

The Perception of Preheads as Accents

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ABSTRACT

An experiment is reported on the perceived accentuation of words preceding the accent in H*L L% sequences, assumed to be due to a %L boundary tone and referred to as ‘prehead’. Four factors were hypothesized to affect the perception of accent on the first word of the utterance: the F0 of %L, the temporal distance between %L and the following H*, the F0 of the peak for the following H* accent and the grammatical status of the word in the prehead. A perception experiment with speech in which the F0-contours were manipulated with the help of PSOLA showed that the F0 of %L and the grammatical status of the word in the prehead have significant effects on perceived accentuation. In addition, a significant effect of the interaction between distance and F0 of %L was found.

1 INTRODUCTION

The perception of accent in European languages has typically been investigated on the basis of varying features of F0-peaks of the sort that are used to signal pitch accents (e.g. [1,2,3]). We report on an experiment in which we obtained listener judgements of accentuation in stretches of speech that would typically be analysed as unaccented. Our motivation was the experience with transcribers of intonation contours of Dutch [4] who heard accents in preheads, i.e., in the sections of utterances occurring before what in our perception was the first accent. The aim is to reach a better understanding of the factors that cause this discrepancy in perception.

Pitch contours are described as a series of F0-targets associated with pitch accents and boundary tones on one hand, and the interpolations between them. Of course, the relation between a given F0-value and perceived accentuation is not absolute. Its interpretation takes place against the background of the remainder of the contour. This includes not just the F0 configuration as such, but also the inferred pitch range it will have, given the gender of the speaker [5] or the estimated pitch register of the speaker [1]. [1] reported an experiment in which the length of the prehead was found to affect the degree of prominence perceived on the following accent peak. If listeners have enough information at their disposal to estimate the speaker’s register, the actual F0 of the peak for H*L will be projected on a scale determined by the estimated register. If not enough information is available, the listener will have to find other evidence to estimate the register.

We report on a listening experiment in which perceived accentuation of the prehead itself in the focus of interest. In many listening experiments, linguistically naive listeners

tend to perceive boundary tones as pitch accents if their F0 is high enough. We expected that the F0 of the prehead will have an important effect on the perception of its accentuation. However, there are a number of factors in addition to the F0 of the prehead which we thought might influence its perceived accentuation.

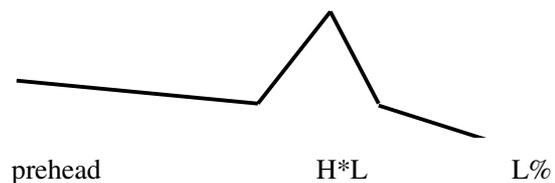


Figure 1: A pitch contour with prehead, a low final boundary tone and an H*L pitch accent.

First, the distance between the utterance beginning and the following H*L accent may have an effect. We hypothesized that when the prehead is particularly short, a relatively high F0 might be taken to result from an allophonic effect. In particular, the F0 might be raised in anticipation of the high target of H*, and if listeners interpret it as such, its perceived accentuation will be reduced relative to a situation in which the listener cannot draw this inference, i.e. a longer onset. That is, as a consequence of tonal coarticulation, the listener might not, or less often, infer that the F0 of the prehead was meant by the speaker to signal a pitch accent. We expect that higher preheads will attract greater perceived accentuation than low F0-values.

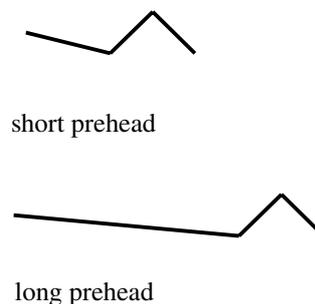


Figure 2: Distances between the initial boundary tone and the following pitch accent as used in the experiment

A third factor might be the meaning of the word. Words which are hardly ever accented, like *van* ‘of’, will not frequently give rise to the perception of an accent, in spite of a high F0, while words which are prone to be focused,

will be perceived as accented much more frequently [6]. In the following we give two examples of hypothetical effects of word class and distance.

- (1a) Van Jansen hoor je weinig
of Johnson hear you little
- (1b) Van mensen als Jansen hoor je weinig
of people like Johnson hear you little

It is quite improbable that an initial boundary tone %L associated with *van* ‘of’ will give rise to the perception of an accent, even if the F0 is quite high. Prepositions are hardly ever accented in Dutch. In (2a) and (2b) the adverb *nooit* ‘never’ will be accented in most contexts [6]. In fact, adverbs vary in the frequency with which they occur as accented. The adverb *nooit* is virtually always accented, but the adverb *ook* ‘also’ may or may not be accented in spontaneous speech.

- (2a) Nooit kan Lilian in het weekend naar huis
Never can Lilian at the weekend to home
- (2b) Nooit kan iemand als Lilian in het weekend naar huis
Never can somebody like Lilian at the weekend to home

In both (1) and (2), the b-examples illustrate the long distance between utterance beginning and the first pitch accent, while the a-examples give the short distance.

Third, the F0 of the peak for the first H*L pitch accent may also affect the perception of accent on the prehead. As shown in [3], listeners will have to estimate the speaker’s register before they can decide on the prominence of any section of the contour. Thus, a low F0 of the prehead, phonologically %L, will yield fewer accent judgements than a high F0, phonologically %H, but this effects is likely to depend on the height of the peak for H*L. Consequently, the variation in peak F0 of H*L was included as a factor in the experiment.

Summarizing, we expect the following factors to play a role in the perception of the accentuation of preheads by Dutch listeners:

1. The F0 of the prehead;
2. The duration of the prehead;
3. Word type (preposition, optionally accented adverb, frequently accented adverb).
4. The F0 of H*

2 EXPERIMENT

2.1 STIMULI

In order to establish which of the factors listed above affect the perception of accent on preheads, we conducted a perception experiment with resynthesized speech (male speaker), in which the F0-contours were manipulated with the help of PSOLA. More specifically, the experiment aimed at assessing the effects of:

1. The F0 of the prehead: 4 levels (110, 125, 140 and 155 Hz);
2. The F0 of the peak for the first H*L pitch accent: 2 levels (125 and 155 Hz);

3. The distance between the utterance beginning and the syllable associated with H*: two levels (short and long);
4. Word type: 3 levels (preposition, optionally accented adverb, frequently accented adverb).

All levels of these four factors were crossed, yielding 24 combinations. For each of the three word types, two sentences were constructed, each with a variant of the word type at the beginning of the sentence, as follows:

1. No accent: *van, door* ‘of, by’
2. Optional accent: *ook, vaak* ‘also, often’
3. Frequent accent: *altijd, nooit* ‘always, never’

Each of these six words began a sentence. Within each of the three word classes, these sentences were identical except for the words that were added to the sentences with the long preheads. These sentences are given below. They contain two accents, which are underlined and printed in bold. The word in the prehead that listeners might hear as accented is printed in bold.

Van Jansen hoor je weinig
Van mensen als Jansen hoor je weinig
Door de warmte gaat het moeilijk
Door de effecten van de warmte gaat het moeilijk

Ook Johan gaat in het weekend naar huis
Ook mensen als Johan gaan in het weekend naar huis
Vaak helpt dat niet bij echte problemen
Vaak zal zoiets niet helpen bij echte problemen

Altijd regent het in Ierland
Altijd valt er wel wat regen in Ierland
Nooit kan Lilian in het weekend naar huis
Nooit kan iemand als Lilian in het weekend naar huis

The rise of the first accent started at 100 Hz and was 100 ms long, which was also the duration of the fall, which ended at 100 Hz. The utterance end was set at 90 Hz. In order to avoid possible confounding effects of durational, spectral or intensity cues, the first word of each sentence – the target word to be assessed for the presence of an accent – was copied and pasted from one sentence of a pair to the other.

2.2 TASK OF THE LISTENER

The task of the listener was to identify the first word in each sentence which he or she perceived as accented. The sentences were presented auditorily, over headphones, and were printed on the answer forms. This instruction was chosen in preference to one whereby subjects were asked to mark all the accents in the stimuli. The reason for this preference was that we feared that listeners might skip the less prominent accents, among which the one in the prehead. The experiment contained 96 experimental sentences, preceded by 4 practice sentences and followed by 2 fillers, and took about 15 minutes. Twenty-four listeners participated in the experiment. They were paid a small fee.

3 RESULTS

Each subject yielded 96 binary values (0 = first word is not accented, 1 = first word is accented) for the 3 (word type: no accent, optional accent, default accent) \times 2 (F0-target of H*: 125 and 155 Hz) \times 2 (duration of prehead) \times 4 (F0 of prehead: 110, 125, 140 and 155 Hz) \times 2 (sentences) = 96 stimuli. The first thing we looked at was the effect of the F0 of H*. Since the results for this factor were negligible, we decided to pool the data for high and low H*. In order to increase the range of the dependent variable for a subsequent analysis of variance (repeated measures), we also pooled the data over sentences. As a result, we had four observations per stimulus category (F0 of prehead, length of prehead, and word type) and thus a maximum score for each category of four. A score of four thus means that all subjects heard the prehead as accented in all four stimuli in a category. In figure 3, we give these mean scores for prehead length and F0 of prehead for the three word types separately.

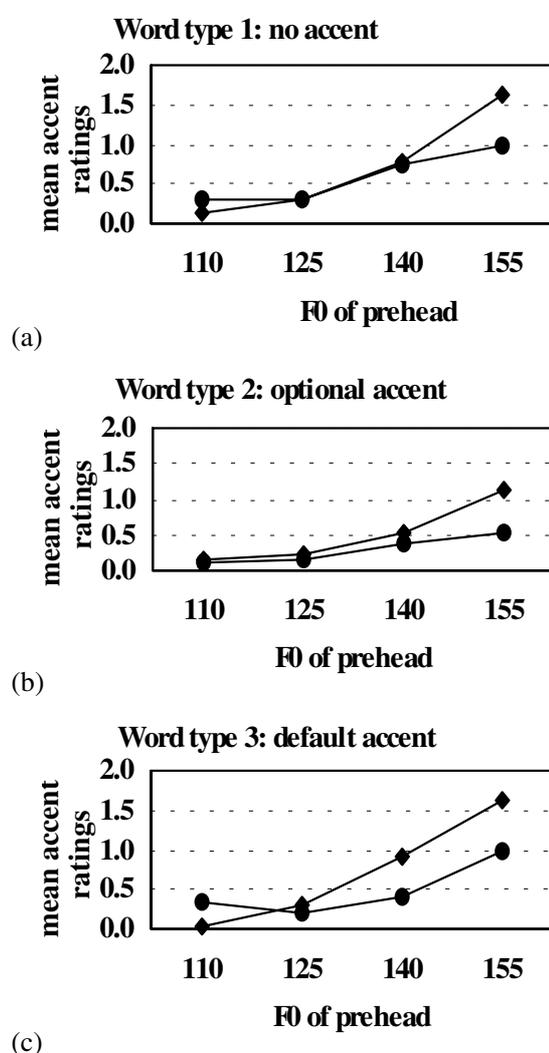


Figure 3: Perceived accents in the prehead: mean frequencies of accent ratings (range 0-4) for four values of the prehead and two distances (● = short, ◆ = long), for three word types separately.

The analysis of variance showed three significant effects at the 5% level (the Huynh-Feldt corrected significance levels are reported):

1. F0 of %L ($F_{3,69} = 30.00$, $p = 0.000$)
2. Word type ($F_{2,46} = 5.191$, $p = 0.009$)
3. Interaction Distance \times F0 of %L ($F_{3,69} = 9.041$, $p = 0.000$)

The F0 of %L had a clear and expected effect. Higher F0-values of %L gave rise to more accent assignments than low %L values. As for the effect of word class, we found that adverbs that have optional accents (panel b) are less likely to be heard as accented than adverbs that are almost always accented 'default accent', panel c). This confirms our intuition that listeners' expectations of the accentuation of words may influence their perception: more accents are heard on words that are accented more frequently. However, when comparing the scores for prepositions, words that are hardly ever accented (panel a), with those for the optionally accented adverbs (panel b), we found that prepositions were more frequently heard as accented than optionally accented adverbs. It seems a counter-intuitive result. We might speculate that an unexpected acoustic marker is going to stand out and for that reason attract more 'accent' ratings. For instance, at a value of 155 Hz for the %L initial boundary tone more listeners will hear an accent on a 'no accent' word than on a word with an 'optional accent'. Since accents on adverbs are not *a priori* unexpected, no such inverse effect is found when comparing the data in panels (b) and (c).

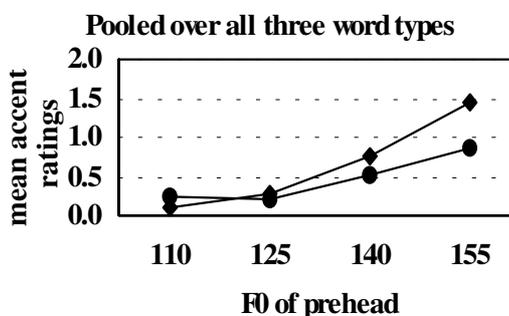


Figure 4: Perceived accents in the prehead: mean frequencies of accent ratings (range 0-4) for four values of the prehead and two distances (● = short, ◆ = long), pooled over three word types.

We also found an interaction between the F0 of the prehead and the distance between utterance beginning and the first H*L accent (Figure 4): long preheads yielded higher accent scores at higher F0 levels than short preheads. This is in accordance with the expectation outlined in the introduction. Listeners will perceive a longer prehead more readily as a separate tonal event, rather than as the result of tonal assimilation. The interaction is the result of the overall low level of perceived accentuation at low values of the prehead and the perceivability of accent at the higher levels, where differentiation can therefore occur at all. Another possible explanation of the effect of distance is that listeners might assume that speakers avoid stress clash,

and therefore hear no accent before H*L. It should be noted, however, that adjacent accents do occur in Dutch.

4 CONCLUSION

The results of this listening experiment have shown that listeners are more inclined to hear unaccented words before the first pitch accent as accented as this pre-accentual stretch of speech is higher. High levels of F0 for the prehead attract more accent judgements than low levels. Second, listeners are more inclined to hear preheads as accented as these are longer. The probable explanation of this latter effect is that mid pitch in short preheads is taken to be an allophonic effect of the high target to be reached for the following H*. Third, listeners are inclined to hear preheads as accented if the relevant word typically occurs as accented. However, prepositions, which are hardly ever accented, exceptionally attracted more accent judgements than words that are optionally accented. This effect was entirely unexpected, and may be due to a surprise factor, if it is the case that prepositions rarely occur in high preheads.

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