

Perception of low-anchoring versus high-anchoring of Dutch accent-lending pitch rises

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ABSTRACT

A perception experiment was conducted to evaluate the hypothesis, derived from earlier production data, that the onset of the Dutch accent-lending pitch rise ('1') is attached to the syllable onset. The accent-lending rise, either anchored with its onset ('low-anchor') to the syllable onset, or with its peak ('high-anchor') at 50 ms after the vowel onset, was presented to listeners in a discrimination and a preference test. Results reveal that, counter to what the relevant literature suggests, there is a preference for the low-anchor, increasing with the magnitude of the shift between the two types of rise.

INTRODUCTION

In the Dutch Intonation Grammar ('t Hart et al. 1990), the *peak* of the standard accent-lending pitch rise is fixed at 50 ms after the vowel onset. This is in concurrence with what is generally assumed in the phonological school of intonation (Pierrehumbert, 1980; Gussenhoven, 1988): in a rising tonal accent, the pitch peak is called the 'target' and is associated with the accented syllable ('H*'). It seems reasonable to assume that this H-target is anchored in the segmental structure. Furthermore, it seems plausible that this important prosodic event coincides with the most salient part of the syllable, i.e. the CV interface (Ohala and Kawasaki, 1984). In production data, however (Caspers and Van Heuven 1992, 1993), we found that the onset of the Dutch accent-lending pitch rise ('1') is relatively fixed with respect to the onset of the syllable, whereas the distance between the peak of the rise and the vowel onset varies considerably under time pressure. We concluded that the onset of the Dutch accent-lending pitch rise is attached to the syllable onset.

We compared our anchor point for the onset of the rise ('low-anchor') with the anchor point used in the Dutch Intonation Grammar: synchronization of the offset of the rise at 50 ms after the vowel onset ('high-anchor'). A discrimination and a preference test were carried out. Assuming that mimicking actual speech production behaviour yields a perceptually adequate alignment of pitch movements, we predict that listeners will prefer our 'low-anchor' over a 'high-anchor' for the Dutch accent-lending pitch rise ('1'), in those cases where a difference can be perceived between both types of rise.

METHOD

Stylized pitch contours from the mentioned production experiment were used as basic material. Eight utterances were selected, containing either isolated accent lending pitch rises ('1'), or so called 'flat hat' intonation contours ('10A', i.e. an accent lending pitch rise, followed by an accent lending pitch fall in the second syllable

after the syllable containing the rise). The accent leading rise was positioned on four different (CVC) target syllables. Target syllables started either with a relatively short consonant (/m/) or a longer consonant (/p/), followed by a low vowel and an /n/ (i.e. /mɔ:n/, /ma:n/, /pɔ:n/ and /pa:n/). The duration of the accent leading rise varied with contour type (220 ms for the isolated rise and 190 ms for the rise in a flat hat). The accent leading rise in each utterance was (i) attached with its onset to the syllable onset ('low-anchor'), and (ii) with its end at 50 ms after the vowel onset ('high-anchor'). After manipulation, the utterances were resynthesized to waveforms, using straightforward LPC resynthesis.

A stimulus consisted of a pair of utterances, separated by a 200 ms silent interval, **only** differing in alignment of the accent leading rise. All possible combinations of low-anchored and high-anchored versions of the accent leading rise were made (i.e. low/high, high/low, low/low and high/high), resulting in 32 stimuli for the discrimination test, 16 'different' and 16 'same'. For the preference test, the 16 different pairs of utterances were used.

Twenty-five naive and 25 experienced listeners (intonologists) participated in the experiment.

Listeners were seated in a sound-isolated booth and listened to the stimuli over good quality headphones. The listener's task was to listen to each of the 32 stimuli and to indicate whether he or she perceived a difference between both utterances or not (discrimination test). In the preference test, listeners indicated for each of the 16 stimuli which of the two utterances they preferred. An ordered list of stimuli was presented online to the subjects (12 kHz, 12 bits, 4.5 kHz LP, 96 dB/oct). They had to press keys to make a pair of utterances audible, and to mark their judgements. Within one trial, subjects could listen to each stimulus as often as they felt necessary.

RESULTS

Overall discrimination and preference responses

In table 1 the overall discrimination and preference responses are presented.

Table 1. *Discrimination responses (absolute and relative frequency of 'different' and 'same' responses) for different and same stimuli (correct responses in shaded cells), and preference responses (absolute and relative frequency of 'pro low-anchor' and 'pro high-anchor' responses).*

stimulus	discrimination responses		preference responses	
	different	same	pro low-anchor	pro high-anchor
different	487 (61%)	313 (39%)	520 (65%)	279 (35%)
same	137 (17%)	663 (83%)		
total	624 (39%)	976 (61%)		

On average, 72% of the utterance pairs were discriminated correctly (shaded cells), and in 65% of all cases the low-anchored rise was preferred to the high-anchored rise. A binomial test showed both frequency distributions to be different

from chance ($z = 53.08$, $p < .001$ and $z = 8.49$, $p < .001$). These results indicate that listeners are able to hear the difference between the two ways of timing the accentuating pitch rise, and that a preference exists for the alignment of the onset of the rise with the syllable onset (low-anchor) to an alignment of the end of the rise at 50 ms after the vowel onset (high-anchor).

The experienced listeners discriminated different stimuli better than naive listeners (70 vs 52% correct responses, $\chi^2 = 27.97$, $df = 1$, $p < .001$). For the class of same stimuli, no effect of experience is found (84 vs 80% correct responses, $\chi^2 = 1.49$, $df = 1$, ins.). As opposed to the discrimination data, there is no association between experience and the preference responses ($\chi^2 = 0.88$, $df = 1$, ins.). Both groups of listeners prefer the low alignment of the rise in ca. 65% of the cases.

Post hoc analysis: effect of 'shift size'

The shift in alignment between the low-anchored and high-anchored rises relative to the segmental structure, is influenced by the duration of the rise and the duration of the initial consonant, and has a magnitude of 40, 60, 70, 80 or 100 ms. In a post hoc analysis, the effect of the magnitude of this 'shift size' on the discrimination and preference responses was examined directly. We hypothesized that larger shift sizes will be easier to perceive, and therefore will produce clearer preferences than smaller shifts. The results are presented in figure 1a and b.

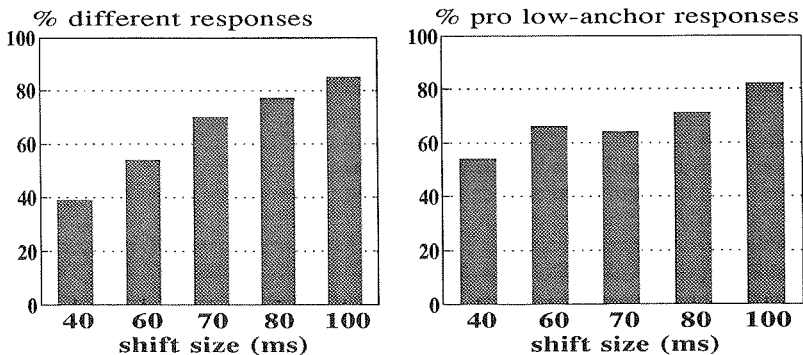


Figure 1. Percentage of 'different' (a) and 'pro low-anchor' (b) responses to different stimuli, broken down by shift size in ms.

It is clear from figure 1a, that discrimination improves with the shift size: the larger the shift, the more correct responses are given. The effect of shift size is significant ($\chi^2 = 87.10$, $df = 4$, $p < .001$). A comparable effect of shift size is found for the preference responses ($\chi^2 = 25.16$, $df = 4$, $p < .001$). This means that the preference for the low-anchor grows with the shift size, as expected.

CONCLUSION AND DISCUSSION

We found that in 65% of the cases, the low-anchor was preferred to the high-anchor, which largely confirms our hypothesis. There was no effect of the experience of the

listener on the preference responses, which means that to experienced as well as naive listeners an anchoring of the onset of the rise is more acceptable than an anchoring of the offset of the rise. The magnitude of the shift between low-anchored and high-anchored rises affects the preference responses considerably: the larger the difference in timing, the stronger the preference for the low-anchored version of the rise is, resulting in over 80% pro high-anchor judgements for the largest shift size (100 ms). The results of this perception experiment lend more credibility to our claim that the onset of the Dutch accent-leading pitch rise is attached to the syllable onset rather than with its offset to the vowel onset.

It is possible that a connection exists between the preference for a low-anchored rise and the P-centre phenomenon (psychological moment of occurrence of a syllable). The location of the perceptual centre is strongly correlated with the duration of the initial consonant(s) (Pompino-Marschall, 1990). Further research into the relationship between P-centres and timing of pitch movements is required.

ACKNOWLEDGEMENT

This research was supported by the Linguistic Research Foundation, which is funded by the Netherlands Organization for Scientific Research, NWO, under project # 300-173-005.

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