

Gradations in Pitch Accents?

T. Rietveld
Nijmegen, the Netherlands

1. Introduction

Much of the work on Dutch intonation is based on the framework developed by Cohen and 't Hart (1967), and Collier and 't Hart (1978). This framework of concepts and terms is presented in a diagram which was taken from a course in Dutch intonation by Collier and 't Hart (1978), see Figure 1.

The diagram presented in Figure 1 distinguishes only one type of pitch accent. This pitch accent is regarded as conspicuous whereas all other accents, realized by duration, are regarded as less conspicuous. If one wants to use the terms 'primary stress' and 'secondary stress' for these types of sentence stress, the latter has to be assigned to the duration accent.

In our work on the automatic detection of prominence in Dutch (Rietveld and Boves, 1979), we have come across several samples of pitch movements with characteristics typical for prominence-lending movements, which did not lead subjects to score 'sentence stress'. These pitch movements very often occurred on that syllable in polysyllabic words which carries word stress. The task the subjects had to perform was an (0,1)-task; this means they only had to mark the stressed syllables in the sentence '1'. The prosodic phenomenon in question cannot be classified as micro intonation since the observed F_0 -movements show fairly large excursions and since their occurrence is not determined by phonetic factors but by a grammatical one, i.e. word stress in polysyllabic words.

The questions we want to discuss should be seen against the background of the construction of a prominence (= sentence stress) detector. This detector

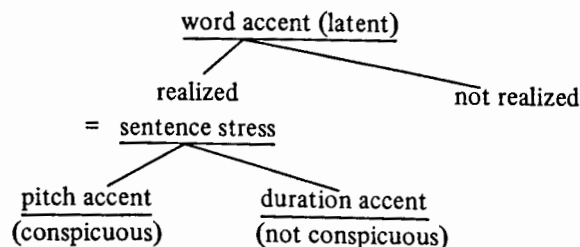


Figure 1. Framework of concepts from Collier and 't Hart (1978).

has to cope with F_0 -movements which - apart from the range - are quite similar to the movements which give rise to sentence stress, but are not prominence-lending themselves.

The relevant questions are:

- To what extent can F_0 -movements which are similar to but not identical with the prominence-lending movements, be expected on syllables carrying word stress but not sentence stress?
- In how far does the F_0 -range of these movements overlap with that of the prominence-lending movements?
- Are the syllables mentioned under a) perceived as carrying some kind of stress?

The first two questions are relevant for the construction of the detector, the last one pertains to its evaluation: 'false alarms' on syllables which carry some kind of 'secondary stress' are less serious than false alarms on other syllables.

Experiment 1 and 2 are carried out in order to answer the first two questions. In the first experiment we gave explicit instructions to the speakers to stress only specific syllables; in the second experiment speakers were free to realize the speech material in their own way. This time, however, we asked them to give stress judgments of their own speech, thus we could say with greater certainty which syllables were meant to take sentence stress and which not. The third and fourth experiments aim at answering the question whether an extra response category ('Half stressed') is a useful and reliable one and can be related to the occurrence of pitch movements which do occur on syllables with word stress.

2. Experiment 1

Procedure

In this experiment three male speakers had to realize one carrier sentence with eighteen different polysyllabic words (target words).

The carrier sentence was:

'Je moet *niet* over de gaan *klagen*, maar er *wel* over *nadenken*'.

(You should not complain about..., but think about it)

The speakers were asked to stress the italic syllables only. The blank (...) had to be completed with a three- or more syllabic compound ('target word').

Six of these had the stress pattern 1 3 2:

'fruitelersbond, suikerbietenoogst, autobusdienst, schoonmaakploeg, vuurwapenwet, veevoederprijs'

six had the stress pattern 1 2 3:

'zakwoordenboek, kinderspeelplaats, sloopstimmerlui, legerwoordvoerder, tandheelkunde, filmtijdschrift'

Six had the stress pattern 2 1 3:

'schooladviesdienst, boerenleenbank, stadsschouwburg, staatsbosbeheer, rijkswaterstaat, burgemeestershuis.'

2.1. Analysis

Pitch and intensity were measured with the IFN-pitchmeter (Van Rossum and Boves, 1978) and the IFN-intensimeter, respectively. The analog output was fed into the computer with a sample frequency of 100 Hz; subsequently the pitch curves were plotted in semitones together with the lower declination line, according to a procedure borrowed from 't Hart (1979), but adapted by us.

The measurement procedure was as follows: (a) If a target word contained an F_0 -rise which started early in the syllable or a fall which started late and if the F_0 -range exceeded 1 semitone, the corresponding pitch jump was measured. We are quite aware of the fact that only an average of more than 1 semitone can be seen as a meaningful result. (b) Pitch jumps were also measured on the syllables which subjects had been instructed to stress.

2.2. Results

We observed pitch movements to or from the lower declination line on all target words. In most cases these pitch movements occurred on the syllable carrying the main word stress.

The following pitch jumps were observed:

Target words; mean F_0 -excursion: 4.04 semitones, s.d.: 1.65 semitones ($n = 54$)

Stressed syllables in other words; mean F_0 -excursion: 6.34 semitones, s.d.: 1.78 semitones ($n = 208$).

The difference in pitch jumps between the two types of syllables was significant: $t = 8.56$, $p < 0.01$, $df = 260$.

Thus, we found evidence that word stress which is not intended to be sentence stress is accompanied by pitch movements in many cases. The fact that the excursion of these movements is smaller than the one for sentence stress, can be regarded as an indication that 'secondary pitch accent' may be a useful category in Dutch prosody.

3. Experiment 2

This experiment was carried out to answer the same questions as in experiment 1. This time, however, the speakers were not instructed to stress any particular syllable. Furthermore, the speakers had to judge their own material twice: once immediately after the realization of the complete set of utterances, and once in a normal listening test which took place a week later. In this way we were able to determine which syllables were meant as stressed by the speakers themselves. In addition a panel of ten listeners performed the listening test too. In all cases the test was an (0.1)-task: all syllables had to be categorized as either 'stressed' or 'unstressed'.

3.1. Speech material

Nine sentences read out by five speakers. In this material three samples from each of the three categories of polysyllabic words mentioned before ('target words') were included (see experiment 1).

The speakers were asked to imagine a situation for each utterance so that they could be used as 'naturally as possible'.

3.2. Analysis

The pitch jumps were determined in the same way as described in experiment 1.

We determined:

- the jumps on the target words
- the jumps on the syllables which were labeled 'stressed' by the majority of the listeners.

3.3. Results

- None of the target words were scored as stressed by the speakers when they had to judge their utterances straight away.
- In the second task (the listening task) four of the five speakers did not change their mind; only one speaker now scored eight of the nine target words as 'stressed'.
- Fourteen of the 45 target words ($= 5 \times 9$) were judged stressed by the panel of ten listeners.
- In 42 of the 45 target words clear pitch movements were found on the syllable carrying word stress.
- The pitch jumps on the target words (mean: 4.87 semitones, s.d.: 2.04 semitones) were significantly smaller than those on the syllables in non-target words which had been judged stressed by the majority of the panel (mean: 8.45 semitones, s.d.: 1.98 st): $t = 1.72$, $p < 0.05$, $df = 156$.
- A significant, though not a strong correlation was found between the excursion of the pitch jumps on the target words and the number of stress scores given by the panel: Pearson's $r: .65$, $p < 0.01$ ($n = 44$).

4. Experiment 3

In the third experiment we presented the same speech material as in experiment 2. This time, however, listeners had the possibility to use three response-categories in their stress-judgments: 'full-stress' 'half-stress' and 'no stress': a (0,1/2,1)-task.

In experiment 1 we observed noticeable F_0 -movements on the syllable carrying word stress in polysyllabic words. These syllables were not judged 'stressed' in an experiment with two response-categories: no stress and stress. In the present experiment with three response-categories we expected the majority of the syllables involved to be judged as 'half-stressed'.

4.1. Results

Thirty out of 45 syllables carrying word stress (= 67%) were judged as 'half-stressed' by the majority of the listeners. This result implies that the dichotomy of pitch accents (= sentence accents) and other accents as introduced by Cohen and 't Hart is not confirmed by our data. The presence of pitch movements on syllables which do not carry sentence stress is related to a stress impression of a certain kind: 'half-stressed'. Experiments with resynthesized speech and manipulated F_0 -movements may show to what extent this relationship is a causal one.

5. Experiment 4

A further indication of the reality of a 'secondary accent' may be deduced from the interrater reliability of scores involving this response category.

To this effect we presented a text consisting of 10 sentences with 221 syllables to two panels of 12 listeners each.

One panel was given a (0,1)-task, the other a (0,1/2,1)-task. We did not use all the scores gathered in this experiment since the method we applied to determine the reliability of the scores is based on the assumption of independence of scores: Ebel's reliability coefficient by analysis of variance. Stress scores, however, are not independent; for that reason we formed subsets of all available scores by quasi-random sampling.

The reliabilities we obtained in both tasks for 'full stress' were high: 0.92; the reliability for 'half-stress' was lower, but still satisfactory: 0.80.

From the latter value we can deduce that the 'secondary-accent' is indeed a real perceptual category in Dutch.

6. Conclusion

In the measurements reported here, clear pitch movements were found on the syllables carrying word stress in words of three or more syllables. The great majority of these syllables were not scored as 'stressed' by the speakers and/or listeners. The range of these pitch movements was smaller than the range on other syllables which had to be pronounced as 'stressed' (exp. 1) or were judged 'stressed' (exp. 2). In another experiment (exp. 3) we found that the majority of the syllables carrying word stress in words of three or more syllables were judged 'half-stressed' in a task which included three possible responses: 'unstressed', 'half-' and 'full stressed'. F_0 -measurements (exp. 2) showed considerable pitch movements on the syllables carrying only word stress.

Our data do not confirm, therefore, the suggestion of the diagram by Collier and 't Hart that accents which are not 'conspicuous' do not carry noticeable pitch movements and are mainly durations accents.

References

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