Sigurd, Bengt, Mats Eeg-Olofsson, Barbara Gawrońska & Per Warter. 1990. *SWETRA – A multilanguage translation system*. Praktisk Lingvistik 14. Dept. of Linguistics, Lund University.
Sigurd, Bengt & Birgitta Lastow. 1993. 'Fragments of a Japanese appending X-bar grammar (AXG)'. *Proceedings NLPRS '93*, 353-357. Fukuoka: Organizing Committee of Natural Language Processing Pacific Rim Symposium.
Soemarmo, Marmo. 1986. *Animated grammar*. Athens, OH: The Ohio University.
Svantesson, Jan-Olof. 1991. *Språk och skrift i Öst- och Sydöstasien*. Lund: Studentlitteratur.

Lund University, Dept. of Linguistics
Working Papers 44 (1995), 129–144

Analysis of intonational phrasing in West Greenlandic Eskimo reading text

Yasuko Nagano-Madsen* and Anne-Christine Bredvad-Jensen

Introduction

West Greenlandic Inuit Eskimo intonation has been described previously at word, phrase, and sentence levels (Mase 1973, Rischel 1974, Nagano-Madsen 1992, 1993). The present study attempts to extend the previous descriptions of intonation in this language by analysing text reading material, with focus on the phrasing function of intonation.

The phrasing function of intonation has received much attention in recent years both from theoretical and practical perspectives. In many languages, coherence among words or phrases is indicated by means of downstepping, by resetting F0 at a higher level for the next unit. Pilot work on West Greenlandic Eskimo indicates that such a phrasing function of intonation is likely to exist in this language as well. Furthermore, West Greenlandic Eskimo is known to make use of phrase-final tone to mark prosodic phrases (Mase 1973, Rischel 1974, Nagano-Madsen 1988, 1993). In this paper, the phrasing function of intonation is analysed with reference to the following strategies: (1) use of phrase-final tone, and (2) F0 reset.

Intonation in West Greenlandic Eskimo

Intonation in West Greenlandic Eskimo is characterized by a terminal tonal contour which appears on each word. As Eskimo is a polysynthetic language, words can be formulated by adding one or more suffixes, an inflectional ending, and sometimes even a particle, to the root which always starts the word. Thus a word in Eskimo, which is separated by a space in written form, often corresponds to a phrase or even to an entire sentence in languages like English and Swedish. The terminal contour seems to appear on each word, regardless of its length and word class.

*Dept. of Oriental Languages, University of Gothenburg.

Thus far, two kinds of analysis have been proposed for the terminal contours in West Greenlandic Eskimo. Rischel (described in Mase 1973) classifies the terminal contour into five categories: (1) phrase-internal, (2) phrase-final, (3) yes-no question, (4) who-question, and (5) absolutely final contour. For each category, different tonal patterns are proposed by combining H and L tones as well as raised H tone ("raised pitch" in his terminology). For example, a phrase-final word has a H-L-H contour which is manifested on the three final vowel morae respectively. For a phrase-internal word, Rischel suggests H on the last mora and raised H on the penultimate mora.

More recently Nagano-Madsen 1993 suggested an alternative analysis to Rischel's analysis. The first and main difference is that in her analysis, the phrase-final H-L-H contour is decomposed into two parts, H-L and H. Only the last H is claimed to be a phrasal property while the first H-L is assigned as a word property. This analysis leads to another difference as to how word property tones in phrase-internal position should be described. Rischel proposed a raised H-H combination for a word in phrase-internal position, while proposing H-L-H for phrase-final position, and H-L-L as absolutely final contour. Nagano-Madsen's H-L analysis for word property appears more consistent than the raised H-H analysis. The acoustic analysis presented in her 1993 article also supports Nagano-Madsen's analysis as H-L for words at phrase-internal position. The last difference is that while Rischel proposes H-L-L as absolutely final contour, Nagano-Madsen treats it as a variant of phrase-final contour, i.e. the phrasal property of the last H is lowered when it coincides with final position in a larger unit like a sentence, i.e. underlyingly it is still a H. However, this last point was still ambiguous and will be examined again in the present study. For the rest of the paper, the term phrase-final tone will be used without referring to it as H or L because of this ambiguity. Rischel and Nagano-Madsen both agree that each tone is manifested on a vowel mora basis, counted retroactively from the last mora.

Material and analysis

A descriptive text composed of mostly declarative sentences was read by two female speakers of Central West Greenlandic. The text included 572 syllables, 148 words, 30 sentences, and was divided into 6 paragraphs in written form. There was no sentence coinciding with a single word, and each sentence consisted of between two and seven words. The material was taken from an introductory textbook of Greenlandic and therefore consist of relatively simple words and syntactic structures. The number of sentences in each paragraph varied from three to nine. Recordings were made in a sound-proof studio for the first speaker and in a quiet room for the second speaker.

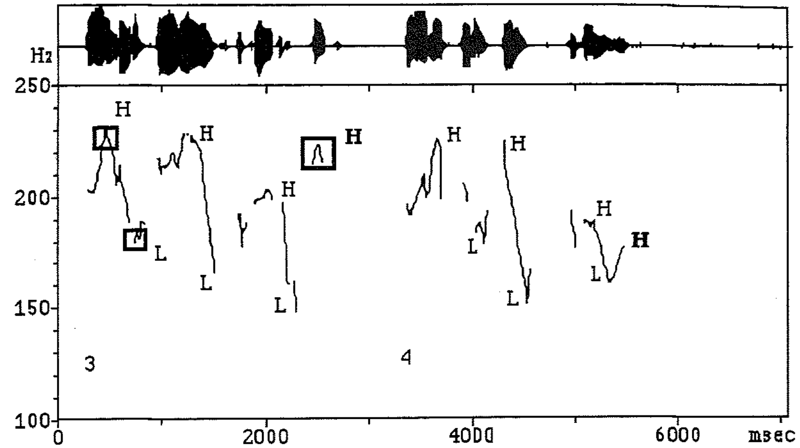

Figure 1. Sample F0 contour and speech waveform for sentence 2 *Kaali aqqanilinnik ukioqarpoq, Kaalallu arfineq sisamanik* 'Kaali is eleven years old, and Kaala is nine years old' (speaker 1), showing how F0 values were taken for target tones. One example each of word H tone, word L tone, and phrase-final H tone are indicated by squares. Phrase-final H tones are differentiated from word H tones by boldface.

Prosodic transcriptions were made for the entire material, marking the H and L tones as well as short and long pauses. The recorded utterances were low-pass filtered at 4.5 kHz and digitized at 20 kHz. F0 was analysed using the pitch analysis command of the CSL software package installed on a PC. The F0 values corresponding to word H and L tones as well as phrase-final H tones were detected visually and measured with the help of the CSL cursor program. The highest values and lowest values of F0 were taken as H tone and L tone with reference to relevant segments.

Results and discussion

Phrase-final tones

Auditory analysis. The main difference between the two speakers was the use of phrase-final tones. While the first speaker frequently divided

Table 1. The mean F0 value, standard deviation, the number of tokens, minimum and maximum value, and pitch range for phrase-final tones at sentence internal/final positions.

	sentence internal		sentence final	
	speaker 1	speaker 2	speaker 1	speaker 2
F0 (Hz)	232	213	195	175
SD	19.8	23.0	18.2	14.5
no.	33	5	30	30
min-max (Hz)	189-270	185-247	172-253	153-217
range (Hz)	81	62	81	64

sentences into smaller units marked by a phrase-final tone, which in most cases was perceived as H, followed by a short pause, the second speaker read most of the sentences without breaking them into smaller units. The total of 30 sentences was divided into 64 units with an additional tone for the first speaker. These units coincide most typically with grammatical phrases or clauses composed of two or more words and in some cases with a single word. In few instances, the grammatical phrase boundaries were neglected. Note that a word in this language is often like a phrase in other languages. Two or more words, each being like a minor phrase, can form a higher level phrase.

For the second speaker, the text was divided into only 35 units, i.e. five sentences were divided into two units respectively. Among the five sentences, three cases were divided at clause boundaries, one at phrase boundary, and one at word boundary.

Nearly all the phrase-final tones which appeared at sentence-internal position were clearly H from an auditory point of view. On the other hand, those phrase-final tones at sentence-final position were, with few exceptions, never clearly perceived as H.

Acoustical analysis. The F0 values for all the phrase-final tones are presented in table 1 with reference to their position in a sentence. For further comparison, the F0 values of word H and L tones are also presented in table 2.

The phrase-final tones in sentence-internal position are in good agreement both in the mean F0 value and in standard deviation with the word H tones. The phrase-final tones in sentence final position, however, are problematic since the F0 value does not convincingly match with either that of word H tone nor word L tone directly. It appears to be more like that of L tone for speaker 2 while for speaker 1, it can be interpreted as lowered H.

Table 2. The mean F0 values, standard deviation, the number of tokens, minimum and maximum value, and pitch range for word H tone and L tone.

	word H		word L	
	speaker 1	speaker 2	speaker 1	speaker 2
F0 (Hz)	226	219	172	165
SD	18.1	23.4	11.8	10.0
no.	147	147	148	146
min - max (Hz)	183-267	169-277	136-206	143-192
range (Hz)	84	108	70	49

F0 reset

Manifestation of F0 reset is related to the theoretical issues of downstep and pitch register, which have been under much discussion for models of intonation (cf. Connell & Ladd 1990). In some approaches, only the H tones are considered to step down thereby narrowing the entire pitch range towards the end of the utterance (Pierrehumbert 1980, Hirschberg 1993). In this approach, downstep of L tones is not expected to occur. In the other type of approach, both H-tones and L-tones are expected to step down, thereby lowering the entire pitch range as the utterance proceeds (Clements 1979, Gårding 1983, Ladd 1990).

As downstep in this language has not been examined previously, we have examined the F0 reset from both H-tones and L-tones. If L tone resets were found to occur simultaneously with H-tone resets, it is indicative that downstepping affects both H and L tones, i.e. the entire pitch register is lowered. If, on the other hand, no F0 reset is found for L tones, it can be assumed that only H tone is relevant for downstep in this language.

Since each word is marked by H and L tones regardless of its word length, the examined F0 reset may differ slightly from those studies in which only F0 reset of pitch accent, which appears on an accented word in a phrase, was analysed (e.g. for American English, Ayers to appear). In Ayers' study, the difference in F0 values for these accented words is much larger than the difference found between each word in the present study of West Greenlandic Eskimo. The sample figures are presented in appendix 1.

The F0 values of each word H tone and L tone were examined successively within the same category of tones to choose words for which F0 was set higher than that of the previous word. Three degrees of F0 reset

Table 3a. The mean F0 value, standard deviation, the number of tokens, minimum and maximum value, and pitch range for H and L tones of different categories for speaker 1.

	non-reset H	single reset H	double reset H	triple reset H	non-reset L	single reset L	double reset L	triple reset L
mean (Hz)	217	229	243	247	166	175	178	191
S.D.	15.3	13.6	12.4	12.5	9.1	8.8	6.4	9.4
no.	80	35	19	14	85	32	13	18
min - max	183-267	206-260	215-267	227-267	136-200	161-198	169-195	174-206
range	84	54	52	40	64	37	26	32

Table 3b. The mean F0 value, standard deviation, the number of tokens, minimum and maximum value, and pitch range for H and L tones of different categories for speaker 2.

	non-reset H	single reset H	double reset H	triple reset H	non-reset L	single reset L	double reset L	triple reset L
mean (Hz)	207	223	232	251	160	167	172	178
S.D.	19.1	14.5	13.1	13.5	9.6	6.7	6.5	7.4
no.	78	31	16	22	86	29	17	15
min - max	169-244	199-253	210-257	215-277	143-177	153-183	159-183	168-192
range	75	54	47	62	34	30	24	24

were marked tentatively by repeating the same procedure. If the value of F0 exceeded the preceding one, it was marked as single F0 reset. In the next step, only those marked as single resets were compared successively to establish higher value of F0 reset (double reset). As the last step, the same procedure was repeated to select those with an even higher value of F0 reset.

Number and degree of F0 reset. The mean F0 values, standard deviation, the number of tokens as well as minimum and maximum value with pitch range for tones of various categories are presented in tables 3a and 3b, respectively. It is seen that, unlike the use of phrase-final tone, there is a striking agreement between the two speakers in the total number of F0 resets found for the entire material. The total number of H tone resets, be that single, double, or triple resets, was 68 (speaker 1) and 69 (speaker 2) while the total number of L tone resets was 63 (speaker 1) and 61 (speaker 2). Seen individually, the number of resets for each category, i.e. single, double, and triple resets, was also reasonably similar for the two speakers. When the corresponding words which bear a F0 reset were checked, however, it turned out that the agreement between the two speakers was

considerably smaller. Only 48 out of 148 words had a H tone reset by both speakers (32%).

The data suggests that both H and L tones are downstepped regularly. In the total occurrences of L tone resets, those which co-occured with H tone resets occurred in 55% of the cases for speaker 1 and 72 % for speaker 2. However, further examination revealed that L-tone reset tends to occur before a phrase-final tone. When the two predictable cases were eliminated, i.e. L tone reset which accompanies H tone reset, or L tone reset before a phrase-final tone, the remaining L tone resets were 25% (speaker 1) and 18% (speaker 2). In other words, about 75-80% of L-tone resets are predictable.

The table shows mean F0 values of H and L tones divided into four categories, those which do not have higher F0 value than the preceding word (non-reset), those which have higher F0 value than the preceding word (single reset), and those which have higher F0 value than the preceding word marked as single reset (double reset). Note, therefore, that mean F0 values for each category represent the relative pitch relation between certain words and not the absolute pitch relation, i.e. even if the F0 value of a given word is relatively high, its reset status depends on the F0 values of the neighbouring words to start with. Even if the entire phrase or utterance has higher F0 values throughout, the word with high F0 value may not be marked as reset at all.

When tested by ANOVA, however, differences in F0 value for the four levels of pitch categories, i.e. tones with three degrees of resets plus tones without reset, were not proved to be significant. It was suggested that only two degrees of H tone resets are differentiated for both speakers. As for L tones, two levels of resets were found to be significant for the first speaker but only one level for the second speaker.

F0 reset and relevant unit. The most consistent categories for which both speakers agreed to place F0 reset were paragraph and sentence initial positions. In order to examine the relationship between F0 reset and unit boundaries, three degrees of resets for H tone and L tone were tabulated for the following grammatical boundaries: (a) paragraph initial, (b) sentence initial, (c) phrase/clause initial, (d) phrase/clause internal, and (e) phrase/clause final. The samples of reset analysis for the first three paragraphs are shown in appendix 2.

All six paragraphs started with a H tone F0 reset. For the second speaker, all the H tone resets were accompanied by L tone resets as well. For the first speaker, two of the paragraphs started without L tone resets. 27 out of 30 sentences started with a H tone F0 reset for the first speaker (90%) and 25 for the second speaker (83%). There were 21 L tone resets for the first speaker (70%) and 25 for the second speaker (83%). Although the second speaker had 25 resets both for H tone and L tone, there was only one incidence of overlap, i.e. only one sentence had no F0 reset at all for the second speaker.

The occurrence of F0 reset at phrase-internal position is considerably lower, and close examinations indicate that those which had only H resets (indicated by X and Y in appendix 2) reflect a case where the word in question is emphasized. As for the phrase-final position, there are two points to be remarked. The first point is when the reset is done only by a L tone, it is nearly 100% predictable that it will be followed by a phrase-final H tone which is manifested as a F0 rise. This can be interpreted as tonal coarticulation when a F0 fall of the word property H-L is followed by a F0 rise. In a well-controlled experiment of tonal coarticulation using a Japanese subject (Nagano-Madsen 1987), a similar phenomenon was reported.

There appeared to be no immediate evidence for the F0 reset values reflecting hierarchical syntactic units, i.e. F0 reset value to be higher at paragraph-initial position than at sentence-initial position, which in turn is higher than sentence-internal position. In order to examine this point closely, the mean F0 reset values for word H tones were compared for those which occur at sentence-initial position with those which occur at non-initial position (see table 4). The F0 values for those at sentence-initial position were only slightly higher for both speakers and the difference was not found to be significant by unpaired t-test. The highest F0 values for reset seem to coincide with words which are emphasized rather than coinciding regularly with those at a larger unit-initial position.

Discussion

The status of phrase-final tone

A close examination of the distribution and F0 values of phrase-final tones strongly suggests that the unit sentence, which is defined in a written form as starting with a capital letter and ending with a period, is the most important unit in determining the actual pitch value for the phrase-final tone. The F0 values of the phrase-final tone at sentence-internal position were very similar to the values of word H tones, while the F0 values of

Table 4a. Mean F0 values, standard deviation, the number of tokens, minimum and maximum value, and pitch range for the reset word H tones at sentence-initial and non-initial positions. Comparisons by the t-test in the last row (2-tail).

	speaker 1		speaker 2	
	initial	non-initial	initial	non-initial
F0 (Hz)	239	235	236	234
SD	15.1	15.7	22.2	16.0
no.	30	39	28	40
min - max	206-267	212-264	202-277	199-266
range	61	52	75	67
test	t = 2.7, p<.48 (29 DF)		t = -5.29, p<.17 (20 DF)	

Table 4b. Mean F0 values, standard deviation, the number of tokens, minimum and maximum value, and pitch range for the reset word L tones at sentence-initial and non-initial positions. Comparisons by the t-test in the last row (2-tail).

	speaker 1		speaker 2	
	initial	non-initial	initial	non-initial
F0 (Hz)	178	180	172	170
SD	8.0	11.5	7.3	8.6
no.	21	41	26	34
min -max	167-198	161-206	153-186	157-192
range	31	45	33	35
test	t = 0.93, p<.87 (27 DF)		t = 0.46, p<.83 (20 DF)	

phrase-final tones at sentence-final position did not directly correspond to the values of word H or L tones.

There seem to be at least two possible ways to interpret the status of the phrase-final tones in sentence-final position. The first possibility is to give the phrase-final tone H status, as was done in Nagano-Madsen 1993, and interpret it as being lowered in its F0 value at sentence-final position. Another possibility is to postulate a sentence final L tone, distinct from a phrase-final H tone. The problem for the latter solution is that it should be stated that the sentence-final L tone has a considerably higher F0 value than word L tones. At this point, the former solution is still favoured for the following reasons. First, there were few occasions where phrase-final tones in sentence-final position had clearly H tone values while none of those in sentence-internal position had clearly L tone values. Secondly, it would probably make more sense to do the interpretation that the H tone is lowered than the L tone is raised in order to indicate terminality. In particular, the second speaker read the very last word in the text with L-L-L tone. To make the analysis that terminality is indicated by a lowered value of F0 seems more likely than vice versa.

The status of word L tone

Following the previous analyses (Rischel 1974, Nagano-Madsen 1988, 1993), the present work treated the L tone as an element of word, which, together with the word H tone, contributes to the organization of intonation in this language. However, the question arises as to how the status of word L tone should be treated. Since this tone is always preceded by a H tone, its occurrence is predictable and therefore it may be redundant to specify it. The significance of L tone arises if there is a consistent regularity which is reflected only in the organization of L tones, and not in the organization of H tones.

The analysis of H and L tone resets indicated that the behaviour of H tone reset reflected the organizational property of F0 more regularly than the behaviour of L tone. In most other cases, the occurrence of L tone reset was predictable from that of H tone reset. The only instance where there was a regularity in L tone reset was when it was followed by a phrase-final H tone. In this position, many L tones had raised F0 values. However, this phenomenon is predictable from the presence of phrase-final H tones.

The foregoing discussion leads to a possibility of altering the earlier analysis of word property H-L tones to simply being pitch accent which appears in relation to word boundary, while the phrase-final H tone can be referred to as phrase accent.

Variation in strategy of phrasing

It was clearly shown that, in reading an identical text, there was a considerable difference between the two speakers in grouping words into larger units by means of intonation and in focusing on certain words. Although a number of studies have shown that intonation functions in differentiating syntactic structure (e.g. Ladd 1988), these studies are based mainly on well designed and well controlled lab experiments. In a material like reading text by non-professionals, there seems to be considerable freedom as to how words are grouped and as to the choice of words to be emphasized.

The data obtained in the present study also suggests that no more than two degrees of reset, be that H or L tone, were differentiated by the two

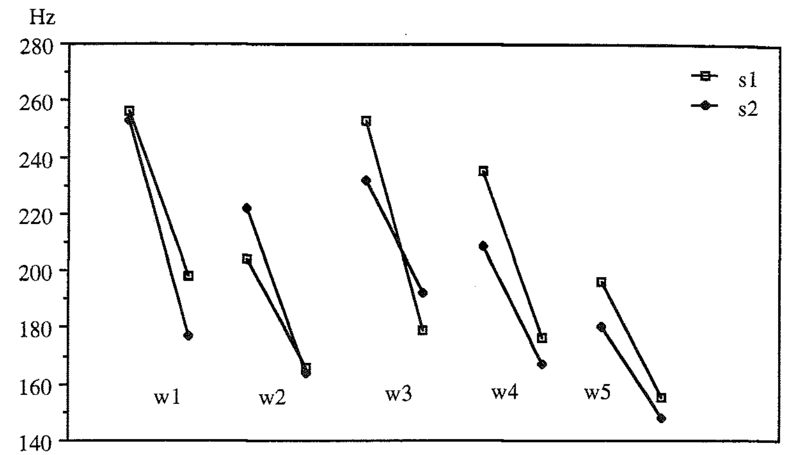

Figure 2. Comparison of the F0 values of word H tone and L tone from both speakers in sentence 3 *Nukarleesaat Jaaku arfineq-marlunik ukioqarpoq.* 'The youngest child Jaaku is seven years old'.The F0 reset is placed after *Jaaku.* Time dimension is normalized and pausing ignored.

speakers. The examination of F0 values for each category suggests that it may be more realistic to mark only two degrees of reset, since the difference in F0 values between the three kinds of reset were not found to be significant. The data on F0 reset also showed no significant difference in the amount of F0 reset at sentence-initial position and sentence-internal position.

Although previous literature on West Greenlandic Eskimo intonation has focused on the phrase-final H tones, the fact that the second speaker used so few phrase-final tones implies that the phrase-final tone is not the only and absolute means of phrasing by means of intonation. The analysis of F0 reset, on the other hand, showed striking similarity for the two speakers in the number of resets found for the entire text, even though there was considerable disagreement in the choice of words where the F0 reset was placed. The size of domain within which word pitch heights are operated may be relatively similar, since the two speakers have a very similar number of F0 resets.

The foregoing discussion indicates that F0 reset is the primary means of phrasing by intonation, since it is found for both speakers. Phrasing marked

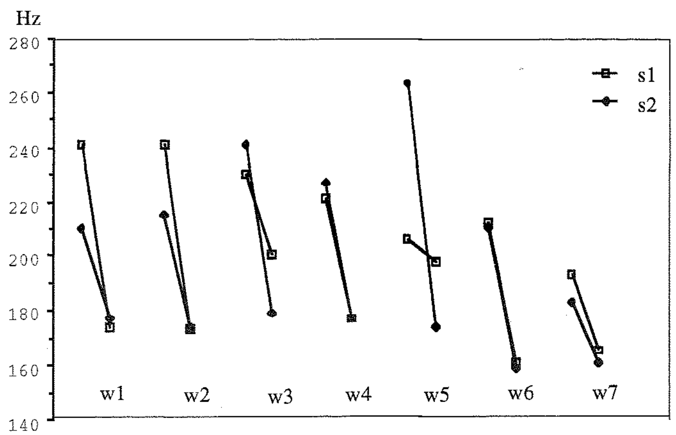

Figure 3. Comparison of the F0 values of word H tone and L tone from both speakers in sentence 1 *Kaali Kaalallu Kalaallit Nunaanni illoqarfiit ilaanni najugaqarput.* 'Kaali and Kaala once lived in a town in Greenland.', where the F0 relationship boundary is placed after word 5. Time dimension is normalized and pausing ignored.

by F0 reset may or may not be accompanied by the phrase-final tone, which is usually followed by a short pause.

Figure 2 displays the F0 relations corresponding to word H and L tones for the two speakers in sentence 3 which contains five words. The first speaker divided the sentence into three prosodic phrases by the insertion of phrase-final tones. Words 1, 2, and 5 were accompanied by the phrase-final tone and a short pause. The second speaker read the whole sentence without breaking it into notable prosodic phrases and without any pauses. When the time dimension and pauses are ignored, as well as the phrase-final tones, the remaining F0 relations are seen to be very similar for the two speakers, consisting of two prosodic phrases marked by the F0 reset in the third word. We have at least two kinds of intonational phrases, one which is organized by F0 height relation, and another one which is marked by an additional H tone in the end. In the example given in Figure 2, the number of intonational phrases marked by F0 reset is two for both speakers occurring at the same location. The number of intonational phrases marked by phrase-final H tone differed greatly, three for speaker 1 and one for speaker 2.

It is possible that there is yet another alternative strategy to mark an intonational phrase. Figure 3 displays a sentence which is divided into two intonational phrases by F0 height relations, with the boundary between word five and six. For the first speaker, the peak F0 declines all the way to the fifth word, which has a markedly small pitch range and is accompanied by a phrase-final H tone (the presence of phrase-final H tone is not shown in the figure). For the second speaker, the peak F0 steps up to the fifth word, which has a notably wide pitch range and is not accompanied by a phrase-final H tone. Yet the resulting effect is that the sentence is divided into two phrases. Many of the grammatical phrase-final words were marked by increased pitch range by the second speaker, thereby giving a particular prominence.

Acknowledgements

The present research is a part of the project *Multilingual Prosodic Rules*, with specific reference to Eskimo, Japanese, and Yoruba, funded by a grant to Lund University by the Swedish Research Council in Humanities and Social Sciences (HSFR). The authors are grateful to Gösta Bruce, the leader of the project, for many useful comments.

References

Ayers, Gayle M. to appear. 'Discourse functions of pitch range in spontaneous and read speech'. *Ohio State University Working Papers*, vol 44.

Clements, G. Nick. 1979. 'The description of terraced-level tone languages'. *Language* 55, 536-558.

Connell, Bruce & D. Robert Ladd. 1990. 'Aspects of pitch realisation in Yoruba'. *Phonology* 7, 1-29.

Gårding, Eva. 1983. 'A generative model of intonation'. In Ann Cutler & D. Robert Ladd (eds.), *Prosody: Models and Measurements*, 11-25. Berlin: Springer.

Hirschberg, Julia. 1993. 'Studies of intonation and discourse'. In *Proceedings of an ESCA Workshop on Prosody* (=*Working Papers* 41), 90-95, Department of Linguistics and Phonetics, Lund University.

Ladd, D. Robert. 1988. 'Declination "reset" and the hierarchical organization of utterances'. *The Journal of the Acoustical Society of America* 84:2, 530-544.

Ladd, D. Robert. 1990. 'Metrical representation of pitch register'. In John Kingston & Mary Beckman (eds.), *Papers in laboratory phonology, 35-57.* Cambridge: Cambridge University Press.

Mase, Hideo. 1973. 'A study of the role of syllable and mora for the tonal manifestation in West Greenlandic'. *Annual Report of the Institute of Phonetics* 7, 1-98. University of Copenhagen.

Nagano-Madsen, Yasuko. 1987. 'Effects of tempo and tonal context on fundamental frequency contours in Japanese'. *Working Papers* 31, 103-115. Department of Linguistics and Phonetics, Lund University.

Nagano-Madsen, Yasuko. 1988. 'Phonetic reality of the mora in West Greenlandic Eskimo'. *Working Papers* 34, 79-82. Department of Linguistics and Phonetics, Lund University.

Nagano-Madsen, Yasuko. 1992. *Mora and prosodic coordination. A phonetic study of Japanese, Eskimo and Yoruba.* Lund: Lund University Press.

Nagano-Madsen, Yasuko. 1993 'Phrase-final intonation in West Greenlandic Eskimo'. *Working Papers* 40, 145-156. Department of Linguistics and Phonetics, Lund University.

Pierrehumbert, Janet. 1980. *The phonology and phonetics of English intonation.* PhD dissertation, MIT.

Rischel, Jørgen. 1974. *Topics in West Greenlandic phonology.* Copenhagen: Akademisk Forlag.

Appendix 1: Sample of F0 values for word H tones, showing how F0 resets of different kind is marked (speaker 1).

word no.	parag. no.	sentence no.	phrase no.	word H (Hz)	reset	reset	reset
1	1	1	1	241	0	0	0
2				241			
3				230			
4				221			
5				206			
6			2	212	0		
7				193			
8		2	3	241	0	0	
9				241			
10				206			
11			4	233	0		
12				244	0	0	0
13				220			
14		3	5	256	0	0	0
15			6	204			
16			7	253	0		
17				235			
18				196			

Appendix 2: F0 reset and unit boundaries for the first three paragraphs

Paragraph 1

word no.	phrase-internal	phrase-final	phrase-initial	sentence-initial	paragraph-initial
1			XXXxxYYyy	XXXxxYYyy	XXXxxYYyy
2		YY			
3			xxxYYYyyy		
4					
5		xYYY			
6			X		
7		xy			
8				XXxxYyy	
9			Y		
10					
11			XxxxY		
12			XXYYyy		
13					
14				XXXxYYYyy	
15					
16			XxYyy		
17					
18					

Paragraph 2

word no.	phrase-internal	phrase-final	phrase-initial	sentence-initial	paragraph-initial
19			XXxxYYy	XXxxYYy	XXxxYYy
20		xx			
21					
22				XXxY	
23			XXXyy		
24		xxyyy			
25					
26				XxxYYyyy	
27					
28	Yy				
29		xxYYY			
30					
31		X			
32		y			
33				XXxYyy	
34	YY				
35		YYY			
36		xx			
37				XYyyy	
38		xxxyyy			
39			XX		
40	x				
41		Xxy			

Paragraph 3

word no.	phrase-internal	phrase-final	phrase-initial	sentence-initial	paragraph-initial
42			XXYYYyyy	XXYYYyyy	XXYYYyyy
43	YYY				
44		Xx			
45					
46				XXxxxYy	
47	yy				
48		XYY			
49			YYY		
50		XxYYY			
51					
52				XXxxYyy	
53		xxx			
54					
55			XxYYYy		
56					
57			xYy		
58					
59				XXXYYyyy	
60	XXXYY				
61		xYY			
62		X			
63				Y	
64		xxYYy			
65		yy			
66				X	
67		YYy			
68			Xx		
69			XXYYy		
70	x			x	
71		Xy			
72					

Note:
X = speaker 1, word H tone reset
x = speaker 1, word L tone reset
Y = speaker 2, word H tone reset
y = speaker 2, word L tone reset
X, x, Y,y = single reset (higher F0 value than the preceding tone)
XX, xx, YY, yy = double reset (higher than the preceding single reset value)
XXX, xxx, YYY, yyy = triple reset (higher than the preceding double reset value)

Lund University, Dept. of Linguistics
Working Papers 44 (1995), 145–157

STOCKTEXT – Automatic generation of stockmarket reports

Bengt Sigurd

Introduction

The generation of text by computer is an interesting undertaking which involves all areas of linguistics: semantics, pragmatics, lexicon, morphology, syntax, text linguistics and – if the output is to be speech – also phonology and speech technology. Text generation is an expanding field which has its own workshops and sections at conferences, and there is a reasonable understanding of the main problems of the field (see references). Members of the Swetra group at Lund have some experience of text generation, above all from the project Commentator (Sigurd 1983, Fornell 1983, Sigurd 1984). The new project Stocktext to be introduced in this paper is aimed at both generation and translation of stockmarket texts. It is supported by HSFR/Nutek and is based on experience from both Commentator and Stocktra – a system for automatic translation of stockmarket texts (Sigurd et al. 1992, Sigurd (ed.) 1994).

The following is an excerpt of stockmarket reports as they appear in *Dagens Nyheter* and in *Sydsvenska Dagbladet* (abbreviated):

> Stockholmsbörsen fortsatte att stiga under tisdagen. Affärsväldens generalindex steg till 1536,8, en uppgång med 0,3 procent. Omsättningen stannade på 1946 miljoner kronor... Skania blev dagens vinnare med en uppgång på 20 procent... Det totala börsvärdet sjönk 0,6 procent till 1005 miljarder kronor. 47 höjda köpkurser noterades, 95 sänkta och 150 oförändrade.

> 'The Stockholm stockmarket continued to rise during Tuesday. The *Business World* general index rose to 1536.8, a rise of 0.3 percent. The trade stopped at 1946 million crowns... Skania was the winner of the day with an increase of 20 percent... The total value of the stockmarket fell 0.6 percent to 1005 billion crowns. 47 increased rates were noted, 95 decreased and 150 unchanged.'