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Durational effects of boundaries in Italian fricatives

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Abstract

We examine durational effects in Italian word-initial fricatives – singleton [f], [s] and fricatives in the clusters [fr], [sp], [sk] – as a function of two positional factors: position with respect to stress (including the context of raddoppiamento sintattico – RS) and position relative to an Intonational phrase (IP) boundary. Results show that word-initial fricatives are longer the closer they are to the main stress syllable of the preceding word, in keeping with RS. Fricatives are shorter in IP-initial position than in non-IP-Initial, in keeping with increased consonanticity in domain-initial position. An interaction between the two factors shows that word-initial fricatives lengthen only when non-IP-initial, confirming the fact that RS is blocked in the presence of an IP boundary. We discuss the implications of the results for the linguistic use of segmental duration.

Keywords: fricative duration, raddoppiamento sintattico, cluster, initial boundary, stress

1. Introduction

The linguistic role of duration in Italian is quite extensive. As in many languages, vowel duration is the primary cue to lexical stress in Italian (Bertinetto 1980). Phrase-final vowel lengthening is documented in several varieties of Italian (D'Imperio & Gili-Fivela 2003; White, Payne, Mattys 2009). It has also been suggested, on the basis of articulatory data (Gili-Fivela et al., 2008, 2011), that consonant duration may signal stronger (IP) prosodic boundaries in Italian.

At the lexical level, consonant duration encodes lexical contrast intervocalically, between singleton and geminate consonants: *pala* 'ball' vs. *palla* 'shovel' (Bertinetto & Loporcaro 2005; Payne 2005). In addition, more subtle language-specific effects seem to ride on this phonemic length distinction. Non-local temporal adjustments have been found to affect the onset consonant in the syllable preceding a geminate vs. singleton consonant. Turco & Braun (2016) thus showed that the initial [p] in *palla* preceding the geminate, is significantly longer than the initial [p] in *pala* preceding the singleton. At the same time, [p] in *palla* is significantly longer than [p] in palco 'stage', ruling out a syllable structure effect.

At the post-lexical level, consonant duration is involved in implementing *raddoppiamento sintattico* (henceforth RS), a well-studied phonological process attested in Southern and Central Italian varieties (Chierchia 1986; Repetti 1991; Bertinetto & Loporcaro 2005, among others), whereby a word-initial consonant is geminated after a word-final stressed vowel. RS occurs when two stressed syllables are adjacent within a phonological phrase, as in [ˈtre ˈ**kː**aːse] 'three houses', or when they are separated by at most one unstressed syllable, as in [parˈlɔ **lː**aˈtiːno] 'spoke Latin'.

2. The present study

We examine durational effects in Italian word-initial consonants as a function of two positional factors: position with respect to stress and with respect to an Intonational phrase (IP) boundary. We ask to what degree native speakers of RS varieties of Italian show durational differences in their speech patterns both in relation to RS as a function of proximity to stress, and as a function of their position with respect to an IP boundary (initial or non-initial in the IP). RS is known to be blocked by an IP boundary. Evidence for IP as a major prosodic boundary in Italian is based on Grice et al. (2005), D'Imperio & Gili-Fivela (2003).

We test the following hypotheses:

H1: Consonant duration varies with respect to both stress and IP position.
In RS varieties of Italian, we expect, under H1, longer duration when the consonant is closer to a preceding stressed syllable (ˈσ#ˈ**σ**), than when it is further away from the preceding stress (ˈσσ#ˈ**σ**), based on Marotta (1986) and Payne (2005). We also expect longer duration in IP-initial position relative to non-IP-initial, based on Cho & Keating's (2001) finding for acoustic stop closure duration in Korean. In Italian we expect to find such a difference only when the word-initial fricative is further away from stress.

H2: Alternatively, consonant duration varies only as a function of stress.
In RS varieties of Italian, we expect, under H2, longer duration when the consonant is closer to a preceding stressed syllable than when it is further away, but no differences in duration between IP-initial and non-IP-initial positions.

We tested the hypotheses through a systematic comparison of consonant duration with respect to word stress position and with respect to IP boundary. The consonants we examined are the singleton onset fricatives [f], [s] and the fricatives in the onset clusters [fr], [sp], [sk]. Proximity to stress was varied by varying the stressed syllable of the preceding word – final or penultimate.

3. Methods

3.1. Data and participants

The experimental data consist of sentences where the same consonant occurs in four different conditions (see Table 1). We paired sentences where the test word is preceded by a word with final or penultimate stress with the same word in IP-initial and non-IP-initial positions. In the final stress condition, the consonant is both preceded and followed by a stressed syllable: [assadˈ**ʤɔ** ˈ**faː**ve] 'tasted broad beans'. The sentence contains a simple past verb with final stress ([assadˈʤɔ]) followed by a consonant-initial word with initial stress ([ˈfaːve]). In our experimental material, this example type illustrates the RS environment.

Table 1: *Example of experimental material in the four test conditions*.

	C in non-IP-initial position	**C in IP-initial position**
Final stress on word$_1$	*Quando era piccolo, Marco* [assadˈ**ʤɔ** ˈ**fa:**ve] *e lenticchie.*	*Quando era piccolo, di legumi Marco ne* [assadˈ**ʤɔ**]. [ˈ**fa:**ve] *e lenticchie non gli sono mai piaciute.*
Penultimate stress on word$_1$	*Quando era piccolo, Marco ha* [assadˈ**ʤa**to ˈ**fa:**ve] *e lenticchie.*	*Quando era piccolo, di legumi Marco ne ha* [assadˈ**ʤa**ti]. [ˈ**fa:**ve] *e lenticchie non gli sono mai piaciute.*

In the penultimate stress condition, the consonant is only followed by a stressed syllable. The same sentence contains a past tense verb with penultimate stress, followed by the same stress-initial word: [a assadˈʤato ˈfa:ve] 'has tasted broad beans'. Within each of these two stress conditions, the verb+noun combination was further manipulated to contrast the presence vs. absence of IP. We thus have a sentence with one verb phrase (non-IP-initial position: [assadˈʤɔ / a assadˈʤato ˈfa:ve ɛ lenˈtikkje]) or two separate clauses (IP-initial position: [ne assadˈʤɔ / ne a assadˈʤati]. [ˈfa:ve ɛ lenˈtikkje]).

Eight Italian native speakers (5 female) aged between 25 and 45, participated in the recordings. All were speakers of RS varieties of Italian: four speakers were from Rome, one from Florence, two from Naples, one from Marsala, Sicily. They signed informed consent forms, and received payment for their participation. The sentences they recorded were presented in two blocked lists, in a pseudo-randomized order.

3.2. Analysis

The recordings were made in a sound-attenuated booth, directly on a laptop computer (44.1kHz, 16 Bit), using a cardioid condenser microphone (Audiotechnica ATM33a) and a Roland Quad Capture audio interface. The recordings were automatically annotated with SPPAS (Bigi 2015), then checked for alignment errors in Praat (Boersma & Weenink 2018). Fricative duration was determined by frication noise.

Statistical analyses were based on linear mixed-effects models (Bates *et al.* 2014) using the R software (R Core Team) and the lme4 package (Bates *et al.*, 2015). We modelled the duration of the initial consonant (in ms) as a function of the following fixed effects: stress position (final vs. penultimate) and IP position (initial vs. non-initial). For the random effects, we modelled intercepts for speaker and item. A similar model was performed to test the effect of consonant type on the fricative duration in words located in non-IP-initial position. By-speaker and by-item random slopes for each of the fixed effects were also included. We obtaind *p*-values on the basis of *Satterthwaite* approximations through the *lmerTest*-() function (Kuznetsova *et al.* 2013). The threshold value was set to $p<.05$. Likelihood ratio tests as implemented in the *anova*()-function were performed to check main effects of each fixed factor and interactions. We performed a posteriori analysis of contrasts using *lsmeans*()-function from the library "emmeans" (Lenth *et al.* 2018) with Tukey's *p*-value adjustments.

4. Results

The model revealed a main effect of stress: the duration of the initial fricative was significantly longer when preceded by a word with a final stressed syllable than when preceded by a word with a penultimate stressed syllable (β=38.97; SE=3.47; *t*-value=11.2, $p< .0001$).

A main effect of IP position was also found, although in the opposite direction of the one found in Korean stops: the duration of the initial fricative was significantly longer in non-IP-initial position than in IP-initial (β=15.69; SE=6.49; *t*-value=2.41, $p< .05$). An interaction was found (see Figure 1), confirming the fact that an IP boundary blocks RS. As expected, in the non-IP-initial position, compared to the IP-initial, the fricative was significantly longer when preceded by a word with a final stressed syllable than by a word with a penultimate stressed syllable (β =36.33; SE=4.09; *t*-value=8.86, $p< .0001$). In sum, the stress-based difference in fricative duration is larger for the non-IP-initial context (the data in Table 1, left column) than for the IP-initial context (Table 1, right column).

Moreover, within the IP-initial context, there is no difference in the duration of the initial fricative between the two stress positions, final vs. penultimate (p=.6). Overall, the fricative is significantly longer only when located in non-IP-initial position, for both stress conditions (final: β=29.13, SE=7.78; *t*-value=3.74, $p<.05$; and penultimate: β=31.74, SE=8.41; *t*-value=3.77, $p<.05$).

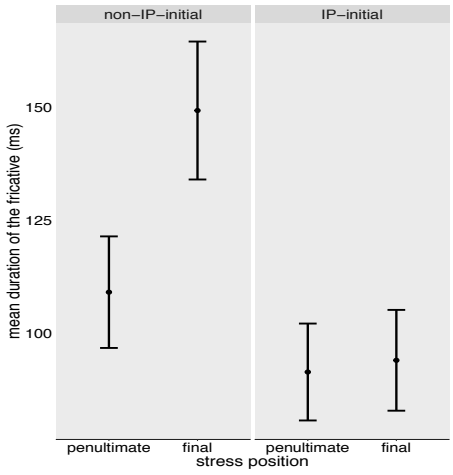


Figure 1: *Mean fricative duration as a function of stress position (penultimate vs. final) and IP position (initial vs. non-initial).*

We now turn to the results in non-IP-initial condition only, to test the type of consonant that undergoes RS. We look at the effect of stress condition on the type of word-initial fricative (Figure 2). The model revealed no main effect of stress condition (p=.2) and an effect of consonant type on duration ($\beta_{[fr]cluster}$=29.70, SE=7.90, *t*-value=3.75, $p<.01$; $\beta_{[sC]cluster}$=44.03, SE=11.83, *t*-value=3.72, $p<.01$). There was furthermore an interaction between stress position and consonant type, confirming earlier findings: compared to [s] in the [sC] clusters, singleton fricatives [f],[s] and the fricative in the cluster [fr] are significantly longer ($\beta_{singleton*final}$=29.83, SE=5.02, t-value=5.93, p<.0001; $\beta_{[fr]cluster*final}$=36.86, SE=5.82, t-value=6.32, p<.0001) when preceded by a word with final stress than by a word with penultimate stress.

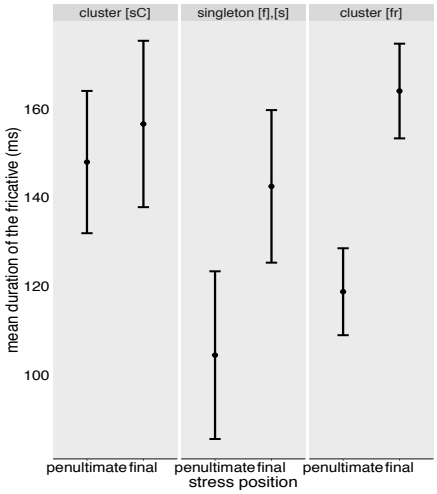


Figure 2: *Mean fricative duration as a function of stress position (penultimate vs. final) and type of consonant (singleton [f], [s], cluster [fr], cluster [sC]) in non-IP-initial position.*

The same pattern is shown in Figure 3 illustrating the mean duration of the fricative (as a function of stress position and type of consonant in non-IP-initial position) for teh four tested central-southern Italian cities (Florence, Naples, Rome, Marsala).

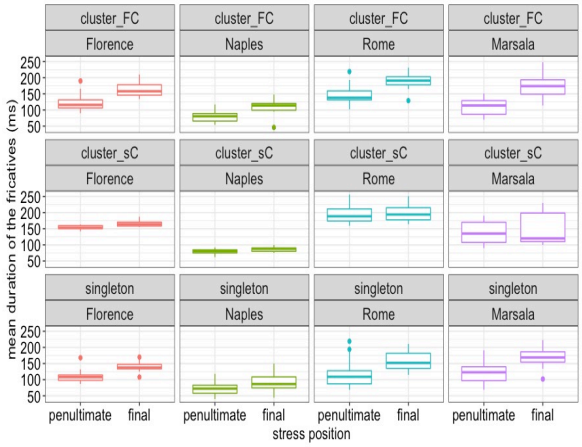


Figure 3: *Mean fricative duration as a function of stress position (penultimate vs. final) and type of consonant (singleton [f], [s], cluster [fr], cluster [sC]) in non-IP-initial position for each tested Italian city.*

However, preliminary comparisons of the stop duration in [sp], [sk] show that C_2 in these clusters is longer when preceded by a word with final stress (mean = 91.25 ms) compared to a preceding word with penultimate stress (mean = 59.5 ms).

5. Discussion and conclusion

The results support H2, confirming that longer duration signals proximity to stress (cf. Marotta 1986; Payne 2005). This was found for all onset types, singleton fricatives and fricatives in clusters, excepting [s] in [sC] clusters. This exception is fully consistent with the well-documented behavior of the so-called 'impure /s/' in Italian (see McCrary 2004). It is also consistent with the exceptional coordination pattern of such clusters by comparison with other types of onset clusters in Italian. Hermes et al. (2012, 2013) present robust evidence from kinematic (EMA) data that [s] in Italian [sC] clusters is syllabified differently from word-initial obstruent-liquid clusters, supporting the interpretation that the sibilant is not part of the onset. The authors specifically point out that the absence of [s] gemination in the RS context is consistent with the atypical coordination patterns they found between consonantal and vocalic gestures, that depart from the coordination pattern of an onset cluster across languages.

Contrary to expectations for strong domain positions, we did not find IP-initial lengthening, even outside the context of RS. However, domain-initial strengthening refers to the realization of segments with stronger articulations – understood as an increase in consonantal constriction – after a higher than a lower prosodic boundary (Fougeron & Keating 1997, and for a review, see Cho 2016). Our finding, that fricatives are actually significantly shorter in IP-initial position, is in fact consistent with a stronger consonantal articulation in this position. Nasals, for example, have been reported to be acoustically shorter in utterance-initial position (Cho & Keating 2001, Fougeron & Keating 1997). Domain-initial strengthening is not necessarily correlated with lengthening. Initial consonants can be strongly articulated without always being longer. In Korean, stop closure duration was indeed longer in domain-initial position, but the acoustic duration of nasals, and their amplitude, decreased. This finding was interpreted as an enhancement of the consonanticity of nasals, which involves a decrease of their sonority by reducing degree of nasality (Cho 2016). In the case of fricatives, a stronger consonantal articulation involves a stop-like production by increasing the degree of constriction, but possibly also by shortening acoustic duration. Cross-linguistic processes of fortition include changes of fricatives to stops or affricates (Bybee & Easterday 2019). It is therefore not unexpected for fricatives to be acoustically shorter if they are produced more like stops in domain-initial position. Under this interpretation, our results, taken together with preliminary articulatory evidence from Gili-Fivela et al. (2008, 2011), support the presence of domain-initial strengthening in Italian, without lengthening. Italian fricatives in the RS varieties we tested are characterized by short duration in IP-initial position.

In our study, longer fricative duration was clearly produced in the RS context, consistently by all speakers. It has been suggested by McCrary (2004), D'Imperio & Gili-Fivela (2003), that longer duration in the RS context may be used to signal the local proximity relation within a verb or noun phrase. In our data the morphological structure was controlled for. All non-IP-initial examples include word boundaries across the same type of morpho-syntactic (verb + direct object) juncture. If fricative duration is indeed recruited to signal this type of linguistic structure, our results show that it is clearly modulated by position with respect to stress.

The proposal could be further considered in the context of recent findings by White *et al.* (2020), who showed that native Italian speakers rely on longer consonant duration as a perceptual cue to locate word boundaries in an artificial language learning task. Importantly, speakers did not rely on longer vowel duration in the same way. We note as a caveat that the participants in White *et al.*'s study are not speakers of an RS variety of Italian. Nevertheless, their findings are worth considering in trying to further understand the phenomenon of RS as a local effect modulated by the position of stress. As White *et al.* (2020) point out, Italian has lexically contrastive stress. Thus, even though word stress is predominantly penultimate, the location of prominence alone cannot constitute a reliable cue to word boundary. It can indicate the number of

lexical items, assuming that there is one prominent syllable per word, but the location of prominence alone will not necessarily signal where the word boundary is. There is one exception: the RS context. In this context, two prominent syllables are close enough to each other that a word boundary can be reliably hypothesized to fall between the two. In other words, the proximity of the stresses in and of itself may be a potential cue for word segmentation. If this reasoning is correct, it may seem unnecessary for the word-initial consonant to lengthen in this context. Since it does lengthen, we can hypothesize that it does so not necessarily in relation to word segmentation, but rather in relation to lexical access. Longer consonant duration word-initially in the RS context may facilitate the identification of the consonant, which in turn aids lexical access. As shown by Tagliapietra & McQueen (2010), durational information can serve different functions in speech comprehension, and in their study on Italian, consonant duration appeared to be more important for segmental identification than for word segmentation.

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