Syllable Structure vs. Segmental Phonotactics:
Geminates and Clusters in Italian Revisited.

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This paper reports on research that seeks to determine whether individual native Italian speakers consistently treat consonant clusters as heterosyllabic vs. tautosyllabic in experiments involving two phonological phenomena which have received syllable based-analyses: *Raddoppiamento-Sintattico* (RS) and definite article allomorphy. The convergence of both RS and article allomorphy on the same syllable structure has been claimed to provide empirical verification for the success of the syllable-based analyses. However, experimental results show that while speakers vary in the choice of article allomorph before various consonant clusters (e.g. CN, CS), interpreted as variability in syllabification, comparable variability does not occur in the application of RS. An analysis of RS is proposed that draws on syllable-independent phonotactic constraints governing the context where geminates are permissible.*

1. Introduction

Constraints on syllable structure have been claimed to provide a unified analysis of two phonological phenomena in Italian (Vogel 1982, Chierchia 1982, 1986, Davis 1990, Repetti 1989, 1991, Marotta 1993, D'Imperio & Rosenthall 1998, Wiltshire & Maranzana 1998, Morelli 1999, Moren 1999).

1) *Raddoppiamento Sintattico* (RS): the gemination of a word initial consonant when preceded by a stressed vowel: e.g. *parló bene* → *parlób.bene* 'spoke well'.
2) Definite article allomorphy: the selection of the allomorph *il* vs. *lo* before various word initial consonant clusters: e.g. *il presidente* vs. *lo studente*.

* I would like to thank the members of the Linguistic Laboratory of the Scuola Normale Superiore in Pisa, Italy where the research for this paper was conducted: Maddalena Agonigi, Pier Marco Bertinetto, Lorenzo Cioni and special thanks to Barbara Gili Fivela for assistance in the design of the RS experiment. I am also grateful to Donca Steriade, Bruce Hayes and participants in the UCLA phonetics and phonology seminars for discussion and criticism that has led to considerable improvement in the content and presentation of this analysis.

The application of RS and the selection of the article allomorph are both claimed to reflect the syllabification of word initial consonant clusters in Italian. For examples, claimed tautosyllabic consonant clusters undergo RS while claimed heterosyllabic clusters do not (Vogel 1982, Chierchia 1982, 1986, Repetti 1989, 1991). The allomorph *il* precedes claimed tautosyllabic clusters while the allomorph *lo* precedes claimed heterosyllabic clusters (Davis 1990, Marotta 1993, Wiltshire & Maranzana 1998, Morelli 1999). The convergence of these two phonological processes on the same syllabifications appears to lend empirical verification to the syllable based analysis.

(1.)

Claimed Syllabification	Raddoppiamento-Sintattico		Article Allomorphy	
Tauto CC (e.g. CL)	**RS**	e.g. *cittá* ***ttri****ste*	***il***	e.g. *il* ***tr****eno*
Hetero CC (e.g. SC)	**NO RS**	e.g. *cittá* ***sp****orca*	***lo***	e.g. *lo* ***st****udente*

However, variability in the choice of definite article allomorph has also been reported. For example, some speakers prefer the allomorph *il* before CN[1] clusters [i.e. *il pneumatico*] while others prefer *lo* [i.e. *lo pneumatico*]. If the syllable-based analysis is correct, speakers who prefer *il* before CN will also apply RS to this cluster while speakers who prefer *lo* will fail to do so, as both phenomena are claimed to reflect syllabification.

This paper will compare the results of an RS experiment and an article allomorphy experiment in order to determine whether individual speakers consistently treat consonant clusters as either tautosyllabic or heterosyllabic across experiments. The main finding is that speakers are not consistent in their treatment of consonant clusters across experiments. In fact, inter-speaker and intra-speaker variability was found in the choice of article allomorph yet no variability was found in the application of RS. Therefore, one of the main advantages of the syllable-based analyses of RS and article allomorphy, the convergence of two phenomena on the same syllabifications, is not supported by the experimental data. Furthermore, the constraints on syllable structure claimed to account for RS and article allomorphy are shown to over predict the application of RS in Italian and the distribution of geminates in Italian and other languages. An analysis of RS is proposed that draws on syllable-independent phonotactic constraints governing the context where geminates are permissible

[1] The following abbreviations will be used throughout: C = obstruent, S = sibilant fricative, T = non-nasal stop, L = liquid, N = nasal, V = vowel

2. Standard Analysis of Italian Syllable Structure

The following summary reflects the general consensus reached in the literature on Italian syllabification (Vogel 1982, Chierchia 1982, 1986, Davis 1990, Repetti 1989, 1991, Marotta 1993, D'Imperio & Rosenthall 1998, Wiltshire & Maranzana 1998, Morelli 1999, Moren 1999). According to the standard analysis of Italian syllable structure, consonant clusters have the following claimed syllabifications in Italian[2]:

(2.)

a) Claimed tautosyllabic clusters: CL, CN
   e.g. *pa.dre, li.tro, i.pno.si*
b) Claimed heterosyllabic clusters: LC, NC, SC, CS, CT[3]
   e.g. *al.to, par.to, tan.to, pas.ta, lap.sus, naf.ta, ic.tus*

A further assumption of the standard anlaysis is that geminates must be heterosyllabic (Wiltshire & Maranzana 1998). The distribution of geminates in Italian appears to support this claim. For example, a geminate may occur between two vowels (e.g. 3.a.), or between a vowel and a following tautosyllabic consonant (e.g. 3.b). However, geminates are impossible word initially, since a heterosyllabic parse is not available (e.g. 3.c. and 3.d.)

(3.) **Heterosyllabic CC**

a)	$VC_1.\ C_1V$:	e.g.	*fat.to*	legal
b)	$V\ C_1.\ C_1LV$:	e.g.	*fab.bro*	legal
c)	$*\ C_1\ C_1V.CV$:	e.g.	**ttato*	illegal
d)	$*\ C_1.\ C_1V.CV$:	e.g.	**t.tato*	illegal

The standard analysis also assumes that Italian codas may contain at most one consonant. A consonant may precede any tautosyllabic cluster, such as CL (e.g. 4.a. and 4.b.), however, a consonant may not precede an obligatorily heterosyllabic cluster, as in the example in 4.c. which contains a geminate.

(4.) **1 Coda Consonant**

a)	$V\ C_1.\ C_2C_3V$	e.g.	*as.pro*	legal
b)	$V\ C_1.\ C_1C_2V$:	e.g.	*fab.bro*	legal
c)	$*V\ C_1\ C_2.\ C_2V$:	e.g.	**part.to*	illegal

[2] Cf. Davis (1990) and Wiltshire & Maranzana (1998) for the claim that these syllabifications follow from sonority distance and sonority sequencing.

[3] All analyses must make special provisions, such consonant adjunction, in order to account for utterance initial SC, CS and CT.

The strict application of the claimed constraints on syllable structure makes the following predictions regarding the distribution of geminates in Italian. If a consonant cluster is a possible onset (tautosyllabic), then the initial consonant of this cluster may appear as a geminate in post-vocalic position (e.g. 5.a). However, if a cluster is obligatorily heterosyllabic, neither consonant of the cluster may appear as a geminate since any parse would induce a violation of the 1CodaC constraint (e.g. 5.b. and 5.c.).

(5.) **Syllable-based Predictions**

a) For any tauto C_1 C_2, possible V C_1. C_1 C_2V: e.g. *fa<u>b.br</u>o*
b) For any hetero C_1 C_2, *VC_1C_1. C_2V: e.g. **pa<u>ss.t</u>a*
c) For any hetero C_1 C_2, *VC_1C_2. C_2V: e.g. **past.ta*

3. Standard Analysis of Raddoppiamento-Sintattico

According to the standard anlaysis, RS results from the interaction of constraints on syllabification and metrical structure in Italian (D'Imperio & Rosenthall 1998, Moren 1999). The process is claimed to be driven by the FootBinarity constraint stated in (6.), which is satisfied in Italian either by a syllable containing a long vowel or a syllable containing a coda consonant.(7.)

(6.) **FootBinarity (FtBin)**
Feet must be binary at either the mora or syllable level. (Prince and Smolensky 1993)

(7.) **FootBin satisfied in Italian**[4]: **CV:** or **CVC**

At the phrase level FtBin is claimed to be satisfied by RS, the gemination of a word initial consonant when preceded by a stressed vowel. Vowel lengthening cannot satisfy FtBin at the phrase level because it would violate a claimed constraint that prohibits word final long vowels in Italian, stated in (8.) (Vogel 1982, Chierchia 1982, 1986, Davis 1990, Repetti 1989, 1991, D'Imperio & Rosenthall 1998, Wiltshire & Maranzana 1998,Moren 1999). For example, in the sequence given in (9.) the initial word, *parló*, contains the monomoraic foot

[4]Word internally FtBin is claimed to be satisfied through open syllable vowel lengthening: CV -> CV: (Vogel 1982, Chierchia 1982, 1986, Davis 1990, Repetti 1989, 1991, Marotta 1993, D'Imperio & Rosenthall 1998, Wiltshire & Maranzana 1998, Morelli 1999, Moren 1999). See my forthcoming dissertation *Experimental Evidence for Syllable Structure in Italian*, for evidence that there is no syllable-dependent categorical vowel lengthening in Italian.

[*ló*]. FtBin is satisfied by the spreading of the initial consonant of *bene* into the empty coda position of the preceding stressed syllable.

(8.) ***Word-Final Long Vowel (*FinalLongV)**
Word-final long vowels are prohibited.

(9.) **Phrase Level Satisfaction of FtBin**
e.g. *par[ló] bene* → *par[lób].bene* 'spoke well'

The tableau in (10.) illustrates the relevant constraint ranking. Candidate 10.a., which contains a monomoraic foot, violates FtBin. Candidate 10.b. violates *FinalLongV. Candidate 10.c. violates the constraint requiring the alignment of the left edge of word boundaries with the left edge of syllable boundaries. The RS candidate, candidate10.d., violates the lowest ranked constraint and thus surfaces as the winning candidate.

(10.) **FtBin, *FinalLongV, Align-L (wd, σ) >> Dep-IO (C)**[5]

parló bene	FtBin	*FinalLong V	Align-L (wd, σ)	Ident [±long]
a. *par[ló] bene*	*!			
b. *par[ló:] bene*		*!		
c. *par[lób].ene*			*!	
d.☞ *par[lób].bene*				*

This same ranking accounts for the application of RS to tautosyllabic consonant clusters. The tableau in (12.) again illustrates the ranking assumed in the standard analysis. Candidates 12.a., 12.b. and 12.c. violate FtBin, *FinalLongVowel and Align-L (wd, σ) respectively. The RS candidate, 12.d., again surfaces as the winning candidate.

(11.) **Gemination of C_1 satisfies FtBin for tautosyllabic C_1C_2**
e.g. cittá triste → cittát.triste 'sad city'

(12.) **FtBin, *FinalLongV, Align-L (Wd, σ) >> Dep-IO (C)**

cittá triste	FtBin	*FinalLong V	Align-L (Wd, σ)	Ident [±long]
a. *cit[tá] triste*	*!			
b. *cit[tá:] triste*		*!		
c. *cit[tát].riste*			*!	
d.☞ *cit[tát].triste*				*

[5] Or alternatively *Mora[con], as proposed in Moren (1999)

However, FootBin is claimed to be satisfied by leftward re-syllabification of C_1 for heterosyllabic clusters, as in the resyllabification of /s/ in word initial SC cluster in (13.). The relevant constraint ranking is given in (14.). Candidate 14.a. violates *SC onset (the standard anlaysis assumes that SC is obligatorily heterosyllabic[6]). Candidate 14.b. violates both Hetero CC and 1CodaC. The candidate in which /s/ is resyllabified, candidate 14.c., violates the lowest ranked constraint, Align-L(wd,σ) and surfaces as the winning candidate.

(13.) **Resyllabification of C_1 satisfies FtBin for heterosyllabic C_1C_2**
e.g. *cittá sporca* → *cittás.porca* 'dirty city'

(14.) ***SC onset >> Align-L (wd, σ)**

cittá sporca	*SC Onset	Hetero CC	1CodaC	Align –L(wd, σ)
a. *cit[tás].sporka*	*!			
b. *cit[táss].porka*		*!	*	
c. ☞ *cit[tás].porka*				*

A summary of the syllable based constraints that are claimed to drive RS and the structures that they prohibit is given in (15.).

(15.) **Summary**

a)	Heterosyllabic Geminates	**cittáss.porca*
b)	1 Coda Consonant	**cittáss.porca*
c)	FtBin	**cit[tá] sporca*
d)	*FinalLongV	**cittá: sporca*
e)	*SC onset	**cittás.sporca*
f)	Align-L (wd, σ)	**cittát.riste*

4. Article Allomorphy

Definite article allomorphy, the selection of *il* vs. *lo* before various word initial sequences, appears to provide complementary evidence for the syllabification of consonant clusters. Again, allomorph selection is claimed to depend on the syllabification of the following consonant cluster. According to the standard analysis, "allomorph + noun" output forms are evaluated by the syllable structure constraints already shown to be active in the analysis of RS. As shown in (16.), the concatenation of *il* with a any following tautosyllabic consonant cluster does not violate the claimed constraints on syllabification.

[6] The syllable-based analysis must make further provisions for utterance initial SC clusters, e.g. consonant adjunction. *SC onset is therefore not undominated.

(16.) ***il* + claimed tautosyllabic CC (e.g. CL, CN)**

a)	*il.presidente*	satisfies 1 Coda C, CL onset
b)	*il.pneumatico*	satisfies 1 Coda C, CN onset

The selection of the article *il* before an obligatorily heterosyllabic cluster would violate syllable structure constraints such as *SC onset (e.g. 17.b.) and 1CodaC (e.g. 17.a). The selection of the allomorph *lo* before heterosyllabic SC permits leftward resyllabification of C_1 (e.g. 17.c.)

(17.) ***lo* + claimed heterosyllabic CC (e.g. SC, CS)**

a)	**ils.tudente*	violates 1CodaC
b)	**il.studente*	violates *SC onset
c)	*los.tudente*	satisfies *SC onset, 1 Coda C

5. Predictions of Syllable-Based Analysis

Overall, the syllable appears to be successful as a basic phonological unit in Italian under the standard analysis. Constraints on syllable structure appear to account for distribution of geminates, the application vs. non-application of RS to various consonant clusters and the selection of the definite article allomorphs *il* and *lo*. The syllable-based analysis also seems to provide a rationale for RS that captures the interaction of syllabification and metrical structure. Finally, the convergence of multiple phonological generalizations on the same syllable structure appears to provide empirical support for the standard analysis of Italian syllable structure.

However, there is reported variability in the selection of the article allomorph which has been interpreted as inter-speaker variability in the syllabification of consonant clusters (Davis 1990). For Example, some speakers prefer the allomorph *il* before CN clusters [i.e. *il pneumatico*] while others prefer *lo* [i.e. *lo pneumatico*]. If article selection does reflect syllabification then a speaker who selects *il* before CN prefers a tautosyllabic parse for this cluster while a speaker who selects *lo* before CN prefers a heterosyllabic parse. Since both RS and article allomorphy are claimed to converge on the same syllabifications it therefore follows that a speaker who selects *il* before CN, should also apply RS to this cluster while a speaker who selects *lo* will fail to do so. The predictions of the standard analysis are summarized in (18.).

(18.) **Predictions of Syllable-Based Analysis**

Syllab.	RS	Article Allomorphy
Tauto	**RS** applies (V $\underline{C_1}$. $\underline{C_1}$ C_2V possible) e.g. *cambió* ***p.pne****umatico*	Preceded by ***il*** e.g. ***il pne****umatico*
Hetero	**No RS** (*V$\underline{C_1}C_1$. C_2V) e.g. *cambió* ***p.n****eumatico*	Preceded by ***lo*** e.g. ***lo p.n****eumatico*

The strength of the standard analysis crucially depends on the empirical validity of the above stated predictions. Specifically, whether or not speakers consistently treat consonant clusters as either tautosyllabic vs. heterosyllabic across phenomena. In order to answer this question an RS experiment and an article allomorphy experiment were conducted at the Scuola Normale Superiore in Pisa, Italy. The results are presented in 6. and 7.

6. Raddoppiamento Sintattico (RS) Experiment

The purpose of the RS experiment was to determine whether individual speakers apply RS to CV, CL, CN, SC and CS sequences. Five native Pisan Italian speakers participated in the experiment. The test stimuli, listed in (19.), were words that contained various word initial consonant clusters. The subjects produced 6 repetitions of the target stimuli in carrier phrases for the –RS and +RS conditions, shown in (20). The first and last repetitions were discarded and the word final vowel, C_1 and C_2 of the remaining 568 total tokens were measured using waveforms and spectrograms.

(19.) **RS Stimuli**

Cluster	Stimuli
CV	patérno, sensíbile
CL	presidénte, plurilíngue, fratérno, flemmático
CN	pneumático
SC	sregoláto, sleále, snervánte, spiacévole, stimáto, scortése
CS	psicopático

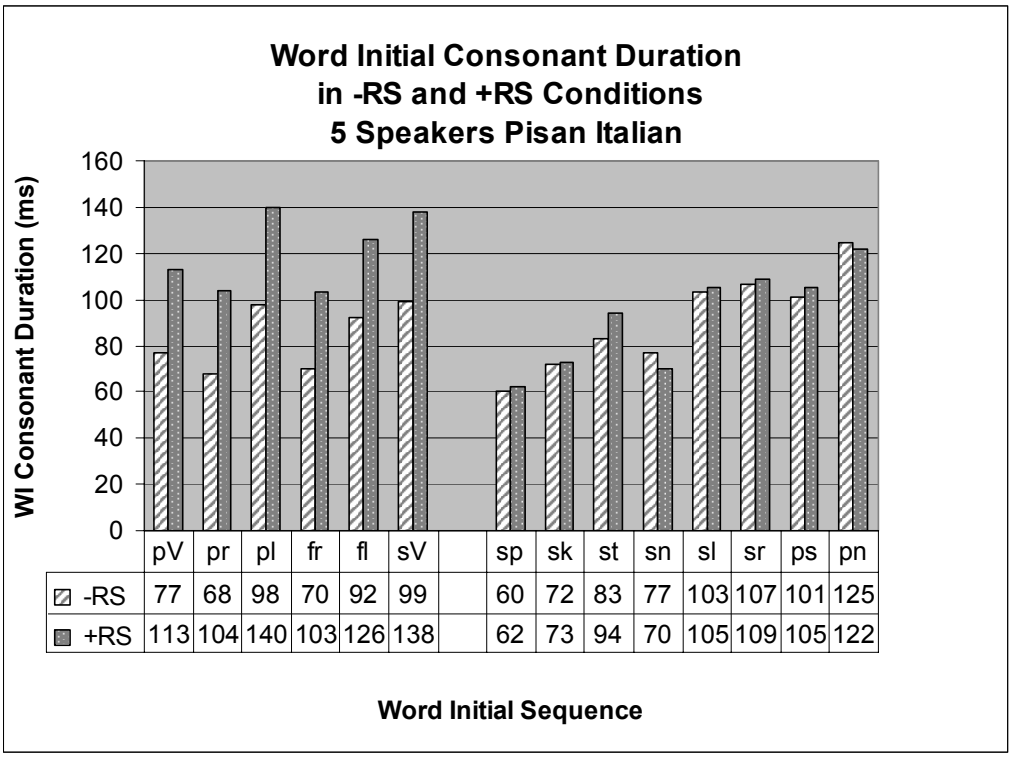
(20.) **Example Carrier Phrases**

a) - RS condition: *Io, divento **T**ARGET a questo punto.*
[*as for me, I become TARGET at this point.*]

b) +RS condition: *Lui, diventò **T**ARGET a questo punto.*
[*as for him, he became TARGET at this point.*]

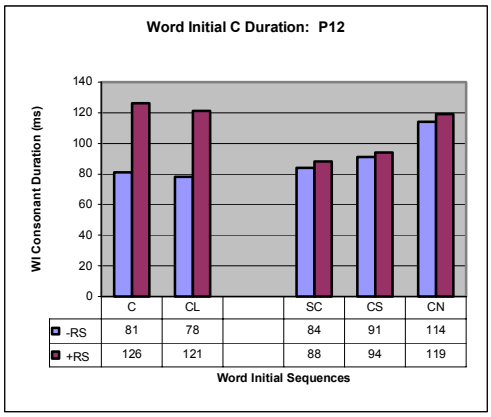
The finding of the experiment is that RS only affects CV and CL sequences. The table in (21.) reports the duration of the word initial consonant in CV and C_1C_2 sequences in the –RS and +RS conditions. The duration of C_1 in CV and CL sequences is reported in the columns on the left side of the table. The duration the word initial consonant of these sequences in the +RS condition (following a stressed vowel) is from 33 to 41 ms. longer than the duration of the same consonant in the –RS condition (following a unstressed vowel). The reported differences are all statistically significant ($p < .05$). The columns on the right side of the table report the duration of C_1 in SC, CS and CN sequences. The durational difference of the word initial consonant in the +RS and –RS conditions for these sequences is very small, from 2 to a maximum of 11 ms. and not statistically significant ($p > .05$). The graphs in (22.) present individual speaker results, which confirm to the pooled consonant duration findings. All 5 speakers apply RS to CV and CL sequences. None of the five speakers apply RS the initial consonant of SC, CS and CN clusters.

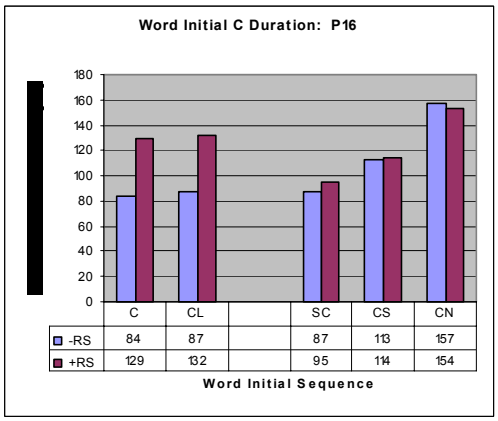
(21.)

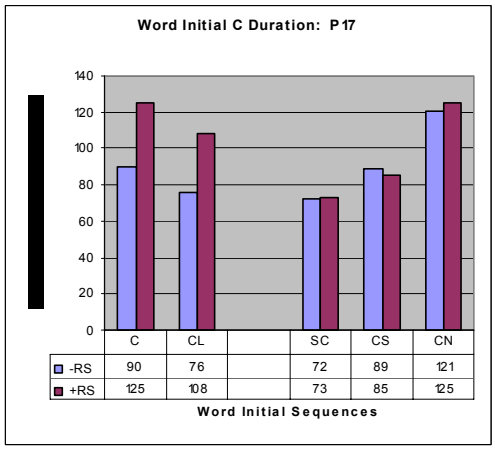


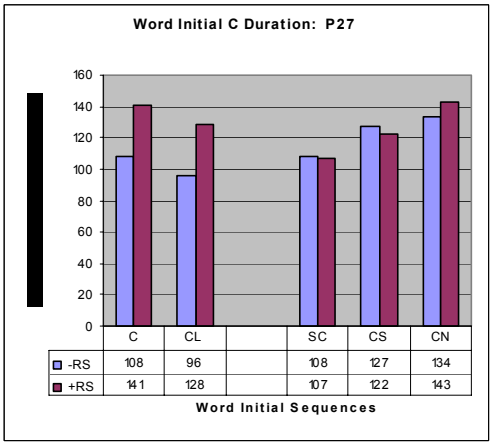
	pV	pr	pl	fr	fl	sV		sp	sk	st	sn	sl	sr	ps	pn
-RS	77	68	98	70	92	99		60	72	83	77	103	107	101	125
+RS	113	104	140	103	126	138		62	73	94	70	105	109	105	122

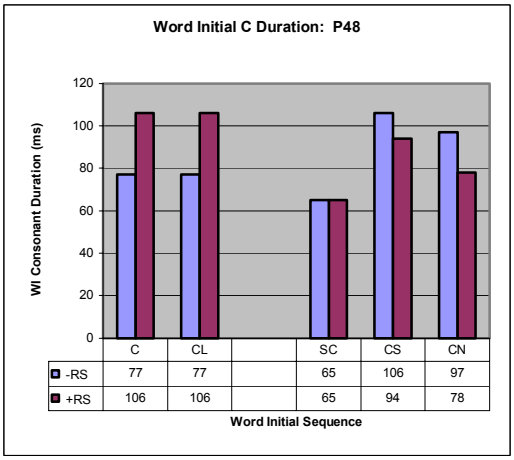
(22.) **Word Initial Consonant Duration by Subject**











If the application of RS reflects syllabification, then the tested sequences should have the following syllabifications for all five speakers:

(23.) **Hypothesized Syllabification**

Tautosyllabic:	CV, CL
Heterosyllabic:	CN, SC, CS

According to the predictions of the standard anlaysis, all five speakers should select the definite article allomorph *il* before CV and CL sequences and *lo* before CN, SC and CS.

7. Article Allomorphy Experiment

The same five speakers participated in a forced choice article allomorphy experiment in which the they were asked to choose *il* or *lo* before real and pseudo words beginning with various consonant clusters, such as *tréno*, *pneumático*, *psicólogo*[7].

(24.) **Word Initial Sequences**

C = p, t, k, f, s, l, r, m, n	count per subject = 48
CL = pl, kr, pr, tr, kr	count per subject = 20
CN = pn, kn	count per subject = 16
CS = ps, ks, ts	count per subject = 13
SC = sp, st, sk, sn, sm, sl, sr	count per subject = 22

The individual speaker results of this experiment are given (25.). All five speakers agree that the *il* precedes CV, CL and that the article *lo* precedes SC. However there is both intra-speaker and inter-speaker variation in the choice of allomorph before CN and CS clusters. For example P27 demonstrates a preference for the article *lo* before CS while all other speakers prefer *il*. The results for CN are less unanimous. P16 prefers *lo* before CN, P17 and P27 prefer *il,* and both P12 and P48 appear to be undecided. No significant difference between real and pseudo words was found for these speakers ($p > .05$)

[7] See my forthcoming dissertation "*Experimental Evidence for Syllable Structure in Italian*" for results for 50 Pisan speakers and further details of the experimental design.

(25.) **Article Allomorphy Results by Subject**

Subjects	**P12**		**P16**		**P17**		**P27**		**P48**	
	% il	% lo	% il	% lo	% il	% lo	% il	% lo	% il	% lo
CV	100	0	100	0	98	2	96	4	100	0
CL	100	0	95	5	100	0	100	0	100	0
CN	44	56	6	94	87	13	81	19	44	56
CS	0	100	0	100	0	100	38	62	7	93
SC	0	100	0	100	0	100	5	95	0	100

8. Comparison of RS and Allomorphy Results.

The table in (26.) presents the cross-experimental results that support the predictions of the standard anlaysis. For all five speakers CV and CL undergo RS and are preceded by the definite article allomorph *il*, in line with a tautosyllabic analysis of this cluster. For all five speakers SC fails to undergo RS and is preceded by the article *lo*. For four out of five speakers CS fails to undergo RS and is preceded by *lo*.

(26.) **Correct Predictions of Standard Analysis**

Initial Sequence	Raddoppiamento	Article Allomorphy
CV	+RS	*il*
CL	+RS	*il*
SC	-RS	*lo*
CS	-RS	*lo* [except P27]

Cross-experimental individual speaker results for CN are presented in the table in (27.) The application of RS to CN correctly predicts article selection for only one of the five speakers, subject P16, who selects *lo* before CN and also fails to apply RS to this cluster. All other results conflict with the syllable-based predictions. P17 and P27 select *il* before CN yet do not apply RS to this cluster. P12 and P48 select *il* or *lo* at chance before CN. According to the syllable-based interpretation, this result indicates that these speakers are undecided about the syllabification of CN. However, the same speakers consistently fail to apply RS to CN. In sum, neither inter-speaker nor intra-speaker variation in article allomorph selection before CN corresponds to variation in the application of RS to this cluster: CN fails to undergo RS for all five speakers, regardless of article allomorph preferences.

(27.) **Individual Results for CN Across Experiments**

		Allomorphy Results	RS Results
P12	CN	*il* = 44%; lo = 56 %	-RS
P16	CN	*lo*	-RS
P17	CN	*il*	-RS
P27	CN	*il*	-RS
P48	CN	*il* = 44%; lo = 56%	-RS

The cross-experimental comparison of results for CS partially confirms the syllable based predictions. Four out of five speakers prefer *lo* before CS and fail to apply RS to this cluster. However, subject P27 shows variation in the choice of allomorph before CS [38% *il*, 62% *lo*], but again, variation in the choice of allomorph does not correspond to variation in the application of RS for this speaker.

To summarize, the cross-experimental comparison of the results of the RS and article allomorphy experiments for CN and CS show that variability in the choice of allomorph never corresponds to variability in the application of RS. The predictions of the syllable hypothesis are not supported by the experimental data.

9. Limitations of the Syllable Based anlaysis.

Various problems with the standard analysis of syllable structure emerge when the empirical data is examined closely. The experimental data presented above shows that speakers do not consistently treat consonant clusters as either tautosyllabic or heterosyllabic across the RS and article allomorphy experiments. One of the main achievements of the standard anlaysis, the convergence of various phenomena on the same syllabifications, is not supported by the empirical data.

The second problem of the standard analysis is that the proposed constraints on syllable structure over predict the application of RS and the distribution of geminates in Italian. Again, the strict applications of the constraints on syllabification predict that for any tautosyllabic cluster, the first consonant of this cluster may occur as a geminate post-vocalically [2.(5.)]. However, CN is a possible syllable onset in Italian yet $VC_1.C_1NV$ is unattested in Italian, both word-internally and in the RS condition. The over prediction problem also occurs in the syllable based anlaysis of the distribution of geminates in other languages. For example, in Ancient Greek (Steriade 1982) and in Latin (Giannini & Marotta 1989) geminate consonants only

occur intervocalically. However, both languages allow tautosyllabic consonant clusters, such as CL. V C_1. C_1LV should be possible word internally in Ancient Greek and Latin because a heterosyllabic parse is available. Therefore, the Hetero CC over predicts the distribution of geminates for languages that have tautosyllabic consonant clusters but restrict geminates to intervocalic position.

The results of the RS experiment also cast doubt upon the empirical validity of the interaction of syllabification and metrical structure as the rationale for RS. According to the standard analysis, RS occurs instead of vowel lengthening in order to satisfy FtBin, thus preventing a violation of *FinalLongV. Duration data from the RS experiment, presented in (28.) show that word final stressed vowels are longer than word final unstressed vowels ($p < .05$). Word final stressed vowels **do** lengthen in Italian, both before consonants that undergo RS and consonants that fail to do so. In light of this new vowel length data, the interaction FtBin and *FinalLongV does not seem plausible as the structural rationale for RS.

(28.) **Word Final Vowel Duration: stressed vs. unstressed**

	V / __ CV, CL (RS applies)		V/ __ SC, CS, CN (No RS)	
- Stress V	35 ms.	*divénto presidénte*	44 ms.	*divénto stimáto*
+Stress V	66 ms.	*diventó presidénte*	74 ms.	*diventó stimáto*
Mean dif.	31 ms.		30 ms.	

10. Syllable-Independent Analysis

In this section a phonotactic analysis of RS will be presented that correctly accounts both for the distribution of geminates in Italian and the attested RS pattern.

Again, the experimental results suggest that the interaction of FtBin and *FinalLongV cannot be the structural motivation for RS (since word final stressed vowels **do** lengthen). An alternative rationale for RS remains to be identified. One possibility is the formulation of RS as a parochial constraint that serves to mark potentially ambiguous morphological word boundaries. The argument is as follows. Stress in Italian usually falls on the penultimate or antepenultimate syllable (e.g. 29.a. and 29.b.) A word final stressed vowel may result in an ambiguous morphological word boundary. The rationale for RS may be the demarcation a word initial sequences, functionally motivated by a preference for clear morphological word boundaries. This morphological RS constraint is formalized in (30.)

(29.) **Stress on the penult or antepenult in Italian**

a) Penult: e.g. *páne*
b) Antepenult: e.g. *líbero*

(30.)**Morphological[8] RS Constraint [+RS]**

In a sequences $word_1$ $word_2$, geminate C_1 of $word_2$ when $word_1$ ends with a stressed vowel.

In this syllable-independent analysis, the failure of RS to apply to certain clusters can be accounted for by phonotactic constraints on the distribution of geminates, without making reference to syllable boundaries. Again, the syllable structure constraints proposed in the standard analysis predict that if a consonant cluster is a possible onset, the initial consonant of the cluster may appear as a geminate in post-vocalic position. However, the standard analysis over predicts the distribution of geminates in Italian by allowing sequences such as V $\underline{C_1}.\ \underline{C_1}$ N_2V (e.g. *pap.pna*) which are unattested in Italian. A solution to this problem is the formulation of syllable-independent phonotactic constraints on geminates. The distribution of non-nasal stops in Italian is correctly accounted for by the constraint in (31.)

(31.) **TT/ in V__ [+son, +cont]**

Geminates may only occur after a vowel and before [+son, +cont] (before vowels and liquids)

This constraint correctly accounts for the distribution of geminates in Italian, banning word initial geminates (e.g. 32.a.) and geminates stops before a nasal consonants (e.g. 32.b.) yet does not suffer from the over prediction problem encountered in the standard analysis.

(32.)

a) Bans word initial geminate T: e.g. **tt*afo*
b) Bans Geminate T before N: e.g. **pakkno*
c) RS only applies to CV, CL: e.g. *diventó ppresidente*
**cambió ppneumatico*

The ranking of TT / in V __ [+son, +cont] above the morphological +RS constraint accounts for the restricted application of RS to CV and CL sequences.

[8] Morphological RS constraints are also necessary for the anlaysis of stressless monosyllables that induce RS (*a, da, e, fra, ma, ne, se, su, tra*) and the few paroxytones that induce RS (*cóme, dóve quálche*).

As illustrated in the tableaux in (33.) and (34.), the application of RS to CN or CS would violate the proposed phonotactic constraint.

(33.) **TT / in V __ [+son, +cont] >> +RS**

cambió pneumático	TT / in V __ [+son, +cont]	+RS
a. *cambió ppneumático*	*!	
b. ☞*cambió pneumático*		*

(34.)

diventó psicopático	TT / in V __ [+son, +cont]	+RS
a. *diventó ppsicopático*	*!	
b. ☞*diventó psicopático*		*

A further costraint is necessary in order to account for the lack of gemination of the initial consonant of SC clusters in the +RS condition. The syllable-independent phonotactic constraint, formalized in (35.) accounts for both the word internal distribution geminate /s/ in Italian and the failure of RS to apply to SC clusters

(35.) **SS/ in V __ V**
Geminate /s/ is restricted to intervocalic position.

a) Bans word initial geminate /s/: e.g. ***ss**afo*
b) Bans Geminate s before [+cons]: e.g. **pa**ss**ta, pa**ss**ra*
c) RS many not apply to SC: e.g. *diventó **ss**leale*

The phonotactic constraint on the distribution of geminate /s/ again dominates the +RS constraint, as illustrated in (36.).

(36.) **SS / in V__V >> +RS**

diventó stimáto	SS / in V __ V	+RS
a. *diventó sstimáto*	*!	
b. ☞*diventó stimato*		*

The phonotactic analysis of the distribution of geminates in Italian is based on the hypothesis that the geminate vs. singleton contrast is only permitted where the cues for geminate consonants are robust. Perceptual and acoustic studies (Esposito and Di Benedetto 1999, Pickett et al. 1999) have shown that preceding vowel duration is a perceptual correlate for geminate consonants in

Italian across speech rates (specifically the C/V ratio). Furthermore, the assessment of a consonantal length contrasts crucially depends on the ability to identify consonantal boundary. Non-nasal stop boundary cues are salient before vowels and liquids, where the burst and CV transitions are most audible. Other geminates, such as geminate /s/ and geminate liquids, may be further restricted to intervocalic position precisely because they lack a salient right edge boundary cue, such as a burst.

Phonotactic constraints on the distribution of geminates are also able to account for languages that restrict geminates to intervocalic, such as Ancient Greek and Latin. Again, the syllable based Hetero CC constraint over predicts the word-internal distribution of geminates in these languages. The syllable independent analysis does not face the over prediction problem. Geminates in Ancient Greek and Latin are permissible in the most restricted phonotactic context where the singleton vs. geminate contrast is maximally perceptible: CC / in V__V. A simple extension of this constraint accounts for morphological gemination in Latin (Giannini & Marotta 1989). At morpheme boundaries Latin allows geminate stops after a vowel and before vowels and liquids: TT /in V_[+son, +cont]): e.g. *ad+clamare* → *acclamare*. This extended constraint, TT / in V __ [+son, +cont], is precisely the constraint active in Italian.

11. Conclusion

In summary, the standard analysis claims that constraints on syllable structure are able to account for distribution of geminates, the application vs. non-application of RS to various consonant clusters and the selection of the definite article allomorphs *il* and *lo* in Italian. The convergence of multiple phonological generalizations on the same syllable structure was also claimed to provide empirical support for this analysis of Italian syllable structure. However, we have seen that the standard analysis is inadequate in accounting for the empirical data. The strict application of the constraints on syllable structure over predicts the distribution of geminates in Italian and other languages. The cross-experimental comparison of the results of the RS and article allomorphy experiments revealed that variability in the choice of allomorph never corresponds to variability in the application of RS; these two phenomena do not converge on the same syllabifications. Furthermore, duration data did not support the interaction of FtBin and *FinalLongV as the structural motivation for RS (since word final stressed vowels **do** lengthen). A syllable independent analysis of both the distribution of geminate and RS was proposed based on the observation that geminates are permitted precisely in the phonotactic contexts where length

contrasts are most perceptible: TT / in V __ [+son, +cont], SS / in V __ V. Crucially, this analysis does correctly accounts for the empirical data, does not conflict with allomorphy data and overcomes the over prediction problem encountered in the standard analysis.

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