

# Spirantization of /p t k/ in Sienese Italian and so-called semi-fricatives

Mary Stevens & John Hajek

School of Languages  
University of Melbourne, Melbourne, Australia  
mes@unimelb.edu.au; j.hajek@unimelb.edu.au

## Abstract

This paper presents the results of a first acoustic phonetic investigation into voiceless spirantization in the variety of Tuscan Italian spoken in Siena. Based on spontaneous speech data (6 speakers), we focus upon occurrences of a phonetic variant, previously referred to as a ‘semi-fricative’. Intermediate between a voiceless stop and a voiceless fricative, it is reported to occur in Pisan (e.g. [1], [2]) but not Florentine Italian (e.g. [3]).

## 1. Introduction

This paper forms part of a larger ongoing investigation into stop contrasts in naturally occurring Sienese Italian speech (see e.g. [4], [5], [6]). In this paper we focus specifically on the phonetic realization of singleton /p t k/ in post-vocalic contexts. Fine-grained phonetic information of this sort, drawn from natural speech, helps to uncover the mechanisms by which, and extent to which, phonological contrasts are upheld in natural speech. It can also assist the development of speech recognition technology, in particular - an area for which linguistic diversity across dialects and speakers continues to pose a considerable problem.

In Sienese and other - though not all - varieties of Tuscan Italian, singleton voiceless stops /p t k/ are weakened to voiceless fricatives [ɣ γ x/h] e.g. *siamo partiti* [sjamo ɣartiɣi] ‘we left’, under the spirantization process known as the *Gorgia toscana* (hereafter GT). Further weakening of dental /t/ and especially velar /k/ to glottal [h] (and even to [ø]) can occur in fast or careless speech. GT is a well-known feature of Tuscan Italian pronunciation, and has been the subject of a number of detailed descriptive and sociophonetic studies, e.g. [7], [8], [9].

GT has only very recently been the subject of experimental phonetic investigation, e.g. [1], [2] for Pisan, & [3] for Florentine Italian). These studies have confirmed that GT is optional in natural speech, where phonetic stops occurred instead of lenited variants in 13.7% of Florentine and 47.7% of Pisan tokens analyzed. They have also confirmed reported differences between voiceless stops in GT contexts in the two varieties, largely due to the fact that GT is a relatively more recent development in Pisan Italian, whereas Florence, along with Prato, Pistoia and Siena, is known as the region in which GT originated [1]. Amongst the differences between the two varieties, most notable was a so-called ‘semi-fricative’ variant that was reported to occur for 18.7% of Pisan tokens analyzed in [1], but not in Florentine Italian [3].

## 1.1. The ‘semi-fricative’ variant

The ‘semi-fricative’ is described as involving a period of full closure, as for a voiceless stop, followed by a long VOT of relatively weak intensity, without a release burst [2; p.10]. Crucially, closure is still reported to occur for the ‘semi-fricative’ variant. In terms of features, this was described as partial loss of the [-cont] feature, in the second portion of the stop:

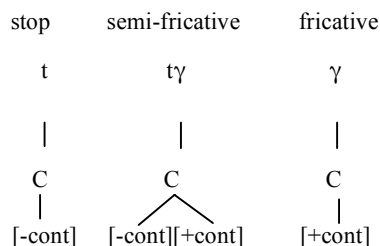


Figure 1. The proposed intermediate stage if GT weakening, in terms of features (taken from [1; p. 47]).

While the feature specification in Figure 1 appears to correspond to that of an affricate, it is argued that a ‘semi-fricative’ can be distinguished from a true affricate by the lack of release burst and the ‘weaker’ VOT [1]. Although true affricates and post-aspirated stops with a release burst and ‘strong’ VOT would be interpreted as fortis [1; p. 47], it is claimed that they do not occur in Tuscany (but see [9; p. 71] for discussion, and §3.1). Nonetheless, based upon these two criteria, Marotta proposed that ‘semi-fricatives’ should be interpreted as lenis, constituting a stage of GT weakening intermediate between stops and full voiceless fricatives.

Given this proposed trajectory of GT weakening, we would reasonably expect the intermediate semi-fricative variant to occur in other GT-affected varieties of Tuscan Italian. However, fine-grained acoustic phonetic analyses of post-vocalic /p t k/ in Florentine Italian, e.g. [3], do not report any evidence of the intermediate variant. We might wish to attribute the non-occurrence of ‘semi-fricatives’ in Florentine to GT being more established and prevalent in that variety than in Pisan. However, the phonetic facts suggest otherwise, because full phonetic stops were reported to occur, albeit infrequently, alongside weakened variants in Florentine speech.

## 2. The current study

In an attempt to clarify the nature and status of semi-fricatives in Tuscan, we investigate the acoustic appearance of voiceless stops /p t k/ in Sienese, another Tuscan Italian variety with GT. We only briefly compare our results with the existing studies, instead focusing specifically upon occurrences of the ‘semi-fricative’ variant, and investigating its role, if any, in the gradual weakening process affecting voiceless stops.

Siene Italian or Tuscan is very close to Standard Italian, apart from the presence of GT, which is well established and prevalent in spoken Siene. The present study is the first to examine GT-affected /p t k/ in Siene from an acoustic phonetic perspective. Experimental investigation of geminate voiceless stops /pp tt kk/ (in the same spontaneous speech corpus from which /p t k/ were drawn for the present study) found frequent preaspiration i.e. /pp tt kk/ > [hp ht hk] and a range of associated processes (see e.g. [4], [5], [6]).

The data were taken from a corpus of spontaneous Siene Italian speech recorded in Siena in 1997. Six speakers (3 male, 3 female), all raised and living and working in Siena, participated in the study. Each speaker spoke on a subject of their choice for 5-10 minutes.

## 3. Methods

For the present study, occurrences of phonemic /p t k/ in post-vocalic position were extracted, and labelled within Praat. Following [1]-[3], both word-boundary and word-medial sequences were included, and surrounding vowel type & lexical stress were not controlled for. Sequences were discarded where a pause intervened between the vowel and the target consonant, since this is expected to block GT. The duration of the target consonant and that of the preceding vowel were then measured (see §3.1). Based on their spectral appearance, tokens were divided up into 7 categories according to (a) manner, i.e. stop v. fricative v. elision; (b) the presence or absence of voicing; & (c) whether frication occurred at the glottis or in the oral tract. These parameters differ from those in existing studies: 4 categories were used in [1], [2], while a finer distinction was drawn between voiced fricatives and approximants in [3] for Florentine. Vowel duration was not measured in any of the existing acoustic phonetic studies on Florentine or Pisan Tuscan.

### 3.1. Segmentation criteria

Tokens were firstly labelled in a phonological tier within Praat: vowel duration was measured from the onset to the offset of modal voicing, and consonant duration was measured from the offset of the preceding vowel to the onset of the following vowel.

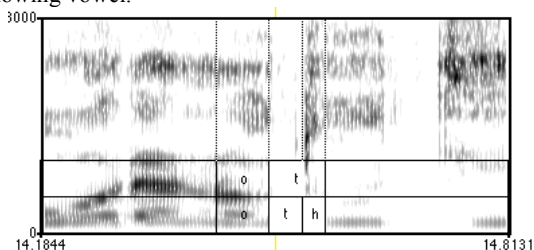


Figure 2. Post-vocalic [t<sup>h</sup>], with burst and post-aspiration, where spirantization was predicted (s5:14 *lavorano tutti* ‘they all work’).

Within a separate phonetic tier, the overall consonant duration measurements were broken down into their component parts, where appropriate. For /p t k/ tokens that were realized as phonetic stops, the duration of the closure portion and the VOT were measured separately, as in Figure 2. Fricatives were measured from the onset to the offset of high frequency frication energy on the spectrogram, which typically coincided with the offset of the vowel, as shown in Figure 3.

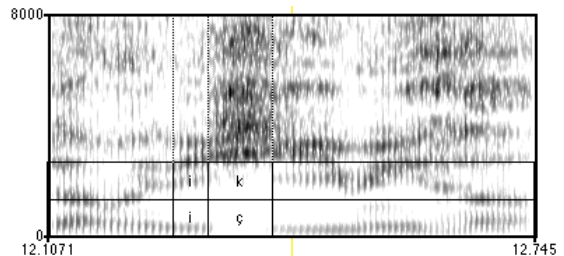


Figure 3. Post-vocalic /k/ realized as a full palatal fricative [ç] in *di chimica* ‘of chemistry’ (s4:58).

However, in some cases the spectral appearance of fricatives showed a very gradual onset of supralaryngeal frication, as in Figure 4. This necessitated two separate measurements, whereby the duration of supralaryngeal frication energy was measured separately from any preceding portion of silence or glottal frication that occurred in the V-/p t k/ transition.

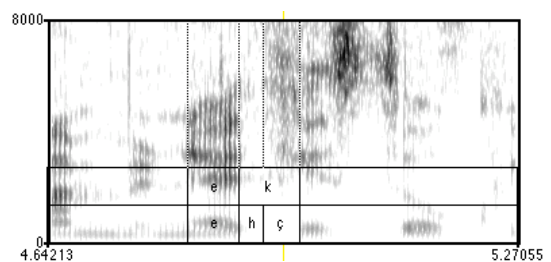


Figure 4. Velar /k/ realized as a palatal fricative [ç]. The preceding silent portion was included in the overall C-duration (s3:119 *diamine che* ‘damn it that...’).

The spectral appearance of the velar /k/ token in Figure 4, realized phonetically as [hç], appears to correspond most closely to that of the ‘semi-fricatives’ that were reported to occur in Pisan Italian, but with one important difference: full closure does not occur preceding the onset of frication associated with the palatal fricative [ç]. We return to this point below.

## 4. Results

### 4.1. Qualitative observations

The acoustic appearance of /p t k/ across the Siene data involved approximantization, spirantization, debuccalization, voicing assimilation (not discussed further here) and complete elision. As such, the Siene data are closer to existing descriptions of GT in Florentine e.g. [3] than Pisan e.g. [1], for which less fine-grained variation was reported. However, tokens that at least partially correspond to the ‘semi-fricatives’ of Pisan were found to occur in Siene.

These tokens involved an appreciable period of silence preceding the onset of the supralaryngeal fricative portion (cf. Figure 4). However, closer inspection showed considerable overlap between these tokens and those realized with clearly visible glottal frication (voiceless [h] or breathy voiced [ɣ]) preceding the supralaryngeal fricative portion, as below:

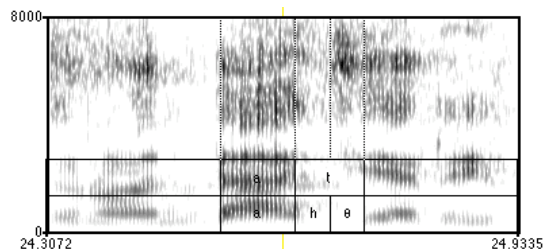


Figure 5. A phonemic voiceless dental stop /t/ token realized as a voiceless fricative, showing glottal frication in the vowel – voiceless fricative transition (s5:129 andati).

For glottal frication to be audible, there can be no closure in the oral cavity. Therefore, based on the spectral appearance of /p t k/ in Siense, we suggest that ‘semi-fricatives’ would be more accurately described as involving a slow onset of supralaryngeal frication - rather than a period of full closure. Such a description of voiceless fricatives finds cross-linguistic confirmation, e.g. [10] for voiceless spirantization in Austrian German. Between the offset of the vowel and the onset of supralaryngeal frication the glottis might be more or less open, resulting in voiceless or breathy voiced glottal frication - or a brief period of apparent silence if the airflow is sufficiently reduced - before the onset of frication at the consonant place of articulation.

The only cases where full closure occurred in the Siense data were the 14 tokens that were realized as, and perceived as, full phonetic stops. By definition the occurrence of a stop indicates the non-occurrence of GT, which is optional in natural speech. Of the stops that occurred, 8 were post-aspirated (but not post-fricated); 3 had a release burst but no post-aspiration, and 3 had no visible release burst. On a fortis-lenis continuum of GT-affected /p t k/ variants, we would interpret the post-aspirated stops [p<sup>h</sup> t<sup>h</sup> k<sup>h</sup>] as more fortis than stops without a release burst [p t k], in line with their (claimed hypothetical) position in [1; p. 47]. However, given only relatively few tokens were realized as stops in the data set, for the purposes of this investigation post-aspirated and unaspirated stops were included together. We note that in none of the 14 cases of a full phonetic stop was there visible preaspiration, which was instead frequent in their geminate counterparts /pp tt kk/ e.g. [4], [5], [6].

Returning briefly to the issue of a possible continuum of GT weakening, we suggest that semi-fricatives are not intermediate between phonetic stops and fricatives, as suggested in [1], but rather belong further along a continuum of GT weakening, between supralaryngeal fricatives [ɣ ɣ x] and their glottal counterparts [h/ɣ].

This interpretation of semi-fricatives as not involving a stopped onset is further motivated by our auditory impression, which was in each case that of some kind of fricative, and not a stop. This appears to be in line with Marotta [1; p. 50], who notes that frication “without a burst... and even if it is

preceded by silence, would lead to - or at least not inhibit - the perception of a spirant”. However, Marotta in fact appears to favour their interpretation as stops, claiming that speakers, whether linguists or not, Tuscan or otherwise, would be more inclined to interpret ‘semi-fricatives’ as occlusives [1; p. 50]. Further investigation involving controlled perceptual studies is clearly needed on this point.

## 4.2. Frequency of phonetic variants

The relative frequency of each phonetic variant amongst the 494 tokens was first calculated, and is listed in Table 1 in order of the degree of articulatory reduction. Sharing properties of both the supralaryngeal and glottal fricatives, the semi-fricative variant was at this stage interpreted as being intermediate between the two. Values shown are the percentage of the total number of stops analyzed for each phonemic place of articulation (133 bilabial tokens, 185 dental and 176 tokens), and for all three places of articulation combined, in the final column.

Table 1. Percentage of tokens according to phonetic realization, by consonant place of articulation.

|            | bilabial | dental | velar | all   |
|------------|----------|--------|-------|-------|
| [p t k]    | 4.5      | 4.3    | 0     | 2.93  |
| [ɣ ɣ x]    | 50.4     | 50.3   | 20.5  | 40.4  |
| [ɣ ɣ ɣ]    | 30.8     | 16.2   | 4     | 17    |
| [hɣ hɣ hx] | 14.3     | 16.2   | 1     | 10.5  |
| [h]        | 0        | 5.4    | 20.5  | 8.63  |
| [ɣ]        | 0        | 6.5    | 45.5  | 17.33 |
| [∅]        | 0        | 1.1    | 8.5   | 3.2   |

These values confirm existing reports of the interaction between GT weakening and consonant place of articulation [3], [8]. As expected, velar /k/ showed the highest degree of reduction, notable in the absence of any full phonetic stops, and debuccalization to voiced or voiceless glottal variants [h/ɣ] in 66% of cases.

Overall, semi-fricatives were not infrequent in the data, constituting 10.5% of all tokens. However, with regard to specific place of articulation, semi-fricatives made up only 1% of tokens for velar /k/, whereas reduction to full glottal variants was frequent. On the other hand, semi-fricatives were more frequent for bilabial /p/ and dental /t/, at 14.2% and 16.3% respectively, but debuccalization was not. In particular, no /p/ tokens were realized as [h] or [ɣ]. As such, across place of articulation the frequencies of semi-fricatives and glottal [h] are not positively correlated.

If the semi-fricative variant were intermediate between supralaryngeal and glottal articulations, as its acoustic and articulatory properties would suggest, we would expect its frequency to pattern more closely with the frequencies of adjacent variants in Table 1. There is, therefore, an apparent discrepancy between the acoustic properties of semi-fricatives and their patterning in terms of frequency across place of articulation.

### 4.3. Duration of phonetic variants

The duration measurements for each of the phonetic variants were listed in Table 2, in order of the degree of articulatory reduction.

Table 2. Duration values (in ms.) for vowel + /p t k/ tokens, according to phonetic realization. Vowel duration, overall consonant duration, consonant:vowel ratio, and number of tokens are listed.

|            | vowel          | /C/            | C/V         | no tokens  |
|------------|----------------|----------------|-------------|------------|
| [p t k]    | 86 (58)        | 82 (17)        | 0.95        | 14         |
| [ɣ ɣ x]    | 74 (43)        | 75 (20)        | 1.01        | 196        |
| [ɣ ɣ ɣ]    | 75 (48)        | 69 (18)        | 0.92        | 78         |
| [hɣ hɣ hx] | 91 (55)        | 98 (26)        | 1.08        | 51         |
| [h]        | 71 (37)        | 66 (18)        | 0.93        | 46         |
| [ɣ]        | 73 (41)        | 63 (20)        | 0.86        | 92         |
| [ø]        | 73 (44)        | -              | -           | 17         |
| <b>all</b> | <b>78 (47)</b> | <b>76 (20)</b> | <b>0.96</b> | <b>494</b> |

Vowel duration was not found to vary appreciably across the different allophonic realizations of voiceless stops /p t k/, but was nonetheless longest before semi-fricatives. We note that there was no compensatory lengthening in the vowel where the following consonant portion was fully elided.

The duration of the consonant was also found to be longest for the semi-fricative variant, while the durations recorded for other variants reflected the degree of articulatory reduction. We note that these patterns were upheld within each place of articulation, and, aside from the semi-fricative variant, are in line with duration measurements reported for Florentine Italian in [3].

However, the values for semi-fricatives do not support their interpretation as being intermediate between supralaryngeal and glottal fricatives on a continuum of weakening (cf. §4.1), as both the vowel and the consonant portions of the semi-fricative variant were found to have the highest durations. Within the consonant portion itself, the average durations recorded for the glottal and supraglottal sub-components, at 47ms and 51ms respectively, are each within the range of durations recorded for the other lenited variants.

### 5. Discussion & conclusions

This acoustic phonetic investigation has shown that semi-fricatives do occur in Siene Italian, although they do not precisely correspond to existing descriptions in [1]. We argue that the difference lies in the interpretation of the variant, not the variant itself. Instead of closure occurring between the offset of the vowel and the onset of supralaryngeal frication, as in [1], we suggest that for semi-fricatives the glottis might be more or less open, resulting in voiceless or voiced glottal frication - or a brief period of apparent silence if the airflow is sufficiently reduced - before the onset of frication at the consonant place of articulation. The key to this interpretation, was the occurrence of tokens with visible glottal frication due to a more widely abducted glottis, rather than apparent silence preceding supralaryngeal frication. Given their acoustic structure as [hC] they are perhaps better referred to as preaspirated fricatives, rather than semi-fricatives, since they

are in fact typically fricated throughout. We note that preaspirated fricatives have previously been reported to occur in Middlesborough English [11].

The particular acoustic structure of semi-fricatives leads us in the first instance to interpret them as more weakened than they are described as in [1]; that is, intermediate between archetypal GT fricatives and their debuccalized counterparts, rather than intermediate between (non-GT) stops and voiceless supralaryngeal fricatives. However, seen amongst the other variants, neither the frequency and nor the duration of semi-fricatives supports this position. This complicates the task of interpreting their place along a continuum of weakening. Matters are further complicated by the frequent preaspiration of geminate voiceless stops in this variety, such that the timing of supralaryngeal closure is reduced, e.g. /pp/ > [hp]; see [4], [5], [6]. At this stage the relationship, if any, between preaspirated geminates and newly uncovered preaspirated fricatives, is unclear. We have hypothesized previously that preaspiration in the former may in fact be intended by speakers as a kind of perceptual enhancement to aid listeners in difficult circumstances. The speech rate of spontaneous spoken Tuscan is quite elevated, favouring supralaryngeal reduction, but preaspiration helps to maintain voicelessness at the VC boundary - and hence the perception of a following voiceless obstruent. Whether this is related to the occurrence of glottal frication preceding fricatives derived from singleton /p t k/ requires further investigation.

### 6. References

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