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# Alignment of the Second Low Target in Dutch Falling-Rising Pitch Contours

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## Abstract

Two production experiments were conducted to establish the anchor point for the beginning of the final rise in Dutch falling-rising pitch contours. We systematically varied the prosodic structure of the post-nuclear words by including the stress level (primary or secondary) of the penultimate syllable and the distance of the last stressed syllable to the utterance end as factors. None of the syllable types provided an anchor point for the timing of the beginning of the rise, which appeared to be most constant relative to the utterance end or to the end of the rise. Our finding is not consistent with earlier experiments which found a tendency for the beginning of the rise to be attracted to the last stressed syllable. Additionally, we found that unaccented primary stressed syllables are somewhat longer than un-accented secondary stressed syllables confirming earlier findings for Dutch obtained on the basis of reiterant speech.

**Index Terms:** intonation, pitch timing, tonal alignment, phrase accent, Dutch

## 1. Introduction

Phonetic studies have provided evidence that turning points in F0 contours are aligned relative to “anchor points” in the segmental string ([1], [2], [3], [4]). A contour which has recently attracted some attention is the nuclear fall-rise, which consists of a falling pitch movement from the nuclear syllable and a rising movement at the end of the utterance ([5], [6]). The contour has been expected to provide evidence for the “phrase accent”, introduced by [7] and further developed by [8], [9]. For [9], phrase accents are tones which come with the final boundary of some larger phrase and have a “secondary association” to a stressed or some other designated syllable. The low turning-point in English and Dutch fall-rises would be expected to behave in this way, as reflected in the representations of the contour as H\*L-H% in [9].

A study by [5] of Dutch fall-rises in questions in which the stress pattern of the final nuclear word was varied (*S<sub>ww</sub>*, *S<sub>ws</sub>*, *S<sub>sw</sub>*, and *S<sub>sws</sub>*, where *S* is the nuclear syllable and *s* a post-nuclear stressed syllable) did not provide direct evidence for a close link between the low turning-points of the fall-rise and the post-nuclear stress, but the variation was apparently in conflict with alternative anchor points. In particular, they found a variable distance of the first turning-point (L1) to the nuclear peak and of the second turning-point (L2) to the vowel onset of the last syllable as well as to the utterance end, and similar variation was found for the single F0 minimum between the nuclear fall and the final rise (L). Earlier reports on the timing of the final rise include ‘t Hart’s [10] informal statement that it “comes very late in the last syllable”. His observation failed to distinguish between syllables containing schwa, which in [5] clearly fail to behave as he predicts, and other syllables. Yet, it suggests that L2 may occur at a fixed distance from the end of the utterance, or from some point

within the last (non-schwa) syllable. An indication that the end of the utterance determines the location of L2 is provided by a study that examined the effect of second occurrence focus (SOF) [11]. Sentences like *Maar je hebt toch al een mooi lam?* ‘But don’t you already have a beautiful lamb?’ spoken in response to *Ik wil graag een mooi lam* ‘I would like to have a beautiful lamb’ contrasted with *Maar je hebt toch al een mooi lam?* (SOF underlined, capitals for nuclear accent). Varying the stress patterns of the final and pre-final post-nuclear words, [11] found that L2 is stably aligned with reference to the end of the utterance, without the last stressed syllable or the SOF-bearing syllable having an effect.

The question arises why L2 occurred at a variable distance to the end of the utterance in [5], but not in [11]. One factor which might have affected the alignment of L1, L and L2 in [5] is the variation in the distance between the nuclear syllable and the utterance end, combined with the proximity of these two events. Their test sentences contained a maximum of three and a minimum of two post-nuclear syllables, and L2, if realised at all as a separate event from L1, may have been affected by the timing of the preceding turning-point. In [11], the nuclear syllable was further removed from the utterance end, and speakers were thus under no time pressure when realizing two separate low turning points.

While the post-nuclear stressed syllable in [5] had secondary word stress, those in [11] were deaccented words, and thus represented primary stressed syllables. If L2 is attracted to post-nuclear stress, another question is therefore whether its alignment is affected by the level of stress. If a place name like *Oudewater*, used by [5] in nuclear position to represent the stress pattern *S<sub>sws</sub>*, were to be used in post-nuclear position, should we then expect the rise to be aligned relative to the last stress (*wa*) or the last primary stress (*Ou*)? Accordingly, we intended to address two questions. First, to what extent is L2 in Dutch determined by the end of the utterance and/or by the location of the last (stressed) syllable? And second, what is the role played by primary word stress? If there is no effect of stress level, are post-nuclear primary and secondary stresses distinguished at all?

To answer these questions, we carried out two production experiments. We first had speakers produce fall-rises on utterances in which the distance from the last stress to the end of the utterances was varied (*s*, *sw*, and *sww*). We used sentences with longer post-nuclear stretches, allowing our speakers to realise the second low turning-point (L2) of the low plateau independently of the first one. More particularly, we attempted to answer the following questions, inspired by [5]: (i) Does L2 align relative to the last post-nuclear stress? (ii) Does L2 align relative to the final syllable? (iii) Does L2 align relative to the end of the utterance (or the end of the final rise, which will occur close to the end of the utterance)?

In the second experiment, we examined whether the order of primary and secondary stress in final post-nuclear words affects the timing of L2, and, if not, how primary and secondary stress are distinguished in this position.



Table 2. Mean distances from L2 to (1) vowel onset of last post-nuclear stress, (2) vowel onset of last syllable, (3) end of utterance, and (4) end of final rise (H2).

	Stress Pattern	N	Mean (ms)	SD
1	s	66	58	39
	sw	66	158	41
	sww	66	243	54
2	s	66	58	39
	sw	66	-29	40
	sww	66	-17	37
3	s	66	148	50
	sw	66	144	42
	sww	66	146	40
4	s	66	137	45
	sw	66	134	38
	sww	66	134	45

In a second analysis, we examined the null hypothesis that L2 is constantly aligned with the last syllable of the utterance. The distance from L2 to the vowel onset in the last post-nuclear syllable was the independent variable, and STRESSPATTERN a fixed within-subjects factor (Table 2-2). Mauchly's test indicated that the assumption of sphericity had been violated ( $\chi^2(2) = 9.70, p < .01$ ), and degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ( $\epsilon = .88$ ). STRESSPATTERN had a significant effect on the distance from L2 to the vowel onset in the last syllable,  $F(1.75, 113.97) = 129.42, p < .001$ . Contrasts revealed that the distance in *s* words differed significantly from the distance in *sw* and *sww* words ( $p < .001$ ), while the distances in *sw* and *sww* words did not differ significantly. We obtained comparable results when using the beginning of the last syllable or the centre of its sonorant rhyme as point of reference. These findings suggest that L2 does not consistently align relative to the last syllable.

In a third analysis, we examined the hypothesis that L2 is constantly aligned with the end of the utterance. The distance from L2 to the end of the sonorant rhyme of the final syllable was the independent variable, and STRESSPATTERN a fixed within-subjects factor (Table 2-3). We found no significant effect of STRESSPATTERN,  $F(2, 130) = .35, p = .709$ . Since H2 did not always coincide with the end of the sonorant rhyme of the final syllable, we carried out an alternative analysis using the distance from L2 to H2 as dependent variable (Table 2-4). Again, we found no significant effect of STRESSPATTERN,  $F(2, 130) = .14, p = .873$ .

These findings suggest that L2 aligns neither relative to the last stress nor to the last syllable, leaving open the possibility that it aligns at a fixed distance to either the end of the utterance or the end of the final rise. The data strongly suggest that this conclusion is correct. Mean distances from L2 to the vowel onset of last post-nuclear stress vary from 58 ms to 243 ms, and those between L2 and the vowel onset of the last syllable vary from 58 to -17 ms. By contrast, mean distances from L2 to the utterance end or those from L2 to H2 differ by maximally 4 ms.

### 3. Experiment 2

As L2 is not bound to the last stress, it cannot be used as a cue to the position of the last stress. Would this independence persist if stress is distinctive, as in *Hogelonen* (primary stress on *ho-*, secondary stress on *-lo-*; proper name) vs. *hoge lonen* (secondary stress on *ho-*, primary stress on *-lo-*; 'high

salaries')? The experiment in [5] did not allow for the detection of any influence of stress level on the timing of L2, as all primary stresses occurred in nuclear position, thus confounding any effects of primary word stress and focal accent.

#### 3.1. Method

We used the same speakers and the same procedure of data elicitation and analysis as reported for Experiment 1. The test sentences contained (near-)minimal pairs of words varying in the position of primary and secondary stress. The first half of the target words consisted of compounds, the second of a short noun phrase (adjective-noun). Compounds are pronounced with primary stress on the first element in Dutch, whereas in adjective-noun combinations primary stress falls on the second element. Accordingly, we used the pairs of compounds and phrases shown in Table 3 in three pairs of test sentences in post-nuclear final position. They were separated by three syllables from the nuclear syllable. In the example in (2), target words are underlined and the nuclear syllable is in bold type.

- (2) a. Maar jullie gingen toch naar het **strand** met meester Hogelonen?  
's w s w  
*But you went to the beach with Mr. Hogelonen, didn't you?*
- b. Maar ze heffen toch ook veel meer **belasting** op die hoge lonen?  
s w 's w  
*But they apply much higher taxes to higher salaries, don't they?*

Table 3. Target phrases used in Experiment 2. ('s=primary, s=secondary, w=unstressed)

's'wsw	sw'sw
Hogelonen (proper name)	hoge lonen 'high salaries'
Oudebomen (proper name)	oude bomen 'old trees'
Grotehuizen (proper name)	grote huizen 'large houses'

#### 3.2. Results

Figure 2 shows mean syllable durations for the stress patterns 'swsw and sw'sw in post-nuclear final position and the timing of the beginning and the end of the final rise.

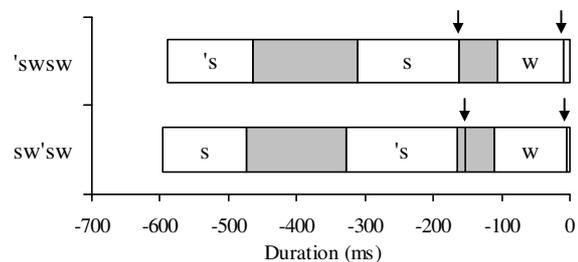


Figure 2: Mean syllable durations, position of L2 (left arrows), and position of H2 (right arrows). White boxes mark sonorant rhymes of the first, third, and fourth syllables.

The final rise starts near the beginning of the last syllable in both stress patterns. A dependent-*t* test (two-tailed) shows that the distance of L2 from the beginning of the primary stress is significant ( $t = 26.063, p < .001$ ) (Table 4). We may

thus reject the null hypothesis that the timing of L2 depends on the position of the primary stress in the stress patterns tested. Mean distances from the vowel onset to L2 differ by no less than 252 ms. We may also conclude that the pairs of target words are not distinguishable by the timing of the final rise.

Table 4. Mean distances from L2 to vowel onset of primary stress.

Stress Pattern	N	Mean (ms)	SD
'sww	35	427	50
sw'w	35	175	49

In order to establish any other phonetic differences between unaccented primary and secondary stress, we compared duration and F0 ratios between the first and second stressed syllables in the two stress patterns. They show that (i) the second stressed syllable is longer than the first one in both stress patterns (ratios are 1.22 for 'sww and 1.38 for sw'w,  $N = 35$ ); (ii) the second syllable is lengthened more when bearing primary stress ( $t = -3.05$ ,  $p < 0.01$ ); (iii) the second stressed syllable is lower than the first one in both stress patterns and lowered more in sw'w words; but this difference did not reach statistical significance ( $t = 1.88$ ,  $p = 0.068$ ). To summarize, the sw'w words differ from the 'sww words in post-nuclear final position by an additional amount of penultimate syllable lengthening. There would appear to be a trend to lower the penultimate syllable more in sw'w words than in 'sww words.

#### 4. Discussion

The results of Experiments 1 and 2 suggest that the beginning of the final rise in Dutch (L2) is not aligned with reference to the last primary stress, the last stress, or the last syllable, but is located at a highly stable distance from the end of the utterance and the end of the final rise. For these distances, we found a maximum difference of 4 ms between the mean position in *s* words and the mean position in *sw* and *sww* words. These results are in line with the findings in [11]. They appear to be in conflict with the findings of [5]. A possible explanation for the apparent tendency of L2 to occur near stressed syllables in that study may lie in the short distances between the nuclear syllable and the end of the utterance. In our test sentences, there were minimally four syllables between the nuclear syllable and the last syllable, while in [5] there was a minimum of one. As a consequence, there was little opportunity to realise L2 outside a stressed syllable. In many cases, speakers did not realise two separate low pitch targets, such that L1 coincided with L2. In our experiment, as in the experiments reported by [11], the effect of the timing of L1 on the timing of L2 was greatly reduced. Indeed, the longer post-nuclear stretches used in [6] allowed L2 consistently to fall after the last stressed syllable in comparable contours in American English.

Experiment 2 was conducted to see if a durational or F0 difference between unaccented primary and unaccented secondary stressed syllables exists in natural, read speech. It was found that primary stressed syllables were longer than secondary stressed syllables in penultimate position in the post-nuclear stretch. This confirms results by [15] with reiterant speech. The alignment of L2 in Dutch is thus very different from the alignment of the last high target in Roermond Dutch questions, which is constant relative to the last stressed syllable, but variable relative to the utterance end [16].

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