Emergence of the Unmarked in Interlanguage Coda Production

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Either then he has at some time acquired the knowledge which he now has, or he has always possessed it. – Plato

1 Introduction

1.1 Overview – The Availability of Negative Constraints in IL Phonology

In his dialogue between Socrates and Meno, Plato argues that Meno's knowledge has not been taught to him, but is instead innate. We find similar arguments posed by Ingram (1995) in his discussion of negative constraints, which "restrict the child's learning space through restrictions on Universal Grammar," Kager (1999) in his review of Optimality Theory, in which "all constraints are part of the grammars of all natural languages," and Pinker (1984) in his discussion of default settings that are maintained until altered by input. A crucial implication of all such arguments is the notion that grammatical constraints are not acquired, and that it is positive evidence from native language input that "leads the child to the correct grammar" (Ingram 1995).

While the theory of Universal Grammar (UG) is widely accepted, there is some debate as to the accessibility of UG to the adult language learner. Schachter (1991) discusses the ability of a learner who has abandoned a default setting or negative constraint in his first language to "re-adopt" the default setting in the second language. She admits that such an ability would constitute positive evidence for the availability of UG in adults, but cites a number of studies (Finer & Broselow 1986; Rutherford 1989; White 1989a) that fail to produce such positive evidence.

The data in this study support a theory of innate, universal negative constraints that are continually accessible to the adult language learner. I will go farther and claim that without such a theory it would be difficult to explain the study's results.

1.2 Focus of the Study

This study specifically tests for and analyzes the types of syllable-final segments (codas) produced by native English speakers in the early stages of Italian acquisition. Testing was accomplished using a language game (ludling) as a diagnostic tool and analysis of the results focuses on determining sonority preferences in the speakers' coda production. It is shown that the English speakers' coda production exhibits a strong preference for sonorant segments in syllable-final position, contradicting the surface patterns of native English phonology. Such a preference indicates that English speakers possess knowledge of a negative constraint that resurfaces in their interlanguage phonology.

1.3 Outline of the Paper

In the first section of this paper I will review the phonological theories relevant to this study, specifically sonority and its implications for syllable structure, and use them to illustrate a difference between English and Italian. In section two I will discuss the methodology used to gather data for this study, note any logistical problems and explain the manner in which raw data were analyzed. I will present the results of the data analysis in section three. Lastly, in section four I will discuss possible explanations for the study's results.

2 PHONOLOGICAL BACKGROUND

2.1 A Discussion of Sonority

Sonority can be defined as the amount of acoustic energy carried by a segment. Ladefoged (1975) defines the sonority of a sound as "its loudness relative to that of other sounds with the same length, stress and pitch." Implicit in this definition is the notion that sounds will vary in sonority and thus may be "ranked along a scale according to the degree to which they possess the property of sonority" (Clements 1992). This ranking constitutes the foundation of the *Sonority Principle,* allowing for the characterization of sounds in a hierarchy, as proposed by Clements and illustrated in (1).

(1)	Most sonorous	Vowel
	↓	Glide
		Liquid
		Nasal
	Least Sonorous	Obstruent

It should be noted that the types of sounds in (1) have been further categorized in terms of relative sonority (Selkirk 1982; Broselow and Finer 1991; Eckman and Iverson 1993). For the purposes of this study, however, it is sufficient to collapse the hierarchy rather than expand it. Roca and Johnson (1999) define sonorants as unobstructed sounds and obstruents as obstructed sounds. This definition allows us to draw a line between two discreet categories as in (2).

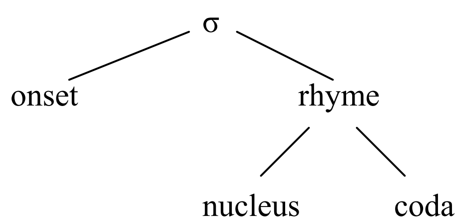
(2)	+Sonorant	Vowel
		Glide
		Liquid
		Nasal
	-Sonorant	Obstruent

From here on I will refer to the sounds in question as either *sonorants* or *obstruents*, ignoring any relative variations in sonority within each class.

2.2 Sonority as a Factor in Syllable Structure (Constraints)

A further implication of the Sonority Principle is its role in the formation of syllables. Blevins (1996) and Clements (1992) discuss the syllabification in terms of peaks and falls in sonority. The general observation is that syllables contain peaks of sonority which constitute their nuclei and may be surrounded by less sonorous material. A widely accepted syllable structure presented by Blevins is given in (3).

(3)



Clements *Dispersion Principle* proposes a cross-linguistic asymmetry within this structure, where sonority "rises maximally towards the peak and falls minimally towards the end." We should then see a preference for sonorant codas over obstruent codas in the world's languages. Such a preference is, in fact, exemplified in Blevins and given this we may conclude that obstruent codas are more marked than sonorant codas.

2.3 English and Italian Syllable Structure Constraints

English and Italian can be shown to have differing syllable structures in terms of allowable segments in coda position (Basbøll 1974) as noted in (4).

(4)	English:	C_1VC_2	C_2 may be any English consonant
	Italian:	C_1VC_2	C_2 is a sonorant[1]

Nagy and Napoli (1995) propose the Harmonic Coda Principle (HCP) to account for sonority preferences. The HCP states that the more sonorous a consonant is, the less marked it will be in coda position. This principle can be restated as an Optimality Theory constraint (5) that is more active in Italian than English.

(5) NoObstCoda[2]

For the purposes of this study, a thorough analysis of Italian coda constraints is somewhat unnecessary. The relevant fact is that a constraint against obstruency in syllable-final position exists, as exemplified by Italian, but is dormant in English. This study indicates that an inactive constraint like NoObstCoda may become active under certain conditions.

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[1] The segment [s/z] presents a perpetual problem, which Basbøll solves by categorizing [s/z] as a sonorant Note that [s/z] is found to be an irritant in other instances.

[2] Nagy and Napoli claim that Italian does allow obstruent codas when they occupy the first part of a geminate pair and other exceptional positions. Extensive analysis of this claim is outside the scope of this study. Further, the claim has no effect on the generalizations formed from data gathered in this study.

3 METHODOLOGY

3.1 The Subjects

Subjects consisted of nine native English speakers in the early stages of Italian acquisition[3] (< two months) and one native Italian speaker used as the control. None of the native English-speaking subjects was bilingual and none began acquisition of Italian earlier than 18 years of age. For details on subject background see Appendix A.

3.2 The Diagnostic Device

Subjects were instructed in a common Italian language game (*Farfallina*) of the infixation type. The rules of the game and an example are given in (6).

(6) Insert the sequence [fV] after each syllable of an input word.
Harmonize the V to the existing vowel.

Example*:* mano [mano] *(hand)* → ma **fa** no **fo** [mafanofo]

It should be noted that these rules were not used in subject instruction. At no point prior to the data elicitation were the subjects informed of the study's goal, and the word "syllable" was intentionally omitted from all discussions with subjects. Instruction, therefore, consisted of providing subjects with bisyllabic, CVCV words such as the example word in (6). No sample word contained a coda, cluster, or geminate consonant.

3.3 The Data-gathering Process

Subjects were provided with a list of minimal pairs where the gemination of a word-internal consonant served as the contrasting element in each pair. Words were read by the investigator in random order and subjects were asked to repeat the input word and subsequently perform the language game on the input word. All subjects were audio-recorded. The list of input words is given in Table 1 below. Note that five of the input word minimal pairs contain mid-word obstruents and six contain mid-word sonorants.

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[3] One of the nine subjects is in the advanced stage of Italian acquisition (four years). No significant variance from early stage speakers was noted.

Table 1

	Nongeminate	***Gloss***	**Geminate**	***Gloss***
Obstruents:	Bruto	*Brutus*	brutto	*Ugly*
	mogio	*dejected*	moggio	*Bushel*
	papa	*Pope*	pappa	*thick soup*
	tato	*Daddy (infantile)*	tatto	*Tact*
	tuto	*secure*	tutto	*everything, all*
Sonorants:	fumo	*smoke*	fummo	*(we) were*
	mole	*massive shape*	molle	*soft/week*
	nona	*ninth (fem.)*	nonna	*Grandmother*
	pena	*pain*	penna	*Pen*
	sono	*(I) am*	sonno	*Sleepiness*
	stele	*stele*	stelle	*Stars*

4 DATA ANALYSIS

Analysis of the data consisted of noting two observations: subjects' recognition of geminate consonants and subjects' treatment of the first segment in the geminate during the language game process. Subjects' recognition of lengthened consonants was assessed in three ways: first, by listening to subjects' speech samples; second, by measuring rough distance between vowel segments using an audio-editing device; and third, by measuring length of time taken to produce each utterance in a non-geminate/geminate pair. The first method was relied on more heavily than the second two, which served for purposes of confirmation.

Given geminate recognition by a subject, there are two possible ways to treat the geminate's first segment. If the geminate is not split as a result of [fV] infixation, as in (7a), no coda will be produced in the first syllable. If the geminate is split, the first segment of the geminate will constitute a coda of the first syllable, as in (7b).

(7) a. brutto [brutto] *(ugly)* → [brufutofo]
b. brutto [brutto] *(ugly)* → [brutfutofo]

Note that the geminate consonant, even though not split, was not maintained in the control's production of output words. For the purposes of this study, I am not considering maintenance of the geminate or the usual accompanying vowel shortening.

5 RESULTS

5.1 Geminate Recognition

The speakers differentiated consonant lengths in the non-geminate and geminate words in each minimal pair. The average Geminate Recognition Rate (GRR) was 3% for non-geminates and 83% for geminates, with no significant difference between GRR within obstruent word and sonorant words.

5.2 Coda Production

Overall Coda Production Rate (CPR), or the number of codas produced as a percentage of total output words, was relatively low for both non-geminate and geminate words – 10% and 24%, respectively. These low numbers imply a general avoidance of geminate-splitting (and the resulting coda production) on the part of the speakers[4]

Given the scope of this study is to analyze the types of codas produced by speakers whose NL constraints seemingly make no distinction, we must consider not just overall coda production, but coda production within classes of sounds. When we take into consideration only the codas that were produced, the number of obstruent codas and sonorant codas as a percentage of total codas (crucially not total output words) varies: average Obstruent Coda Production Rate (O-CPR) was 13% for non-geminate words and 16% for geminate words while average Sonorant Coda Production Rate (S-CPR) was 87% for non-geminates and 84% for geminates These numbers exhibit a high level of significance ($p < .01$) and indicate a strong preference for sonorant codas over obstruent codas. Tables 2 and 3 summarize overall GRR, CPR, O-CPR and S-CPR for non-geminates and geminates, respectively. Detailed information on geminate recognition and coda production by individual subjects may be found in Appendices C and D.

Table 2

	S1	S2	S3	S4	S5	S6	S7	S8	S9	Averages
Overall GRR	0%	27%	0%	0%	0%	0%	0%	0%	0%	*3%*
Overall CPR	0%	45%	9%	27%	0%	9%	0%	0%	0%	*10%*
O-CPR	N/A	20%	0%	33%	N/A	0%	N/A	N/A	N/A	*13%*
S-CPR	N/A	80%	100%	67%	N/A	100%	N/A	N/A	N/A	*87%*

[4] Hisagi (1999) gives an account of geminate treatment in the production of language game utterances in Japanese. She suggests a pre-game stage in which the Obligatory Contour Principle (OCP) motivates geminate reduction to a singleton, thus altering the input to the language game process, which would result in failure to split geminates (and thus produce codas). Hisagi notes that nasals are not accounted for by the OCP. If an OCP account is used to explain the subjects' geminate treatment and subsequent coda production in this study, it requires that liquids also be considered exceptional. Further investigation into the representation of geminate structures may help to explain this study's data, but at present I am uncomfortable with any rule requiring exceptional treatment of at least two classes of sounds. I will regard underlying representation of geminates, and any pre-game representations, as the same for all input words.

Table 3

Fig. 10		1) TD	2) EL	3) EB	4) KT	5) LA	6) DIP	7) RS	8) DS	9) ES	10) LL	11) CHS	12) LH	13) KW	14) CLS	15) MS	16) EDS	17) BS	18) SM	19) ROS	20) RM	21) KM	22) DPJ	23) JW	24) MC	25) DP	TOTAL	AVERAGE
HIGHEST BACK [u] - MID BACK [ɔ]																												
# 15	strupe strawp	1	0	1	1	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	9	36 %
	strawp strupe	0	1	0	0	1	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	16	64 %
# 25	hube hawb	1	1	0	1	1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	1	0	0	14	56 %
	hawb hube	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	0	1	1	11	44 %
# 26	chufe chawf	1	0	0	1	1	0	0	1	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	0	0	9	36 %
	chawf chufe	0	1	1	0	0	1	1	0	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1	1	1	16	64 %
# 47	glune glawn	1	1	1	1	0	1	0	0	0	1	1	0	1	1	0	0	0	1	1	0	0	1	1	1	1	15	60 %
	glawn glune	0	0	0	0	1	0	1	1	1	0	0	1	0	0	1	1	1	0	0	1	1	0	0	0	0	10	40 %

	AVERAGE	P-VALUE
[u] - [ɔ]	47 %	0.15951
[ɔ] - [u]	53 %	

Note that the control was deliberately excluded from all geminate recognition and coda production analyses. This control recognized geminates in all of the geminate words but produced no codas in the language game variations. Such an avoidance of geminate-splitting is not necessarily characteristic of Italian speakers, as documented by Nagy & Napoli (1995) and Bertinetto (1992).[5]

6 DISCUSSION

6.1 Language Game as Language

It is important to note that the language game used as a diagnostic tool in this study is not exceptional. Bagemihl (1988) describes ludlings (language games) as "utilizing various forms of nonconcatenative morphological manipulations" and cites evidence that "points to the conclusion that surrogate systems are in fact a natural linguistic behavior." Given this view of language games as natural processes, there is every reason to believe that the subjects' behavior documented in this paper conforms to normal linguistic processes and can be explained by generally accepted linguistic principles.

6.2 Why a preference for sonorant codas?

The data support a preference for sonorant codas over obstruent codas in native English speakers' production of Italian. Why would this be the case when the constraint NoObstCoda clearly does not apply in English? We might hypothesize that although NoObstCoda is not an *active* English constraint, it nonetheless exists in the English speakers' grammar and something triggers its resurfacing in an exceptional phonology such as interlanguage.

First, it is necessary to rule out both NL transfer and TL knowledge as motivating factors in the subjects' avoidance of obstruent codas. Transfer is not a satisfactory explanation, as the NL, English, in this case, provides no evidence for a preference in coda sonority. Such a lack of evidence is clear from the empirics of English lexical entries. The argument that TL knowledge is not at work is weaker – the subjects could, in theory, have formulated a NoObstCoda constraint from Italian evidence, however, this does not seem probable for two reasons. First, it is highly unlikely that the subjects would have been explicitly taught that Italian prefers sonorous codas or that they would have inferred this from linguistic evidence in the short period of their exposure to Italian. Second, the methodology used to elicit coda production was such that it precluded any

[5] Nagy and Napoli gathered data using a language game and found a tendency for speakers to ambisyllabify geminates, noting that 96% of sonorant geminates were ambisyllabified, as compared with 87% of obstruent geminates. Bertinetto, also using a language game diagnostic, found a similar tendency to split geminates, but did not examine different treatments among obstruent and sonorant classes.

conscious effort on the part of the subjects to determine coda sonority and subsequently select different values of sonority in their coda production. Replication of this study using English speakers with no exposure to languages that have an active NoObstCoda constraint would certainly rule out TL knowledge as a factor in determining coda preferences. For the moment, I am comfortable assuming that knowledge of sonority constraints in coda position was neither transferred from knowledge of NL surface forms nor learned from TL evidence.

The case for a resurfacing of markedness constraints, or "emergence of the unmarked" is made by McCarthy & Prince (1994) and argued by Broselow et al (1998) and Bhatt & Bhatt (1997). They claim that phonological phenomena in interlanguage may be explained by principles of Universal Grammar, specifically by assuming that negative constraints are present in all speakers' grammars and that some of these constraints are dominated by higher-ranked constraints in the NL. Fluctuation of constraint rankings in a speaker's interlanguage then allows for the resurfacing of previously low-ranked constraints. This provides a sound explanation for the presence of NoObstCoda in my subjects' productions. All that remains is to motivate such an emergence of the unmarked.

A simple theory based on competition between markedness and faithfulness constraints in an Optimality Theory framework may suffice to explain the sonority preferences discussed in this paper. If we assume that constraints are universal, we must explain the inactivity of the NoObstCoda constraint in English; in other words, what is such a constraint outranked by? It seems reasonable to assume, given a theory of richness of the base, that faithfulness to the input is a primary factor in nullifying NoObstCoda constraints in English, therefore, will be ranked as in (8).

(8) IDENT-IO >> NoObstCoda

If the ranking in (8) is sound, then the demotion of the faithfulness constraint IDENT-IO will allow the markedness constraint NoObstCoda to emerge. Such a demotion would imply that faithfulness is less active in some speakers' IL grammars. This deranking of faithfulness seems to be evident in some speakers' preferences for deletion over epenthesis, as mentioned in Ingram 1995. The fact that variation in coda production occurs is a further instantiation of constraint re-ranking in an OT account: as subjects move from the NL grammar to the TL grammar their constraint rankings fluctuate at the individual level (Broselow et al, 1998).

6.3 Methodology problems and observations

A number of issues arose during this study that could have effects on the data or their interpretation. The first is the non-native Italian proficiency of the interviewer, which could have two possible effects: it could bias the subjects' geminate recognition by providing input with little contrast between geminate and non-geminate pairs or could result in a less accurate judgement of geminate recognition. Because the control recognized geminates consistently and provided a benchmark for geminate recognition judgements, the interviewer's non-native speech may not have posed a problem.

It is possible that another rule of English phonology (at least one operating at the lexical level) has a role in the subjects' avoidance of obstruent codas. The Syllable Contact Law, which favors the sequence <sonorant,obstruent> where the coda and onset of two syllables are juxtaposed, would prohibit a sequence [Cf] where C is an obstruent. This observation calls for a second study using different segments in the consonant position of the ludling's inserted material.

The majority of subjects did not follow the vowel harmonization rules of the language game and sometimes altered the vowel segments in the input word (see Appendix B for details). Any unsatisfactory performance of the game, however, did not pose a problem for the purposes of this study, as the only relevant consideration is subjects' treatment of the geminates. The data gathered allow for the analysis of the subjects' production of syllable codas.

7 CONCLUSION

At the start of this paper I presented several accounts of the universality of negative constraints and introduced Schachter's hypothesis that an emergence of such constraints would constitute evidence for continued accessibility of UG to post-critical period speakers. This study has presented evidence of sonority preferences on the part of speakers whose native language surface forms do not show such preferences. Of three possible explanations for these results, namely, NL transfer, TL knowledge and UG availability, only the latter seems plausible, and has been rationalized within a simplified framework of Optimality Theory where inactive markedness constraints are permitted to emerge as higher-ranked constraints are demoted. If such an emergence can be held to account for the data in this study, Schachter's challenge has been met and UG is available to adults.

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APPENDIX A
Subject Profiles

Subject	Testing Pool	Age/ Gender	Other Languages/ Proficiency	Age of TL Onset	Time TL Studied
1	NVCC Alexandria Italian 101	19/M	Spanish/1.5	19	6 weeks
2	NVCC Alexandria Italian 101	?/F	-	?	6 weeks
3	NVCC Alexandria Italian 101	20/F	Spanish/2.5	20	6 weeks
4	NVCC Alexandria Italian 101	57/F	Latin/1 Thai/1 German/1 French/2	57	6 weeks
5	NVCC Alexandria Italian 101	30/F	Russian/2	30	6 weeks
6	NVCC Alexandria Italian 101	42/F	-	42	6 weeks
7	NVCC Alexandria Italian 101	36/M	Spanish/2 French/1	36	6 weeks
8	NVCC Alexandria Italian 101	21/F	French/2 Spanish/1 Hebrew/1	21	6 weeks
9	Casa Italiana, Wash. DC Advanced Conversation	44/F	French/1	38	5 years
10 (Control)	Italian NS (Tuscany)	59/M	French/4 English/4 Spanish/2 German/2	n/a	n/a

APPENDIX B

IPA Transcriptions of Language Game Productions

Subjects 1-5

Input	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
bruto	bɹufotufo	bɹufatufo	bɹufotofo	bɹufotufo	bɹufutofo
mogio	mofodʒofo	mofadʒofo	mofodʒofo	mofodʒofo	mofodʒofo
papa	pafapafa	pafapafa	pafapafa	papfapafa	pafapafa
tato	tafotafo	tafatofo	tafotofo	tafotafo	tafatofo
tuto	tufotufo	tutfatufo	tufotufo	tufotofo	tufutofo
fumo	fufomufo	fumfamofo	fufamufa	fufomufo	fufumufo
mole	mofelefe	mofalefo	mofolefo	mofelofe	mofolefe
nona	nofonofa	nonfanafa	nonfanonfa	nonfononfo	nofonafa
pena	-	penfanafa	pefanefa	penfanenfa	pefenafa
sono	sofonofo	sofanofo	sofonofo	sofonofo	sofonofo
stele	stefelefe	stelfalefa	stefalefa	stefelefe	stefelefe
brutto	bɹufotufo	bɹufatufo	bɹufotofo	bɹutfotufo	bɹufutofo
moggio	mofodʒofo	mofadʒofo	mofodʒofo	mofodʒofo	mofodʒofo
pappa	pafapafa	pafapafa	pafapafa	papfapapfa	pafapafa
tatto	tafofato	tafatofo	tafotofo	tæfofafo	tafatofo
tutto	tufotufo	tufatufo	tufotofo	tutfotufa	tufutofo
fummo	fufomufo	fumamufo	fufomofo	fufomufo	fufumofo
molle	mofolefe	mofalefe	mofalofa	mofelofe	mofolefe
nonna	nofonafa	nonfanonfo	nonfanonfa	nonfanonfa	nofanafa
penna	pefenefe	penfanafa	penfanenfa	penfanenfa	pefenafa
sonno	sofonofo	sonfanonfo	sofonofo	sonfononfo	sofonofo
stelle	stelfeelfe	stelfalefa	stelfolelfo	stelfelelfe	stefelefe

APPENDIX B (continued)
IPA Transcriptions
Subjects 6-10

Input	Subject 6	Subject 7	Subject 8	Subject 9	Subject 10
bruto	brufatafa	brufatofa	brufotufo	brufatofa	brufotofo
mogio	mofadʒofa	mofadʒofa	mofodʒofo	mofadʒofa	mofodʒofo
papa	pafapafa	pafapafa	pafopafo	pafapafa	pafapafa
tato	tafatofa	tafatofa	tafotofo	tafatofa	tafotofo
tuto	tufatofa	tufatofa	tufotufo	tufatofa	tufatafa
fumo	fufamofa	fufamofa	fufomufo	fufamofa	fufomofo
mole	mofelefe	mofalefa	mofolofo	mofalefa	mofolefo
nona	nofanofa	nofanofa	nofanofa	nofanofa	nofanafa
pena	pefanefa	pefanafa	pefonefo	pefanefa	pefenafe
sono	sonfanofa	sofanofa	sofonofo	sofanofa	sofonofo
stele	stefalefa	stefalefa	stefolefo	stefalefa	stefelefe
brutto	brufatofa	brufatofa	brufotufo	brufatofa	brufotofo
moggio	modfadʒafa	mofadʒofa	mofodʒofo	madfadʒofa	mofodʒofo
pappa	pafapafa	pafapafa	pafapafa	pafapafa	pafapafa
tatto	tafatafa	tafatofa	tafofafo	tafatofa	tafotofo
tutto	tufatofa	tufatofa	tufotofo	tufatofa	tufotofo
fummo	fufamofa	fufamofa	fufomufo	fufamofa	fufomofo
molle	mofelefe	mofalefa	mofolefo	mofalefa	mofelefe
nonna	nonfanonfa	nofanofa	nofolefo	nonfanafa	nofanafa
penna	penfanafa	pefanefa	pefonefo	penfanafa	pefenafe
sonno	sonfanofa	sofanofa	sofonofo	sofanofa	sofonofo
stelle	stelfalafa	stefalefa	stefelefe	stefalefa	stefelefe

APPENDIX C
Geminate Recognition Data

Non-geminates

Input	Sonority	S1	S2	S3	S4	S5	S6	S7	S8	S9	GRR by word
bruto	O	N	N	N	N	N	N	N	N	N	*0%*
mogio	O	N	N	N	N	N	N	N	N	N	*0%*
papa	O	N	N	N	N	N	N	N	N	N	*0%*
tato	O	N	N	N	N	N	N	N	N	N	*0%*
tuto	O	N	Y	N	N	N	N	N	N	N	*11%*
fumo	S	N	Y	N	N	N	N	N	N	N	*11%*
mole	S	N	N	N	N	N	N	N	N	N	*0%*
nona	S	N	N	N	N	N	N	N	N	N	*0%*
pena	S	-	N	N	N	N	N	N	N	N	*0%*
sono	S	N	N	N	N	N	N	N	N	N	*0%*
stele	S	N	Y	?	N	N	N	N	N	N	*11%*

	S1	S2	S3	S4	S5	S6	S7	S8	S9	Averages
Average Overall GRR	*0%*	*27%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*3%*
Average O-GRR	*N/A*	*33%*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*33%*
Average S-GRR	*N/A*	*67%*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*67%*

Geminates

Input	Sonority	S1	S2	S3	S4	S5	S6	S7	S8	S9	GRR (by word)
brutto	O	Y	Y	N	Y	Y	Y	Y	N	Y	*78%*
moggio	O	Y	Y	N	Y	Y	Y	Y	Y	Y	*89%*
pappa	O	Y	Y	N	Y	Y	Y	Y	N	Y	*78%*
tatto	O	N	Y	Y	Y	Y	N	Y	Y	Y	*78%*
tutto	O	Y	Y	Y	Y	Y	Y	Y	N	Y	*89%*
fummo	S	Y	Y	N	Y	Y	N	N	N	Y	*56%*
molle	S	Y	N	N	Y	Y	Y	N	N	Y	*56%*
nonna	S	Y	Y	Y	Y	Y	Y	N	Y	Y	*89%*
penna	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	*100%*
sonno	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	*100%*
stelle	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	*100%*

	S1	S2	S3	S4	S5	S6	S7	S8	S9	Averages
Average Overall GRR	*91%*	*91%*	*55%*	*100%*	*100%*	*82%*	*73%*	*55%*	*100%*	*83%*
Average O-GRR	*40%*	*50%*	*33%*	*45%*	*45%*	*44%*	*63%*	*33%*	*45%*	*44%*
Average S-GRR	*60%*	*50%*	*67%*	*55%*	*55%*	*56%*	*38%*	*67%*	*55%*	*56%*

APPENDIX D
Coda Production Data

Non-geminates

Input	Sonority	S1	S2	S3	S4	S5	S6	S7	S8	S9	CPR (by word)
bruto	O	N	N	N	N	N	N	N	N	N	*0%*
mogio	O	N	N	N	N	N	N	N	N	N	*0%*
papa	O	N	N	N	Y	N	N	N	N	N	*11%*
tato	O	N	N	N	N	N	N	N	N	N	*0%*
tuto	O	N	Y	N	N	N	N	N	N	N	*11%*
fumo	S	N	Y	N	N	N	N	N	N	N	*11%*
mole	S	N	N	N	N	N	N	N	N	N	*0%*
nona	S	N	Y	Y	Y	N	N	N	N	N	*33%*
pena	S	-	Y	N	Y	N	N	N	N	N	*22%*
sono	S	N	N	N	N	N	Y	N	N	N	*11%*
stele	S	N	Y	N	N	N	N	N	N	N	*11%*

	S1	S2	S3	S4	S5	S6	S7	S8	S9	Averages
Average Overall CPR	*0%*	*45%*	*9%*	*27%*	*0%*	*9%*	*0%*	*0%*	*0%*	*10%*
Average O-CPR	*N/A*	*20%*	*0%*	*33%*	*N/A*	*0%*	*N/A*	*N/A*	*N/A*	*13%*
Average S-CPR	*N/A*	*80%*	*100%*	*67%*	*N/A*	*100%*	*N/A*	*N/A*	*N/A*	*87%*

Geminates

Input	Sonority	S1	S2	S3	S4	S5	S6	S7	S8	S9	CPR (by word)
brutto	O	N	N	N	Y	N	N	N	N	N	*11%*
moggio	O	N	N	N	N	N	Y	N	N	Y	*22%*
pappa	O	N	N	N	Y	N	N	N	N	N	*11%*
tatto	O	N	N	N	N	N	N	N	N	N	*0%*
tutto	O	N	N	N	Y	N	N	N	N	N	*11%*
fummo	S	N	Y	N	N	N	N	N	N	N	*11%*
molle	S	N	N	N	N	N	N	N	N	N	*0%*
nonna	S	N	Y	Y	Y	N	Y	N	N	Y	*56%*
penna	S	N	Y	Y	Y	N	Y	N	N	Y	*56%*
sonno	S	N	Y	N	Y	N	Y	N	N	N	*33%*
stelle	S	Y	Y	Y	Y	N	Y	N	N	N	*56%*

	S1	S2	S3	S4	S5	S6	S7	S8	S9	Averages
Average Overall CPR	*9%*	*45%*	*27%*	*64%*	*0%*	*45%*	*0%*	*0%*	*27%*	*24%*
Average O-CPR	*0%*	*0%*	*0%*	*43%*	*N/A*	*20%*	*N/A*	*N/A*	*33%*	*16%*
Average S-CPR	*100%*	*100%*	*100%*	*57%*	*N/A*	*80%*	*N/A*	*N/A*	*67%*	*84%*