A note on the phonology and phonetics of CR, RC, and SC consonant clusters in Italian

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1. Introduction

Previous generative research on Italian phonology starting with Vogel (1982) and Chierchia (1986) has proposed that intervocalic consonant clusters are parsed into contrasting tauto- vs. heterosyllabic categories based on several factors: phonotactic restrictions on word-initial consonant sequences, syllable weight as reflected in the distribution of stress and the length of a preceding tonic vowel, the distribution of prenominal allomorphs of various determiners, and the application of syntactic gemination (*radoppiamento sintattico*). Based on these criteria, clusters of rising sonority (in particular stop plus liquid) fall into the tautosyllabic category while falling sonority clusters composed of a sonorant plus obstruent are heterosyllabic. Clusters composed of /s/ plus a stop display mixed behavior but generally pattern with the heterosyllabic group. In her 2004 UCLA Ph.D. dissertation, Kristie McCrary investigated corpus-external reflexes of these cluster distinctions with a psycholinguistic test of word division and measurements of the phonetic duration of segments (both consonants and vowels). Her results support some aspects of the traditional phonological analysis but call into question others. In this squib we summarize the literature supporting the traditional distinction among these clusters and then review McCrary's results. An important finding in McCrary's study was that stops in VCV and VCRV contexts (R = a liquid) were significantly shorter than stops in VRCV contexts. She observed that these contexts align with the distribution of geminates in Italian and proposed that singleton stops are significantly shorter in the VCV and VCRV contexts in order to enhance their paradigmatic contrast with geminates. We review this finding and then explore two consequences. First, we look at the distribution of the lenition found in the Tuscan dialects known as the *gorgia toscana* and see that it targets the shorter stops. Second, we introduce data from a pilot study of Brazilian Portuguese, which has phonotactic restrictions similar to Italian but crucially lacks the systematic contrast of singleton vs. geminates. The prediction is that the duration of the stops in these contexts should not differ systematically in the way reported for Tuscan. This prediction is confirmed.

2. Background

A stressed penultimate syllable in standard Italian is canonically analysed as bimoraic (Krämer 2009 and references). In the OT framework (Prince & Smolensky 2004), this generalization reflects the activity of the Stress to Weight constraint ("If stressed then heavy"). In an open syllable, the tonic vowel is lengthened to make the syllable heavy

and has been shown by a number of researchers to have significantly greater duration compared to the stressed vowel of a syllable closed by the first half of a geminate consonant. For example, in a study of seven Italian speakers D'Imperio & Rosenthall (1999) found a mean duration of 177 ms. for the stressed vowel of [fa.te] vs. 126 ms. for [fat.te]. On the other hand, word-final stressed vowels are barred from lengthening by a markedness constraint against final long vowels: *V:#. Following up on previous observations by Vogel (1982) and earlier literature, Chierchia (1986) showed that the bimoraic constraint for stressed syllables is satisfied in an alternative fashion for word-final vowels by geminating the initial consonant of the following word (*radoppiamento sintattico*): *città [pp]ulita* 'clean city' and *città [ss]anta* 'holy city'.

An interesting question that these analyses raise is just which consonant clusters count as closing the penultimate syllable and thereby bleed the vowel lengthening process as well as preventing stress from receding to the antepenultimate syllable by the Latin Stress Rule (see Section 3). Cross-linguistically the syllabic parsing of intervocalic consonant clusters is often guided by what are possible word-initial and word-final consonants and consonant clusters (Pulgram 1970, Steriade 1999). This strategy is based on the assumption that the word is exhaustively parsed into syllables, entailing that a word-initial consonant (cluster) occupies the syllable onset and a word-final consonant (cluster) occupies the syllable coda. As in most languages, a single intervocalic consonant parses as an onset with the following vowel in Italian. This generalization follows automatically in an OT grammar, given the constraints of Onset and No-Coda and the absence of any higher-ranking constraint to counteract a V.CV parse. The inventory of permissible word-initial (and hence syllable onset) clusters is largely controlled by the Sonority Sequencing Generalization discovered by 19th century scholars such as Sievers (1876) and resuscitated by Steriade (1982) and Clements (1990) and invoked by many other scholars since. According to this generalization, onsets rise in sonority and codas fall in sonority. By this criterion, a stop plus sonorant (liquid or glide) cluster is a valid onset while a sonorant plus stop cluster is not and hence the latter will parse with a syllable break in word-medial position. The one situation where the Sonority Sequencing Generalization breaks down in Italian is with SC clusters, which are possible word-initially (*spago* 'string', *stato* 'state', *scala* 'stairs') but are claimed to block tonic vowel lengthening, as seen in the data of (1) taken from Morelli (1999: 166-173).

1.	CV	fá:.to	'fate'	CC	fát.to	'fact'
		pé:.lo	'hair'		mán.to	'coat'
	CR	ká:.pra	'goat'	SC	vés.pa	'wasp'
		ré:.tro	'behind'		pás.ta	'pasta'
		sá:.kro	'sacred'		mós.ka	'fly'

An SC cluster also stands out in selecting vowel-final allomorphs for various prenominal determiners, as in the paradigm in (2) from Davis (1990).

2.	ponte	proposito	specchio
	il ponte	il proposito	lo specchio
	un ponte	un proposito	uno specchio
	quel ponte	quel proposito	quello specchio

nessun ponte	nessun proposito	nessuno specchio
'bridge'	'purpose'	'mirror'

Lastly, word-initial SC clusters differ from TR clusters in failing to geminate in the *radoppiamento sintattico* context (Chierchia 1986): *città [s]porca*, **città [ss]porca* 'dirty city' vs. *città [tt]riste* 'sad city'. This property has been explained by postulating that the [s] in SC clusters does not have the same phonological status as the stop of CR clusters and is licensed by a separate stipulation or at a higher level of prosodic structure as a syllable appendix. As a syllabically 'stray' consonant (Steriade 1982), the [s] of *sporca* can freely associate to the coda of the preceding stressed syllable to satisfy the bimoraic Stress to Weight constraint. But the onset consonant of *triste* requires the addition of an autosegmental association to the coda of the stressed syllable to create a geminate and hence close the tonic syllable.

3. Consonantal interludes and stress

Italian inherited the Latin Stress Rule according to which the accent fell on the penultimate syllable unless it was light, in which case stress receded to the preceding antepenultimate syllable if there was one. In the development of Italian from Proto-Romance, long vowels shortened when outside of a penultimate open syllable. This results in a state of affairs in which there is a tradeoff between phonemicizing stress and predicting length with a rule CV́. > CV́: or phonemicizing length and predicting stress with the rule CV: > CV́:. The latter interpretation was proposed by Saltarelli (1970) while the former is the view adopted by most of the later literature (e.g. Krämer 2009). From the latter perspective, stress is primarily penultimate in Italian. It can--but need not--recede to the antepenult if the penult is an underlying light syllable. A number of factors bias stress to the paroxytone or proparoxytone categories and these factors have been shown to play a role in novel word experiments (Krämer 2009, Burani et al. 2014). How do the three cluster types (CR, RC, and SC) behave with respect to the distribution of stress when they form the hinge between the penultimate and final vowels? The data of Table 1 below show our counts of the type frequencies for the locus of stress in trisyllabic verbs and nouns, respectively, taken from the stress-marked corpora of Delmonte (1999) and Thornton et al. (1997).

Table 1: Accent placement from two stress-marked corpora

Delmonte	verbs		Thornton	nouns	
	penult	antepenult		penult	antepenult
VCV	307	252		557	289
VCRV	7	4		8	10
VRCV	59	0		75	1
VSCV	30	0		57	0

The VCV structures counted in this table exclude geminates as well as palatal consonants such as [ʎ] (orthographic *gl*) and [ɲ] (*gn*) that pattern with geminates. Even when these factors are controlled for, there is a bias to penultimate stress in VCV structures. The rising sonority CR clusters are compatible with both antepenult and penult stress, while RC clusters uniformly make the syllable heavy and hence force the

word into the paroxytone class. CR clusters are much smaller in number and so the learner cannot make a reliable choice here just based on the statistics of the lexicon. See Appendix 1 for a list of these items. On the other hand, SC clusters uniformly make the syllable heavy and so there is consistency between stress and *radoppiamento sintattico* with respect to this cluster type. These generalizations are utilized by speakers in novel word experiments. For example, Krämer (2009: 185) reports that his subjects uniformly assigned penultimate stress to the nonce words *tapirco* and *grotulfo* while stimuli with all light syllables such as *frunaco*, *frudalo*, and *nalico* were more variable but displayed an overall bias to penultimate accent.

Table 2 below summarizes the various phonological factors that bear on the tauto-syllabic versus hetero-syllabic parses of the CR, RC, and SC clusters. The only inconsistency is in the unexpected licensing of the SC clusters at the beginning of the word.

Table 2: Phonological factors reflecting syllable parse

	V.CRV	VR.CV	VS.CV
SSG	✓	✓	✓
Initial cluster	✓	✓	*
Stress	✓	✓	✓
Allomorphy	✓		✓
Radoppiamento sintattico	✓		✓
Tonic length	✓	✓	✓

4. Phonetic duration reflexes

In reviews of the available data on the duration of tonic vowels in paroxytone structures, Vogel (1982) and later McCrary (2004) report that the most secure finding is a complementarity between the durations of the consonantal interlude and the tonic vowel. A geminate consonant is approximately twice as long as a singleton consonant and the tonic vowel is invariably shorter before the geminate than before the singleton, although the ratio varies quite bit. In addition, the tonic vowel is significantly longer than the following consonant in V.CV structures. These findings are summarized in Table 3 below.

Table 3: Average duration in milliseconds of tonic vowel and consonant interludes from Josselyn (1900), Parmenter & Carmen (1932), Fava & Magno Caldognetto (1976), and Vogel (1982)

	Josselyn	P & C	F & MC	Vogel
V.CV	260	200	207	130
V.***C***V	140	110		84
VC_i.C_iV	170	150	107	105
V***C***$_i$.***C***$_i$V	240	250		162

5. McCrary (2004)

McCrary utilized two different experimental methods to investigate behavioral and phonetic reflexes of the phonological contrasts in syllabification among the various types of post-tonic consonantal interludes. The first was a syllable break task in which 50 subjects were asked to divide an orally presented nonsense word into two parts. The word "syllable" was not used in the instructions and the subjects were trained on CVCV stimuli such as *Roma* and *Bari*, all of which were divided CV.CV. In the test trials, words with consonant clusters were introduced. The major findings are as follows. First, CL clusters (L = liquid) were parsed as tautosyllabic by 88% of the subjects versus only 8% for NC clusters and 5% for LC clusters—a significant difference both in terms of statistical reliability as well as magnitude. SC clusters showed much more variability and were not reliably distinguished from the baseline. These results are consistent with the phonological evidence distinguishing the CR and RC clusters (R = liquid) as tautosyllabic versus heterosyllabic. The subjects' uncertainty on how to divide SC clusters might reflect a conflict between the fact that SC appears as a well-formed word-initial cluster, suggesting a tautosyllabic parse, vis à vis its uniformly counting for weight with respect to the distribution of stress, motivating a heterosyllabic parse.

Another of McCrary's findings concerns the duration of the tonic vowel and the consonants occupying the interlude between the penultimate and ultimate vowels. The phonological evidence leads to the expectation that CR clusters should be associated with a longer tonic vowel than RC clusters, while SC clusters should occupy an intermediate position. This hypothesis is based on the assumption that syllable structure will be a primary determinant of phonetic duration—a legitimate expectation if the moraic structure of the syllable plays a major role in determining its phonetic duration, as suggested by the findings of Broselow et al. (1997). Of course, other factors such as the inherent durational properties of the individual segments may also be relevant.

To investigate this question, McCrary (2004) constructed the corpus of disyllabic nonsense words seen in Table 4 that held the vowel constant as [a] and systematically varied the consonantal interlude among the clusters of interest. Fifteen subjects residing in Pisa produced six repetitions of these items in the frame "non trovo la parola X nel dizionario".

Table 4: Nonsense words for tonic vowel duration from McCrary (2004)

Tauto C_1C_2 and CVCV stimuli		Hetero C_1C_2 stimuli	
CV́CRV	pápra, pátra, pákra	CV́RCV	párpa, párta, parka
CV́CLV	pápla, pátla, pákla	CV́LCV	pálpa, pálta, pálka
CV́CNV	pápna, pátna, pákna	CV́NCV	pánpa, pánta, pánka
CV́CV	pápa, páta, páka	CV́SCV	pápsa, pásta, páska
	pása, pána, pála, pára	CV́CSV	pápsa, páksa
		CV́CTV	pápta

In calculating the results, the first and last repetitions were discarded, leaving 1,851 tokens. Segmentation was based on the appearance/disappearance of high amplitude in the second formant of the vowel. By this criterion, the VOT associated with the voiceless stops was counted as part of the consonant. The corpus contains a CV.CV baseline for the expected longest duration but no CVCCV with a geminate as baseline for the expected shortest duration. The main findings of this part of McCrary's study are summarized as follows (see Table 5). First, while interludes beginning with a stop consonant (*pápsa*, *páksa*, *pápta*) were associated with the shortest tonic vowel duration as expected, there was essentially no significant difference in the duration of the tonic vowel between CV.CRV and CVR.CV structures (R = liquid). Second, the tonic vowel in CVS.CV structures was significantly shorter than in CV.CV structures but longer than in interludes starting with a stop, a finding that would be consistent with the conflicting evidence regarding the syllabic affiliation of SC clusters mentioned earlier. Third, the duration of the tonic vowel was significantly correlated with the duration of the entire consonantal interlude regardless of whether it was phonologically tautosyllabic or heterosyllabic. Indeed, the duration of the interlude proved more predictive of the duration of the tonic vowel than the tautosyllabic vs. heterosyllabic distinction. Finally, the particular consonants composing the interlude had a significant effect on the duration of the tonic vowel. The tap [r] was associated with a longer tonic vowel than the lateral [l], which in turn was associated with a longer tonic vowel than the fricative [s]. This point held true regardless of whether the consonant occupied either the first or second position in the interlude. In sum, it seems that the differences in the duration of the tonic vowel depended more on the particular consonants occupying the interval independent of their position in the onset or coda of the phonological syllable. At least this was true for the two liquids. Nasals at the beginning of the cluster were associated with a longer vowel compared to when they terminated the cluster.

Table 5: Duration of tonic vowel in various interlude structures

Test Category	Mean Stressed Vowel Duration (ms.)	Std. Dev.	Claimed Syllable Type
CV́.CV	186	34	Open
CV́.CRV	169	28	Open
CV́R.CV	167	28	Closed
CV́.CLV	158	27	Open
CV́N.CV	158	25	Closed
CV́L.VC	156	27	Closed
CV́S.CV	145	24	Closed
CV́.CNV	135	24	Open
CV́.C.SV	127	23	Closed
CV́C.TV	125	21	Closed

When viewed from the perspective of Broselow et al. (1997), one might propose that in the case of the SC clusters the coda [s] shares the second mora of the tonic syllable

with the nuclear vowel. Taking the CV.CV structure as a baseline, the duration of 145 ms for SC is approximately 3/4ths of 186 ms: 186/2 = 93 + 47 = 140. However, it is far from obvious how the behavior of the interludes containing a liquid consonant could be explained by judicious allocations of the moraic structure of the tonic syllable.

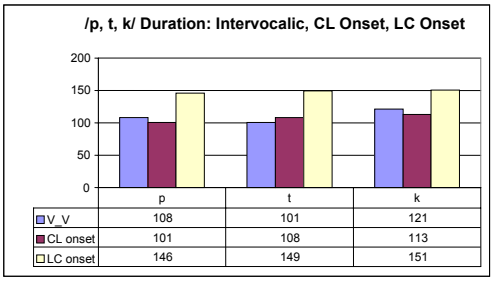
A second aspect of McCrary's study examined the duration of stop consonants in three positions: VCV, VCRV, and VRCV (R = liquid). Once again, nonsense words were utilized (Table 6). In this table, McCrary used L to stand for either liquid consonant.

Table 6: Nonsense words for measurements of stop duration (McCrary 2004:236)

	Onset – V_V	Onset - CV**C**LV	Onset - CVL**C**V
/p/	*pápa*	*pápra, pápla*	*párpa, pálpa*
/t/	*páta*	*pátra, pátla*	*párta, pálta*
/k/	*páka*	*pákra, pákla*	*párka, pálka*

Other things being equal, one might expect the stop to be shortest in the CVCLV contexts since it must share the syllable's onset with the following liquid under the CV.CLV parse. The surprising finding was that the stop in the simple VCV context was also significantly shorter in comparison to the stop in the VLCV structure, as shown in the chart of Table 7, where L = liquid.

Table 7: Duration of stops in various interludes (McCrary 2004:238)



McCrary insightfully connects this surprising distribution with another one in Italian phonology—namely, the positions where a geminate consonant is permitted. While a singleton-geminate contrast is possible in the VCV (*fato* vs. *fatto*) and VCRV (*te.atro* vs. *quattro)* contexts (R = liquid), no contrast is possible in VRCV contexts (*quarto* but **quartto*). In traditional terms, the geminate must span the syllable boundary and the overriding ban on complex codas blocks a VRC.CV parse. These requirements are active in the adaptation of word-final stops in loanwords, which are normally geminated and accompanied by an epenthetic vowel (*sud* > *sudde*); but gemination is blocked in *nord* > *norde* (Marotta 2008). McCrary sees the shortening of the stop in the VCRV (R = liquid) and especially the VCV structures of Table 7 as a manoeuvre by the phonetics to enhance the paradigmatic contrast between singleton and geminate consonants. Duration is of course the major cue to this contrast and so curtailing the duration of the singleton is an effective strategy to sharpen the difference between the two

consonantal categories. Recent research allows us to connect this distribution with another asymmetry in Italian phonology—the *gorgia toscana*.

6. Gorgia Toscana

The Tuscan dialects of Italian exhibit a lenition process known traditionally as the *gorgia* in which post-vocalic stops are realized as fricatives. The dialects differ in terms of which consonants are more likely to undergo the process. One secure generalization is that the process does not affect geminates. Marotta (2008) views the *gorgia* as a weakening process that reduces the articulatory pressure of the consonantal constriction gesture as well as the segment's duration. The canonical locations for the process are either simple or complex onsets (i.e. VCV and VCRV contexts). It does not apply after a consonant or word-initially after pause. The discussion of McCrary's study at the end of Section 5 suggests that the *gorgia* targets the stops with curtailed duration that stand in opposition to the geminates and may reflect an incomplete closure of the stop's constriction under increased time pressure. McCrary does not indicate whether or not her Pisan subjects spirantized any of their stops in her experimental results. According to Marotta (2008), the gorgia is primarily found with the velar stops in Pisa while essentially all stops are lenited in the Florentine variety. From a phonological perspective, the *gorgia* enhances the geminate-singleton opposition with a difference in manner of articulation—a common cross-linguistic phenomenon found in languages such as Berber (Saib 1974). A recent study by Ulfsbjorninn (2016) on the phonological behavior of different consonant clusters from the Government Phonology perspective reports data that corroborate our hypothesis that the *gorgia* targets the polarized short consonants. In particular, he finds that consonants which occupy the coda of the syllable when followed by an onset consonant (his "bogus" clusters) fail to lenite even though they are postvocalic. As Ulfsbjorninn observes, the failure of lenition in these contexts cannot be attributed to their status as loanwords since the *gorgia* is readily extended to borrowings and even applies in the same word containing a bogus cluster when its conditions are met, as in [at.lɛθɛ] 'athlete'. The data in (3) illustrate these points.

3. Lenition of postvocalic stops (Marotta 2008; Ulfsbjorninn 2016)

VCV	abete	[aβeθe]	'fir'	lago	[laɣo]	'lake'
CRV	capra	[kaɸra]	'goat'	magro	[maɣro]	'thin'
	la preghiera	[laɸreɣjɛ́:ɾa]	'the prayer'	i crackers	[ixrɛ́:xe(ɾ)]	'the crackers'
VRC	porta	[pɔrta]	'door'	largo	[largo]	'large'
VCC	atlete	[at.lɛθɛ]	'athlete'	ɛtna	[ɛt.na]	'Mt. Etna'

We don't have duration measures from McCrary for stops in coda position. But if the lenitions really are motivated by the reduced duration that enhances the singleton-geminate contrast, then the stops in the coda of words like *atlete* and *Etna* should be longer than the stops in the simple and complex onsets of words like *abete* and *capra*. In any case, even in the absence of such phonetic evidence, we can say that the *gorgia* targets precisely those stops that McCrary found to be polarized in duration with respect to the geminates: the intervocalic singleton VCV and the rising sonority VCRV.

7. Portuguese

The preceding discussion suggests that if a language lacks the singleton-geminate contrast then the motivation for the duration differences between stops in the VCV and VCRV vs. VRCV contexts found by McCrary for Italian will be absent. Moreover, the large differences in tonic vowel duration between VCV and VCCV structures should also be absent if the relatively short vowel duration before geminates is a cue to the geminate category. Finally, the relatively large differences between the duration of the tonic vowel and the following consonant in the simple CVCV structures seen in Table 1 should not be found if the vowel duration cues the singleton-geminate contrast in the following consonant.

In order to pursue these points, we recorded a corpus of 62 disyllabic words (see Appendix 2) from two female Brazilian Portuguese (BP) speakers from San Paolo (thanks to Suzana Fong and Karin Vivanco for sharing their language). BP lacks systematic geminates. Moreover, in its historical development from Proto-Romance, SC clusters underwent initial epenthesis in BP, as in Spanish. Thus, unlike in Italian, there is no conflict between the phonotactic distribution of these clusters and the fact that they are associated with penultimate accent. In other respects the two languages are similar in virtue of having inherited the same basic stock of vocabulary and the Latin Stress Rule (at least in nominals). The words in our corpus varied the consonantal interludes among the five types of interest (VCV, VCRV, VRCV, VSCV, and VCCV) and distributed the voiceless stops [p, t, k] evenly across the first three structures. The stressed vowel was predominantly [a]; in some cases a different vowel had to be used in order to complete the paradigm. Unlike in McCrary's study, we used existing words (all nouns) rather than nonsense words. The speakers were recorded in a sound-proof booth reading a randomized version of the list of the target words in both an isolation form as well as in the frame "*Eu não tô encontrando a palaura X no dicionário* "I can't find the word X in the dictionary". The data were analysed in Praat (Boersma and Weenink 1992-2017) with text grids delimiting the word and the individual phonemes. Segmentation followed the procedure used by McCrary (2004) by including VOT as part of the stop consonant. The duration measures were normalized with respect to the duration of the entire word in order to accommodate any differences in speech rate between the two speakers. To analyse the results, a series of regression analyses were run with word, speaker, and trial (repetition) as random factors and the five consonantal interludes as predictor factors. Here we report only the duration measures for the words as spoken in isolation. As far as the duration of the tonic vowel is concerned, the VCV structure served as the baseline. As seen in Table 8, it was significantly longer than in each of the other structures (using t = 2.0 as the baseline level of significance). However, multiple comparisons (Tukey) among the other clusters found no significant differences except for SC vs. RC (p = 0.03).

Table 8: Tonic vowel duration (normalized milliseconds)

	mean	Std error	t
VCV	322	15	
VSCV	294	13	-2.0
VCRV	274	14	-3.4

VCCV	262	6	-3.5
VRCV	252	13	-5.1

The second regression analysed the duration of the stop consonants in the various interludes. Once again VCV was the baseline. As seen in Table 9, the duration of the stops in the clusters were all significantly shorter than the baseline. Multiple comparisons (Tukey) found that the SC context was significantly shorter than CR and RC contexts but there was no significant difference between the latter two clusters themselves. Thus, just as in McCrary's findings with respect to Italian, the duration of the stop seems to be more affected by the consonant it is paired with in the interval (in our case the rhotic) rather than its position as onset or coda in the syllable.

Table 9: Stop duration (normalized milliseconds)

	mean	Std error	t
VCV	315	15	
VSCV	178	14	-9.5
VCRV	268	15	-3.2
VCCV	198	18	-3.5
VRCV	260	14	-6.4

The final regression compared the duration of the tonic vowel to the duration of the following consonant in the VCV structures. Recall from Table 1 that in Italian the consonant was noticeably shorter in this context compared to the tonic vowel. This was attributed to two factors: minimization of the duration of the consonant to enhance its paradigmatic contrast with a geminate and maximization of the duration of the stressed vowel in order to implement a bimoraic structure. Since BP lacks geminates, there is no particular motivation for the single intervocalic consonant to be significantly shorter than the tonic vowel. And in fact this is what our data reveal. The average duration of the tonic vowel was 323 ms and that of the consonant was 326 ms.

Table 10: Singleton consonant and tonic vowel duration

	mean	Std error	t
V***C***V	325	10	
VCV	323	4	-0.66

There was however a significant difference when the comparison was restricted to the stop consonants.

Table 11: Singleton stop consonant and tonic vowel duration

	mean	Std error	t
V***C***V	243	10	
VCV	288	3	14.00

However, the ratio between the duration of the tonic vowel and the intervocalic stop in BP is much smaller compared to what is reported in the earlier studies of Italian mentioned in Table 1 above and summarized in Table 12 below.

Table 12: Mean duration and ratio of tonic vowel to following stop

	Josselyn (1900)	P&C (1932)	Vogel (1982)	BP
V.CV	260	200	130	288
V.***C***V	140	110	84	243
ratio	1.85	1.81	1.54	1.18

We thus tentatively conclude that there is a linguistically significant difference between Italian and Brazilian Portuguese regarding the duration of an intervocalic stop in CVCV structures that can be explained by the hypothesis that the consonant is much shorter than otherwise expected in Italian in order to enhance its paradigmatic contrast with a geminate.

8. Summary and Conclusion

In this squib we reviewed the various phonological factors that converge on a tautosyllabic parse for intervocalic CR clusters versus a heterosyllabic parse for RC clusters in Standard Italian. For the most part, these factors also motivate a heterosyllabic structure for SC clusters. We then reviewed some the behavioral and phonetic experiments of McCrary (2004) which sought corpus-external confirmation for these structural differences. The results of a syllable-parsing task were largely consistent with the phonological distinctions while the duration of the tonic vowel failed to differentiate the tautosyllabic CR from the heterosyllabic RC interludes. We concluded with McCrary that the duration requirements of the individual consonants masked any differences that should have emerged from the putative syllabic structures. We then reviewed McCrary's other surprising finding from her study of Italian—namely that the duration of the stop in VCV interludes was significantly shorter than in VRCV interludes and comparable to its duration in onset-sharing VCRV structures. McCrary insightfully connected this finding to another asymmetry in Italian phonology—the distribution of geminate consonants. Geminates are permitted in intervocalic VCCV and rising sonority VCCRV clusters but are banned from falling sonority VRCCV clusters. McCrary views the shortening as an enhancement strategy to polarize the singleton's paradigmatic contrast with geminates. We followed up on this point with the observation that the *gorgia toscana* lenition process targets precisely the stops which stand in paradigmatic opposition to the geminates. Finally, we called attention to Portuguese, a language largely comparable to Italian save for the lack of a systematic singleton-geminate contrast. A small pilot study of two Brazilian Portuguese speakers did not find the large differences in the duration ratio of the tonic vowel to the following singleton consonant reported in earlier studies of Italian. This failure would be consistent with the absence of geminate consonants in this Romance variety, which in turn would remove any motivation for dramatically shortening a single intervocalic consonant and magnifying the duration of the preceding tonic vowel. A critical task for future research is to replicate McCrary's study with actual instead of nonsense words. Also, other dialects such as the Roman variety should be studied to establish the independence of the Gorgia lenition and the paradigmatic shortening of the intervocalic singletons.

Appendix 1 – Italian words with CR clusters

verbs		nouns	
proparoxytone	paroxytone	proparoxytone	paroxytone
calibro	massacro	palpebra	ottobre
integro	allegro	tenebra	massacro
arbitro	riciclo	vertebra	mezzadra
penetro	consacro	calibro	puledra
cronometro		cattedra	mezzadro
centimetro		anatra	puledro
millimetro		arbitro	psichiatra
		scheletro	aratro
			teatro
			manovra

Appendix 2 – Brazilian Portuguese disyllabic words

vaca	‘cow’	opta	‘opts’	certo	‘right’
lassa	‘weary’ (f.)	pacto	‘pact’	porca	‘dirty’ (f.)
pato	‘duck’	rapto	‘kidnapping’	carta	‘paper’
coca	‘coca’	táxi	‘taxi’	marco	‘landmark’
passo	‘step’	lapso	‘lapse’	barca	‘ship’
data	‘data’	acre	‘acrid’	parto	‘childbirth’
passa	‘raisin’	potro	‘colt’	surto	‘outburst’
caco	‘shard’	litro	‘litre’	arco	‘arch’
gato	‘cat’	cetro	‘sceptre’	basta	‘basta’
bata	‘blouse’	metro	‘metre’	casca	‘crust’
rapa	‘scrap’	ocre	‘ochre’	tasco	‘bit’
sopa	‘soup’	macro	‘macro’	casta	‘caste’
saco	‘bag’	sopro	‘puff’	casto	‘chaste’
mapa	‘map’	atriu	‘atrium’	vasto	‘vast’
classe	‘class’	lucro	‘profit’	raspa	‘shavings’
mata	‘forest’	sacro	‘sacred’	asco	‘disgust’
capa	‘cover’	parca	‘scanty’ (f.)	rasto	‘track’
paca	‘bloody’	corpo	‘body’	lasca	‘silver’
tapa	‘slap’	sorte	‘luck’	basca	‘Basque’ (f.)
massa	‘mass’	parco	‘scanty’	pasto	‘pasture’
				casco	‘shell’

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