SO NEAR YET SO FAR: FINE PHONETIC DIFFERENCES IN TONAL ALIGNMENT AND TEMPORAL STRUCTURE IN CLOSE CONTACT VARIETIES

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ABSTRACT

This study investigates peak alignment in nuclear rising accents in two generations of West Central Bavarian (WB) speakers compared to Standard German (SG) speakers. WB and SG differ in the segmental timing of vowel plus consonant sequences but younger WB speakers approach the temporal patterns found in SG due to dialect levelling. We analyzed time-normalized, speaker-scaled f0 trajectories extracted from sequences of long vowels plus sonorants in pitch accented trochees in nuclear position from 38 SG as well as 22 older and 22 younger WB speakers. Results from functional linear mixed models indicate differences in peak alignment between SG and WB speakers but not between age groups. However, a subsequent analysis revealed that younger WB and SG speakers share a weakly positive duration-alignment-correlation. No such correlation was found for older WB. Findings are discussed in light of dialect levelling as well as diverging mechanisms to deal with available sonorant material.

Keywords: Tonal alignment, segmental timing, dialect levelling, fine phonetic differences, FLMM.

1. INTRODUCTION

The temporal coordination of a tonal target in the fundamental frequency (f0) contour with the segmental level – known as phonetic alignment [1] – is, amongst others, affected by dialectal background and pragmatic context. Particularly the low beginning (L) but also the high target (H) of non-contrastive prenuclear rises are aligned later with the stressed syllable in Southern compared to Northern German varieties [2-5]. No such regional difference in peak alignment was found for rising pitch accents marking contrast, regardless of whether they occur in prenuclear [3, 6] or nuclear position [6, 7]. A comparison in [8] further suggested the regional differences to emerge mainly in tokens containing phonemically long vowels in the stressed syllable followed by sonorants; i.e., in contexts allowing for a delay given the sufficiently available and advantageous segmental material (e.g., [9, 10]).

While f0 peak delay has been described for many southern varieties of German (e.g., [11, 12]) including Southern Bavarian dialects spoken in Austria [5] and regardless of timing constraints due to the segmental material, not much is known about peak alignment in West Central Bavarian (WB) spoken in south-eastern Germany. Yet, for two reasons this dialect is of particular interest. First, its temporal structure diverges from Standard German (SG; [13, 14]) such that word-medial post-vocalic consonants show clear tendencies of a singleton/geminate contrast (cf. [15], usually referred to as fortis/lenis contrast for obstruents) accompanied by a predictable (allophonic) length of the preceding vowel: Long consonants (including sonorants) follow short vowels and vice versa (e.g., [16, 17]). Second, this WB dialect feature appears to level out (caused by an increasing SG influence, cf. [18]) as suggested by apparent-time studies [19-21] showing that younger WB speakers' fortis consonants are less geminate-like than those of older WB speakers, resulting in shorter durations closer to SG consonants (which does not feature a singleton/geminate contrast). Investigating this dialect offers a rare opportunity to study the effects of segmental structure on peak delay in a variety undergoing a prosodic change in terms of its temporal structure.

The two main aims of this study were thus to test for peak alignment differences between (i) the standard and the WB variety spoken in Bavaria and (ii) two generations of WB dialect speakers. The hypotheses were (i) that WB speakers align non-contrastive nuclear rises later than SG speakers because SG resembles Northern SG more closely than WB and (ii) that younger as opposed to older WB speakers show less peak delay given the levelling out of temporal dialect features in this group.

2. METHODS

2.1. Speech materials and participants

The disyllabic, trochaic target words in Table 1 with phonemically long vowels (V_1) in the stressed, open syllable and sonorants (C_2) in the onset of the unstressed syllable were part of two bigger corpora (cf. [21] for 1) containing, among others, acoustic recordings from 38 SG (aged 19–82, mean 38.0 years, 20 female) as well as 22 younger (aged 18–30, mean 24.8 years, 11 female) and 22 older (aged 49–73, mean 58.0 years, 11 female) WB speakers. While age was balanced within SG speakers, they were not assigned to age groups given their function as control group in the present study. SG speakers were city dwellers with roots in Munich (where Southern SG is spoken) and self-identified as non-dialectal in terms of dialect competence and use. WB speakers were originally from rural areas in the broader vicinity of Munich where WB is still acquired as first variety of German; their WB competence was assessed by native dialect speakers (the experimenters).

Corpus	Target word (item)		Gloss	Tokens (n)
2	*Dame*	/ˈdaː.mə/	'lady'	120
1	*Diener*	/ˈdiː.nɐ/	'servant'	210
2	*Fahne*	/ˈfaː.nə/	'flag'	120
1	*Höhle*	/ˈhøː.lə/	'cave'	210
2	*Krone*	/ˈkʰʁoː.nə/	'crown'	120
2	*Panik*	/ˈpʰaː.nɪkʰ/	'panic'	120

Table 1: Number of tokens per target item (42 speakers × 5 repetitions per item in corpus 1 and 40 speakers × 3 repetitions per item in corpus 2).

All target words are part of the SG and the WB lexicon, respectively. They were embedded in word-specific, but within and across corpora syntactically similar carrier phrases. WB sentences were translations from SG; see (1) for an example with the target word in bold. In all carrier phrases the number of syllables per sentence was kept constant across variety and as constant as possible across sentences (three syllables before and one or two after the target word). The probability for nuclear pitch accents to occur on the target was high (cf. [22, 23]).

(1)	SBJ	MOD	ART	OBJ	V
SG:	*Er*	*will*	*die*	***Dame***	*treffen.*
	/ʔɛɐ	vɪl	diː	ˈdaː.mə	ˈtʰʁɛf̩ən/
WB:	*Ea*	*mog*	*de*	***Dame***	*treffa.*
	/eːa	moːk	de	ˈdaː.mə	ˈtrɛf̩a/

Gloss: 'He wants to meet the lady.'

Recordings were made using SpeechRecorder [24] at a minimum sampling rate of 44.1 kHz, either in a sound-attenuated booth or at participants' homes (with a condenser microphone) or remote via Wikispeech [25] (with headsets). Sufficient recording quality was carefully monitored. Participants read each carrier phrase prompted on screen in silence and reproduced it from memory after it had disappeared. All target words in Table 1 have a high lexical frequency and were produced at a normal speech rate.

2.2. Data analysis

Recorded utterances were automatically segmented with WebMAUS [26] into words and phones on two interval levels and stored as EMU databases [27, 28]. Relevant segment boundaries, i.e., start and end of (i) the utterance, (ii) the target word, and (iii) the target word's phonemes, were manually corrected. Using a minimal set of GToBI labels [29], tonal targets were marked on an event level based on visual inspection of the f0 trajectory, which was calculated separately for males and females with the *ksvF0*-function of *wrassp* [30]. All of these manual adjustments were done by trained phoneticians. A cascading multi-stage process ensured that ambiguous cases were particularly checked and independently judged by at least two labellers (including one or both authors).

F0 trajectories across $V_1C_2(V_2)$-sequences were computed with *emuR* [31], using *R* [32] (v. 4.2.0) in *Rstudio* [33] (v. 2.3.492). The extracted Hertz (Hz) values per trajectory were linearly normalized to equidistant points in a 0-to-1-time interval, also due to significant between-group differences in phrase-level articulation rate – defined as an utterance's number of canonical syllables per second. Time points with Hz values equal to zero and f0 outliers were removed (cf. [34]). To control for individual pitch level, we calculated speaker-scaled f0 values (*z*-scores) across all voiced frames (e.g., [35]).

Sentences with no nuclear rise on or towards the target word and/or a high phrase-final boundary tone were excluded from all subsequent analyses. Speakers who realized less than 25 % of the sentences with a rise-fall nuclear contour were discarded completely (four SG, one younger and four older WB speakers).

Speaker group	Total (n)	Incl. (n)	BpS (%)
Dialect, older	240	150	0.77
Dialect, younger	240	190	0.83
Standard German	420	296	0.79

Table 2: Percentage of bundles per speaker (BpS) included in the analysis, split by speaker group.

The f0 trajectories across the V_1C_2-sequences (hereafter V+S-sequence) in the remaining utterances (cf. Table 2) were then analyzed with functional linear mixed models (FLMM; [36, 37]). We fitted two separate FLMM using *sparseFLMM* [38] because of the current restrictions to binary (i.e., two-level) fixed factors only. Despite this small methodological drawback, FLMM is particularly suitable for our analyses because it enables the evaluation of entire f0 contours and irregularly sampled functional data. The two models aimed at between-group comparisons of (i) regional background in general (*Variety*: SG vs. WB speakers) and (ii) different dialect generations (*Age*: younger vs. older WB speakers). For both, the dependent variable was the speaker-scaled f0 contour mapped onto the 0-to-1-time interval. *Variety* and *Age* were added as single covariates, respectively.

The binary covariate effects (comparable to fixed effects in *lmer()* of *lme4* [39]) were dummy coded to 0 or 1. Finally, we included *Speaker* and *Item* as crossed random effects (intercepts only, due to model-specific restrictions). FLMM estimations (based on penalized splines) are evaluated on the basis of combined covariate effect and summed effects plots (s. 3.2. for details).

3. RESULTS

3.1. Preanalysis

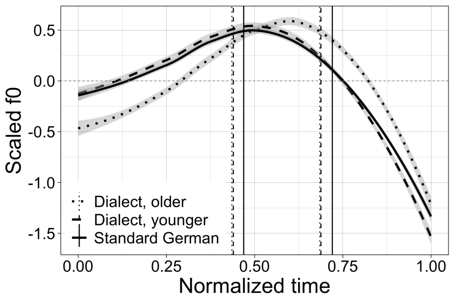

Figure 1: Mean loess-smoothed f0 contours across $V_1C_2V_2$-sequence, corresponding confidence intervals (level = 0.95) and mean segment boundaries per group.

Prior to FLMM, we visually inspected the aggregated f0 trajectories per speaker group (i.e., all three levels within one graph, which is impossible in FLMM) and across the longer $V_1C_2V_2$-sequence. Fig. 1. confirms that, on average, f0 patterns were rise-falls with peaks reached during C_2 (and not later in the sequence). This preliminary observation not only shows the realization of unambiguous nuclear peaks on the target words but particularly justified our focus on the rise within the V_1C_2-sequence in the subsequent FLMM.

$$(2) \qquad t_{norm}(bound.) = \frac{t_{orig}(bound.) - t_{orig}(t_{norm}=0)}{t_{orig}(t_{norm}=1) - t_{orig}(t_{norm}=0)}.$$

A further observation is that, while the mean f0 curves of older WB speakers in Fig. 1 clearly show a later peak alignment and steeper f0 rises than those of SG speakers, younger WB speakers seem to pattern with the latter group at first glance. To factor out variation due to potential differences in segmental duration, we calculated the respective mean time-normalized positions of the C_2-on- and -offset with the formula in (2) and superimposed them on the f0 trajectories in Fig. 1 (as alternative to landmark registration; cf. [8]). This further revealed for both WB speaker groups (i.e., regardless of age) and in contrast to SG speakers (i) proportionally shorter V_1 and longer V_2 relative to the entire $V_1C_2V_2$-sequence (s. Table 3 for mean positions) and (ii) a delayed peak alignment in reference to the C_2-onset. Thus, the apparently similar H alignment of both SG and younger WB speakers in Fig. 1 may in fact be caused by temporally diverging segmental structures.

Speaker group	C_2-onset	C_2-offset
Dialect, older	0.44	0.68
Dialect, younger	0.44	0.69
Standard German	0.47	0.72

Table 3: Mean values for time-normalized C_2-onset and C_2-offset positions per speaker group.

3.2. FLMM *Variety*: Standard vs. Dialect speakers

For the between-group comparison of *Variety*, each of the analyzed 636 f0 trajectories consisted on average of 31.44 data points (range: 8-56 data points). The solid line in Fig. 2a shows the mean covariate effect ($f_1(t)$). Significance is claimed at time points at which the point-wise confidence bands (dashed lines) do not include zero. Fig. 2b., in turn, displays the corresponding summed effects curves, calculated by adding the effect curve in plot a. to the reference mean (or 'baseline', $f_0(t)$), which represents the covariate (here: *Variety*) set to zero (0: Standard, 1: Dialect). Both plots need to be assessed together when interpreting potential differences.

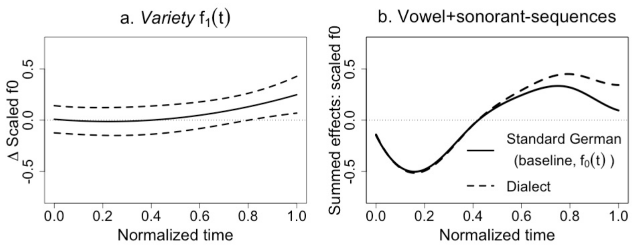

Figure 2: Between-group comparison of *Variety*: covariate effect (a.) and summed effects curves (b.).

In Fig. 2b., the estimated scaled f0 contour for SG speakers (solid baseline: $f_0(t)$) shows a clear peak between time points 0.7 and 0.8. According to Fig. 2a., *Variety* has a rising effect on scaled f0 from around this peak onwards. Comparing the baseline to the model contour for WB speakers (dashed line in Fig. 2b.: $f_0(t) + f_1(t)$) indicates that WB speakers show higher f0 values towards the end of the analyzed V+S-sequence than SG speakers. Together with the time points of C_2-onset and C_2-offset in Table 3, this suggests that dialect speakers realize f0 peaks significantly later than standard speakers.

3.3. FLMM *Age*: Younger vs. older Dialect speakers

The between-group comparison of *Age* among WB speakers consisted of 340 f0 trajectories with a mean of 31.11 data points per curve (range: 8-56 data points). In this analysis, the solid reference mean in Fig. 3b. represents younger WB speakers (0: younger, 1: older). The sum of the baseline and the covariate effect curve of *Age* (Fig. 3a.) is, hence, representative of older WB speakers (dashed line). Again, the baseline shows a clear peak between time points 0.7 and 0.8. The ostensible peak delay in older WB speakers in Fig. 3b. (and Fig. 1 for that matter) is, however, not systematic as the confidence bands in Fig. 3a. only approach the zero-reference line towards the end of the V+S-sequence without reaching significance. Thus, we do not find significant effects of *Age* on scaled f0 within the dialect group.

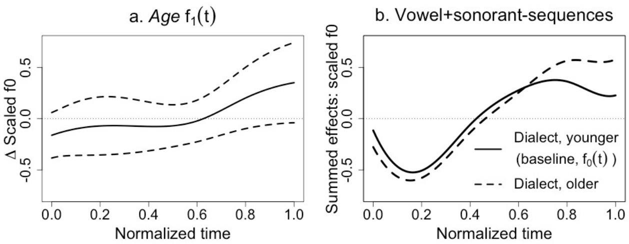

Figure 3: Between-group comparison of *Age*: covariate effect (a.) and summed effects curves (b.).

3.4. Relationship of duration and timing of f0 maxima

In a final step, we examined the relationship of segmental duration and f0 alignment. To this end, we tested for a correlation between the temporal synchronization of the automatically detected f0 maximum with each speaker's loess-smoothed, time-normalized scaled f0 curve and the again longer $V_1C_2V_2$-sequence using Pearson's *r* (cf. [40]). In rarer cases of two peaks, we selected the second (older WB: 9 %; younger WB: 14 %; SG: 16 %).

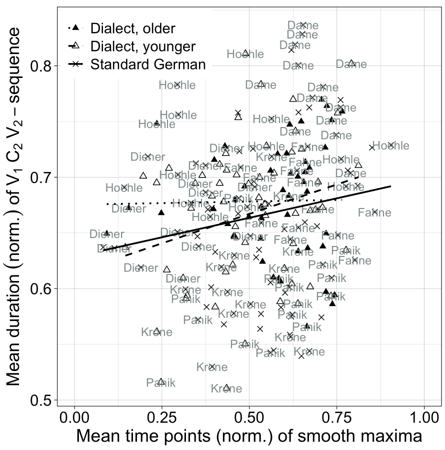

Figure 4: Mean values for both normalized $V_1C_2V_2$-durations and time points of f0 maxima, averaged across repetition. 3 outliers were excluded (x close to 0 or 1).

Commensurate with Fig. 4, younger WB and, to a lesser extent, the SG speakers showed a weakly positive correlation between duration and alignment indicating delayed peaks in longer sonorant sequences. The correlation reached significance in the former group ($r = 0.26$, df = 56, $p_{\text{one-tailed}} = 0.02$) and approached it in the latter ($r = 0.17$, df = 92, $p_{\text{one-tailed}} = 0.06$). Due to heteroscedastic residual variance, we used rank-based Spearman's ρ as non-parametric test for older WB speakers. Again in line with Fig. 4, no significant correlation was found ($\rho = 0.07$, $p_{\text{one-tailed}} = 0.32$), suggesting no effect of duration on alignment in older WB speakers.

4. DISCUSSION AND CONCLUSION

Two main findings arise from this study. First, WB speakers aligned non-contrastive nuclear peaks significantly later than SG speakers. This finding is in line with previous findings on peak delay in southern compared to northern German varieties [2-5] and confirms our first hypothesis. Unlike the SG speakers in [8] who differed regarding the underlying segment (V_1 vs. C_2), the German speakers of this study reached H on average during C_2. This suggests, on the one hand, rather fine phonetic differences in peak alignment between the close contact varieties spoken in Bavaria that differ greatly in register [17] and, on the other, more substantial differences between geographically distant national standard varieties.

Second, although the two WB age groups did not differ in peak alignment, their relationship between the target sequence duration and the timing of the f0 maxima did: Younger but not older WB speakers displayed a weak yet statistically significant positive correlation similar to SG. This result reveals the potential complexity underlying a prosodic change, which apparently not only affects segmental quantity [19-21] but also peak alignment which had been shown to be intertwined in previous studies [22, 23] but without reference to sound change. The correlation differences between the WB age groups are indicative of diverging mechanisms to deal with the available sonorant material, despite the otherwise and perhaps surprisingly similar segmental timing. Younger WB speakers' patterning with SG speakers in this respect can be interpreted as a result of more general trends for dialect levelling in this variety.

Given the identical segmental structure of all analyzed long vowel plus sonorant sequences offering sufficient voiced material for the realization of the intended f0 contours, no right-sided time pressure effects occurred across speaker groups in this study (cf. [8]). The positive correlation found for both younger WB and SG speakers might still reflect a form of truncation by which f0 movements are cut off abruptly under increased time pressure [41] and which has been found to be predominantly used in SG phrase-final falls (cf. [42]). Even though a general pattern to compensate for limited voicing time in WB is yet unknown (but s. [43] on compression in a Southern Bavarian dialect), our results may indicate a non-truncation pattern in older WB. To further address these potential compensation mechanisms as well as their influence on peak alignment, future studies should include target words with short vowels and/or obstruents.

5. ACKNOWLEDGEMENTS

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