THE REALIZATION OF PLOSIVES IN NASAL/LATERAL ENVIRONMENTS IN SPONTANEOUS SPEECH IN GERMAN

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ABSTRACT

This paper deals with the realization, within words and across word boundaries, of plosives as glottal stops or through creak in surrounding sonorants in German spontaneous speech. It also discusses the wider spectrum of phonetic processes affecting plosive production in the frame 'nasal + plosive + /@/ + nasal'.

INTRODUCTION

It was shown in [1] on the basis of limited data from read speech that German plosives within nasal environments may be realized in a way that the velum remains in a lowered position and that instead of a velic closure for a plosive there is a break in the type of phonation from voice to creak and possibly back to voice.

The starting point of this investigation is the occurrence of the notations /ptkbdg/-/Qq/ (in modified SAMPA transcription [2,3]) in the Kiel Corpus of Spontaneous Speech [4]. Here /Q/ refers to a segmentally delimitable glottal stop, /q/ to the componential feature of glottalization, i.e. an irregular vocal fold vibration of low frequency. "-" symbolizes replacement, "-:" deletion, "=-" insertion of a symbol in relation to a canonical citation form pronunciation of a lexical item. Thus, e.g., /t-q/ indicates the replacement of a plosive by glottalization. However, in keeping with its componential reference, it is not given a duration, but only put on the same time mark as the following segment (for further details see [2,3]). The data will be broken down into three classes: instances in word-final '/@/ + sonorant' syllables, in non-final positions and across word boundaries. These groupings will be supplemented by an enquiry into other phonetic processes for the canonical transcription sequences of 'nasal + /ptkbdg/ + /@/ + nasal', namely nasalization of plosives and the addition of other voice qualities than creak.

GLOTTALIZATION FOR CANONICAL PLOSIVES

The label files and variants lexica of the corpus [4] provide 179 instances either of plosives being replaced by a glottal stop, or of neighbouring nasals and laterals being characterized by glottalization. The latter process is by far the most common. Of this total

- 156 apply to word-final syllables of the type 'plosive + /@n/', e.g. *können*, *halten*, *einverstanden*, *hatten*,
- 6 occur word-internally, viz. *eigentlich* (/Qq'aIg-:@-:=-~n-:t-qlIC/, with glotalization in addition to the replacement of canonical /g@n/ by nasalization of the preceding diphthong, and /Q-:q'aIg-N@-:n-:t-qlIC/, with nasalization of /g/ and glottalization of the sonorants), *schrecklich*, *bedeutendsten* (/b@d'OYt-q@-:nt-:sth@n/ and /b@dh'OYt-Q@-:nt-:st-:@-:n/), *besonders* (/b@z'Ond-q6s/),
- 17 across word boundaries, e.g. *bedanke mich* /bh@d'aNk-q@-: mIC+/, *und dann* /Q-:U-:nt-q+ d-na=-~n-:+/.

Of the 156 word-final syllable glottalizations

- the vast majority, 127, are tied to the canonical structures 'nasal/lateral + plosive + /@/ + nasal'
- only 29 occur without a preceding 'nasal/lateral'; they are all of the type /t@n/.

Of the 17 glottalizations across word boundaries

- 13 involve a nasal at the beginning of the following word, also including nasalized initial lenis plosives, as in *und dann* with continuous nasality all through the two words,
- 3 occur before the approximants /v/ and /j/;
- in one case final /t/ is realized as /Q/ before initial /d/.

In 5 instances of word-final /nt@n/ the sequence becomes monosyllabic, with glottalization running into an initial nasal (resulting from assimilated /d/, /v/) or vowel of the next word, e.g. *zehnten das* /ts'e:nt-Q@-:n-: d-nas+/, *könnten wir uns* /kh9=-~n-:t-q@-:n-m+ v-mi:6-:+ Q-:Uns+/.

THE FRAME 'SONORANT + PLOSIVE + /@/ + SONORANT'

There are 237 instances of this structure in the corpus with only 5 examples of /l/ in the second 'sonorant' slot (the proper name *Schindel*) and 43 in the first (all /lt/, *gelten*, *halten* and compounds, *sollten*, *wollten*). /@/ is kept in only 5 cases; 3 occur in the second of two successive /@n/ syllables: in *folgenden*, either realized as /g@-:n-Nd-n@n/, or as /g-N@-:n-:d-n@n/ with lenis plosive nasalization and nasality throughout the last two syllables, but with an oral opening in the second. Of this total of 232 /@/ elisions

- 127 have glottalization or glottal stop for the plosive,
- 105 either have a 'plosive-nasal/lateral' sequence or, in 9 cases, plosive nasalization; the latter occurs in one lenis plosive structure - *einverstanden* (2) - and in 7 fortis ones, all of which are either in unstressed syllables or non-accented function words - *fünfzehnten* (2), *sechzehnten*, *siebzehnten*, *achtzehnten*, *könnten*, *sollten*.

Of the 127 glottalizations

- 114 involve fortis stops,
- 13 lenis ones.

SIGNAL ASPECTS OF GLOTTALIZATION

The time course of glottalization and its synchronization with supraglottal articulation in the frame 'nasal + plosive + nasal' varies a great deal. Figure 1 illustrates 6 different realizations in the word *könnten*.

(a) comes closest to a segmental sequence of 'voice - creak - voice', corresponding to two voiced nasals, separated by creak for a stretch in time where the plosive is located in the canonical structure. But this case is still treated componentially in view of a consistent treatment of the variability encountered in (a) - (f), and because the auditory syllable boundary occurs at the beginning of the 3rd creak pulse. The SAMPA notation is /kh9nt-q@-:n+/; /t-q/ and /n+/ have the same time, at the syllable boundary.

(b) and (c) represent two-phase cases with either voice or creak coming first. They are disyllabic; in (b) the second syllable begins after the 1st creak pulse, in (c) with the 3rd, according to auditory assessment. There is strong nasalization of the preceding vowel. The SAMPA notation and the alignment are the same as for (a) in both cases. The vowel nasalization being treated as conditioned by /n/ is not marked.

(d) takes us one step further from (c): it is auditorily monosyllabic, the vowel is absorbed in the aspiration of the word-initial plosive, and the final voiced nasal is very weak before the labiodental /v/ of *wir* (which is also shown in the spectrogram, fused with *uns*). The two creak pulses are sufficient to signal the word *könnten*, rather than *können* to the listener. The SAMPA notation is /kh9n-:t-q@-:n+/; /t-q/ and /n+/ have the same time, at the 1st creak pulse.

(e) is one-phased, with creak only, but it is auditorily disyllabic, the boundary occurs at the 4th creak pulse. The SAMPA notation is /kh9nt-q@-:n+/; /t-q/ and /n+/ have the same time, at the boundary.

(f) is again one-phased, but auditorily monosyllabic, with strong nasalization of the preceding vowel, which replaces a missing voiced /n/. The SAMPA notation is /kh9=-~n-:t-q@-:n+/; /t-q/ and /n+/ have the same time, at the beginning of glottalization (the spectrogram also shows the following *wir un(s)*). In this

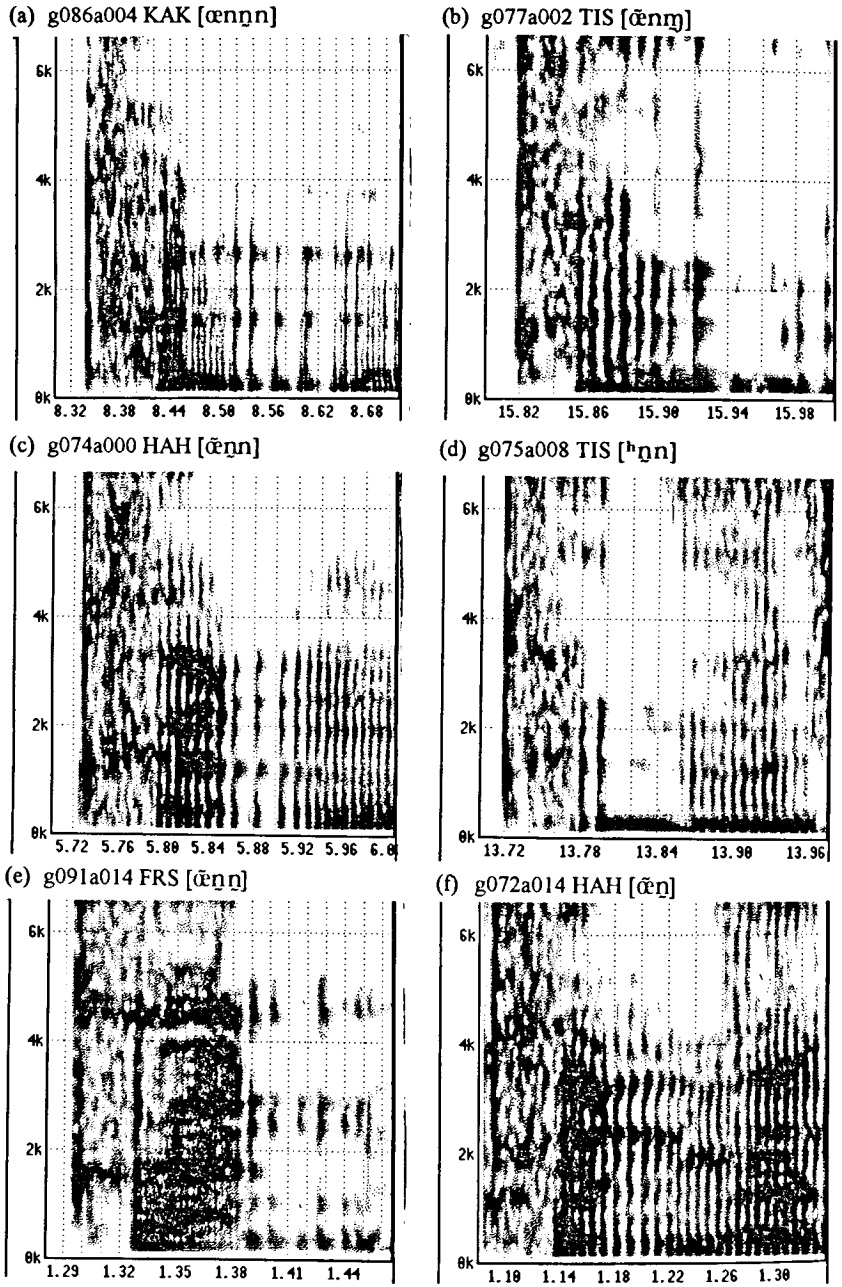

Figure 1. Different manifestations of glottalaziation in "könnten" from the Kiel Corpus of Spontaneous Speech. 4 speakers, 1 female (FRS)

case the nasalization of the vowel has to be marked specially by the insertion of /=~/ because it would otherwise not be implied by the notation.

PHONETIC EXPLANATION

All the glottalizations in the 'nasal-plosive-nasal' frame can be subsumed under the principle of economy of effort: the velum remains lowered during the whole sequence, and further adjustments to ensure a differentiation between the presence or absence of stop articulation in, e.g., *könnten* and *können*, are transferred to the glottis for the signalling of a break in the nasality feature. As long as this break is there its timing can be quite variable, ranging from the vowel to the final nasal, spanning syllable and word boundaries. This phonetic process represents a gestural reorganization and is extremely common in spontaneous German speech since more than half the potential cases in the corpus exhibit it. It seems to affect lenis and fortis plosives alike, although the frequency of potential frames for the former is very much reduced in the data base. The phonetic exponency is comparable to the Danish stød [5], even if the historical genesis is quite different.

The timing of velum lowering is variable as well: it may precede, or more or less coincide with, the formation of the oral occlusion for the sequence. In the case of lenis plosives there is also the possibility of velum lowering for the complete sequence without glottalization, i.e. a simple change in the timing of the velic gestures. The shorter closure phase, compared with fortis plosives [6], supports this process. If fortis plosives are shortened in unstressed position they can go the same way. Again the corpus is not big enough for a more exhaustive analysis of this aspect. Similarly, the question as to whether, in glottalization, there is complete coalescence of fortis and lenis, e.g. in the timing parameters of vowel and sonorant durations, cannot be answered by this data base because of its restricted size and contextual heterogeneity.

A break in the sequence can also be effected in a different way, which this corpus, however, does not provide any examples of. For fortis stops the glottis may open, which together with a lowering of the velum during the entire sequence results in a voiceless nasal. In the case of lenis stops the vocal fold vibration may change to breathy voice, which combined with velic lowering produces a voiced but breathy nasal as a break within the continuous nasality. These features have been noticed in such words as *gebunden*, *vierzehnten*, with the latter having either voiceless or, because of the unstressed position, voiced nasal breath. The feature of breathy voice replacing lenis stops in a nasal environment can again not be explained by simple changes in synchronization: it requires gestural reorganization, just like glottalization, for the function of creating a break in the nasal stream for a listener.

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