GLOTTAL MARKING OF VOWEL-INITIAL WORDS IN GERMAN

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ABSTRACT

The present study analyzes glottal marking (i.e. glottalization and glottal stops) of vowel-initial German words in dependence on speech rate, word type (content vs. function words), word accent, phrasal position and quality of the following vowel. The material investigated consists of several speeches by Konrad Adenauer, Thomas Mann and Richard von Weizsäcker.

The investigation shows that the marking of vowel-initial words in German is realized (a) in a rate-dependent manner ranging from glottal stop insertion via glottalization to no marking at all. The strength of marking is influenced by the intervening variables of (b) word type: content words are more strongly marked than function words, and (c) stress: stressed initial vowels are more strongly marked than unstressed ones. (d) Position within the phrase does not vary with speech rate and the realization is affected only slightly. Finally, it could be shown that (e) glottal marking is also dependent on the very nature (i.e. tongue height) of the marked vowel itself.

Keywords: glottal stop, glottalization, German

1. INTRODUCTION

Glottal stops and glottalization have attracted the increasing interest of phonologists and phoneticians, probably due to their hardly definable, almost chameleon-like behaviour.

Several studies have reported the huge variability of glottal stops and glottalizations in their acoustic realization. This inter- and intra-speaker variability has been observed in a number of languages, e.g. American and British English, Chitwan Tharu, Danish, Garo, German, Nootka, Tümpisa (Panamint) Shoshone and shown to be dependent on several parameters such as phrasal position, accented vs. unaccented syllable, segmental context, speech rate, dialect, speaker's gender, and others, cf. e.g. [7, 8, 10].

The present study focuses on German and explores the appearance of glottalization and glottal stops in vowel-initial words. Phonologically, it has been stated that glottal stops occur optionally at the beginning of a vowel-initial foot. For example, *Theater* is realized as [te.ʔáː.tɐ] or [te.áː.tɐ] 'theater', see [2]. Alternatively, it has been argued that a glottal stop appears in Standard German in two contexts: (i) at the left edge of a vowel-initial stressed syllable and (ii) at the left edge of a vowel-initial root or prefix, see [3].

This paper investigates to what extent the appearance of glottal stops/glottalization depends on other parameters such as speech rate, prosodic boundary, phrasal position, accented vs. unaccented segmental context, and content vs. function words. In contrast to other studies of German, cf. [4, 5, 9], in which speech rate was not investigated (in detail), the present study highlights the role of speech rate with respect to the presence/absence of glottal stops/glottalization.

2. ACOUSTIC STUDY

For the purposes of the present investigation we hypothesized, partly based on previous studies, that:

(i) faster speech rates reduce glottal marking,
(ii) content words are more often glottally marked than function words,
(iii) stressed syllables are more often glottally marked than unstressed ones,
(iv) phrase-initial positions incur more glottal marking than non-initial ones,
(v) low vowels undergo glottal marking more readily than non-low ones.

The last hypothesis was based on our previous observations, cf. also [6].

2.1. Experimental design

The glottal marking of vowel-initial words was analysed in historical recordings of prominent Germans (Konrad Adenauer, Thomas Mann, Richard von Weizsäcker) taken from the CD collection "Tondokumente zur deutschen Geschichte" (Audio documents of German history; Stiftung Deutsches Rundfunkarchiv). Three recordings of each speaker were extracted from the

audio CDs to *.wav files using CDex and segmented/annotated in PRAAT. Statistical analyses were conducted with the help of STATVIEW software.

Our three selected speakers were Konrad Adenauer (1876-1967; first Federal German chancellor 1949-1963); Thomas Mann (1875-1955, famous writer and Nobel prize winner 1929) and Richard von Weizsäcker (*1920, Federal German president 1984-1994). The acoustic analysis included three speeches of each speaker:

(i) Adenauer: 1929, 1949a, b,
(ii) Mann: 1945, 1949, 1950,
(iii) von Weizsäcker 1984, 1989, 1992.

With the exception of Adenauer whose speech clearly shows the influences of his Cologne dialect (not relevant with respect to glottal marking word-initially) all the delivered speeches are in Standard Northern German pronunciation. The analyzed material amounted to 29:04 minutes of recording time. In total, 740 vowel-initial words underwent the acoustic analysis.

The recordings were first transcribed orthographically and segmented with respect to pauses (>150 ms). Information on the duration of pause delimited phrases, the number of syllables produced and the duration of the following pause were stored in tabular form for the later analysis of speech rate. The orthographic transcript was then scanned for vowel initial words.

In a second annotation/segmentation step these word-initial vowels were classified as being unmarked, marked by glottalization (creaky voice) or by a glottal stop proper. Glottalizations could be easily distinguished from glottal stops proper by the onset of irregular pitch periods even before the word's initial vowel (utterance medially) or by irregular voicing of more than two pitch periods of the (utterance initial) vowel.

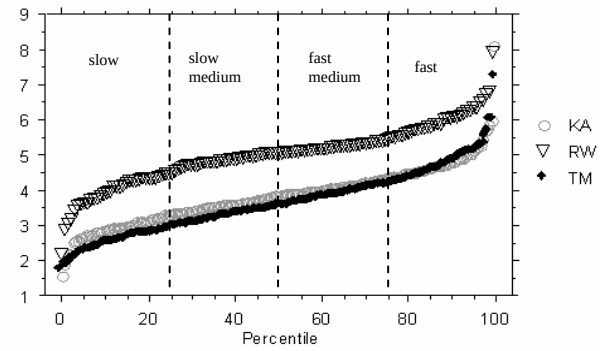
Marked items were segmented with respect to the beginning and end of single pitch periods, i.e. glottalizations from the first to the last irregular pitch period (onset of modal voicing), glottal stops from burst/first affected pitch period to the onset of modal voicing (segmentation of the closed phase was difficult or impossible (i.e. phrase-initially)).

2.2. Results

Despite a comparable speech style ('prepared' speech), speech rate turned out to be quite speaker-specific, with clear significant differences between the fastest speaker (Richard von Weizsäcker) and the others as well as between the following two, i.e. Konrad Adenauer and Thomas Mann. Only Thomas Mann exhibits a slower speech rate once, i.e. in his post-war BBC broadcast.

For the more detailed analysis of glottal markings given below, we therefore decided to base speech rate dependent analysis on the quartile ranges (depicted in Figure 1) for the three speakers separately.

Figure 1: Percentile plot of speech rate distribution split by speakers.



The distribution frequencies of the differently marked vowel-initial words were analyzed with respect to the speaker specific speech rates. So the non-marked, glottalized and abrupt vowel onsets (i.e. those with preceding glottal stop) were counted separately in slow (i.e. first quartile of the speakers' rate range, cf. Figure 1), slow medium (second quartile), fast medium (third quartile) and fast rate (fourth quartile) utterances.

Figures 2 and 3 depict the distribution of glottal markings in vowel-initial words for our three speakers in general and separately. As can be seen, the glottal marking of word-initial vowels is generally diminishing in line with the increasing speech rate: non-marked items continuously rise in frequency from about 30% in slow speech (1st quartile of the speakers' rate ranges) to more than 50% in fast speech; on the other hand, realisations of canonical glottal stops stepwise reduce from 48% in slow speech to ca. 16% in fast speech, parallel to an increase in markings by creaky voice only (from about 22% to about 31%).

Besides this general trend there are some interesting differences between the speakers: For Adenauer we can see a change from glottal stop marking at slower rates to a loss of marking in faster speech. For Weizsäcker, who is from a younger generation, marking by glottalization seems to be preferred at almost all rates (with the exception of equally frequent markings by glottal

stop at the slowest and some more losses of marking at the fastest rate). Thomas Mann's behaviour, lying in between both these extremes, more closely resembles that of Adenauer in this respect. An ANOVA for rate and speaker yielded significant results for rate dependent non-marking (significant more unmarked in faster speech ($F_{(3,727)} = 6.956$; $p < .001$) [speaker effect ($F_{(2,727)} = 4.914$; $p < .01$)]) and glottal stops (less glottal stop markings ($F_{(3,727)} = 15.226$; $p < .001$) [speaker effect ($F_{(2,727)} = 7.047$; $p < .01$)]) and speaker dependent glottalization (speaker dependent glottalizations ($F_{(2,727)} = 26.353$; $p < .01$)).

Figure 2: Rate-dependent relative frequencies of glottal markings for all speakers together.

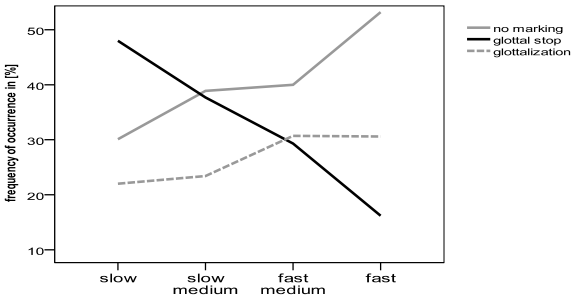
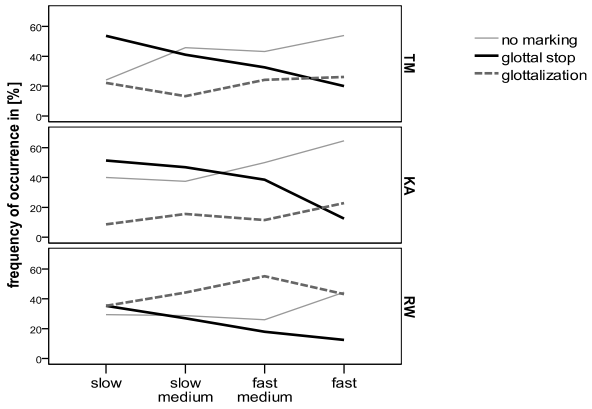


Figure 3: Rate-dependent relative frequencies of glottal markings in individual speakers' pronunciation.



In Figure 4 the relative frequency of different markings is presented with respect to word type (content words vs. function words).

The fact of diminishing glottal marking with increasing speech rate mentioned above is clearly shown as being dependent on word type: Content words are more resistant to the total loss of marking at higher rates ($F_{(1,729)} = 53.902$; $p < .01$) in contrast to the generally unstressed function words. Therefore, in Figure 5 the effect of stress on the relative frequency of glottal markings in vowel-initial content words is illustrated.

Due to the smaller number of tokens the results are not as clear cut as before, but the general tendency of unstressed items to lose markings at lower rates than stressed ones is still visible.

Figure 4: Rate-dependent relative frequencies of glottal marking in content and function words.

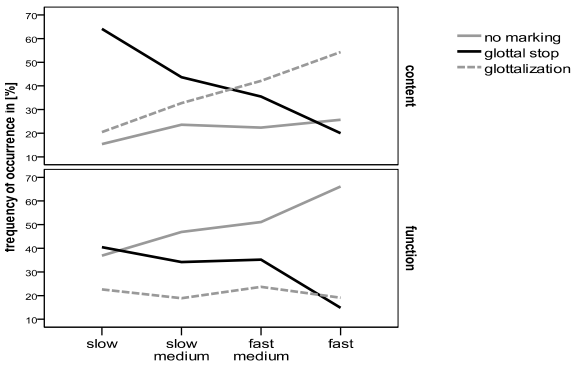
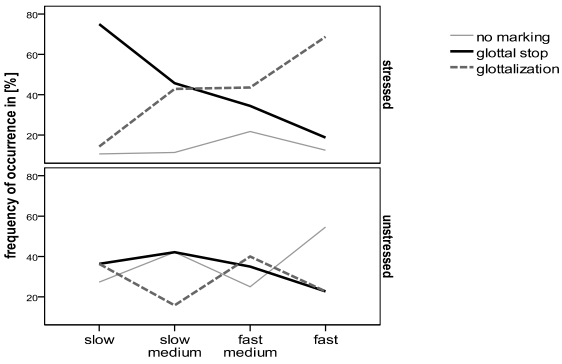
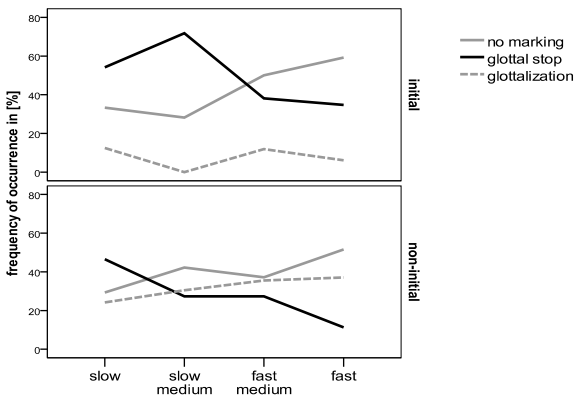


Figure 5: Rate-dependent relative frequencies of glottal markings in stressed vs. unstressed content words.



The effect of position on the nature of glottal marking (cf. Figure 6) also shows a tendency for stronger marking in phrase-initial items but this effect seems to be rather weak.

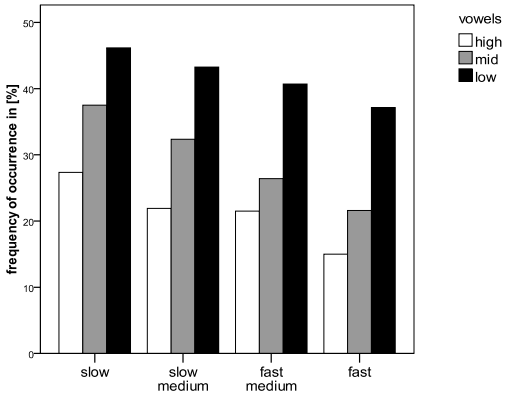
Figure 6: Rate-dependent relative frequencies of glottal markings in phrase-initial and phrase-non-initial position.



In contrast to Umeda [10], who found no differences of glottal marking with respect to vowel identity in American English, our German material clearly shows the dependency of glottal marking on vowel height: low vowels are more strongly marked by glottal stops and glottalization than non-low ones (vowel height effect: $p<.001$). This is illustrated in Figure 7.

The glottal marking appears to be greater in slow speech ($F_{(3,728)} = 7.227$; $p < .001$) and in low vowels ($F_{(2,728)} = 55.868$; $p < .001$): low > ($p < .001$) mid > ($p < .01$) high (after post-hoc Scheffe).

Figure 7: Vowel-height and rate-dependent relative frequencies of glottal markings of word-initial vowels.



The preference of low vowels to be glottalized more readily than non-low ones is hypothesized to be conditioned physiologically, i.e. favored by certain laryngeal settings typical for low vowels and glottal stops, and perceptually, a point which we discuss in [2].

3. SUMMARY AND DISCUSSION

Glottal marking of vowel-initial words in spontaneous German speech was shown to be remarkably variable. From a phonetic point of view, it is best described as a realization along a continuous scale of vocal fold adduction/compression. This gives rise to exactly timed canonical glottal stop insertions before onset vowels at the extreme value of glottal activation, changing to amalgams of glottal stop and glottalization as well as less strictly timed glottalization at word boundaries as well as to only minor reflexes in fundamental frequency and no reflexes at all in the stream of voicing.

In any annotation scheme this glottal behavior will result in a more categorical scale. As our results show, the distribution of the different marking categories (i.e. [ʔ], [˷] and 0) is highly dependent on a number of factors. But, in general, it is clearly dependent on speech rate, irrespective of all other factors under consideration. This again speaks for its principally gradual nature. Parallel to the published results presented in [7-10] we found that linguistic variables, like word type, word accent and phrase position all influence the relative frequency of glottal markings. This influence has been shown to be rate-dependent. On the other hand, it could be shown that glottal marking is also dependent on the very nature (i.e. tongue height) of the marked vowel itself. This finding has an important implication for prosodic research, namely, it shows that glottal stops/ glottalizations are not only conditioned by prosodic boundaries but depend on the segmental level as well.

Finally, the present study provides relevant material for phonological approaches to German prosody showing that the present accounts of glottal stops and glottalizations need to be extended by taking into consideration the complexity of phonetic evidence.

4. ACKNOWLEDGMENTS

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5. REFERENCES

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