THE TIMING OF NUCLEAR HIGH ACCENTS IN GERMAN DIALECTS

Jörg Peters
University of Potsdam, Germany

ABSTRACT

Experimental studies on the timing of nuclear and prenuclear high accents in different languages have shown that the placement of the F_0 peak is influenced by segmental factors as well as by the prosodic context. To examine possible effects of dialectal variation on the timing of nuclear high accents acoustic analyses were performed on spontaneous speech data recorded from speakers born in Berlin and Hamburg. The analyses demonstrate that: 1) the speakers use different alignment strategies; and 2) speakers from Hamburg tend to place the F_0 peak earlier than speakers from Berlin. Results from the present study represent preliminary evidence that the timing of high accents may play an important role in prosodic variation of German dialects.

1. INTRODUCTION

Experimental studies on the F_0 peak timing of nuclear and pre-nuclear high accents provide evidence that segmental duration and the right-hand prosodic context are the main sources of peak location variation in English [5,10,11,12], German [4,5], Dutch [3,9], Mexican Spanish [8], and Greek [1]. It was found that F_0 peaks are placed earlier when the duration of the syllable is shortened, e.g. in fast speech. A similar effect can be observed when an intonational phrase boundary, a word boundary, or another accented syllable immediately follows the accented syllable. In addition, segment type was found to have some effect on F_0 peak placement.

Previous research also suggests that the tonal alignment of word and sentence accents may be an important feature of dialectal variation. For example, it was found that in eastern dialects of Swedish the F_0 peak follows immediately after the accented syllable, whereas in western dialects the peak occurs at a later time [2]. The study reported here is intended to contribute to this line of research. It aims at identifying the main factors that influence F_0 peak placement in two varieties of North-East and Northern German, spoken in Berlin and Hamburg.

A second question addressed by this study is how much the factors used in experimental studies contribute to tonal alignment in spontaneous speech data. A non-experimental setting was chosen in order to prevent speakers from switching to a locally less marked code as can be expected in a laboratory situation. On the other hand, spontaneous speech data show much more variation, which is caused by additional factors held constant in experimental studies. It was attempted to control these factors as far as possible, either by minimizing their effects through restricting the data set, or by including them in the set of variables under investigation.

2. METHOD

2.1. Speech materials

Twenty male speakers, 60-70 years of age, took part in informal conversations recorded by a paid interviewer. Ten speakers were born in Berlin and ten in Hamburg. From each group four conversations were randomly selected for analysis, comprising a total of 13 hours of recorded speech.

2.2. Data selection

The main sources of variation in spontaneous speech data which may affect F_0 peak location are segmental composition of the accented syllable, speech rate, scaling of pitch accents, prosodic context, and accent type. In particular, accented syllables were expected to show semantically conditioned variance of peak placement. Kohler [6] distinguished three types of semantically different accents in German, which are associated with an “early peak”, a “middle peak”, and a “late peak”. Possibly, these accent types may be related to the English H+L*, L+H*, and L*+H accents [7]. Furthermore, German “middle” and “late peak” appear to differ not only by the location of the F_0 peak but also by the location of the preceding F_0 minimum [4].

To minimize the effects of these variables, only those utterances were selected for analysis which met the following criteria: (1) They end with a nuclear high accent (H*, L+H*, or L*+H), followed by a low pitch. All nuclear accents associated with an “early peak” in the accented region and all downstepped accents were excluded. (2) The accented syllable consists of a sonorant (*m, n, l, r*) and a vowel.

About 2% of the utterances were omitted from the data set because of overlapping speech, low intensity, or articulatory abnormalities.

A total of 349 utterances were selected according to the above mentioned criteria, 179 from the Berlin corpus and 170 from the Hamburg corpus. For statistical analysis, the data from each group of speakers were pooled.

In order to account for variation in pitch range, F_0 range was included as an additional variable. Furthermore, rise delay was measured to account for different locations of the start of the rise in “middle” and “late peaks”.

2.3. Acoustic measurements

The target words were segmented from waveform and spectrogram displays using PRAAT software (P. Boersma, 1999). F_0 was computed by autocorrelation analysis. The following measurements were extracted from the accented syllable and the remaining part of the utterance:

1. Onset duration (*Onset Dur*)
2. Vowel duration (*Vowel Dur*)

3. Distance in syllables to end of phrase (*DEP*)
4. Distance in syllables to end of word (*DEW*)
5. *F_0 range*, defined as the distance from the F_0 peak to the preceding F_0 minimum (in Hz)
6. *Rise delay*, defined as the temporal distance from the start of the F_0 rise to the onset of the accented syllable
7. *Peak delay*, defined as the temporal distance from the F_0 peak to the onset of the accented syllable
8. *Peak lead*, defined as the temporal distance from the end of the vowel to the F_0 peak

3. RESULTS

3.1. Effects on F_0 peak location

Multiple regression analysis was performed to determine the relative importance of different factors in predicting peak delay. Tables 1 and 2 show the results obtained for Berlin and Hamburg.

	B	beta	*t*	Sig *t*
Segmental Duration				
Onset Dur	0.32	0.12	2.62	0.010
Vowel Dur	0.48	0.48	9.10	0.000
Prosodic Context				
DEP	8.72	0.28	5.28	0.000
DEW	15.39	0.21	4.09	0.000
Other Factors				
F_0 range	0.45	0.28	5.72	0.000
Rise Delay	0.56	0.43	8.54	0.000
(Constant)	7.30			

Table 1. Effects on peak delay: Berlin speakers.

	B	beta	*t*	Sig *t*
Segmental Duration				
Onset Dur	1.02	0.40	6.95	0.000
Vowel Dur	0.12	0.12	1.92	0.056
Prosodic Context				
DEP	8.92	0.28	4.24	0.000
DEW	-3.38	-0.06	-0.95	0.344
Other Factors				
F_0 range	0.89	0.45	7.76	0.000
Rise Delay	0.44	0.24	4.21	0.000
(Constant)	-12.52			

Table 2. Effects on peak delay: Hamburg speakers.

Tables 1 and 2 list unstandardized partial regression coefficients (B), standardized partial regression coefficients (beta), *t*-values, and levels of significance. Beta coefficients indicate the relative importance of each factor for predicting peak location.

Table 1 indicates that in the Berlin group both a longer onset and a longer vowel trigger a longer peak delay. Beta weights, however, indicate that onset duration and vowel duration contribute differently to peak delay. Vowel duration strongly influences peak delay (0.48), whereas onset duration exerts only a weak influence (0.12). Table 2 indicates that in the Hamburg group the pattern is reversed. Onset duration strongly influences peak delay (0.40), whereas vowel duration exerts only a weak influence on peak delay, if any (0.12, p = 0.056).

A second difference between both groups of speakers shows up in the analysis of the right-hand prosodic context. Distance to end of phrase (DEP) correlates positively with peak delay in both groups (beta = 0.28 in both groups), i.e. peak delay increases as a function of the number of postnuclear syllables. Distance to word boundary (DEW) contributes to peak delay in the Berlin group (beta = 0.21) but does not seem to have any effect on peak delay in the Hamburg group (beta = -0.06, p = 0.344).

A third difference between both groups of speakers concerns the importance of F_0 range and rise delay. The beta coefficients indicate that F_0 range contributes to peak delay in the Berlin group (0.28) and even more in the Hamburg group (0.45). In the latter group, F_0 range appears to be one of the most important factors influencing peak delay. The reversed pattern is found for rise delay. In the Berlin group, rise delay seems to be one of the most important factors contributing to peak delay (0.43), whereas in the Hamburg group this factor exerts a weaker influence (0.24).

In order to get further information on the relative contributions of onset and vowel duration on peak location, the analysis was extended by substituting Peak Lead for Peak Delay as a dependent variable. This analysis enables us to determine the effect of segmental duration on the distance between the F_0 peak and the end of the vowel.

Table 3 shows the effects of onset duration and vowel duration on peak lead for both groups of speakers. The remaining factors are omitted as their unstandardized coefficients correspond to the coefficients in Table 1 and 2 (except that they take effect in the opposite direction) and only minimal changes in the beta coefficients occur.

	B	beta	*t*	Sig *t*
Berlin				
Onset Dur	0.68	0.24	5.53	0.000
Vowel Dur	0.52	0.49	9.71	0.000
Hamburg				
Onset Dur	-0.02	-0.01	-0.14	0.893
Vowel Dur	0.89	0.71	14.73	0.000

Table 3. Effects of segmental duration on peak lead.

The data of the Berlin group show the same pattern as found for onset and vowel duration in predicting peak delay (cf. Table 1), with only a minor difference concerning the importance of onset duration (beta = 0.24 vs. 0.12). On the other hand, the beta coefficients for the Hamburg data indicate that in this group of speakers the pattern has dramatically changed. As mentioned above, onset duration was found to be one of the main contributors to peak delay and vowel duration did not have a significant influence at all (cf. Table 2). In contrast, peak lead depends strongly on vowel duration (0.71), whereas it seems not to be affected by onset duration (-0.01, p = 0.893).

Multiple regression analysis enables us to assess how much of the variance in the dependent variable can be accounted for by the independent variables. Based on linear models including all factors that reached a 5% level of significance, the following results were obtained. For the Berlin data, the linear models explained 64% of the overall variance of peak delay and 68% of the overall variance of peak lead. For the Hamburg data, the models explained 53% of the overall variance of peak delay and 71% of the overall variance of peak lead.

The predictive power of the model for the Hamburg data can further be improved by accounting for inter-subject variability. This can easily be achieved by introducing binary variables for three of the four subjects (dummy-variable coding). After the inclusion of these variables, the linear model for the Hamburg data explained 62% of the overall variance of peak delay and 77% of the overall variance of peak lead. No improvement of the model for the Berlin data was achieved by this method.

3.2. Dialectal variation of F_0 peak location

Hamburg speakers were found to align F_0 peak on average 29 ms earlier than Berlin speakers with respect to the beginning of the syllable (t = 5.20, df = 347, p = 0.000) (Table 4).

	Mean (ms)	SD	N
Berlin	142.0	51.0	179
Hamburg	113.0	53.4	170

Table 4. Mean peak delay.

The location of the F_0 peak may also be expressed as a percentage of the overall duration of the accented syllable. In the Berlin dialect, the peak appeared at 79% of overall syllable duration. In the Hamburg dialect, the peak appeared at 57%.

As an additional source of information, mean values for onset duration and vowel duration in both groups were measured (Table 5).

	Mean (ms)	SD	N
Onset Dur			
Berlin	47.4	19.3	179
Hamburg	66.1	21.1	170
Vowel Dur			
Berlin	133.3	50.8	179
Hamburg	133.4	54.5	170

Table 5. Segmental duration.

Onsets tended to be longer in the Hamburg group than in the Berlin group (mean difference = 19 ms, t = -8.65, df = 347, p = 0.000). No difference was found with respect to vowel length (t = - 0.03, df = 347, p = 0.979).

From these results, it was expected that both groups of speakers would differ even more with respect to the distance between the F_0 peak and the boundaries of the vowel. Comparing mean values for peak lead in both groups yielded a mean difference of 48 ms (t = 7.28, df = 347, p = 0.000) (Table 6). The comparison of the distance from F_0 peak to vowel onset (*DistVowelOnset*) yielded similar results (mean difference = 48 ms, t = 9.12 df = 347, p = 0.000).

	Mean (ms)	SD	N
Peak Lead			
Berlin	38.7	54.1	179
Hamburg	86.6	68.3	170
DistVowelOnset			
Berlin	94.6	50.7	179
Hamburg	46.9	46.9	170

Table 6. Mean peak lead and distance to vowel onset.

In the Berlin dialect, the peak appeared at 71% of overall vowel duration, whereas the Hamburg peak appeared at 35%.

4. DISCUSSION

Onset duration, vowel duration, and right-hand prosodic context are important factors for predicting F_0 peak location in German spoken in Berlin and Hamburg. However, these factors affect peak location differently in both varieties.

Both, Berlin and Hamburg speakers tend to place the F_0 peaks later when the onset is lengthened. This result is in line with the findings for Mexican Spanish [8]. Speakers from Braunschweig (Northern Germany) were found to align F_0 peaks with the right edge of the rhyme, no matter what the segmental composition of the onset was [5]. Furthermore, Dutch was found to place F_0 peaks earlier when the onset gets longer due to varying segmental composition [9]. However, these results do not necessarily contradict the findings for Berlin and Hamburg, as the present study does not account for differences in onset duration due to segmental composition.

Berlin speakers also tend to place F_0 peaks later when the duration of the vowel increases. Similar findings have been reported for Mexican Spanish and English [8,10,11,12] but no comparable effect was found for Hamburg. A comparison of the relative importance of onset and vowel duration in the Berlin dialect reveals that vowel duration contributes more to peak delay than onset duration. In Mexican Spanish and English, the reversed pattern was found.

The number of postnuclear syllables increases peak delay in both groups of speakers. This finding is consistent with the results obtained for Northern German, Mexican Spanish, and English [4,5,8,11]. In the Berlin dialect, also within-word position of the accented syllable influences peak location. In word-final position of the accented syllable, which is associated with syllable lengthening, the peak was placed earlier than in a non-final condition. Similar results have been reported for Mexican Spanish and English [8,10]. In the Hamburg dialect, however, no effect of within-word position was found.

In contrast to data available for Mexican Spanish [8], F_0 range was found to highly correlate with peak delay in Hamburg and, to a lesser degree, in Berlin. This result may be explained by the fact that pitch range varies much more in natural conversations than in laboratory speech, due to changes of emotional involvement, emphasis, etc.

An additional finding was that on average Hamburg speakers tend to place F_0 peaks earlier than Berlin speakers. Given the peak location as a percentage of the overall syllable duration, the results for Berlin and Hamburg (79% and 57%) may be compared to similar results obtained for Braunschweig German and Southern Standard English (98% and 66%)[5].

The question arises how the different effects of onset and vowel duration on peak placement in the two groups of speakers can be explained. The predictions of three models were compared to the results found for Berlin and Hamburg.

The first model states that the F_0 peak is placed at a fixed distance from the onset of the vowel. It predicts that: 1) onset duration does positively correlate with peak delay, 2) vowel duration does not correlate with peak delay, 3) onset duration does not correlate with peak lead, and 4) vowel duration does positively correlate with peak lead. The Hamburg data fit this model as longer onsets increase peak delay, but onset duration does not affect peak lead. Furthermore, longer vowels increase peak lead, but vowel duration does not affect peak delay. However, further inspection of the data reveals that vowel duration does not seem to be totally uncorrelated with peak delay. Therefore, an alternative model was tested.

The second model states that the F_0 peak is placed at a fixed proportion into the vowel. It predicts that: 1) onset duration does positively correlate with peak delay, 2) vowel duration does positively correlate with peak delay, 3) onset duration does not correlate with peak lead, and 4) vowel duration does positively correlate with peak lead. According to this model, the strength of the correlation between vowel duration and peak delay depends on the position of the peak in the vowel. If the peak occurs early in the vowel, lengthening of the vowel will only have a small effect on moving the peak to the right. If the peak occurs late in the vowel, lengthening will have a larger effect. As Hamburg speakers tend to place the F_0 peak early in the vowel, only a small effect of vowel lengthening on peak delay was to be expected. Therefore, the second model may explain the pattern found for Hamburg slightly better than the first model.

Neither of these models fits the Berlin data. Both models predict that onset duration does not correlate with peak lead. However, the analysis of the Berlin data reveals that lengthening of the onset does increase peak delay as well as peak lead. A third model, which states that the F_0 peak is placed at a fixed proportion into the syllable and not just into the vowel, may account for this pattern. This model predicts that longer onsets and longer vowels increase peak delay as well as peak lead. This is exactly what was found for the Berlin data. The finding that onset duration has a smaller effect on peak delay and peak lead than vowel duration may be due to the fact that onsets were much shorter than vowels (47.4 ms vs. 133.3 ms) and thus contribute less to overall syllable duration.

The results reported here provide preliminary evidence for the assumption that speakers from Berlin and Hamburg adopt different alignment strategies. Furthermore, the amount of variance explained by the linear models proposed in section 3.1 indicates that several factors which were examined in experimental studies may successfully be used to account for variation of peak location in spontaneous speech.

Nevertheless, the results of this study must be considered with caution. First, because of lack of data it is not possible to compare peak delay in all prosodic conditions. Second, doubts arise as to whether accent type was sufficiently accounted for by including rise delay as an additional factor. Before including utterances with different accent types in the data set, a more detailed inspection is probably necessary. Finally, the effects of many factors that are known as contributing to phonetic variation could not be accounted for because of limited data resources.

Despite these limitations, the present study suggests that variation of tonal alignment in dialects may be a promising field for further investigation.

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