Linguistic Society of America
2002 Annual Meeting

Phonology: Syllables and Moras
January 3 – 6, 2002

Segmental Constraints on Geminates and their Implications for Typology*

Robert J. Podesva
podesva@stanford.edu

Stanford University

1 Introduction

Phonological analyses of geminate consonants are largely concerned with prosodic structure and representation. This focus on prosody alone carries the implication that all geminates behave the same, regardless of segmental composition. In point of fact, few languages permit gemination of all consonants in their inventories, suggesting that independent of prosodic acceptability some geminate types are more well-formed than others. I argue that segmental constraints on geminates are necessary to account for geminate alternations within languages as well as geminate patterns across languages.

(1) *Goals*
   a. Propose a universal set of constraints on the segmental composition of geminates.
   b. Motivate each constraint on articulatory, perceptual, or typological grounds.
   c. Account for language-internal alternations occasioned by these constraints.
   d. Based on a cross-linguistic survey of geminate inventories in fifty-two languages, evaluate the typological predictions arising from the proposed constraint set.

(2) *Assumptions*
   a. Constraint-based Optimality Theoretic framework
      (Constraints are assumed to be universal.)
   b. *geminate* – a long consonant spanning syllable boundaries
      (Initial and final geminates are not under consideration.)

* This work has at various stages of development benefited from the suggestions of Abby Cohn, Penny Eckert, Will Leben, Draga Zec, and especially Edward Flemming. I alone accept responsibility for any errors. The collection of Buginese data was supported in part by NSF grant number SBR-9511185 to Abigail Cohn.

2 Segmental Constraints on Geminates

2.1 Buginese and *DD

(3) Geminates at the prefix-root (*maC*+ROOT) boundary (data from Podesva 1998)

Voiceless Obstruents	ma**pp**asaʔ	‘to go to the market’
	ma**tt**apa	‘to smoke (meat)’
	ma**tʃtʃ**iruʔ	‘to sharpen’
	ma**kk**ota	‘to go to the city’
	ma**ss**araŋ	‘to build a nest’
Voiced Obstruents	ma**ʔb**usəʔ	‘to eat (rude)’
	ma**ʔd**eceŋ	‘to ask for forgiveness’
	ma**ʔdʒ**ama	‘to work’
	ma**ʔg**oriʔ	‘to scratch’
Sonorants	ma**mm**usuʔ	‘to go to war’
	ma**nn**asu	‘to cook’
	ma**ŋŋ**awa	‘to breathe’
	ma**ll**ebo	‘to form into a ball’

(4) AGREE – Adjacent consonantal root nodes may not differ in their feature specifications.

```
*      C        C
       |        |
   [αFeature] [βFeature]
```

(See Pulleyblank (1997), who refers to this constraint set as IDENTICAL CLUSTER CONSTRAINTS, and Lombardi (1995), who appeals to AGREE (VOICE)).

(5) MAX (McCarthy and Prince 1995)

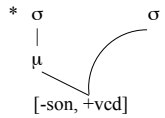
   a. MAX-μ – Every input mora has an output correspondent.
   b. MAX-IO – Every input segment has an output correspondent.

(A word of clarification on MAX-μ: Although the assignment of prosodic structure (including moraification) is generally understood to be supplied by *Gen*, I assume that minimal moraic structure is present in input representations in order to differentiate between underlying singleton and geminate consonants (and short and long vowels). Thus MAX-μ is needed to ensure that input moras are realized phonetically.)

(6)

/maC-lebo/ ‘form into ball’	MAX	AGREE
a. maʔlebo		*!
b. ☞ mallebo		
c. malebo	*!	

(7) *DD – Geminate voiced obstruents are prohibited.



(8) *Motivation*
In order for voicing to occur, subglottal pressure must be greater than oral pressure. This pressure differential sends air past the vocal folds, setting them into motion. However, in the production of obstruents, all exit valves are nearly closed (completely closed in the case of stops). Oral pressure therefore quickly approaches subglottal pressure, slowing airflow and eventually extinguishing voicing (Ohala 1983).

(9)

/maC-goriʔ/ 'scratch'	MAX	*DD	AGREE
a. ☞ maʔgoriʔ			*
b. maggoriʔ		*!	
c. magoriʔ	*!		

2.2 Selayarese and *RR

(10) Geminates at the prefix-root (*taʔ*+ROOT) boundary (data from Mithun and Basri 1986)

Voiceless Obstruents	ta**pp**elaʔ	'to get lost'
	ta**tt**uda	'to bump against'
	ta**kk**alupa	'to faint'
	ta**ss**ambaŋ	'to stumble, trip'
Voiced Obstruents	taʔ**b**essolo	'to slip'
	taʔ**d**oʔdoʔ	'to be sleepy'
	taʔ**dʒ**ai	'to be sewn'
	taʔ**g**araŋ	'to get stained'
Sonorants	taʔ**m**uri	'to smile'
	taʔ**n**oʔnoso	'to be shaken'
	taʔ**ɲ**uʔɲuʔ	'to almost fall'
	taʔ**ŋo**aʔ	'to yawn'
	taʔ**l**esaŋ	'to be removed'
	taʔ**r**iŋriŋ	'to be walled'

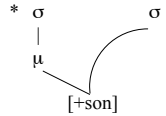
(11) Goldsmith (1990) suggests that sonorants and voiced obstruents pattern together because they are both marked by the feature [+voiced]. I argue that the sonorant and voiced obstruent patterns should be attributed to two different constraints for the following reasons:

a. Even though sonorants and voiced obstruents pattern together at the prefix-root boundary, they exhibit different patterns root-internally. Within roots geminate voiced obstruents are prohibited, whereas geminate sonorants are permitted:

ʔa**mm**a	'father'	ma**ŋŋ**aŋ	'tired'
ba**nn**aŋ	'thread'	ba**ll**i	'price'
pa**ɲɲ**u	'turtle	ba**rr**oʔ	'eagle'

b. Although the articulation of geminate voiced obstruents is marked, geminate sonorants are not difficult to produce.

(12) *RR – Geminate sonorants are prohibited.



(13) *Motivation*
Changes in segment duration are perceived most easily when accompanied by major jumps in intensity (Kato et al. 1997). Sonorants exhibit higher intensity levels (i.e., levels approaching those of the vowels that surround them) than non-sonorants, potentially making more difficult the perception of phonological length among sonorants.

(14)

/taʔ-muri/ 'smile'	MAX	*DD	*RR	AGREE
a. ☞ taʔmuri				*
b. tammuri			*!	
c. tamuri	*!			

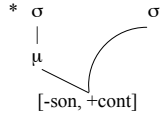
N.B. *RR does not rule out geminate sonorants root-internally because of a higher ranking root faithfulness constraint. See Podesva (2000) for a full analysis.

2.3 Wolof and *SS

(15) Alternations between singletons and geminates (data from Ka 1994)

	ROOT		ROOT + C-*initial suffix*	
Voiceless Stops	jo**t**	'obtain'	jo**tt**ali	'transmit'
Voiced Stops	u**b**	'close'	u**bb**i	'open'
	te**g**	'put'	te**gg**i	'put away'
Sonorants	xa**m**	'know'	xà**mm**ee	'recognize'
	së**n**	'garbage'	sà**nn**i	'throw away'
	la**l**	'lay sheet'	la**ll**i	'take off sheet'
Fricatives	so**f**	'join'	so**pp**i	'disjoin'
	fa**s**	'tie'	fe**cc**i	'untie'
	so**x**	'load (gun)'	so**qq**i	'unload'

(16) *SS – Geminate fricatives are prohibited.



(17) *Motivation*
Geminate fricatives require greater articulatory precision than geminate stops. The upward-moving gesture of the active articulator during the production of fricatives must be prevented from being realized too fully, which could result in a stop articulation. The upward gesture required in geminate stop production, on the other hand, is impossible to overshoot. Kirchner (2000) suggests that geminate fricatives require greater effort, arguing that the upward gesture must be counteracted by a simultaneous downward gesture.

(18) IDENT(CONT) McCarthy and Prince (1995) – Input and output correspondents must have identical feature values for the feature [cont].

(19)

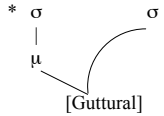
/sof-Ci/ 'disjoin'	*SS	AGREE (CONT)	MAX	IDENT (CONT)
a. ☞ soppi				*
b. sofi			*!	
c. sofpi		*!		
d. soffi	*!			

2.4 Biblical Hebrew and *GG

(20) Geminates at the prefix-root (*haC*+ROOT) boundary (data from Lambdin 1971)

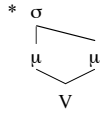
Non-Gutturals	ha**pp**aːr	'the steer'
	ha**bb**ayiθ	'the house'
	ha**gg**aːn	'the garden'
	ha**mm**elex	'the king'
	ha**nn**aʕar	'the youth'
	ha**yy**əhuðim	'the Jews'
Gutturals	ha**ːʔ**iʃ	'the man'
	ha**ːh**aːr	'the mountain'
	ha**ːʕ**ir	'the city'

(21) *GG – Geminate gutturals are prohibited.



(22) *Motivation*
Of the fifty-two geminating languages surveyed, fourteen languages allow all consonants to geminate except gutturals. These languages come from a variety of language families (Afro-Asiatic, Altaic, Austronesian, Eskimo-Aleut, Indo-European, Uralic), making it clear that the tendency to avoid geminate gutturals is not a pattern specific to Semitic languages.

(23) NLV (No Long Vowels – Rosenthall 1994) – Long vowels are prohibited.



(24)

/haC-ʔiʃ/ 'the man'	*GG	AGREE (PLACE)	MAX	NLV
a. ☞ haːʔiʃ				*
b. haʔiʃ			*!	
c. hatʔiʃ		*!		
d. haʔʔiʃ	*!			

3 Typological Implications

(25) The set of constraints on geminates gives way to a number of implicational universals. To test these predictions, a cross-linguistic survey was conducted, comparing the inventories of singleton and geminate consonants in fifty-two languages that contrast consonant length. See appendix for languages.

3.1 Geminate → Geminate Voiceless Obstruent

(26) Since the proposed constraint set contains no constraint prohibiting geminate voiceless obstruents, the presence of any geminate implies the presence of geminate voiceless obstruents (though *SS may rule out geminate voiceless fricatives). The survey upholds this generalization with only two apparent counter-examples, Gilbertese and Somali.

(27) A closer look at Somali suggests that the language might have geminate voiceless stops after all. Somali grammars (Zorc and Issa 1990, Puglielli 1997) report that voiced obstruents and sonorants occur as geminates, but voiceless obstruents do not. From the phonetic description of the stops, however, it appears that the distinction classified as voiced/voiceless may in fact be unaspirated/aspirated. Voiced stops are described as almost devoiced in initial position, and voiceless stops are described as strongly aspirated, suggesting that Somali might distinguish these sounds not along the lines of voicing, but rather of aspiration. If this is the case, then the Somali geminate 'voiced stops' are in fact geminate voiceless unaspirated stops. A more rigorous phonetic analysis is necessary to determine the true nature of the distinction.

N.B. Blevins (1999) lists Ponapean as a counterexample to the pattern, citing that it does not have geminate voiceless obstruents. Rehg and Sohl (1979), however, list a number of geminate voiceless obstruents appearing in Japanese loanwords: *nappa* 'Chinese cabbage', *kakko* 'putting on airs', and *isso:piŋ* 'sauce bottle'. Moreover, Garvin (1971) reports that at least the retroflex voiceless stop and alveolar fricative appear as geminates in words native to Ponapean, as in *paʈʈərek* 'nearby' and *issow* 'seven'.

3.2 Geminate Fricative → Geminate Stop

(28) Geminate fricatives are more marked than geminate stops, due to the additional articulatory gesture required for their production. Thus languages that permit geminate fricatives should also allow geminate stops. The survey upholds this generalization.

(29)

Language	Voiceless Obstruents			Voiced Obstruents		
	stop	affr	fric	stop	affr	fric
Amharic, Balochi, Biblical Hebrew, Chechen, Gurage, Hadiyya, Hungarian, Italian, Kambata, Luganda, Persian, Skolt Saami, Tigre	+	+	+	+	+	+
Hausa, Turkish	+	+	+	+		+
Ge'ez, Inuktitut, Levantine Arabic, Moroccan Arabic, Punjabi, Syrian Arabic	+		+	+		+
Bengali, Buginese, Gujarati, Hindi, Madurese, Malayalam, Oromo, Toba Batak	+	+	+	+	+	
Fula	+	+		+	+	
Maithili	+		+	+		
Selkup	+	+	+			
Blackfoot, Ponapean, Trukese	+		+			
Maranungku	+					
Sidamo	+	+	+	+	+	-
Swedish	+		+	+		-
Somali	+				-	
Japanese	+	+	+	+	-	-
Yakut	+	+	+	-	-	-
Finnish	+		+	-		-
Estonian, Icelandic	+		+			-
Karo Batak	+	+	+	-	-	
Chuvash	+	+	+		-	
Selayarese	+		+	-	-	
!Xóõ	+			-		
Wolof	+	+	-	+	+	
Chaha	+	-	-	-	-	-
Wichita	-	+	+			
Gilbertese	-		-			-

Key: + = occurs as geminate
– = occurs as singleton, but not geminate
□ = sound absent from language

(30) Wichita, which has geminate voiceless affricates and fricatives, but not geminate voiceless stops, stands as an apparent counterexample to this implicational pattern. Kirchner (2000) does not consider this a problem, arguing that non-continuants do indeed appear in Wichita—as affricates.

3.3 Geminate Sonorant → Geminate Sonorant of Lower Sonority

(31) Sonority Scale (Clements 1990)

		Sonorant Consonants							
obstruents	<	nasals	<	liquids	<	glides	<	vowels

sonority increases →

(32) According the sonority scale, some sonorant consonants have greater sonority levels than others. Thus we might expect that cross-linguistically, the higher a given geminate's sonority level, the more severely *RR should penalize it. In other words, if a language allows any sonorant consonant to geminate, it should also permit geminates of lower sonority. The survey upholds this generalization, as shown in (33).

(33)

Language	Nasals	Liquids		Glides
		laterals	rhotics	
Amharic, Balochi, Buginese, Chechen, Chuvash, Ge'ez, Gujarati, Gurage, Hadiyya, Hausa, Hungarian, Kambata, Levantine Arabic, Madurese, Malayalam, Moroccan Arabic, Oromo, Sidamo, Skolt Saami, Syrian Arabic	+	+	+	+
Finnish, Hindi, Icelandic, Karo Batak, Maithili, Persian, Ponapean, Somali, Tigre, Toba Batak	+	+	+	-
Bengali, Estonian, Inuktitut, Italian, Selayarese, Swedish	+	+	+	
Trukese	+		+	-
Blackfoot	+			-
Biblical Hebrew, Wolof	+	+	-	+
Punjabi, Selkup, Yakut, Fula	+	+	-	-
Chaha, Japanese, Luganda, Maranungku	+	-	-	-
Wichita	+		-	-
Gilbertese	+		-	
!Xóõ	-	-		

(34) The results suggest that we might view *RR as a set of constraints, universally ranked:

*YY (glides) » *LL (liquids) » *NN (nasals).

3.4 Observed Implication

(35) Though not independently predicted, one final implicational universal can be observed:

Geminate guttural → All other geminates

Can be captured by universal ranking: *GG » *DD, *RR, *SS

4 Conclusion

(36) Constraints on the segmental composition of geminates are necessary to account for language-internal alternations.

(37) Further work on constraints on the place of articulation for geminates is necessary.

(38) Segmental constraints on geminates work to restrict permissible geminate inventories cross-linguistically, suggesting that typological patterns are derived from the grammar and should not be considered merely descriptive generalizations.

Appendix

LANGUAGE	SOURCES USED[†]
Amharic	Leslau 1995
Balochi	Elfenbein 1997
Bengali	Bhattacharya 1984
Biblical Hebrew	Jouon 1991, Kelley 1992, Blau 1993, Lambdin 1971
Blackfoot	Uhlenbeck 1938, Frantz 1991
Buginese	Sirk 1983, Abas and Grimes 1995, Podesva 1998a, b
Chaha	Ford 1991
Chechen	McCarus 1997
Chuvash	Krueger 1961
Estonian	Lehiste 1966
Finnish	Lehtinen 1964, Sulkala and Karjalainen 1992
Fula	Paradis 1997
Ge'ez	Gragg 1997
Gilbertese	Groves et al. 1985
Gujarati	Cardona 1965
Gurage	Leslau 1992
Hadiyya	Stinson 1976
Hausa	Newman 1997
Hindi	Kaye 1997b
Hungarian	Kenesei et al. 1998
Icelandic	Garnes 1976
Inuktitut	Spalding 1979
Italian	Agard and di Pietro 1965, Rosenzweig 1965
Japanese	Vance 1987, Akamatsu 1997
Kambata	M.G. Sim 1998
Karo Batak	Woollams 1996
Levantine Arabic	Snow 1971
Luganda	Kirwan and Gore 1951
Madurese	Stevens 1968
Maithili	Yadav 1996
Malayalam	Asher and Khumari 1997
Maranungku	Tryon 1970
Moroccan Arabic	Harrell 1965
Oromo	Lloret 1997
Persian	Mehan 1966, Mahootian 1997
Ponapean	Garvin 1971, Rehg and Sohl 1979
Punjabi	Bhatia 1993, Malik 1995
Selayarese	Mithun and Basri 1986
Selkup	Helimski 1998
Sidamo	Moreno 1940
Skolt Saami	McRobbie-Utasi 1999
Somali	Armstrong 1964, Zorc 1990, Puglielli 1997
Swedish	Sigurd 1965, Holmes and Hinchcliffe 1996
Syrian Arabic	Cowell 1964
Tigre	Raz 1983
Toba Batak	Nababan 1981, Percival 1981, Hayes 1986a
Trukese	Dyen 1965
Turkish	Underhill 1965
Wichita	Rood 1974
Wolof	Ka 1994
!Xóõ	Traill 1968
Yakut	Krueger 1962

[†] Fuhll citations are not provided in the list of references, but will be provided upon request.

References

BLEVINS, JULIETTE. 1999. Understanding geminates: The evolution of consonantal length contrasts. Paper presented at the MIT Linguistics Colloquium, December 3, 1999, MIT.

GOLDSMITH, JOHN. 1990. Autosegmental and metrical phonology. Oxford: Blackwell.

KA, OMAR. 1994. Wolof phonology and morphology. Lanham, MD: University Press of America.

KATO, HIROAKI, MINORU TSUZAKI, and YOSHINORI SAGISAKA. 1997. Acceptability for temporal modification of consecutive segments in isolated words. Journal of the Acoustical Society of America 101.2311-22.

KIRCHNER, ROBERT. 2000. Geminate inalterability and lenition. Language 76.509-45.

LAMBDIN, THOMAS O. 1971. Introduction to Biblical Hebrew. New York: Charles Scriber's Sons.

LOMBARDI, LINDA. 1995. Restrictions on the direction of voicing assimilation: An OT account. University of Maryland Working Papers in Linguistics 3.89-115.

MCCARTHY, JOHN. 1994. The phonetics and phonology of Semitic pharyngeals. Papers in laboratory phonology III: Phonological Structure and Phonetic Form, ed. by Patricia Keating, 191-233. Cambridge: Cambridge University Press.

—— and ALAN PRINCE. 1995. Faithfulness and reduplicative identity. Amherst, MA and New Brunswick, NJ: UMass-Amherst and Rutgers University, MS. [ROA-13-0594, http://ruccs.rutgers.edu/ roa.html].

MITHUN, MARIANNE, and HASAN BASRI. 1986. The phonology of Selayarese. Oceanic Linguistics 25.210-254.

OHALA, JOHN. 1983. The origin of sound patterns in vocal tract constraints. The production of speech, ed. by Peter MacNeilage, 189-216. New York: Springer-Verlag.

PODESVA, ROBERT J. 1998. Buginese consonants: A phonetic and phonological study. Ithaca, NY: Cornell University honors thesis.

——. 2000. Constraints on geminates in Buginese and Selayarese. West Coast Conference on Formal Linguistics 19.343-56.

PUGLIELLI, ANNARITA. 1997. Somali phonology. Phonologies of Asia and Africa, ed. by Alan Kaye, 521-35. Winona Lake, IN: Eisenbrauns.

PULLEYBLANK, DOUGLAS. 1997. Optimality Theory and features. Optimality Theory, ed. by Diana Archangeli and D. Terence Langendoen, 59-101. Malden, MA: Blackwell.

ROSENTHALL, SAM. 1994. Vowel/glide alternation in a theory of constraint interaction. Amherst, MA: UMass dissertation.

ZAWAYDEH, BUSHRA ADNAN. 1998. The natural class "guttural": Endoscopic and acoustic evidence. Paper presented at Texas Linguistics Society (Exploring the Boundaries Between Phonetics and Phonology), March 13-15, 1998, University of Texas at Austin.

ZORC, DAVID, and ABDULLAHI ISSA. 1990. Somali textbook. Wheaton, MD: Dunwoody Press.