

# TOWARDS A PHONETIC CONSPECTUS OF PREASPIRATION: ACOUSTIC EVIDENCE FROM SIENESE ITALIAN

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## ABSTRACT

Preaspiration, i.e. [hC], is a rare feature of stop production in the world's languages that has been recently found to occur in Sieneese Italian. We present a qualitative acoustic-phonetic description of voiceless geminate stops /p: t: k:/ with preaspiration that occurred in a corpus of spontaneous Sieneese Italian speech (6 speakers). We outline the different fine-grained realizations of preaspiration and discuss the findings in the context of our general knowledge of the phenomenon across languages.

**Keywords:** preaspiration, geminate, voiceless stop, Italian

## 1. INTRODUCTION & AIMS

This study aims to (1) contribute to our general knowledge of the phonetics of preaspiration, by providing a first qualitative acoustic overview of variability within the phenomenon; and (2) to provide a first detailed picture of preaspiration in a Romance variety. We are particularly interested in what this phonetic information may tell us about the nature of preaspiration in Sieneese.

Auditory descriptive studies report considerable variation in the phonetic realization of preaspirated stops [hC], alternating with, e.g. voiced glottal frication [ɦC] or vowel lengthening [V:C] (see [7] for an overview, and §2). However, acoustic-phonetic studies (e.g. [4, 6, 8, 9]) typically take preaspiration [hC] as a cover term for a range of realizations, without any close analysis. While other variants can be treated as instances of preaspiration in most cases, preaspiration is often overlooked or miscategorized in the literature [4, 7]. Therefore, it is important to be as specific as possible about the forms that preaspiration can take, and how these may be distinguished from other features of connected speech, e.g. phrase-final lengthening and/or glottalization.

An ongoing investigation into Sieneese (e.g. [8, 9]), the first to report the existence of preaspiration

in any Romance variety, has shown that geminate voiceless stops /pp tt kk/ are frequently realized with preaspiration in spontaneous speech. Sieneese Italian is unusual in allowing preaspiration both word-medially and at word boundaries. At present, native speakers are unaware of preaspiration *per se*, perceiving preaspirated voiceless stops [hp ht hk] as phonetically long plain stops [p: t: k:]. There is evidence that the fine-grained realization of preaspiration can impact upon the perceptual salience, and ultimate survival of the phenomenon in a language [7]. With this in mind, the present overview also aims to shed light on the potential stability of preaspiration as a feature within Sieneese Italian.

## 2. BACKGROUND

As noted above, preaspiration is a rare phenomenon: within Europe it is only reported to occur in languages spoken in the geographical area extending from Northern England and Ireland to Northern Scandinavia (see [4] for more detail). In terms of preaspiration within Romance varieties, only [2] reports relatively early glottal abduction in /Vp: Vt: Vk:/ sequences (resulting in breathy voice at vowel offset) for speakers of Florentine Italian. Preaspirated stops, the focus of this investigation, also involve an early glottal abduction relative to the onset of supralaryngeal closure.

The exact phonetic realisation of preaspiration varies because “[d]uring [h] sounds, the shape of the supralaryngeal cavity is contextually determined by proximate supralaryngeal gestures” [7]. As such, based on auditory descriptive rather than acoustic-phonetic evidence, [7] distinguishes archetypal preaspiration, i.e. voiceless glottal frication [h], from a range of associated phonetic variants. Arguing that archetypal preaspiration [hC] is rare, [7] shows that across languages it is more typical for preaspiration to be realized as a fricative, homorganic to the following stop, e.g. palatal [çç]; or conditioned by the preceding vowel, e.g. [ahC] v. [içC]. Preaspiration can also

alternate with vowel lengthening, i.e. [VhC] ~ [V:C], for some speakers and in some languages. Finally, there is also evidence that preglottalization, i.e. [ʔC ~ VC], can alternate with preaspiration (e.g. [1] for /t/ in Derby and Newcastle English). Here we use the cover term *preaspirated stop* to refer to all four realizations of the preaspiration portion.

Archetypal preaspiration is known to be of low perceptual salience, especially in comparison to post-aspiration [C<sup>h</sup>] [4, 7]. As [7] explains, “[archetypal] preaspiration’s weak cues may lead to its eventual elimination from the system (with or without surviving vowel length) ([(:)p, (:)t, (:)k)]”. However, there are strategies to enhance the perceptual salience of archetypal preaspiration: “the reintroduction of a downstream noise source [...] enhances the salience of the otherwise jeopardized contrast ([fp, çc, xk])” [7]. In this way, preaspiration can lead to either weakening (/VhC/ > /V(:)C/) or strengthening (/VhC/ > /VC:/) of a segment, or segments, in a particular language.

### 3. METHODS

The data comprise 380 V + /p: t: k:/ sequences drawn from a corpus of spontaneous Sienese speech (3 male, 3 female; cf. [9] for more detail). We include both word-medial [VC:], and word-boundary [V#C:] sequences, in stressed [ˈVC:] and unstressed [VC:] contexts. Neither word position [9], nor stress [8] affects the frequency or duration of preaspiration in Sienese Italian.

### 4. RESULTS AND DISCUSSION

In §4.1 we outline the frequency of preaspirated stops (in the general sense) amongst the 380 /p: t: k:/ tokens examined, before focusing on the variation within the preaspirated stops in §4.2.

#### 4.1. Overview of preaspirated /p: t: k:/ tokens

Amongst the corpus of 380 tokens, 111 (29.2%) are realized with preaspiration (identified as a region of glottal noise between the offset of modal voicing in the vowel and the onset of consonant closure; cf. also [8, 9]). Plain voiceless stops are the most frequent, comprising 250 of the tokens, while the remaining 19 (5%) comprise fricatives and incomplete stops. In terms of the potential stability of preaspiration as a feature of voiceless stop production in Sienese Italian, we note that the frequency of preaspirated tokens as well as the

other variants is in line with the realization of voiceless stops in spontaneous Central Standard Swedish [4], a variety which, like Sienese Italian, also presents non-obligatory preaspiration.

Figure 1 shows a preaspirated stop, in this case with archetypal preaspiration (cf. §4.2). Preaspirated stops are readily distinguishable from plain stops by the presence of glottal activity (indicated by the arrow) in the transition between vowel and closure. They are also distinguishable from fricatives and incomplete stops, the remaining variants, by visible supralaryngeal closure, shaded in Figure 1.

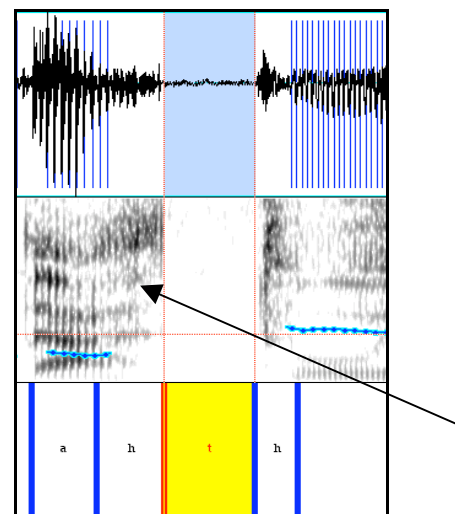


Figure 1. A geminate dental voiceless stop realized with (archetypal) preaspiration, i.e. /Vt:/ > [Vht], at the word boundary in the sequence *da tutte /da tutte/* ‘from all’ (s3:126).

The spectrogram shows that the frication energy associated with preaspiration [h] initially appears in the formant region of [a], the preceding vowel, and later shows some high frequency energy, evidence of an approximated dental closure gesture for /t:/ at the word boundary. Preaspirated stops in the present corpus often have a portion of post-aspiration, due to the wide abduction of the vocal folds relative to plain voiceless stops (see e.g. [5] for discussion). Although some (primarily phonological) sources claim pre- and post-aspiration alternate (e.g. [3] for Icelandic), the realization of voiceless stops with both pre- and post-aspiration i.e. [hC<sup>h</sup>] is in line with phonetic sources on some other preaspirating languages [4].

#### 4.2. Variation within the preaspirated tokens

Based on their spectral appearance, the preaspirated stops can be divided into the four specific sub-categories listed in Table 1.

preaspiration portion		<i>n</i>	%
voiceless glottal fric.	[hC]	47	42.3
glottal stop/creak	[ʔC] ~ [ʋC]	30	27.0
Voiced glottal fric.	[ɦC]	24	21.6
supralaryngeal fric.	[çC] ~ [θC]	10	9.0
all 'preaspirated'		111	100

Table 1. Finer categorization of the preaspirated voiceless stops in the Siense corpus according to the spectral appearance of the preaspiration portion.

Turning first to the tokens with voiceless glottal frication [h] (archetypal preaspiration), these are most frequent, comprising nearly half the preaspirated tokens. This pattern differs from [7] which, as noted above, claims this kind of archetypal preaspiration to be rare. Cases of archetypal preaspiration [h] typically show visible frication energy in the formant structure of the surrounding vowels, like /h/ more generally (cf. Figure 1, earlier, and e.g. [4, 7]).

The next most frequent realization of the 'preaspiration' region involves creaky voice in the offset of the vowel, or a full glottal stop as in Figure 2.

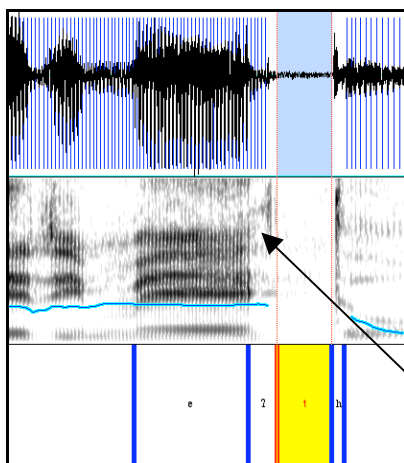


Figure 2. Geminate voiceless stop realized with adducted vocal folds preceding dental closure in *attuali* 'actual' (s6:55), resulting in a visible glottal stop (indicated by the arrow).

Tokens with glottal stop or creak, as seen in Figure 2, differ from the other tokens because they

involve adduction rather than abduction of the glottal folds. However, the timing of the glottal gesture (relative to supralaryngeal closure) remains the same as for [hC], whereas glottal and supraglottal gestures are aligned in plain unaspirated stop. A relatively early glottal abduction or adduction secures voicelessness in and around the onset of closure.

Next we turn to the tokens with a voiced glottal fricative [ɦ], i.e. a period of breathy voice before supralaryngeal closure, as below:

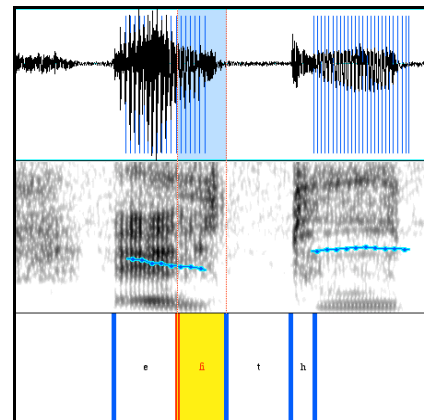


Figure 3. A preaspirated voiceless stop token in which preaspiration, shaded, is realized as breathy voice [ɦ] in *tutto* /e tutto/ 'it's all' (s3:48).

Tokens of the type shown in Figure 3 are very close to archetypal preaspiration [h] in both auditory and acoustic terms, as both are realized with glottal frication. However, the fact that complete voice offset is not achieved before supralaryngeal closure in the breathy voiced tokens is an important difference between the two kinds of preaspiration. In particular, the perceptual similarity of voiced glottal [ɦ] to the preceding vowel means that listeners may perceive such tokens as having a long vowel, i.e. [VɦC] > [V:C], rather than a long consonant /VC:/ as intended by the speaker.

Tokens in which the preaspiration portion is realized as a supralaryngeal fricative are the least frequent, comprising only 9% of the data. In these cases the rapid flow of air through the glottis associated with archetypal preaspiration is reinforced by an approximated closure gesture at the place of articulation of either the following consonant or the preceding vowel, resulting in frication in the oral tract rather than at the glottis. An example appears below in Figure 4:

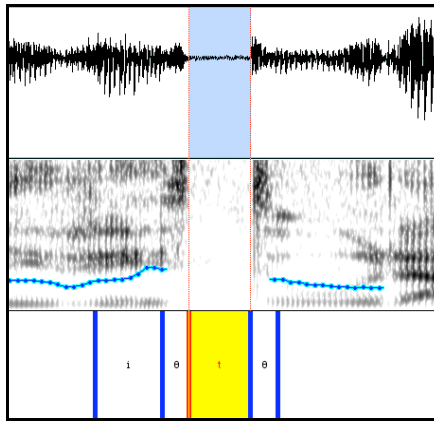


Figure 4. A preaspirated voiceless stop in which preaspiration is realized as a supralaryngeal fricative i.e. /it:/ > [iθt] in *addirittura* 'directly' (s3:193).

Amongst the tokens with preaspiration realized as frication in the oral tract, the post-aspiration portion also typically shows supralaryngeal frication. This is visible in Figure 4, where the spectral energy either side of the closure portion is concentrated in the higher frequencies for [θ], rather than the more dispersed pattern associated with glottal frication [h]. With a portion of supralaryngeal frication, these tokens show a similarity to the tokens classified as 'fricatives' in the broader categorization in §4.1. However, full fricatives do not have complete supralaryngeal closure at the offset, which is instead seen here in Figure 4.

In terms of factors conditioning the realization of preaspiration as one of the four variants just described, both vowel type and consonant place have an effect. Following low central /a/, preaspiration is most frequently realized as glottal [h] or [ɦ], and only 2% of tokens are realized with supralaryngeal frication. After high /i/, for which there is greater supralaryngeal constriction than for /a/, 46% of the preaspirated tokens are realized with supralaryngeal frication. As for consonant place, archetypal preaspiration [h] and its voiced counterpart [ɦ] are most frequent for bilabial /p:/, less frequent for dental /t:/ and least frequent for velar /k:/. The remaining realizations of preaspiration (glottal stop and supralaryngeal frication) show the opposite pattern across C-place, i.e. velar >> dental >> bilabial. These patterns provide some acoustic phonetic support for the overview of preaspiration in [7], which was based

on auditory descriptions of other preaspirating languages.

## 5. FURTHER DISCUSSION

In terms of our general knowledge of preaspiration, this study has provided some acoustic phonetic evidence of variability within the production of the phenomenon. Specifically, 57.7% of tokens in the present corpus are not realized as archetypal preaspiration [h]. Therefore, in order to accurately label (preaspirated) voiceless stops, it is important to be aware of the possibility of all four variants outlined here.

Specific to Sieneese, we found that only 9% of preaspirated stops are realized with supralaryngeal frication. In other words, they are infrequently reinforced, which may explain why native speakers are not aware of preaspiration as a feature of geminate voiceless stops (cf. §1). Nonetheless, the relatively more frequent glottal realizations of preaspiration can secure voicelessness in and around supralaryngeal closure. This would explain why native speakers perceive preaspirated stops [hp ht hk] as fully long /p: t: k:/.

## 6. REFERENCES

- [1] Docherty, G., Foulkes, P. 1999. Derby & Newcastle: instrumental phonetics and variationist studies. In: Foulkes, P., Docherty, G. (eds), *Urban Voices: Accent Studies in the British Isles*. London: Arnold, 47-71.
- [2] Gobl, C., Ni Chasaide, A. 1999. Voice source variation in the vowel as a function of consonantal context. In: Hardcastle, W., Hewlett, N. (eds), *Coarticulation. Theory, Data and Techniques*. Cambridge: Cambridge University Press, 122-143.
- [3] Gussmann, E. 2002. *Phonology: Analysis and theory*. Cambridge: Cambridge University Press.
- [4] Helgason, P. 2002. *Preaspiration in the Nordic languages. Synchronic and diachronic aspects*. PhD dissertation. Stockholm University.
- [5] Ladefoged, P., Maddieson, I. 1996. *The sounds of the world's languages*. Oxford: Blackwell.
- [6] Shuken, C. 1979. Aspiration in Scottish Gaelic stop consonants. In: Hollien, H., Hollien, P. (eds), *Current Issues in the Phonetic Sciences. Proc. IPS-77 Congress*. Amsterdam: John Benjamin, 451-458.
- [7] Silverman, D. 2003. On the rarity of pre-aspirated stops. *Journal of Linguistics* 39, 575-598.
- [8] Stevens, M., Hajek, J. 2004. Preaspiration in Sieneese Italian and its interaction with stress in /VC:/ sequences. In: Bel, B., Marlien, I. (eds), *Proc. Speech Prosody 2004* Nara, 57-60.
- [9] Stevens, M., Hajek, J. 2005. Raddoppiamento sintattico and word-medial gemination in Italian: are they the same or are they different? The evidence from spontaneous speech. In: Gess, R. S., Rubin, E. J. (eds), *Theoretical and Experimental Approaches to Romance Linguistics*. Amsterdam: John Benjamin, 257-272.