Temporal Control at the Utterance Level in German

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1. Introduction

In German, the duration of a stressed syllable is inversely related to the number of the following unstressed syllables in a rhythmic foot structure (Kohler et al. 1982, Kohler 1982), not to the total number of following syllables in the sentence, as was suggested by Lindblom and Rapp (1973) for Swedish, This tendency is constrained by articulatory complexity (Kohler 1982) and by a ceiling effect in the number of syllables, more than two having little influence. Temporal adjustment within the foot is both left-to- right, as a function of the number of unstressed syllables, and right-to-left, as a function of the complexity of the stressed syllable (Kohler 1982). Further factors that might influence the stress-timing of German are (1) F_0 (e.g. in *EINe geZEIGT* vs. *EINe gezeigt*), (2) utterance-final position (e.g. in *er zeigt EINe/EINige* vs. *er wird EINe/EINige zeigen*), (3) complementary right-to-left adjustments between two feet, depending on the length of the first one (e.g. *zeigen* in *EINige zeigen* vs. *EINe zeigen*), (4) coarticulation (e.g. articulatory control in *-e* before *be-* vs. *-e* before *ge-*), (5) word structure (e.g. in *EINe ge-* vs. *EINige*) (About the use of capitals see below.)

2. Experiment

To investigate the hypotheses concerning these factors a production experiment with the following sentences was run:
a. er zeigt EINe/EINige
b. er wird EINe/EINige ZEIGen/beNENNen (zeigen/benennen)
c er hat EINe/EINige geZEIGT/beNANNT (gezeigt/benannt).

Capitals indicate sentence stresses, realised as falling pitch nuclei on the last capitalized word in each sentence and as level or rising pitches about the starting points of the falls on the preceding capitalized word. Each of the 18 sentences was typed on a separate card, and these cards were randomized. Two speakers (the author, KK and CW ♀, phonetically naive) produced the whole set 11 and 10 times, respectively. Microphone and laryngograph (Fourcin) signals were recorded simultaneously on a two-track Revox A-77 tape recorder (19 cm/s) in the studio of the Kiel Phonetics Department. The

following sections of the audio time signals were determined and measured with the help of the DISPLAY programme (Barry et al. 1982): stem *ein*; first unstressed syllable *e/i*; second unstressed syllable *ge* in *einige*; prefix *be, ge*.

The end of each utterance was located either at the disappearance of periodicity (*zeigen, nennen, eine, einige*) or at the beginning of the stop release (*zeigt, nannt*). The data of each speaker were subjected to ANOVAs with fixed effects.

3. Results

1. F_0
   The items with double stress have longer durations of *EIN* than the corresponding single-stressed ones in both speakers and in all cases. 3-way ANOVAs of the *EIN* duration in the whole corpus (except for final *EINe/EINige*) with the factors 'word *eine/einige*', 'unstressed syllable after *eine/einige*' and 'stress' yield a high significance for 'stress' in both speakers. A rising F_0 (CW) or a high level one (KK) accompanies this timing difference.
2. Utterance final position
   Final *EINe/EINige* are considerably longer (in all their syllable components) than the non-final counterparts (i.e. single-stressed and with no prefixes following). Two-way ANOVAs with the factors 'word *eine/enige*' and 'sentence position' show high significance for the latter in all the dependent variables and in both speakers.
3. Right-to-left adjustments
   In KK's data there is a negative correlation between the duration of final *zeigen* or *zeigt* or *NENNen* or *NANNT* and the duration of the preceding foot as determined by the complexity of *EINe* vs. *EINige*. This is in accord with the findings from several speakers including KK, referred to in Kohler (1982). In this corpus the temporal adjustment between two feet does, however, show a combined influence of 'stress' and ' vowel quantity': a long vowel is more expandable under stress than a short one, and a short vowel is less reducible under lack of stress than a long one so that in these cases the timing control by the duration of *EINe/EINige* is less effective. CW has no such temporal regulation in this material although she showed it in the data of Kohler (1982). The mechanism behind this right-to-left adjustment of succeeding feet is obviously a tendency towards foot isochrony, subsequently correcting deviations caused by too complex articulations (cf. also Lehiste 1980).
4. Coarticulation
   The unstressed vowel before *be* is shorter than before *ge*. Two-way ANOVAs for the main effects 'stress' and 'following syllable *be/ge*' on the final vowels of *EINe* and *EINige*, respectively, prove '*be/ge*' to be highly significant in both speakers. This difference can be explained by coarticulation: the labial closing movement is initiated during the vowel because the lips are not involved in its production; this does, however, not apply to the dorsal gesture. On the other hand, *be* is always longer than *ge* because the distance the articulators have to move from the closure into the vowel is shorter for *ge*. In the sequence *EINige ge-* the first *ge* is longer than the second because the elevation of the dorsum is more sluggish than that of the apex. CW begins this slowing down of the movement even as early as the vowel preceding the first *ge*: *i* is longer than in *EINige be-*, which is in turn compensated for by a shortening of *EIN*, according to the negative correlation between stem and ending (cf. Kohler 1982). This adjustment is also found in KK's *EINe be-/ge-*, resulting in a highly significant duration difference of *EIN*, complementary to that of *e* which is in turn comple mentary to that of *be-/ge-*, with temporal equalization at the word level *EINe*.
5. Word structure
   In the data set 'EINe geZEIGT (gezeigt)/EINige ZEIGen (zeigen)' two-way ANOVAs for the dependent variable 'duration of the stem *ein*' show high significance in the main effects 'stress' and 'word boundary' for both speakers and no significant interactions for KK. The same applies to 'duration of *eine/eini-*',where CW, too, has no significant interactions. Neither speaker has a significant duration difference in the first unstressed syllable. There is thus a clear tendency in both speakers to signal the different word structures in durational patterns. This is further supported by a slower F_0 fall for *EINi-* of *EINige zeigen* vs. *EINe* of *EINe gezeigt* in both speakers.

4. Discussion

The timing of utterances in German is controlled at a number of levels. The tendency towards foot isochrony manifests itself not only in the well-known phenomenon of weak forms but also in a foot-internal negative duration adjustment according to the articulatory complexity of the beat syllable and to the number of unstressed syllables following it. Coarticulation further influences this temporal organization by producing duration effects which enter into the negative intra-foot correlations and may thus have repercussions over quite long signal stretches. Temporal compression is, however, limited by the complexity of the articulatory movements to be carried out in segmental types and in their combinations. If no elision occurs the regular foot timing cannot be maintained beyond these constraints. Isochrony is further disturbed by F_0, by utterance position and by word structuring. On the other hand, the principle still manifests itself above the foot level in negative inter-foot adjustments which compensate post hoc for rhythmic deviations. There is thus strong support for a stress-timing structure intervening in German between chains of syllables and utterance prosodies.

References

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