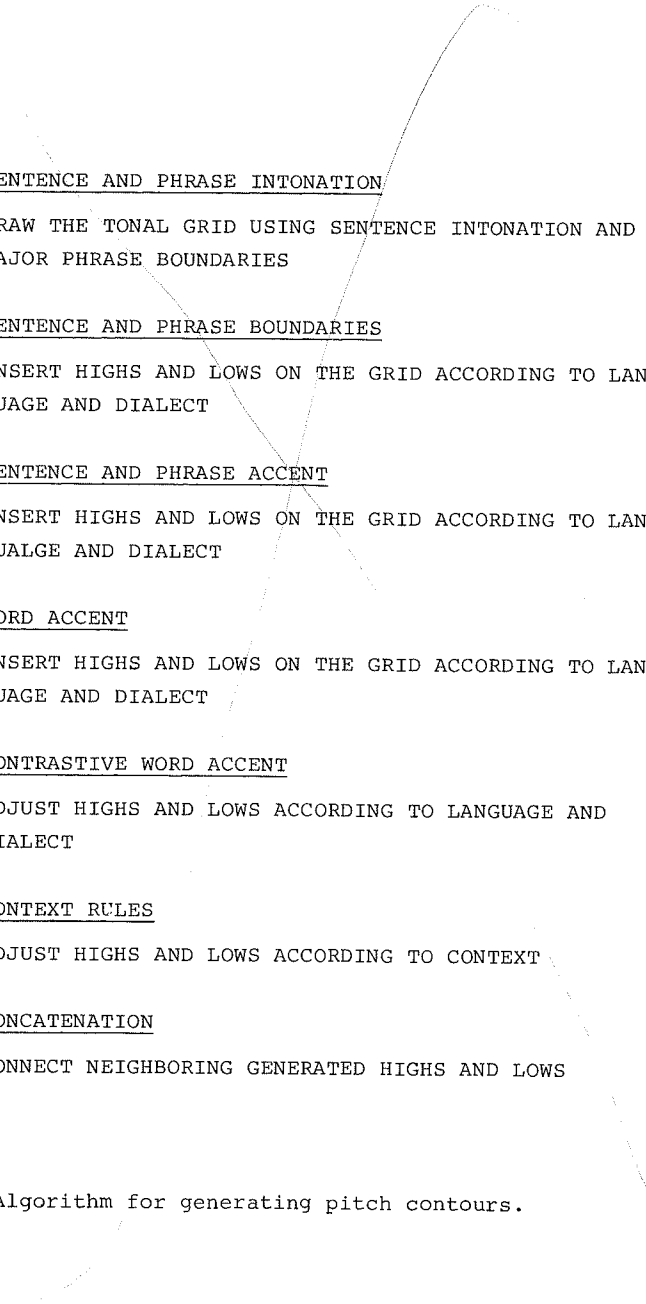
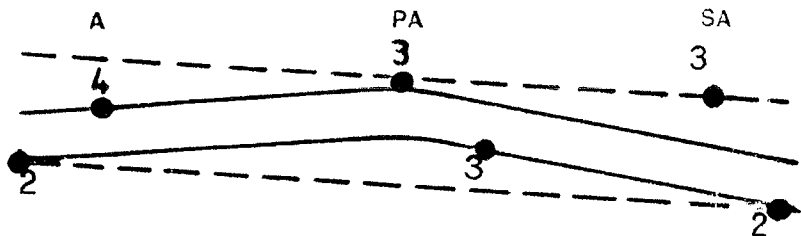
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- RULE 1. SENTENCE AND PHRASE INTONATION
DRAW THE TONAL GRID USING SENTENCE INTONATION AND MAJOR PHRASE BOUNDARIES
- RULE 2. SENTENCE AND PHRASE BOUNDARIES
INSERT HIGHS AND LOWS ON THE GRID ACCORDING TO LANGUAGE AND DIALECT
- RULE 3. SENTENCE AND PHRASE ACCENT
INSERT HIGHS AND LOWS ON THE GRID ACCORDING TO LANGUAGE AND DIALECT
- RULE 4. WORD ACCENT
INSERT HIGHS AND LOWS ON THE GRID ACCORDING TO LANGUAGE AND DIALECT
- RULE 5. CONTRASTIVE WORD ACCENT
ADJUST HIGHS AND LOWS ACCORDING TO LANGUAGE AND DIALECT
- RULE 6. CONTEXT RULES
ADJUST HIGHS AND LOWS ACCORDING TO CONTEXT
- RULE 7. CONCATENATION
CONNECT NEIGHBORING GENERATED HIGHS AND LOWS

Figure 4. Algorithm for generating pitch contours.

Table 1. Rules of pitch algorithm generating declarative sentences consisting of two major phrases in narrative style.

Rule	Swedish (South)	Greek (Athens)	French (Standard)
1	Sentence and phrase intonation Rising-falling grid	do	do
2	Sentence and phrase boundary	SB: Low.....Low PB: Low.....High	SB: Low..... PB: Low.....
3	Sentence and phrase accent	SA: High-Low PA: High-Low	SA: Low PA: High
4	Word accent	High	Void
5	Contrastive accent	High-Low with large range	High-Low with large range
6	Context modifications A. Preparatory rule B. Assimilation rule etc.	A. Preparatory rule B. Assimilation rule	do do
7	Concatenation	Connect neighboring points by a smooth line over the voiced segments	do

Figure 5. Typical grid with insertion of *Highs* and *Lows*

1. Grid: Sentence intonation and major Phrase Boundary
2. Sentence and Phrase Boundaries
3. Sentence and Phrase Accents
4. Word Accents

RULE 4 inserts the word accent Highs and Lows.

RULE 5 inserts contrastive accents.

RULE 6 takes care of context phenomena. Two examples are given:

6A is called *the preparatory rule*. It prepares for a following High or Low by inserting a point of the opposite value.

6B is called *the assimilation rule*. It pushes the inserted pitch value in the direction of a following value when a full movement is not warranted by the context.

RULE 7 connects all the generated Highs and Lows by a smooth line.

APPLICATION TO SWEDISH, GREEK AND FRENCH

Table 1 shows how the rules of the pitch algorithm are applied to Swedish, Greek and French. These rules are here expressed in general terms. Specifications are given elsewhere (e.g. Bruce 1977 and Bruce & Gårding 1978 for Swedish, and Touati, forthcoming, for French). The table has some redundancies. Rules 2 and 3 overlap when a phrase or sentence accent is final. In the case demonstrated here there is no conflict. The rules give the same result. In other cases, however, there is a need for priority rules. For instance, when in Swedish or Greek a phrase or sentence accent is initial and there is a clash between the word accent High and the phrase boundary Low, the accent High takes priority. Note that a final word accent in a phrase or a sentence is analysed as a phrase or sentence accent respectively.

Some of the rules in the algorithm are common to all three languages, others differ. A detailed comparison will be given in the next section. Here we shall just mention the principal features.

Phrase endings are Low for South Swedish but High for Greek. For French the phrase ending is also High, due to the phrase accent. The word accent rule is void for French. Of the two Swedish word accents only Accent 1 is used in the demonstration phrase. (It differs from Accent 2 in that its High occurs earlier. The manifestations of the two accents are dialect dependent. For details see Bruce & Gårding 1978).

The contrastive accent is a pitch expanded word accent in the South Swedish dialect and in Greek. In French contrastiveness is expressed by a Low-High in the first syllable instead of a Low in the contrasted word(s).

Figure 6 illustrates how the points given by the various rules are inserted into the grid which has been generated by Rule 1. The numbers 2, 3 etc. refer to the corresponding rules of the algorithm. Note that the lengths of the grids have been adjusted to the observed patterns. Table 1 and Figure 6 will serve as a basis for our comparison.

COMPARISON

Since our input phrases have been constructed in such a way that sentence accents and phrase accents occur in the same position, the comparison concerns mainly the manifestation of these accents and the intonation contour. The comparison is based on observations in a larger material than the one presented here, particularly for Swedish and French. The French material will be described in more detail in a forthcoming dissertation by Paul Touati. We shall follow the order given by the pitch generating rules.

Rules 1 and 2: Intonation and boundaries

The grids that show the general outline of the declarative sentence intonation are remarkably similar apart from differences

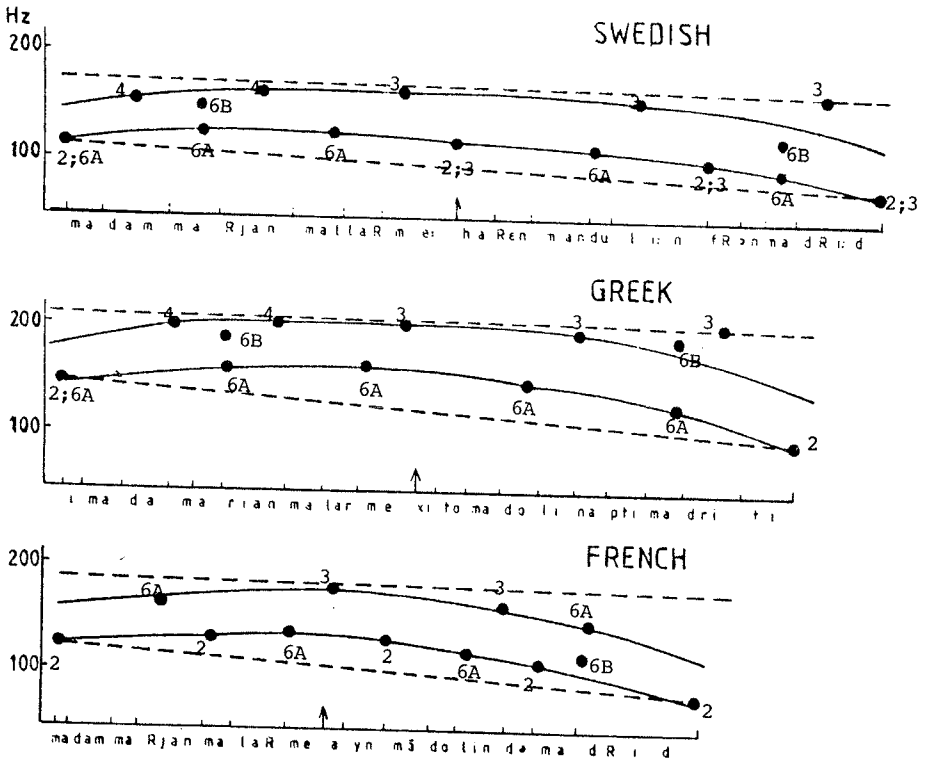


Figure 6. Generated Highs and Lows inserted on tonal statement grids for Swedish, Greek and French.

in overall length. They consist of a slightly rising part covering the subject and a falling part covering the predicate. The pivot marks the boundary between these two constituents. This boundary occurs on different lines, however. For Greek and French it is on the uppermost line, for Skåne Swedish it is on one of the lowest. It should be noted that, although the experimenters made precautions to keep the pragmatic context fixed, there is still room for variation, particularly in the treatment of phrase boundaries. A slightly 'stronger' boundary in Swedish will re-

sult in a continuation of the fall to the lowest level, a similar situation in Greek will create a fall after the rise, whereas in French the duration of the rise and hence the whole syllable on which it occurs will be lengthened. It is clear that the function of the lines of the grid differs in the three languages. In Swedish the lowest lines mark the beginning as well as the end of phrases and sentences. In Greek the low line is reserved for the end of sentences and the high is used for the end of phrases. In French the low line is used for the end of a sentence and for the beginning of a phrase or sentence. The end of a phrase uses one of the upper lines with the highest level marking the boundary between the deepest constituents. The two accent languages, Swedish and Greek, use the highest line also in combination with phrase and sentence accents.

Rules 3 and 4: Accentuation

The manifestation of sentence accent is a steep fall in Swedish and Greek as compared to a very insignificant fall in French. We have regarded this as a support for our phonological analysis of a High-Low sentence accent for Swedish and Greek and a Low sentence accent for French.

The phrase accent is a fall of similar steepness in Swedish but a rise in Greek, corresponding to the phonological representations High-Low and High respectively. For French we have analysed the final accent of a phrase as a phrase accent High to make it parallel with the sentence accent which also has one point, Low. Since all accents in French are phrase or sentence final it would also be possible to analyse them as pitch boundaries. For the Swedish and Greek dialects under investigation, High seems to be the obvious choice for the word accents. The early position of the pitch peak typical of Accent 1 in South Swedish makes this accent mainly falling, whereas in Greek (as in Accent 2 of South Swedish) the peak has a late position in the syllable which gives it a mainly rising pitch.

Rule 5: Contrastive accent

Figure 3 shows some interesting phenomena not present in the demonstration sentence. With contrastive (focal, insisting) accent in Greek and French the pitch goes down to low level and remains there until the end of the phrase. In Swedish, on the other hand, the accents still have their pitch obtrusions. This may be due to the different status of the word accents in the phonological system of Swedish.

In Finland-Swedish, at least in the dialects without lexical accent distinction, the accents behave like in Greek or French (Kerstin Tevajärvi, forthcoming). In French we notice that under contrastive accent the Low of the initial boundary has been replaced by a rise (Figure 3).

Rule 6: Context rules

The context rules reflect perceptual and articulatory constraints. As could be expected they show great similarities across the languages. For the demonstration phrase we shall only need two. (For a more careful analysis of tonal context phenomena in Swedish see Bruce 1977 and for tone languages see Schuh 1978).

Rule 6A: The preparatory rule

This rule says that the generated Highs and Lows are preceded by inserted points of the opposite kind. Our data suggest that the purpose is to give prominence to the following High or Low. The Greek curve in Figure 1 can be used as a demonstration. In the subject phrase (*Madame Marianne Mallarmé*) there are several Lows preceding accent Highs. Similar phenomena can be seen in the Swedish sentence in the same figure.

In French the first Low of *Mallarmé* is prepared for by a High which, according to our interpretation, is introduced to emphasize the Low. If it had not been there, the initial boundary mark of the phrase would not have been present.

Rule 6B: The assimilation rule

The assimilation rule in the present material expresses undershoot phenomena. Before a steep SA fall the preceding Low is undershot in Swedish and Greek. This is so far unexplained. One possible reason is that the steep fall is a strong manifestation of the accent and therefore does not need a preceding full preparation.

The previously mentioned Greek curve in Figure 1 gives other examples of undershoot. In the subject phrase (*Madame Marianne Mallarmé*) there are three Lows preceding three Highs. The assimilation rule has raised the middle High. The reason may be a lack of time for the full preparation before a weakened accent.

This is in agreement with a universal tendency of weakening the second in a group of three 'equal' accents. A similar tendency can be seen in the Swedish sentence in the same figure.

These interpretations are built on observations in acoustic records of real speech that has been varied in a systematic way. We shall use synthesis to check our findings.

Rule 7: Concatenation

This is a mechanical rule and the same for all three languages. In Greek it accounts for tonal enclitization phenomena, i.e. the recognized fact that a group of unaccented syllables form a prosodic unit with the preceding accented one. In the observed sentence (Figure 1) concatenation prescribes the slow fall to the Low of the following accent, prescribed by the preparatory rule.

Table 2 shows the pitch representations proposed for the linguistic variables. It gives an overview of the tonal part of the prosodic structure of the three languages. At the same time it summarizes our comparison: Phrase and sentence intonation in declarative sentences are similar, accentuation and boundaries differ.

The analysis displayed in Table 2 is consistent with impressionistic statements about the languages. The South Swedish dialect

Table 2

PITCH REPRESENTATIONS FOR DECLARATIVE SENTENCES

	SB	PB	SA	PA	WA	CA
SWED- ISH SOUTH	L...L	L...L	↑ HL ↓	HL	1. H(L) → 2. H(L)	↑ HL ↓
GREEK	L...L	L...H	↑ HL ↓	(L)H	(L)H	↑ (L)H ↓
FRENCH	L...	L...	(H)L	(L)H	-	(L)H

LETTERS IN PARENTHESES ARE CONSEQUENCES OF THE PREPARATION RULE

VERTICAL ARROWS INDICATE WIDENED RANGE

HORIZONTAL ARROW INDICATE DELAYED TIMING

is often described as slow, monotonously chopped up, and down to earth. The falling phrase accents may be responsible for these impressions. The table also shows that Greek uses rising pitch much more than the other languages. This together with its preference for open syllables may explain why Greek has a hammering, insisting effect on a Swedish listener. The most conspicuous pitch characteristic of French to a Swede is the recurring phrase final rising pitch.

The importance of the analysis summarized in Table 2 goes beyond the impressionistic remarks just given. It makes it possible to compare the prosodic inventory and structure of various languages. In this way, it will also be an efficient aid in the analysis of foreign accent and the teaching of pronunciation.

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