

# On the Application of Velar Palatalization in Italian<sup>1</sup>

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## 1. Introduction

Velar palatalization is a process common to many Romance languages, although it is present in the various languages with different distribution and phonetic implementation. The origins of this phonological process are to be found in Late Latin and Proto-Romance. Late Latin velars were palatalized in non-derived as well as in derived environments. Morpheme internal palatalization is preserved in case like (1).

(1) It. *tfenere*, Fr. *cenre*, Sp. *ceniza*, Rom. *cenușă* < Lat. KINIS

Palatalization in modern Italian is only triggered by the front vowel /i/ in nouns and adjectives. Palatalization in verbal inflection and in derivation patterns differently, and it will not be discussed here.

In the lexicon of Italian, certain masculine nouns and adjectives palatalize in the plural, and others do not; these alternations are illustrated in the table below:

(2) Alternations in the masculine paradigm: an example

	<b>Palatalizing</b>	<b>Non-palatalizing</b>
<u>Nouns</u>	mediko, meditʃi 'doctor'	arabesko, arabeski 'arabesque'
	filologo, filolodʒi 'philologue'	sfogo, sfogi 'rash'
<u>Adjectives</u>	comiko, comitʃi 'comic'	antiko, antiki 'antique'
		lungo, lungi 'long'

The first goal of this paper is to argue that velar palatalization in contemporary Italian is largely predictable as a function of stress, contrary to what has been extensively claimed in the previous literature (Celata and Bertinetto 2005; Krämer, *forth.*). I show that aside from the idiosyncratic status of some words, the application of palatalization is conditioned by the location of main stress. The second goal of the paper is to propose that the effect of stress on palatalization is likely due to the increase in perceived distance between velar stops and affricates in post-stress position.

## 2. Corpus Study

A corpus study on the lexicon of standard Italian was conducted, with the aim of exploring whether palatalization is really an unpredictable process, or whether its distribution is predictable in some way. If indeed the process is completely arbitrary, no systematicity is expected to emerge in the distribution of palatalization, even across a big corpus; if, on the other hand, the application of palatalization is not random, the analysis of an extensive corpus of the lexicon should allow certain regularities to emerge.

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## 2. 1 The Corpus

The Corpus that has been analyzed is the “LaRepubblica” corpus, a very large body of Italian newspaper text containing approximately 380M tokens. Frequency data are taken from a “Frequency List”, an interface which allows one to collect frequencies from the “LaRepubblica” corpus. Morphological information comes from a further corpus, Morph-It 47, a lexicon of inflected forms (currently 504,906) with their lemma (34,968) and morphological features. Masculine singular nouns and adjectives ending in either *-co* or *-go* were collected from the corpus with the help of a PERL script.

## 2. 2 Main stress in Italian

In approaching the corpus study, I pursue a suggestion in Dressler (1985). The author notes that the position of main stress conditions the application of palatalization. He conducted a nonce word study, in which Italian subjects were asked to form the plural of nonce-words with roots ending in velar consonants: palatalization was applied in 90% of the nonce-words with antepenultimate stress, but only in 56% of the nonce-words with penultimate stress. Despite this finding, prosodic factors are not discussed further in his analysis and in later work on velar palatalization.

Main stress in Italian can be placed on one of the last three syllables of the word, giving rise to antepenultimate, penultimate, and final stressed words. Penultimate main stress is the most frequent stress pattern and it occurs in very frequent nouns. Antepenultimate stress on the contrary, although widely attested, is found in less frequent nouns (e. g. Greek nominal compounds with the suffix *-logo*). Among the adjectives, the very frequent suffix *-ico* causes the words to bear antepenultimate stress.

## 2. 3 Results

The analysis of the two classes of words with velar-ending roots (palatalizing and non-palatalizing) reveals a strong generalization: if the position of main stress is taken into account, nouns and adjectives behave alike and they are clearly divisible into palatalizing and non-palatalizing lexical items. The stress-conditioned distribution hinted at by Dressler seems to be overwhelmingly present in our corpus: apart from a few idiosyncratic exceptions, all palatalizing words in *-co* and *-go* have antepenultimate stress and the vast majority of non-palatalizing words bear penultimate stress.

(3) Nouns:

<u>Stress</u> \ <u>Palatalizing?</u>	Yes	No
Antepenult	240	20
Penult	5	217

Adjectives:

<u>Stress</u> \ <u>Palatalizing?</u>	Yes	No
Antepenult	32	5
Penult	4	153

The tables above suggest that the synchronic distribution of palatalization in modern Italian is far from being unpredictable. If what emerges from this corpus study reflects a deep fact about the distribution of palatalization, beyond the apparent unpredictability, a specific property determines the distribution of palatalization in the language, namely the position of the velar consonant with respect to main stress.

(4) Descriptive generalization:

- a. The synchronic distribution of velar palatalization is predictable by stress;
- b. Plural nouns and adjectives bearing antepenultimate stress palatalize.

→ Contexts where palatalization applies: ('CV)CVki → ('CV)CVtʃi  
 ('CV)CVgi → ('CV)CVDʒi

- c. Plural nouns and adjectives bearing penultimate stress do not palatalize.  
 → Contexts where palatalization does not apply: (CV)'CVki → CV'CVki \*(CV)'CVtʃi  
 (CV)'CVgi → (CV)'CVgi \*(CV)'CVdʒi

It should be noted that although nouns and adjectives almost flawlessly follow the described generalization, there are some exceptions (both among nouns and adjectives) with either palatalization occurring in words bearing antepenultimate stress, or lack thereof in words with antepenultimate stress. Importantly, most exceptions are Greek and Latin compounds (e.g. Sg. *'pro.fu.go*, Pl. *'pro.fu.gi*, \**profudʒi* 'refugee' < Lat. PROFUGUM, PRO+FUGERE) which are clearly borrowings and were presumably preserved from adapting to the stress-conditioned palatalization, retaining the original plurals<sup>2</sup>. Beside the exceptions, there are a few words with vacillating plural forms. Krämer (2006) presents frequency data for those nouns.

Krämer's data indirectly provides evidence to the claim that palatalization of velar consonants which are not adjacent to stress is still a fully productive process in Italian. First, all nouns which he lists as preferably palatalizing bear antepenultimate main stress. Second, the frequency data shows that words with higher text frequency are vacillating less than nouns with lower text frequency. More precisely, among these words, those which are rarer, and therefore less adjusted to the synchronic rule governing the distribution of velar palatalization, are often attested with plural forms which do not conform to the regular pattern of the process. This is shown in the table below:

(5) Occurrence of vacillating nouns in the Italian web (adapted from Krämer, 2006: 3)

Item	Web pages	%	Item	Web pages	%
'far.ma.tʃi	3,730,000	99.99%	'mo.na.tʃi	1,350,000	98.01%
'far.ma.ki	420	0.01%	'mo.na.ki	27,400	1.99%
ki.'rur.gi	718,000	95.82%	'ma.ni.tʃi	338,000	94.95%
ki.'rur.dʒi	31,300	4.18%	'ma.ni.ki	18,000	5.05%
sar.'co.fa.dʒi	83,300	77.5%	'sto.ma.tʃi	73,900	71.61%
sar.'co.fa.gi	24,200	22.5%	'sto.ma.ki	29,300	28.39%

Contrary to previous analyses of velar palatalization in Italian, an account that treats the position of main stress as the factor determining whether or not palatalization is applied provides a way to understand both the corpus data and frequency data from the web in a very straightforward way. The following section shows that the connection between stress and palatalization is not merely one that can only be observed *a posteriori* from a corpus of written language, but one that speakers of the language use productively when faced with the task of computing the plural of a nonce-word whose root ends with a velar stop.

### 3. Productivity of the stress generalization

A nonce-word experiment was designed, in order to test whether the relation between main stress and palatalization is one that arose in the diachronic development of Italian but is no longer productive in the phonology of the contemporary language, or whether, more interestingly, speakers still apply velar palatalization according to the generalization in (4). The data gathered in Krämer's study on vacillating nouns inclines us to expect a productive application of palatalization in antepenultimate stressed words. This experiment aims at bringing further support to this claim.

<sup>2</sup> Besides these apparent exceptions, there are a few true exceptions to the generalization (e.g. *'ca.ri.ko*, *'ca.ri.ki*, \**'cari.tʃi* 'load'; *a.'mi.ko*, *a.'mi.tʃi*, \**a.'mi.ki* 'friend') for a discussion of these see Giavazzi (2008), ms.

### 3.1 Method

The stimuli for this experiment were taken from Krämer (*forth.*). These were fifteen masculine nonce-words with pseudo-roots ending in a velar consonant (*k-* or *kk-*). Additionally, eleven filler items whose roots did not end in a velar consonant were added to the test stimuli. The nonce words were created by Krämer so as to obey Italian phonotactics and as to not be too similar to existing Italian words.

(6) Material (including fillers, in italic): from Krämer (*forth.* (9)).

frunaco	<i>flempile</i>	giompicco
<i>brombulo</i>	tapirco	<i>rocapado</i>
frampeco	chiateppo	plontico
plantico	<i>svappa</i>	<i>frudalo</i>
<i>chiatenno</i>	nalico	ancico
sbancito	fiesova	<i>picutopa</i>
gico	smeco	gionsicco
cincuco	cruvacco	conchico
praco	<i>grotulfo</i>	

Seven native speakers of Italian (1 female and 6 males, age range 25-35) were recruited as subjects for this experiment. Subjects read a small story which introduced them to the task and they were asked to imagine a situation in which they have to buy various things in a store, and they have to tell the shop owner what they would like. This was done to make the task as natural as possible. They were given a written list of singular nonce words. The subjects were asked to read the words out loud and decide where to put the stress. For all trisyllabic words the subjects had two options, either putting the stress on the penult, or on the antepenult (apart from the three roots ending with geminate /kk/, which always have penultimate stress in Italian), for the bisyllabic words they only had two options. Subsequently, subjects were asked to form the plural of these words.

(7) Elicitation of singular nonce words:

Vorrei un x.  
I would like an x.

Elicitation of plural nonce words:

Vorrei due x.  
I would like two xs.

### 4.2 Results

Although placement of stress differed from subject to subject, speakers behaved consistently, maintaining for the plural form the same stress pattern they had chosen for the singular. The variation between speakers allows the experimenter to make sure that the choice to palatalize does not depend on properties of the word itself but the stress pattern the subject decides to assign it.

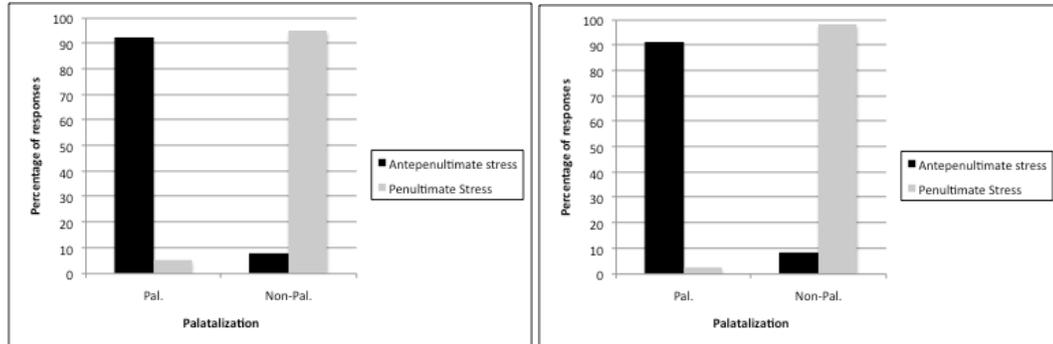
Unlike what was found by Krämer, most speakers of Italian productively applied palatalization in masculine plural words whose roots end in a velar consonant, only if they had decided to put the main stress of these words on the antepenultimate syllable. Therefore, there was variation among subject as to where the stress was placed, but no departure from the stress-generalization. The table below illustrates this result:

(8) Results from the nonsense word test (pooled across speakers):

	<b>Palatalizing?</b>	<b>Yes</b>	<b>No</b>
<b>Stress</b>			
Antepenult		24	2
Penult		4	75

As it appears from the graphs below, the distribution of palatalization as it emerges from this experiment patterns very much like the distribution found in the lexicon of the contemporary language.

(9) Comparing Results: Nonce Word Test      Corpus Study



The results of this experiment support the hypothesis that palatalization is not unpredictable in the modern Italian, and that its distribution depends on the position of main stress. Just as it emerged from the corpus study, the speakers' productions in the plural formation of nonce words show that palatalization is a synchronically active process in the language. Data from the vast majority of the speakers presents the correlation between prosodic structure and palatalization hinted at by Dressler (1985). One speaker only never applied palatalization, but this should not be taken as evidence that the rule is not very productive. Zuraw (2000) notes that it is frequent for subjects to apply a phonological rule in a nonce word test less than in the lexicon of their language; the same speaker.

#### 4. Why should stress matter?

In this section, I try to answer the following questions, which spontaneously arise from the facts discussed above: what is the nature of the link between the position of the velar consonant with respect to main stress? Why should such a connection determine the distribution of palatalization in Italian?

##### 4.1 Background

Guion (1996) investigated the perceptual roots of velar palatalization. Based on acoustic and perceptual analyses, the author concludes that the change from /ki/ to /tʃi/ occurs because the acoustic resemblance between the velar stop and the palatoalveolar affricate when they occur before a palatal vowel, which causes a process of perceptual reanalysis by the speaker/hearer (cf. Ohala 1994 and Wilson 2006).

(10) From Wilson (2006): Table 2

Table 2. Confusions of velars and palatoalveolars (adapted from Guion 1998).

Stimulus	Response							
	[ki]	[tʃi]	[gi]	[dʒi]	[ka]	[tʃa]	[ga]	[dʒa]
[ki]	43	35	10	12				
[tʃi]	10	85	0	5				
[gi]	4	4	71	21				
[dʒi]	9	28	12	51				
[ka]					84	13	3	0
[tʃa]					10	87	0	3
[ga]					4	0	87	9
[dʒa]					2	23	10	65

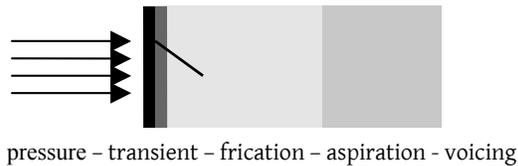
An immediate problem arises when trying to extend the general claim made by Guion to account for the distribution of velar palatalization in Italian: the author shows that there is a strong acoustic and perceptual similarity between /k/ and /tʃ/ when they are followed by a high front vowel; nevertheless, our studies have revealed that in spite of this similarity, palatalization in Italian only occurs in antepenultimate stressed words, and it is almost never attested in penultimate stressed words.

#### 4.2 Contrast markedness

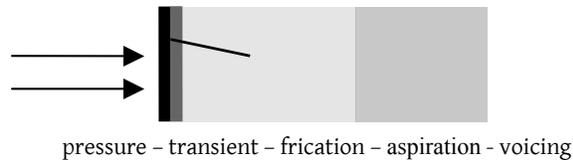
I propose that in Italian particular restrictions apply to the context in which the neutralization of the /ki/ - /tʃi/ contrast can obtain: compared to other languages (e.g. Late Latin), greater acoustic similarity between the velar and the palatoalveolar consonant is required in order for palatalization to be triggered. More precisely, I hypothesize that in immediately post-tonic position (e.g. CV.'CV.ki), the contrast between the two sounds is more perceptible than when the velar consonant is far from stress (e.g. 'CV.CV.ki). Given that less perceptible contrasts are more marked than more perceptible contrasts, and they are more prone to neutralization (Flemming 1995, 2006), only when they are far from stress do velar stops and palatoalveolar affricates neutralize. In immediately post-tonic position the contrast is distinct enough to be licensed, no palatalization occurs.

An acoustic study was conducted with the aim of investigating the effect of stress on the realization of velar stops. Following suggestions in Ladefoged (2004) and Imbrie (2005), I hypothesize that in the immediately post-tonic position, stress causes an increased pressure build-up behind the stop closure, which in turn results in a sharp burst and in a rapid fall in the frication intensity<sup>3</sup>. The fast change in the frication intensity characterizes stops in this particular prosodic position, and makes the sound very perceptually different from an affricate, where burst are generally very weak, and where frication is evenly spread during the transient and after it.

- (11) a. Rapid decrease in intensity between the transient and the frication after a stressed vowel (clear stop consonant):



- b. Gradual intensity contour and evenly spread frication noise between the transient and the frication phase, in a consonant far from stress (more similar to an affricate):



The hypothesis does not assume an increase in the intensity of the transient due to preceding stress; it only makes the prediction that the slope (i.e. rate of change) in the intensity contour will be steeper in the case of a stop consonant immediately following a stressed vowel.

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<sup>3</sup> For an extensive discussion of this point I direct the reader to Giavazzi (2008).

### 4.3 Production study and acoustic analysis

#### 4.3.1 Method

Two native speakers of Italian (age range 24-32; males) were recorded in a sound attenuated booth to collect the data for the acoustic analysis; they did not report any history of hearing or speaking impairment. The speech material consisted in 144 tri-syllabic pseudo Italian words containing the sequence –Ki- word-medially (K = /k/, /g/ and /t/ was used as a filler) and 72 pseudo Italian words containing the sequences –tʃi- and –dʒi-. The words occurred in a carrier sentence of the form “*He V pseudo-word PP*”; the verb was in the *passato remoto*, a past perfective tense which requires the inflectional suffix to be stressed (e.g. *portó* “carry-3PSg-passato remoto”), this choice was made to minimize the effect of secondary stress on the following pseudo-word. A schematic representation of the material is given below:

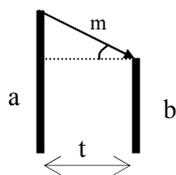
(12) Schema of the test stimuli:

	Velar segment	Voiceless velar /ki/	Voiced velar /gi/
pre-tonic velar		CV <sup>ˈ</sup> CVkiCV	CV <sup>ˈ</sup> CVgiCV
post-tonic velar		CVCV <sup>ˈ</sup> kiCV	CVCV <sup>ˈ</sup> giCV
far from stress velar		CVki <sup>ˈ</sup> CVCV	CVgi <sup>ˈ</sup> CVCV

One block contained three stress conditions in three pseudo-words formed by a permutation of the same 4 syllables. The material therefore contained 48 blocks with stop consonants and 24 blocks with the palatoalveolar affricates.

The recordings were converted into .AIFF sound files that were labeled and analyzed using PRAAT. The acoustic properties that were measured are burst and closure duration of the velar consonant, burst to closure ratio and slope of the intensity contour between the transient and the friction. The drawing below shows how the intensity slope was measured:

(13)



a = intensity value at the peak of the transient  
 b = intensity value at the first minimum of the friction  
 t = time interval between the peak and the minimum  
 m = slope

$$\text{where } m = \frac{a - b}{t} = \text{intensity slope}$$

#### 4.3.2 Results

An analysis of variance was conducted to look for an interaction between the rate of change of the intensity slope and the stress condition. The ANOVA indicated an effect of prosodic condition on the intensity contour (F(2,114), p<0.01): a steeper slope of the intensity contour was found in the release of a stop consonant that is preceded by a stressed vowel, compared to a stop that is far from stress. Between the two segments, stress had the biggest effect on the voiceless velar stop.

(14) Mean change rate of the intensity contour between the transient and the friction phase:

Segment	Condition:	m (slope)
K	far-from-stress (CVki <sup>ˈ</sup> CV)	- 1.345
	post-tonic (‘CVkiCV)	<b>-2.228</b>
G	far-from-stress (CVgi <sup>ˈ</sup> CV)	- 0.625
	post-tonic (‘CVgiCV)	<b>- 0.942</b>

A similar analysis could not be carried out for the affricates, since a clear transient was often not visible, and we could not detect a slope in the intensity contour. For the tokens which could be

measured the intensity slope was 0. Although a bigger study might reveal an effect of stress even in the realization of the affricate burst, this preliminary results suggest that the frication in affricates is homogeneously spread across the burst, without a sharp transient marking its beginning. The increased slope in post-stress position is therefore plausibly making the velar stop less similar to its affricate counterpart.

A further stress-effect was found across the board, both among the stops and the affricates: closure duration was systematically longer in post-tonic segments than in segments far from stress. The increase in closure duration did not cause an increase in the overall duration of the segment; the burst-to closure ratio was therefore bigger in the far from stress condition.

(15) Comparing burst-to closure duration

	<b>Stop consonants</b>	<b>Alveopalatal affricates</b>
Mean ratio "far from stress"	0.570	2.752
Mean ratio "post-tonic"	0.447	1.913

Contrary to the intensity slope, the analysis did not reveal stronger similarity between affricates and stops far from stress than in post-tonic position along the burst/closure dimension. Differences in burst/closure duration were found for both stops and affricates; they can therefore not be taken to be responsible for the distribution of palatalization.

4.3.3 Discussion

The acoustic analysis shows that the presence of immediately preceding stress has an effect on the realization of the stop consonant. More precisely, post-tonic velar stops have increased closure duration, and a more abrupt change in intensity into the frication than stops which are far from stress. Whereas the first effect cannot be responsible for the palatalization of far from stress velars in masculine plurals, I claim that acoustic properties of the transient such as the slope of the intensity contour determine the distribution of palatalization in the language.

In spite of the fact that intensity slope could not be measured exactly in palatoalveolar affricates, careful examination of the spectrograms revealed that a clear burst is missing very frequently, and that when it is present, the intensity slope is 0. On the one hand, the shallow slope observed in non-stress-adjacent velar stops makes the stops in this prosodic condition similar to an affricate: the contrast between the two sounds is marked and therefore prone to neutralization (i.e. palatalization). On the other hand, the effect of stress on immediately post-tonic velars enhances the contrast between velar stops and palatoalveolar affricates thereby licensing the contrast between the two sounds.

Given that palatalization perceptually driven (*inter alia* Guion 1996, Wilson 2006), a further study should be conducted to assess whether differences in intensity slope of the sort observed in our data are indeed perceptible to listeners. It is also plausible that further acoustic properties, such as the uneven distribution of frication in the burst, are also responsible of making post-tonic velars distinct from affricates. Future research will look into these two matters, which will hopefully complete the proposed account.

**5. Concluding remarks**

The paper analyzed the distribution of velar palatalization in Italian masculine plural nouns and adjectives. A corpus study showed that it is far from being unpredictable, and that its application is dependent on stress. As it emerges from the nonce-word experiment, speakers of Italian productively apply palatalization following the stress-generalization. Finally, the acoustic analysis of velar stops in different prosodic conditions revealed an acoustic basis for the link between velar palatalization and stress.

The distribution of palatalization is determined, I propose, by the specific acoustic realizations of stops in the different prosodic conditions, which trigger, or block the perceptually

driven change. Contrary to other languages, where palatalization before high front vowels occurs across the board, in Italian the process is restricted to apply only in those context, in which the absence of an adjacent stressed vowel reduces even further the perceptual distance between the velar stop and its corresponding palatoalveolar affricate. In post-tonic position, i.e. in penultimate stressed words, neutralization is blocked because the perceptual distance between the two sounds is large enough for the contrast to be preserved.

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