# Velar palatalization in Italian: Lexical stress induces resistance to sound change

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**Introduction:** Palatalization is the process through which a velar stop, /k, g/, is fronted to a palatal/palato-alveolar affricate or fricative. It applies more frequently before high front vowels than before other vowels. In Romance languages, the origins of this phonological process are to be found in Late Latin, since Latin did not have any palatal consonants in its earlier stages: this process is known as the 2nd Romance palatalization, and it occurred after the 5th century CE **[1,2]**. It occurred before all front vowels, both root internally and at the morpheme boundary, and independently of morpheme boundaries and stress position **[3]**. Palatalization of velars in contemporary Italian, instead, takes place at the boundary between the root and inflectional (or derivational) suffixes in /-i/. In masculine nouns and adjectives, palatalization before the plural ending /-i/ is predominantly stress-conditioned: it occurs in words with antepenultimate stress such as [ˈko.mi.ko] – [ˈko.mi.tʃi] 'comedian'-'comedians', while it is much rarer in words with penultimate stress such as [ka.ˈdu.ko] – [ka.ˈdu.ki] 'caducous'-'caducous *pl.*' **[4,5]**. The former case presents a stressed syllable FAR from the target of palatalization /k/, while in the latter the /k/ is directly POST-tonic. Whereas the perceptual and articulatory underpinnings of palatalization before high front vowels have been studied extensively **[6, 7]**, the phonetic bases of the stress-conditioned process are not well understood (cf. **[5]**). The aim of this study is to explore the articulatory (Basis1) and acoustic (Basis2) bases of this stress-conditioned process in Italian. In Articulatory Phonology, lexical stress is modulated by a tempo-spatial $\mu$-gesture **[8]**. We postulate that the resistance of POST /k, g/ to palatalize is related to the $\mu$-conditioned articulation of the stressed vowel directly preceding them. In POST, the $\mu$-conditioned stressed vowel introduces coarticulatory resistance between the following consonant and the final vowel, which in turn favors a plosive articulation (Basis1). The large opening gesture of the stressed vowel leads to a later target achievement of the following consonant, causing a longer closure duration. The resulting longer closure duration decreases the perceptual salience of the release with respect to the total duration of the consonant, which in turn favors a plosive categorization (Basis2).

**Method:** First, an ***acoustic study*** was conducted on 18 speakers. Target words were trisyllabic nonce words, structured /$C_1V_1.C_2V_2.C_3V_3$/, differing solely by the position of stress on the first or the second syllable (e.g., /ˈpi.ta.ki/, /pi.ˈta.ki/). The nonce words were designed to compare how the target consonants /k, g, tʃ, dʒ/ (in $C_3$ position) were produced in both FAR and POST contexts. The $V_3$ position is occupied by /i/. $C_1V_1.C_2V_2$ sequences were /pita/, /fesa/, /pufa/ /tipa/ and /suta/. For example, in the nonce words /ˈpi.ta.ki/ and /pi.ˈta.ki/, $C_3$ /k/ was in FAR and POST contexts respectively. The nonce words were written in their orthographic forms with lexical stress marked by an accent (e.g., pítachi, pitáchi). They were embedded in a carrier phrase "*Dimmi __ di nuovo*" and randomized. The 18 speakers repeated the word list three times, yielding 3328 tokens. Second, an ***articulatory study*** (EMA, AG501) is currently on-going. So far, we have recorded four speakers and we present one speaker here. The structure of the nonce words is the same as in the acoustic study, except that the $V_2$ position is occupied by both /a/ and /e/. They were embedded in a carrier phrase "*Pimpa parte da __ la mattina presto*" and randomized. More data will be available at the conference (aim: 15 speakers).

**Results**: The ***acoustic analysis*** of stressed vowels shows that the $\mu$-conditioned stressed vowels are more than twice as long ($\bar{x}$ = 185 ms, $\sigma$ = 45) as the unstressed ones ($\bar{x}$ =82ms, $\sigma$=29). GAMM analysis predicts that the shorter the unstressed vowel [a], the lower its F1 and the higher its F2 (Fig. 1). The analyses of $C_3V_3$ (e.g. [ki, gi, t͡ʃi, d͡ʒi]) in both conditions show that $V_3$ could not be responsible for the blocking of velar palatalization as it has virtually the same acoustic characteristics in both FAR and POST conditions. However, $C_3$ has longer closure duration in

POST compared to in FAR. The preliminary ***articulatory analysis*** based on one speaker shows that the $\mu$-conditioned vowel has longer and larger tongue body movement (Fig. 2). The trajectory from $V_2$ to $V_3$ (i.e. [a-i], [e-i]) is significantly different in POST and FAR. Even when normalizing the duration from $V_2$ to $V_3$, target achievement of $V_3$ is observably earlier in FAR than in POST.

**Discussion:** The articulatory results suggest that the stressed vowel causes resistance to the coarticulation between the following consonant and the final vowel, supporting Basis1. As shown in Fig 3, the $\mu$-conditioned vowel has longer and larger gestural activation intervals (compare $a \rightarrow e$, to $a \rightarrow c$). More importantly, the $\mu$-conditioned vowel has spillover effects on the following consonant and vowel gestures **[9]**: the upcoming gestures are expected to have larger displacements, which in turn results in a delayed maximum constriction of [i], as can be seen in Fig. 2. The acoustic results confirm that the closure duration is modulated by the position of stress, which may serve as the acoustic grounding for Basis2.

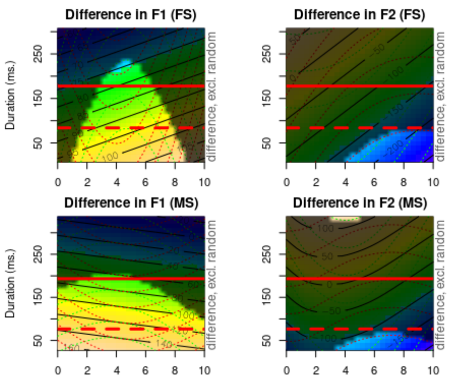


Figure 1. Difference between stressed [a] and unstressed [a] over time (x-axis) modulated by duration (y-axis). The shaded region indicates the area where the difference is non-significant. The red solid and dashed lines indicate the mean duration of stressed and unstressed [a] respectively. FS and MS are for female and male speakers respectively.

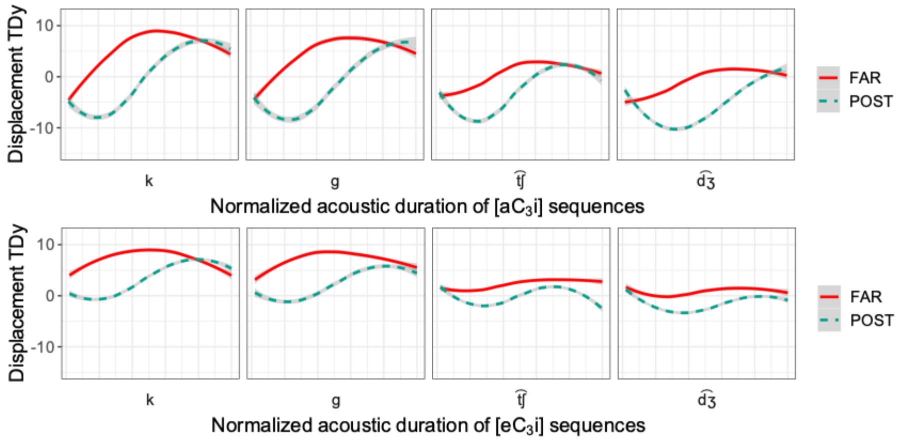


Figure 2. Tongue dorsum displacement trajectory of $V_2C_3V_3$ in y-axis according to stress conditions. Red solid lines represent trajectory when stress is FAR from $C_3$, green dotted lines represent POST stress $C_3$. X-axis represents normalized duration from the acoustic onset of $V_2$ ([a] and [e]) to the acoustic offset of $V_3$ [i].

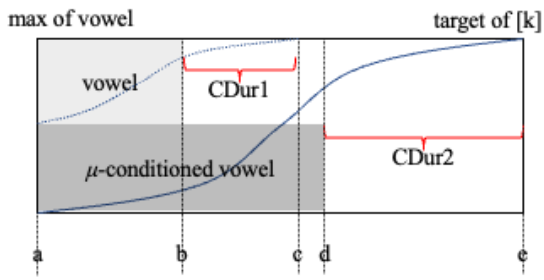


Figure 3. Schematic representation of $\mu$-conditioned/normal vowel and following [k]. The height/width of the boxes represent tongue dorsum displacement/release duration; the blue lines represent the tongue dorsum trajectory in y-axis; the gray boxes represent the second half of the acoustic duration of concerned vowels.

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