

Prosodic and Lexical Effects on German Place Assimilation

Doris Mücke, Martine Grice & Raphaela Kirst

I/L Phonetik, University of Cologne, Germany

{doris.muecke; martine.grice; raphaela.kirst}@uni-koeln.de

Abstract

This production study investigates nasal place assimilation in VN#g sequences in high and low frequency particle verbs of the type 'hingeben' (sacrifice) in German, and in different focus-background structures.

Effects of word frequency were limited to two out of five speakers, whereas effects of focus-background structure were found for all five.

Articulatory reduction strategies (high frequency; background) differed across speakers. Whereas one speaker substituted the coronal gesture, the other four weakened it by reducing (i) the alveolar plateau duration and (ii) the extent of contact in the alveolar region and (iii) the gestural overlap (possibly a byproduct of (i)).

1 Introduction

Instrumental studies using electropalatography (EPG) and electromagnetic midsagittal articulography (EMMA) report only a partial loss of the coronal gesture in alveolar-velar sequences rather than a complete loss resulting of a full substitution of the segment (see [1,2,3] on place assimilation in German, and [4,5] on place assimilation in English). However, considerable differences have been found across speakers. Whereas some execute a full coronal closure (no assimilation), others weaken it (partial assimilation) or produce only a velar closure (segmental substitution).

Recent studies on German place assimilation (alveolar-velar sequences) have found lexical factors to have an effect on a speaker's individual assimilation strategies: In /n#k/ clusters, [3] found greater reduction of the coronal gesture in function

words, e.g. in 'dann kann' (then can) compared to content words, e.g. in 'Zahn kann' (tooth can).

In n#g clusters, [2] found tendencies for shorter alveolar plateau durations in high frequency as opposed to low frequency particle verbs in German. Surprisingly, there was also a tendency for *less* overlap in high frequency words, contrary to predictions within the Articulatory Phonology framework [9]. According to [9], assimilation in fluent speech is usually due to an *increase* in overlap. The present study investigates whether the tendencies in [2] can be found in a larger subset and whether they are statistically robust.

Furthermore, since prosodic strength (accentuation) and focus structure have been shown to have a considerable effect on supralaryngeal articulation, we additionally investigate the effect of these factors too [10].

2 Method

In the present study we carried out recordings of 6 native speakers of Standard German with a Reading Electropalatograph (EPG). All speakers (5 female and 1 male) were aged between 23 and 38 years. The female speakers were from the north of the Benrather isogloss (Low German JM, KA, AH, UK; Low Franconian DM), and the male speaker from the south (Central Franconian).

For speech materials, we investigated heterosyllabic NC sequences in such particle verbs as *hingeben* (sacrifice) and *hinkommen* (get there), where the syllable boundary coincides with a strong morpheme boundary (i.e. it involves a separable prefix), and where N is an alveolar nasal and C a velar plosive (N#g and N#k). We varied focus structure: background, narrow focus, contrastive (corrective) focus, as well as frequency of occurrence (the latter as in [2]): high and low frequency words

(lexicalised and non-lexicalised compounds). Furthermore, we varied the phonological length of the vowel preceding N.

Eight target words were used, four involving lexicalized particle verbs with a high frequency of occurrence ('hingeben, hinkommen, eingipsen, reinkippen' (respectively: sacrifice, get there, cast, fill in) and four which we coined for the purposes of the experiment and which subsequently have a low frequency of occurrence ('hingelen, hinkochen, eingittern, einkitten' (gel in, cook in, fence in, cement in). Since we were concerned with the effect of information structure, the speech materials consisted of mini-dialogues eliciting three different focus structures: The verb was (a) in the background, (b) in narrow focus, or (c) in corrective focus.

A total of 1440 mini-dialogues were recorded (8 test words x 6 speakers x 10 repetitions x 3 focus structures). All acoustic and articulatory landmarks were displayed and labelled by hand using the software programmes in Articulate Assistant©. In the acoustic record we labelled onset and offset of the N and C acoustic segments. In the EPG data, we labelled onsets and offsets of the constriction plateaux (first and last frame of maximum contact) in the alveolar and velar regions. The plateaux were identified by speaker individual profiles as described in [6,7,8].

The following temporal and spatial parameters were used for the analysis:

- *alv.plat.dur* = duration of the alveolar plateau during N production; measured as the interval from the beginning of the alveolar plateau in N to the offset.
- *plat.overlap* = overlap of alveolar and velar plateau corresponding to N and C; offset of the alveolar plateau in N is subtracted from the onset of the velar plateau in C (negative values indicate that the constriction plateaux overlap in time, [8]).
- *alv.contact* = maximum percent contact of the alveolar plateau during N.

3 Results and discussion

In the present paper we concentrate on the results for one segmental condition, VN#g, and show in detail for each speaker separately how word frequency and the three focus structures are differentiated.

We analysed 5 out of 6 speakers (speaker UK is still in progress). A total of 300 tokens went into the analysis (2 test words x 5 speakers x 10 repetitions x 3 focus structures); no utterances were discarded.

We conducted two-way ANOVAs (2x3) separately for each speaker and temporal measures (*alv.plat.dur*, *plat.overlap*), and one spatial measure (*alv.contact*). We included WORD FREQUENCY, and FOCUS STRUCTURE as the independent variables, and carried out post hoc tests for comparisons.

3.1 Effects of word frequency

For 3 out of 5 speakers (KA, JM, and PB), we found no reliable effects of WORD FREQUENCY on the temporal measures. We found no systematic difference of plateau durations (*alv.plat.dur*, $p > 0.05$) or the degree of gestural overlap (*plat.overlap*, $p > 0.05$) between low and high frequency target words. Furthermore, there was no interaction between WORD FREQUENCY and FOCUS STRUCTURE (despite for *plat.overlap*, speaker KA $p < 0.05$).

However, in 2 out of 5 speakers, we found systematic effects of WORD FREQUENCY (DM and AH). It is important to note that each of these two speakers employ different strategies. Their gestural coordination patterns (duration and overlap of the alveolar and velar plateaux) are schematized in figure 1 and 2.

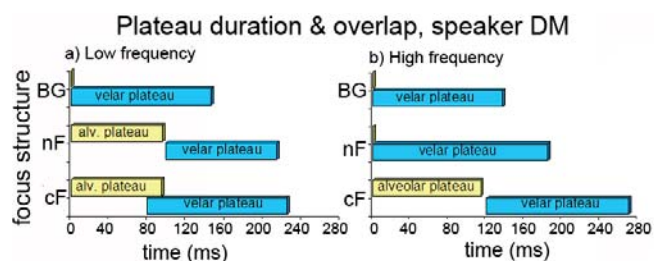


Figure 1: Coordination of coronal and velar plateaux, VN#g target words, speaker DM (background BG, narrow Focus nF, corrective Focus cF).

In low frequency target words, speaker DM substitutes the segment (0ms *alv.plat.dur*) in background items, producing no alveolar plateau at all. However, she produced long alveolar plateau durations in both focus conditions (on average of 95ms). In high frequency target words, she shows a complete loss of the coronal gesture in both background and focus conditions, executing a full coronal gesture (on average of 114ms) only in corrective focus.

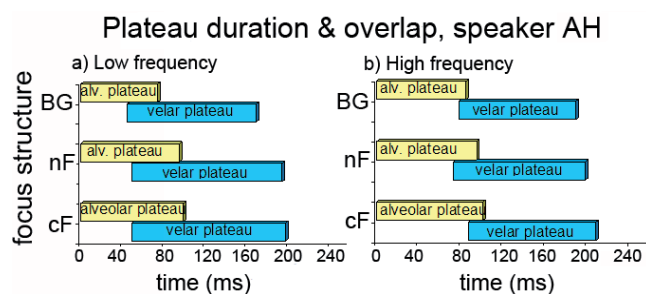


Figure 2: Plateaux coordination, speaker AH (background BG, narrow Focus nF, corrective Focus cF).

In contrast to DM, speaker AH does not show a full loss, but rather a *weakening* of the coronal gesture, when comparing high and low frequency words. Overall, we found shorter plateau durations (on average of 23ms shorter, *alv.plat.dur*, $p < 0.001$) and less gestural overlap (on average of 14ms less overlap, *plat.overlap*, $p > 0.01$) in low frequency target words. Furthermore, there was an interaction between WORD FREQUENCY and FOCUS STRUCTURE only for *alv.plat.dur* ($p < 0.05$, speaker AH).

For the spatial measure maximum contact in the alveolar region, we found a marginal effect of WORD FREQUENCY for only one speaker (JM) with an average of 3% less contact in high frequency words (*alv.contact*, $p = 0.049$). The other 4 speakers showed no effect ($p > 0.05$).

3.2 Effects of focus structure

As discussed in 3.1, we found speaker dependent strategies for expressing the different focus structures. Table 1 provides mean values for alveolar plateau durations and gestural overlap (in ms) for the individual speakers, separately for each focus condition. Note that only mean values for high frequency target words are discussed here (since the speakers JM, KA, and PB showed no effect of the main factor WORD FREQUENCY, see section 3.1).

Table 1: Mean durations (alveolar plat.) and overlap in different focus structures (high frequency target words)

	alv. plateau duration (ms)			gestural overlap (ms)		
	BG	narrow	correct.	BG	narrow	correct.
DM	0	0	114	na	na	7
AH	85	95	101	-8	-22	-14
JM	55	78	88	-7	-26	-24
KA	37	86	85	-25	-45	-40
PB	74	95	99	-29	-46	-49

Only speaker DM shows the full loss of the coronal gesture from corrective focus to background (see figure 1b). This is the only speaker who differentiates between narrow and corrective focus (albeit only in the high frequency set). The other speakers (AH, figure 2b, JM, KA, PB, figure 3) weaken the coronal gesture in the background condition, leading to *shorter alveolar plateau durations* and *less overlap*. E.g. speaker JM (figure 3a) shortens the alveolar plateau on average of 28ms and decreases the overlap of 18ms. Speaker KA (figure 3b) shortens the alveolar plateau on average of 43ms and decreases the overlap of 23ms. And speaker PB (figure 3c) shortens the alveolar plateau duration on average of 23ms and decreases the overlap of 19ms. None of them differentiated within the accented category (narrow versus corrective focus, henceforth focus).

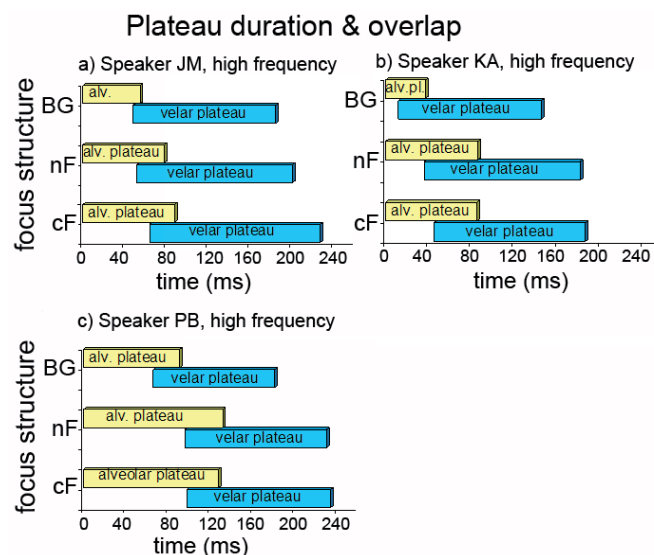


Figure 3: Plateaux coordination in high frequency target words, speakers JM, KA, and PB (background BG, narrow Focus nF, corrective Focus cF).

In the analysis of the 4 “non-substitution” speakers (AH, JM, KA, and PB), the main effect of FOCUS STRUCTURE reached significance in the temporal measures. We found shorter plateau durations in background versus focus condition (*alv.plat.dur*, $p < 0.001$, post hoc BG < NF, CF). Furthermore, we found less gestural overlap in backgrounded versus focussed items except for speaker AH (*plat.overlap*, $p < 0.01$, post hoc BG < NF, CF, speaker JM, KA, PB).

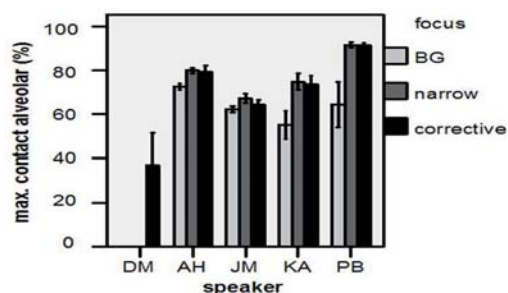


Figure 4: Percentage of contact during the alveolar closure according to different focus structure.

With regard to speaker specific effects of FOCUS STRUCTURE on the displacement measure (*alv.contact*), all speakers differentiate between unaccented and accented words (narrow and contrastive focus together) (*alv.contact*, $p < 0.05$). We found larger displacements in prominent positions, even though the speakers differed considerably in their range (e.g. on average of 3.5% more contact for speaker JM, 19.5% for speaker KA, or even 27% for speaker PB), see figure 4.

As in the temporal measures, we found no systematic difference between narrow and corrective focus for the “non-substitution” speakers AH, JM, KA, and PB.

4 Conclusion

We have shown that high frequency target words incur not only a decrease in plateau duration and displacement for the alveolar gestures, but also a decrease in gestural overlap (confirming the trends found in [2]). The latter is at first surprising, since overlap is usually taken to be a concomitant of coproduction, leading to increased overlap in reduced forms [8]. However, we interpret the decrease in overlap as a byproduct of the decreasing plateau duration of the first gesture.

It is important to stress that effects of word frequency were only found for two of the five speakers. However, this may have been caused by neutralisation of some of the effects, owing to the fact that words were repeated 10 times.

Taking narrow and corrective focus conditions together, we found a consistent effect of accentuation across all speakers as compared to the unaccented background condition. Four out of five speakers decrease both alveolar plateau duration and displacement, and reduce the overlap across the coronal and tongue body gestures. One speaker substituted the alveolar gesture completely.

Furthermore, this one speaker did not only have the substitution in the background condition, but also in the narrow focus condition, but only with high frequency words.

Taking all speakers together, however, we found little or no differentiation within the accented category, i.e. narrow and corrective focus involves similar articulatory strategies.

5 Acknowledgements

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References

- [1] Kohler, K., 1995. Die Instabilität wortfinaler Alveolarplosive im Deutschen: eine elektropalatographische Untersuchung. *AIPUK* 5, 8-9.
- [2] Bergmann, P., 2008. Assimilation within complex words in German. Workshop *Consonant Cluster and Structural Complexity*, 31 Jul–2 Aug, Munich.
- [3] Jaeger, M. & Hoole, Ph., 2007. Articulatory features influencing regressive place assimilation in German. *Proc.16th ICPHS*, Saarbrücken, Germany, 581-584.
- [4] Barry, M.C., 1991. Temporal Modelling of gestures in articulatory assimilation. *Proc. 12th ICPHS*, Aix-en-Provence, France, 14-17.
- [5] Ellis, L. & Hardcastle, W.J., 2002. Categorical and gradient properties of assimilation in alveolar to velar sequences: evidence from EPG and EMA data. *J.Phonetics* 30, 373-396.
- [6] Byrd, D., 1996. Influences on articulatory timing in consonant sequences. *J. Phonetics* 24, 209-244.
- [7] Cho, T., 2000. Effects of morpheme boundaries on intergestural timing: Evidence from Korean. *Phonetica* 58, 129-162.
- [8] Bombien, L., Mooshammer, C., Hoole, P., Rathcke, T. & Kühnert, B. 2007. Articulatory strengthening in initial German /kl/ Clusters under prosodic variation. *Proc.16th ICPHS*, Saarbrücken, Germany.
- [9] Browman, C. & Goldstein, L. 1992 *Articulatory Phonology: An overview*. In: *Phonetica* 49, 155-180.
- [10] Baumann, S., Becker, J., Grice, M., Mücke, D. 2007. Tonal and articulatory marking of focus in German. *Proc. 16th ICPHS 2007*, Saarbrücken, 1029-1032.