

TRANSITIONS FROM VOWELS TO VOICELESS STOPS IN SWEDISH, ITALIAN AND GERMAN

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ABSTRACT

Segmentation of running speech and placing a boundary between a vowel and a following voiceless stop seems to be a trivial task. Segmentation criteria, however, varied in an international cooperation, as different realisations of V+voiceless stop sequences occurred between comparable recorded material of speakers of German, Italian and Swedish. It appeared that Swedish speakers produced V+voiceless stop-sequences frequently with a transitional phase in between, similar to preaspiration in Icelandic.

In this study, elicited data from speakers of Swedish, German and Italian was analysed and the general number of occurrence of preaspiration according to languages was counted and compared in the first place.

The previous observation – that preaspiration predominantly occurs in Swedish speech – was confirmed, and further, detailed inspections were carried out. Occurrence of preaspiration in both vocalic and consonantal contexts, status of quantity were analysed and correlated with the general degree of breathiness of individual speaker's voices.

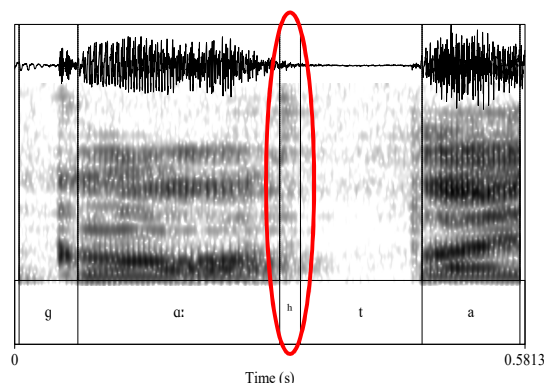
Keywords: preaspiration, breathy phonation, preaspiration in Swedish.

1. INTRODUCTION

A transition from a vowel into a voiceless stop usually includes the articulation of an oral closure and the abduction of the vocal folds. These procedures are often aligned, but may occur disjoined in time. If disjoined, a frication phase may show up: a preaspiration. Preaspiration is known to occur in Icelandic [5], but also in other languages – and dialects – mainly in North Western Europe: some Scandinavian languages and dialects [1], Saami [3], Tyneside English [4], Scottish Gaelic [6]. In some languages and dialects, preaspiration plays a part in the quantity system [5, 9, 11], and in others, it is a socio-phonetic phenomenon [3]. The third possibility is, that it occurs as a non-normative feature, however typical for a certain language or dialect [10]. The question has also been raised, whether observed increased duration of preaspiration by female

speakers [10, 4] is not only based on socio-phonetic factors, but on physiological ones [5, 7].

Figure 1: Example of preaspiration (highlighted) in the Swedish word *gata* (“street”, /ga:ta/, [ga:^hta]).



Based on discussions about segmentation criteria in a previous cross-linguistic project [2] – due to presence vs. absence of preaspiration in V+voiceless stop-sequences –, an attempt is made here, to shed some light into the distribution of preaspiration in comparable data produced by native speakers of Italian, Swedish and German.

Most studies on Italian have not reported any preaspiration [cf. [8]], but it has been shown that it might optionally occur prior to voiceless geminates [9].

There is considerable variation in the distribution and role of preaspiration among Swedish dialects. It may occur as a normative feature in some central dialects, independent of the quantity setting [5]. In other, northern, dialects, variation in length of preaspiration may be related to the contrasting quantity characteristics [11]. In the southern dialects, it may occur as a non-normative, however representative feature [10].

Concerning German, preaspiration does not seem to be an issue of investigation.

In the current study, the occurrence of preaspiration was investigated in comparable, read speech, produced by speakers of Italian, Swedish and German. The consecutive analysis has focused on the distribution of occurrence according to the language, gender of the speaker, vocalic and consonantal context and the quantity characteristics of the context.

As preaspiration can be seen as a phase between a vowel and a voiceless stop, where the timing between devoicing and oral closure is not aligned, the general level of breathiness for each speaker's voice when aiming for a linguistically modal phonation was analysed with HNR. The degree of general breathiness of an individual speaker's voice can shed some light on a habitual inclination of incomplete vocal fold closure, which might also have an influence on the transitions between voiced and voiceless sounds.

2. THE STUDY

In order to make the data comparable between speakers of Italian, German and Swedish, read carrier phrases containing target words with similar vowel+stop-sequences were recorded.

2.1. Material

The participants read carrier phrases with the embedded target words in their first language. The speakers were asked to produce the target with a contrastive focus. The phrases were presented one by one to each participant on a laptop-screen and the target words were highlighted in bold script. Distractor phrases were randomly included in the presentation.

All target words were bisyllabic with the stress on the first syllable and the V+stop-sequence in the rhyme of the stressed syllable. The V+stop-sequence in the various target words varied according to:

- Vowel quality: /a/ and /i/
- Place of articulation for the stop: bilabial and alveolar, /p/ and /t/
- Quantity features of the respective language:

Italian: VC and VC:, *fato* and *fatto*

German: VC and V:C; *Rate* and *Ratte*

Swedish: V:C and VC:; *vita* and *titta*

All these factors were taken into consideration in the statistical analysis. The material contained eight target words for all three languages.

2.2. The speakers

The collected data comprises speech of eight speakers of Italian (5 female, 3 male), residing in the south of Germany or Sweden at the time of recording. In addition, 10 speakers of German (9 female, 1 male) were recorded, eight using a southern standard dialect and two using a northern standard dialect. The Swedish material was produced by nine speakers (6 female, 3 male), with predominantly southern dialects.

2.3. Recordings

The recordings were carried out in different environments in Sweden and Germany: some were made in quiet classrooms or offices, others in a recording booth. The recording devices varied as well: some were made directly on a laptop, in other cases portable digital high quality recorders were used. In all cases, external lapel microphones were used.

Due to considerable echo and background noise or low amplification of the signal, some recordings had to be excluded.

2.4. Analysis procedure

From the recordings, the target words and the V+stop-sequences were segmented in PRAAT and the number of occurrences of preaspiration per speaker within the list of target words was accounted for. In the further analysis process, the counts were treated in percent of occurrence [%]. With statistical tests (Student's *t*, Anova) the influence on frequency of occurrence of preaspiration of the following factors was investigated: a) the speakers' L1, b) the speakers' gender, c) vowel quality, d) place of articulation of the stop and e) quantity characteristics.

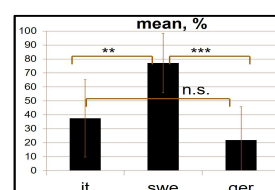
In addition, the degree of breathiness for each speaker's voice was correlated with the frequency of occurrence of preaspiration by calculating Pearson's *r*. Hereby, 10 seconds of each recording, containing periodic/voiced speech sounds – but no voiced fricatives – were singled out for the analysis of the Harmonics-to-Noise Ratio (HNR), i.e. the relative degree of breathiness of a speaker's phonation. The HNR was calculated with the help of the analysis of harmonicity in PRAAT.

3. RESULTS

The results about frequency of occurrence in percentage of a turbulent section between vowels and voiceless stops are presented below, taking the various analysis conditions into consideration.

3.1. Language influence

Figure 2: Average of frequency of occurrence of preaspiration (in [%]) across all speakers per language.



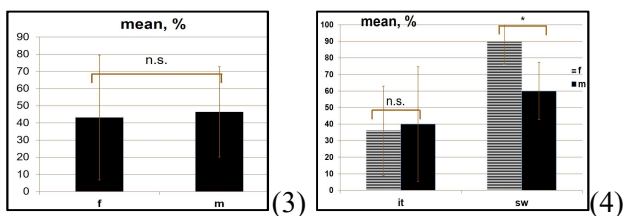
A general overview over the occurrence of preaspiration in the three languages in question is shown in Fig. 2. It shows that the Swedish speakers produce preaspiration significantly more frequently than the Italian speakers ($p \leq 0.01$) and the German speakers ($p \leq 0.001$). The difference between the languages is generally highly significant ($p \leq 0.05$).

3.2. Gender

A general comparison between the speakers' use of preaspiration according to their gender is given in Fig. 3. It should be pointed out, that the number of speakers varied between the groups: 20 female and 7 male speakers. No significant difference between the two groups of speakers is observed.

Fig. 4 shows the results, where gender and language are considered. The German data was excluded, as only one male speaker contributed to it. The results show no significant difference between gender for the Italian speakers, but a weak significance for the Swedish speakers in that female speakers produce preaspiration more often ($p \leq 0.05$).

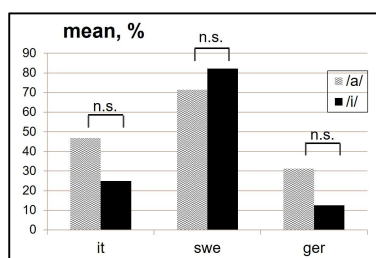
Figures 3 and 4: Average of frequency of occurrence of preaspiration (in [%]) according to gender across all speakers and languages (3) and pooled by language (4).



3.3. Vowel quality

Variation in vowel quality in the sequence in question does not have an effect on the frequency of occurrence of preaspiration in any of the speaker groups according to their language (Fig. 5).

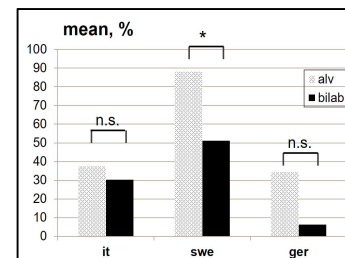
Figure 5: Average of frequency of occurrence of preaspiration (in [%]) according to vowel quality, pooled by language.



3.4. Place of articulation of the stop

Place of articulation of the voiceless stop plays a significant – however not very strong – role for the Swedish speakers only. For that group, preaspiration is found more often, if the voiceless stop is an alveolar one ($p \leq 0.05$, Fig. 6).

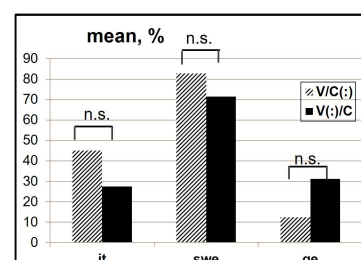
Figure 6: Average of frequency of occurrence of preaspiration (in [%]) according to place of articulation of the voiceless stop, pooled by language.



3.5. Quantity characteristics

It has been mentioned above that the three languages have different quantity characteristics. However, in none of the investigated languages do the speakers show a statistically clear preference in producing preaspiration in combination with any of the contrasting quantity elements.

Figure 7: Average of frequency of occurrence of preaspiration (in [%]) according to language specific quantity characteristics, pooled by language.



3.6. Influence of voice quality

Preaspiration can be seen as a phase between a vowel and a voiceless stop, where the timing between devoicing and oral closure is not aligned. This can be related to phonation control in an individual speaker. Therefore, the degree of general breathiness for each speaker's voice was measured with HNR. In Figure 8 the overall distribution of degree of breathiness is presented. Note that a high HNR-value reflects a relatively lower degree of breathiness! It can be seen, that the German speakers generally had relatively

high HNR-values. The HNR, however, is not significantly different between the speakers of the three language groups ($p = 0.09$)

Figure 8: HNR (in [dB]) for all speakers, grouped by language

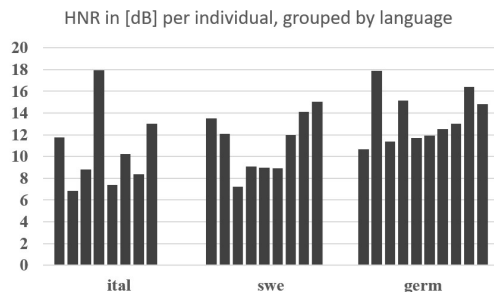
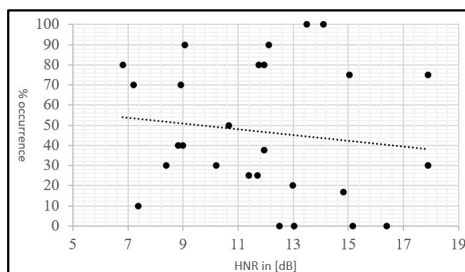


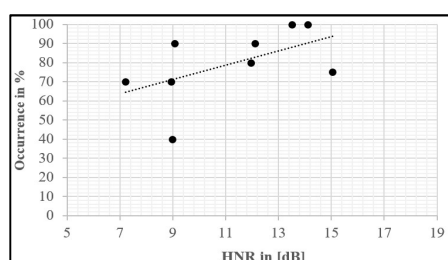
Fig. 9 shows the correlation between every individual's HNR and his/her frequency of production of preaspiration, disregarding the speaker's language. There is a general weak negative trend – not significant ($r = -0.1334$) –, which points towards a possibility that a more breathy voice could be related to a higher degree of preaspiration occurrence.

Figure 9: Correlation between HNR (in [dB]) and frequency of occurrence of preaspiration (in [%]) for all speakers.



When only inspecting the Swedish speakers, the non-significant trend is positive (Fig. 10) ($r = .541805$, $p > 0.1$), the reverse of what could shed a light on the relationship between breathiness of the voice and occurrence of preaspiration.

Figure 10: Correlation between HNR and frequency of occurrence of preaspiration (in [%]) for Swedish speakers only.



4. DISCUSSION

The results confirm observations from earlier segmentation experience, i.e. that preaspiration rather occurs in Swedish speech than in German speech in comparable data [2]. In the recordings of Italian, not much preaspiration was found, however it occurred slightly more frequently than for German. This agrees with [8] and [9]. The speaker's gender plays a role only in that language, where preaspiration generally occurs more frequently, which is Swedish. Hereby, female speakers produced preaspiration slightly more often than male speakers. Preaspiration as a predominantly used feature by women was also found in a sociophonetic study [4].

Vocalic difference did not have any effect. Place of articulation of the stop, however, did have an influence for the speakers of Swedish, for whom preaspiration occurred most frequently. In that way, when tongue articulation was involved for the stop, preaspiration occurred a little more often than in combination with a bilabial stop. A study, which could show tongue movement and the alignment in time with phonation would be a relevant follow-up to the present study.

Quantity characteristics did not have any effect in any of the languages investigated. This is, indeed, surprising, as in both languages, Italian and Swedish, preaspiration has been found to be a marker for one particular type of the two contrasting types in each language ([9], [11]). The dialectal variant predominantly used in this study, however, did not exactly match the variants investigated earlier ([9]).

General breathiness of the speakers' voices as an influence on the production of preaspiration was not confirmed, although a trend was found, that the German speakers, who produced hardly any preaspiration, also produced the least breathy voices. Swedish speakers with most frequent production of preaspiration, however, showed an unexpected and reverse trend in that speakers with a low level of breathiness produced a high level of preaspiration.

This shows that preaspiration is a non-normative feature natural to Swedish. In addition, gender might play a sociophonetic role. Preaspiration is not connected to either quantity factors of the language or phonation attributes in the individual speakers,

It is also confirmed, that preaspiration is not a typical feature for German. Preaspiration occurs not as regularly in Italian as in Swedish. It is, however, a less exceptional attribute in Italian than in German.

5. ACKNOWLEDGEMENTS

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