

# DURATIONS OF VOICELESS STOPS IN A SARDINIAN VARIETY

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## ABSTRACT

This paper presents a phonetic study of the duration of voiceless stops in Campidanese, a Sardinian variety spoken primarily in the south of the island. Only a few Sardinian dialects consider the phonological quantity as a feature to distinguish minimal pairs and this emerges only for selected speech sounds, namely nasals and liquids. The pronunciation of Italian by Sardinian usually shows unexpected gemination or degemination of several sounds, thus determining a dialectal feature of many areas of Sardinia, including Campidano and the city of Cagliari. The study allows the acknowledgement of a general degree of control by speakers of this area in the duration of these sounds in consonant clusters but reveals a duration boost for singletons surrounding stressed vowels. Voiceless stops do not show length as a distinctive feature but present a significant lengthening which could be triggered by prosodic conditions.

**Keywords:** Sound duration, consonant gemination, Sardinian, voiceless stops.

## 1. INTRODUCTION

Phonetic duration is a distinctive feature and it may concern both vowels and consonants. As a correlate of sound gemination, it has been studied in many languages of the world such as Japanese, Cypriot Greek, Finnish and it still represents a topic of interest in current studies [2, 5, 8]. Consonant gemination, which is a feature of Italian [3, 4, 7, 11, 13], is also generally acknowledged in relation to Sardinian varieties [1, 6, 12, 14] where it allows the formation of minimal pairs. Nevertheless, in Standard Italian this phenomenon may affect almost all consonants in postvocalic positions whereas in Sardinian only sonorants may be contrasted on the basis of length (at least in central or southern dialects [6, 18]).

Italian geminates are orthographically transcribed by means of grapheme reduplication (e.g. *cane* /'kane/ “dog” vs. *canne* /'kanne/ “canes”) and this use is sometimes irregularly reflected in the official Sardinian spelling norms which have been recently proposed (for a short review see [12, 14]); we are not dealing here with those obstruents which were involved in diachronic lenition processes).

Sardinian is one of the most conservative Romance languages; nevertheless, it is composed of a multitude of varieties, dialects and sub-dialects, with phonological, morphological and lexical distinctions (which have been extensively studied since [1, 6]). It has a well established spoken tradition and is still learned by younger people, but it has acquired a co-official status only in 1997 and, above all, following the application of the 482/1999 national law. As a consequence, language planning reserved relevant attention to the relationship which should link the most common phonological features to two main spelling proposals: the *LSC*'s one, characterising the *limba sarda comuna*, the Common Sardinian Language, and the *LSU*'s one, which is proper of the *lingua sarda unificata*, the Unified Sardinian Language. Campidanese Sardinian, which inspires the latter, is a variety of the Sardinian language and it is primarily spoken in the south of the island, especially in the province of Cagliari. As shown by the studies of phonetic geography of Sardinian dialects [6], the phonological opposition between singleton and geminate in this region, unlike Standard Italian, affects only a restricted selection of sonorants (mainly /m/, /n/ and /l/). That explains why variation in consonant length affecting the other sounds has been irregularly accounted for by various authors dealing with this dialect.

An instrumental phonetic study was necessary in order to assess whether a systematic lengthening could be observed in particular phonetic contexts. We decided to carry out an experiment on the realisation of voiceless stops, which are frequently perceived as long consonant in spontaneous Sardinian speech and which are often misspelled by Sardinian students when writing in Italian. Therefore, duration of (especially dental) voiceless stops was measured in a selection of Sardinian words uttered by a sample of Campidanese speakers.

The aim was to assess if singletons were realised as such, in this variety, or rather they were subject to a phonetic lengthening in specific positions. Furthermore, since in Standard Italian the geminate consonant also affects the duration of the preceding vowel (long vowel before singleton, short vowel before geminate [2, 8, 13]), the general timing of these sounds was also studied in order to verify whether shortening effects were observable in Sardinian too.

## 2. METHOD

### 2.1. Materials

A list of test words has been created using the Sardinian universal language dictionary [12].

The target consonants were the three voiceless stops /p/, /t/, /k/ in different contexts and a particular care was focused on to the definition of a balanced list. Despite this, in most cases, speakers did not realise a sufficient number of a given phoneme. Therefore we present in this paper only the study of the measurements we carried for the dental stop /t/ in an abridged list.

The complete final set of test words is presented in Table 1.

**Table 1:** Test words and position codes for each phonotactic context: *\_tV* = prevocalic /t/ in initial position and stressed syllable; *\_tV* = prevocalic /t/ in initial position and unstressed syllable; *\_tL* = initial cluster of /t/ + trill in the onset of an unstressed syllable; *VtV* = postvocalic /t/ in a stressed syllable onset; *"tV* = /t/ in an unstressed syllable onset after a stressed vowel; *VtV* = internal /t/ between vowels not belonging to stressed syllables; *NtV* = postnasal /t/ in stressed syll. onset; *NtV* = postnasal /t/ in unstressed syll. onset; *S"tV* = postsibilant /t/ in stressed syll. onset; *StV* = postsibilant /t/ in unstressed syllable onset; *LtV* = postliquid /t/ in unstressed syllable onset; *GtV* = postglide /t/ in unstressed syllable onset.

Pos- ition	Word	Gloss	Pos- ition	Word	Gloss
<i>_tV</i>	<i>taula</i> <i>tecla</i> <i>tiddu</i> <i>tontu</i> <i>turta</i>	table key loom dumb cake	<i>_tV</i>	<i>tallai</i> <i>tanalla</i> <i>tancai</i> <i>tentai</i> <i>tuppai</i>	to cut pincers to close to try to stop up
<i>_tL</i>	<i>traballai</i> <i>tracolla</i> <i>tranchera</i> <i>trascurau</i> <i>trincai</i>	to work satchel costume neglected to guzzle	<i>V"tV</i>	<i>butinu</i> <i>inchietau</i> <i>nativu</i> <i>natura</i> <i>notai</i>	shoe worried native nature to notice
<i>"tV</i>	<i>tappetu</i> <i>latu</i>	carpet wide	<i>VtV</i>	<i>titulai</i> <i>notificai</i>	to (en)title to notify
<i>N"tV</i>	<i>lamentosu</i> <i>spantosu</i> <i>tentai</i>	lamentable clamorous to try	<i>NtV</i>	<i>lentu</i> <i>tontu</i>	slow dumb
<i>S"tV</i>	<i>ghestai</i> <i>tastai</i>	to spend to taste	<i>StV</i>	<i>trastu</i> <i>gastu</i>	tool shopping
<i>LtV</i>	<i>turta</i>	cake	<i>GtV</i>	<i>nauticu</i>	nautical

The target words were embedded in the carrier sentence *Su fueddu \_\_\_ è custu che appu nau* “The word \_\_\_ is the one that I said”. Participants were instructed to utter each sentence at a conversational rate and volume. They produced one repetition of the test sentences.

### 2.2. Speakers

The speech stuff collected was uttered by six speakers but only four of them were considered for this study (two of them pronounced the sentences too markedly so they were not included). Two more speakers of other dialects (Logudorese and Gallurese) have been recorded with similar wordlists for contrastive purposes. These recordings were only informally inspected in order to verify if phenomena of the same magnitude were observable for these varieties.

The main corpus was then offered by four speakers: three males (GM = Sp1, SM = Sp2, RM = Sp4) and one female (TP = Sp3), which age was between 30 and 60 years. They live respectively in Cagliari (GM and RM) and Selargius (SM) and Dolianova (TP), two villages near Cagliari. All of them spoke the Campidanese dialect since they were children but they speak Italian as well. None of the speakers reported any speech or hearing problems. In the considered productions, their speaking rate was in a range of 4-5 syl/s and their speech sounded as in natural conversation to a native speaker. The recording total duration lasts 90 minutes. Before measurements were performed, the recorded utterances were evaluated in order to re-record the unacceptable samples.

### 2.3. Procedure

Each speaker received the target word-list and had been asked to put each word in the carrier sentence previously mentioned. They all produced one repetition of the test sentences at normal rate, spontaneously. Whereas the sentence was wrongly pronounced, they have been asked to repeat it.

The speech materials were recorded in a sound-treated room by means of a TASCAM - DA/P1 digital recorder and a SHURE SM58 microphone at a sampling rate of 44100 Hz. Speech files were subsequently converted in .wav format, segmented and downsampled at 16000 Hz using Goldwave software on a Sony Vaio PC equipped with a Intel C200 series HD audio card.

### 2.4. Measurements

Each word was isolated, segmented and annotated using Praat (www.praat.org). Measurements were then extracted using a script. The utterances of the other speakers were manually segmented and labelled by annotating on different tiers: vocalic and consonantal portions (*Su fueddu \_\_\_* → “s - u - f - ue - dd - u - \_\_\_”) and general labels allowing to distinguish sequences of consonants and vowels for ongliding diphthongs (“c - v - c - cv - cc - v - \_\_\_”).

Standard criteria of segmentation were followed for the measurements. In the waveforms in particular, stops were measured from the onset of implosion phase until the release burst included. Measurements were skipped for those sentences containing an unexpected voiced realisation of the stop or did a too long pause or made a pronunciation mistake. The last vowel of the target word has been segmented earlier (70%) in order to exclude final draws. Plosive sounds (supposed geminate) were considered as a unique phonetic segment since they never shown a double release (or acoustic cues of a pretended rearticulation [9]).

### 3. RESULTS

The articulation rate for the four speakers was between 7 and 12 seg/s, while the speech rate between 4 and 5 syl/s. After normalising the values for the duration of /t/ in each sentence, we evaluated the averaged normalised values and the standard deviation for each occurrence position presented in Table 1 and for all the speakers.

We observed for Sp1 higher values in "tV (0.204), "VtV (0.180) e V"tV (0.174); by contrast, in S"tV (0.100), NtV e StV (both of them 0.111), N"tV (0.121) e VtV (0.126) the values are lower; the highest values for Sp2 fluctuate between 0.136 (V"tV and "VtV) and 0.114 (VtV), while the lowest ones 0.039 (\_tV) and 0.049 (\_tL); for Sp3, the values consist of 0.181 ("VtV), 0.170 (V"tV) and 0.157 (VtV) while the lowest ones are 0.082 (\_tL), 0.091 (N"tV) and 0.095 (S"tV); for Sp4 the highest values concern V"tV and "VtV (both equal to 0.139), the lowest ones are related to \_tV (0.082), "tV and S"tV (both equal to 0.089). We find the highest values in Sp1 (still a lower value of 0.100 in S"tV), while the lowest ones concern Sp2 (0.039 in \_tV).

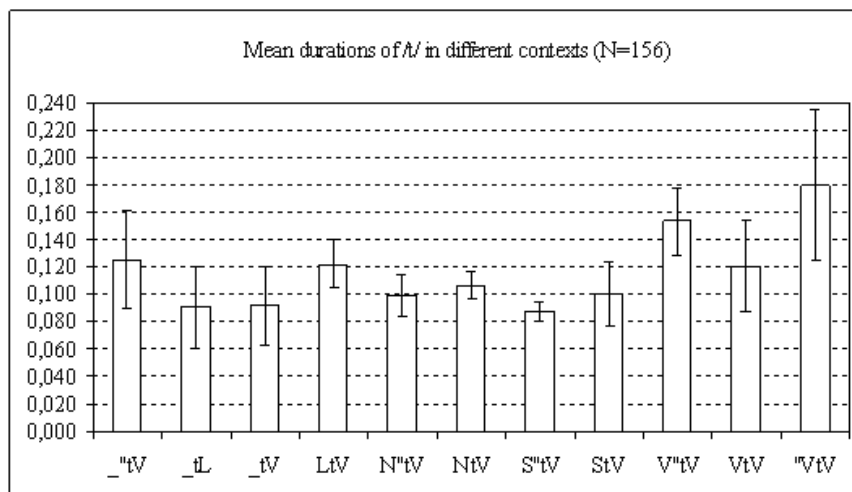
Shorter realisations (\_tL, \_tV, N"tV, NtV, S"tV and StV of about 80-100 ms) are congruent with values reported for Italian by [9] (70÷100 ms), [8] (64÷80 ms), [7] (77÷81 ms), in laboratory speech, and by [13] (73÷92 ms for a voiceless stop) and [16] (66±17\*2 ms), on connected speech. A mid length was observed for realisations in the contexts "tV, LtV and VtV (about 120 ms), whereas longer durations were generally associated to /t/ realisations in the Vt"V and "VtV contexts (124÷238 ms; see Fig. 1).

These values are congruent with duration values measured for Italian geminates (or inherently long consonants, that is *rafforzate*) by various authors (e.g. [9] 140÷200 ms; [7] 128÷142 ms; [13] 112÷153 ms; [16] 114±32\*2 ms; with only [8] showing values within a different range, 205÷266 ms).

Having similar values, \_tL and \_tV were therefore grouped together; we did the same with NtV, N"tV, StV e S"tV. Thus, the duration of each class was statistically analysed. Only two tests got significance values: "tV vs. \_tV (Welch Two Sample t-test,  $t = 2.0261$ ,  $df = 35.68$ ,  $p\text{-value} = 0.05028$ ) and VtV vs. V"tV & "VtV ( $t = -2.9251$ ,  $df = 19.344$ ,  $p\text{-value} = 0.008574$ ).

In reference to the lowest measured values the duration has also been assessed in terms of increase in percentage. As discussed above, singletons in unstressed intervocalic position show average values close to 90 ms, in line with the previous works on Standard Italian (see above); by contrast, if an adjacent vowel is stressed, values are subject to a general increase, up to a mean value of 180 ms, that is +100% (as stated by [3] for geminate to singleton in Standard Italian).

**Figure 1:** Bar diagram with mean durations of /t/ realisations by the 4 Sardinian speakers depending on the context.



A minimal duration (around 88÷92 ms) is even attested for /t/ in the  $\_tL$ ,  $\_tV$  and StV contexts, while there is a light increase for N"tV and StV (+13÷14%): these values can be still considered as singleton realisations. Unexpectedly, the length of /t/ in StV is greater than in S"tV and a similar condition concerns the N"tV vs. NtV contexts, showing slightly higher values in the latter (+21%). While in LtV, the more consistent increase of /t/ (+39%) is probably due to a compensation related to the systematic minor duration of the vibrant. Anyway these percentages are still similar to the ones of  $\_tV$  (+42%) and VtV (+37%). Finally, a more significant lengthening concerns V"tV (+74%) and "VtV (+104%) with durations greater than 150 ms: this let us assume that the consonantal lengthening of the voiceless stops seems to be an effect of lexical stress conditions.

#### 4. CONCLUSION

The analysis on the voiceless dental stop realisation in Sardinian show interesting results. They confirm that the phonetic system of the Campidanese do not consider the opposition between singleton and geminate, at least as regards these sounds (similar conditions appear for the other places of articulation, even though data was not enough for a statistical assessment). There is an actual minimal duration for /t/ in initial position (or following /s/), with a lightly internal lengthening after /n/ or /s/. However, when /t/ follows /s/ or /n/, slightly lower values are measured in unstressed positions compared to the ones at the onset of a stressed vowel. A considerable increase concerns /t/ after /r/, at the onset of a stressed syllable or between unstressed vowels. The most interesting results concern intervocalic /t/ before or after a stressed vowel, showing a correlation with stress that is statistically significant. The condition "VtV, in particular, shows /t/ realisations with duration values that induce to consider them geminates more than singletons. And this probably represents the most important finding of this work, even though it only concerns the dental voiceless stops and has not yet been verified for all the recorded speakers and for other dialects.

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