Explaining Diversity in Geminate Consonant Inventories: An Evolutionary Approach

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Sound Patterns

Phonology is traditionally defined as the study of **sound patterns** of the world's languages.

Sound Patterns include

- Contrastive sound inventories
- Patterns of sound distribution
- Conditioned variants of sounds
- Cognitive aspects of the above

Two basic types of contrast

Quality

/a/ vs. /i/

/á/ vs. /à/

/k/ vs. /p/

/b/ vs. /p/

/m/ vs. /b/

Quantity

/a/ vs. /a:/

/á/ vs. /á:/

/k/ vs. /k:/

/b/ vs. /b:/

/m/ vs. /m:/

Quantity Contrasts: Terminology and Transcription

	singleton	geminate
	short	long
	plain	doubled
	weak, lenis	strong, fortis
	C	C:
IPA:	[p], [t], etc.	[p:], [t:], etc.
Other:	/p/, /t/, etc.	/pp/, /tt/, etc.

Defining languages with singleton/geminate contrasts

For the purposes of this study, a language is said to have a particular singleton vs. geminate contrast when (i) the contrast is one of duration/quantity; (ii) the contrast defines minimal or near-minimal pairs; and (iiia) geminates are morpheme-internal; or (iiib) gemination itself is a morphological exponent.

Singleton/geminate contrast?

	English	Madurese	Koasati
Contrast in consonant duration?	Yes black king blacking	Yes tapa ‘mediate’ pappa ‘ko stem’	Yes aták ‘hang’ bakí ‘buggy’ atták IPFV bakkí ‘head’
(Near-)Minimal pairs?	Yes	Yes	Yes
Morpheme-internal?	No	Yes	(Rarely)
Morphological gemination ?	No	No	Yes exponent of imperfective
CONTRAST?	NO	YES	YES

Singleton/Geminate Contrasts: Phonetic correlates

The most salient phonetic correlate of phonological contrasts between singleton and geminate consonants is closure duration. On average, long stops have between 1.5-3 times the closure duration of short stops in careful speech.
(Ladefoged & Maddieson 1996:92)

Madurese singleton/geminate contrasts: mean closure durations in V_V (Cohn et al. 1999)

	singleton	geminate	ratio
vl. stops	107ms	165ms	1:1.5
vd. stops	85ms	145ms	1:1.7
asp. stops	112ms	159ms	1:1.4
frics. (vl.)	131ms	162ms	1:1.2 !
nasals	90ms	145ms	1:1.6
lateral	85ms	153ms	1:1.8
rhotic	20ms	114ms	1:5.7 !!
glides	106ms	160ms	1:1.5

Universals in geminate inventories

A number of universals or universal tendencies have been suggested for geminate inventories. Most of these are implicational universals, and are claimed to follow from phonetic and/or phonological markedness principles.

Some Proposed Implicational Universals

If there are geminate voiced stops then there are geminate voiceless stops. (Thurgood 1993)

If there is a geminate contrast, then there are geminate voiceless stops. (Podesva 2002)

If there are geminate sonorants, then there are geminate sonorants of lower sonority. (Podesva 2002)

If there are geminate fricatives, then there are geminate voiceless stops. (Podesva 2002)

A universal tendency

In languages with a contrast between long and short consonants, there is a strong tendency for the number of long consonants to be less than or equal to the number of short consonants. (Blevins 2005)

Diversity in geminate inventories

A pilot survey of the world's languages, however, shows that there is great diversity in the composition of geminate inventories. In some languages, all singletons contrast with geminates. In others, only a handful of consonants show a length contrast. (Blevins 2004, 2005)

Diversity in geminate inventories: Four Austronesian languages

Hawaian p k ʔ h l m n w ---------- **no geminates**	**Dobel** b t d k^w ɸ s m n ŋ l r w j ʔ b: t: d: k^w: ɸ: s: m: n: ŋ: l: r: w: j: ʔ: **all geminates**
Palauan p t k ð s m n ŋ l r w ʔ l: r: (some sonorants)	**Anejom^w** p p^w t k ʧ f θ s v ɣ m^w m n ɲ ŋ l r w j h p: p^w: t: k: (some obstruents)

Diversity and Implicational Universals

The initial survey shows counter-examples for all proposed absolute implicational universals:

If geminate voiced stops, then geminate voiceless stops.

No: Somali has only voiced geminate stops.

If geminates, then geminate voiceless stops.

No: 5 languages have only geminate sonorants.

If there are geminate sonorants, then there are geminate sonorants of lower sonority.

No: Palauan has geminate liquids, but not nasals.

If geminate fricatives, then geminate voiceless stops.

No: Wichita has geminate /s:, ts:, r:/ only.

Diversity and Implicational Universals

The initial survey also shows a counter-example to the strong tendency for geminate inventories to be smaller, or the same size as singleton inventories.

In Finnish, each geminate is paired with a corresponding singleton, except for /ŋ:/. The geminate velar nasal /ŋ:/ occurs only intervocalically, where it is the weak grade of /ŋk/. However, since short /ŋ/ occurs only preceding /k/ in Finnish, it is normally considered an allophone of /n/.

Diversity and Universal Tendencies

A number of additional universal tendencies are suggested, including:

- Voicing gaps
- Sibilant gaps
- Tap/flap gaps
- Laryngeal gaps

Diversity and Geminate Origins

The most significant finding of this pilot study, however, is a potential correlation between geminate inventory and historical source of geminate consonants. Given multiple pathways of geminate evolution, it may be possible to explain the diversity of geminate inventories in terms of their distinct historical origins.

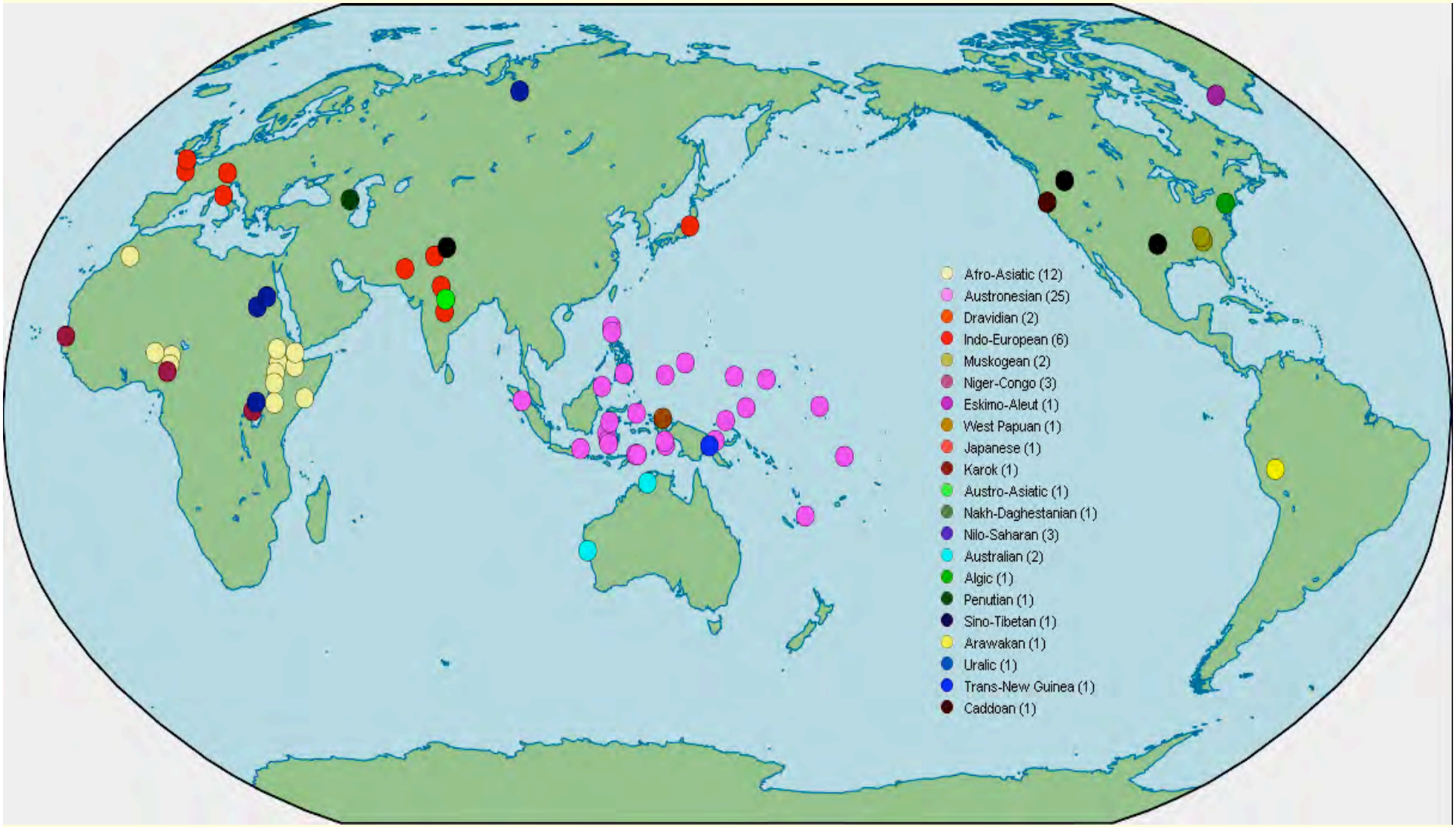
Geminate Origins and Evolutionary Phonology

If verified, this finding would support a central hypothesis of Evolutionary Phonology: namely, that many common sound patterns result from common phonetically motivated sound change. In the case of geminate inventories, different inventory subtypes may be viewed as recurrent or common sound patterns.

A database of geminate inventories

In order to assess the status of these universal tendencies and explanations for inventory diversity, a database of geminate inventories is being compiled. Currently, the database includes 73 languages representing 22 different families and 39 genera. Singleton and geminate inventories are included, as well as geminate gaps, and historical origins, where known.

Geminate Inventory Database: Bird's-eye View



Geminate Inventory Database: Typologist's View

Tashlhiyt	Afro-Asiatic	Berber	**Palauan**	Austronesian	Palauan
Oromo	Afro-Asiatic	Eastern Cushitic	**Taba**	Austronesian	South Halmahera - West New Guinea
Qafar	Afro-Asiatic	Eastern Cushitic	**Kagayanen**	Austronesian	Southern Philippines
Rendille	Afro-Asiatic	Eastern Cushitic	**Bugis**	Austronesian	Sulawesi
Tsamakko	Afro-Asiatic	Eastern Cushitic	**Bugis (Rappang)**	Austronesian	Sulawesi
Sidamo	Afro-Asiatic	Eastern Cushitic	**Konjo**	Austronesian	Sulawesi
Somali	Afro-Asiatic	Eastern Cushitic	**Selayar**	Austronesian	Sulawesi
Amharic	Afro-Asiatic	Semitic	**Totoli**	Austronesian	Sulawesi
Ge'ez	Afro-Asiatic	Semitic	**Batak (Toba)**	Austronesian	Sundic
Hebrew (Tiberian)	Afro-Asiatic	Semitic	**Madurese**	Austronesian	Sundic
Sil'te	Afro-Asiatic	Semitic	**Wichita**	Caddoan	Caddoan
Zay	Afro-Asiatic	Semitic	**Creek**	Muskogean	Muskogean
Bole	Afro-Asiatic	West Chadic	**Kolami**	Dravidian	Central Dravidian
Hausa	Afro-Asiatic	West Chadic	**Brahui**	Dravidian	Northern Dravidian
Pero	Afro-Asiatic	West Chadic	**Greenlandic (West)**	Eskimo-Aleut	Eskimo-Aleut
Munsee	Algic	Algonquian	**Breton**	Indo-European	Celtic
Piro	Arawakan	Arawakan	**Cornish**	Indo-European	Celtic
Nhanda	Australian	Pama-Nyungan	**German (Thurgau)**	Indo-European	Germanic
Maranungku	Australian	Western Daly	**Hindi**	Indo-European	Indic
Korku	Austro-Asiatic	Munda	**Panjabi**	Indo-European	Indic
Begak-Ida'an	Austronesian	Borneo	**Italian**	Indo-European	Romance
Dobel	Austronesian	Central Malayo-Polynesian	**Japanese**	Japanese	Japanese
Kisar	Austronesian	Central Malayo-Polynesian	**Karok**	Karok	Karok
Leti	Austronesian	Central Malayo-Polynesian	**Koasati**	Muskogean	Muskogean
Pattani Malay	Austronesian	Central Malayo-Polynesian	**Lak**	Nakh-Daghestanian	Lak-Dargwa
Roma	Austronesian	Central Malayo-Polynesian	**Luganda**	Niger-Congo	Bantoid
Bontok	Austronesian	Northern Philippines	**Fula (Nigerian)**	Niger-Congo	Northern Atlantic
Ilocano	Austronesian	Northern Philippines	**Wolof**	Niger-Congo	Northern Atlantic
Anejom	Austronesian	Oceanic	**Lango**	Nilo-Saharan	Nilotic
Arop-Lokep	Austronesian	Oceanic	**Nobiin**	Nilo-Saharan	Nubian
Chuukese	Austronesian	Oceanic	**Nubian (Kunuz)**	Nilo-Saharan	Nubian
Kapingamarangi	Austronesian	Oceanic	**Nez Perce**	Penutian	Sahaptian
Kiribati	Austronesian	Oceanic	**Selkup**	Uralic	Samoyedic
Mokilese	Austronesian	Oceanic	**Usarufa**	Trans-New Guinea	Eastern Highlands
Mussau	Austronesian	Oceanic	**Hatam**	West Papuan	Hatam
Tuvaluan	Austronesian	Oceanic	**Zuni**	Zuni	Zuni
Ulithian	Austronesian	Oceanic			

Geminate Inventory Database: Phonologist's View

wals_name	**Palauan**	wals_macro_area	SE Asia & Oceania	wals_all_countrie	
SIL code	pau	wals_fam	Austronesian	wals_genu	

notes on the language

singleton inventory	p t k ð s m ŋ r l w ʔ				
geminate inventory	r: l:				
T: vs. D: contrast	-		entirely obstruents	0	
gap: voicing	-		entirely sonorants	1	
			all geminates	0	
short rhotic flap	1				
short lateral flap	0		geminate voiceless stops	0	
gap: r	0		geminate voiced stops	-	
gap: l	0		geminate affricates	-	
			geminate fricatives	0	
gap: glides	1		geminate sibilants	0	
gap: sibilants	1		geminate liquids	1	
			geminate glides	0	
gap: laryngeals	1		geminate nasals	0	
gap: pharyngeals	-		geminate pharyngeals	-	
laryngeal gap due to restricted distribution	0		geminate laryngeals	0	

referer

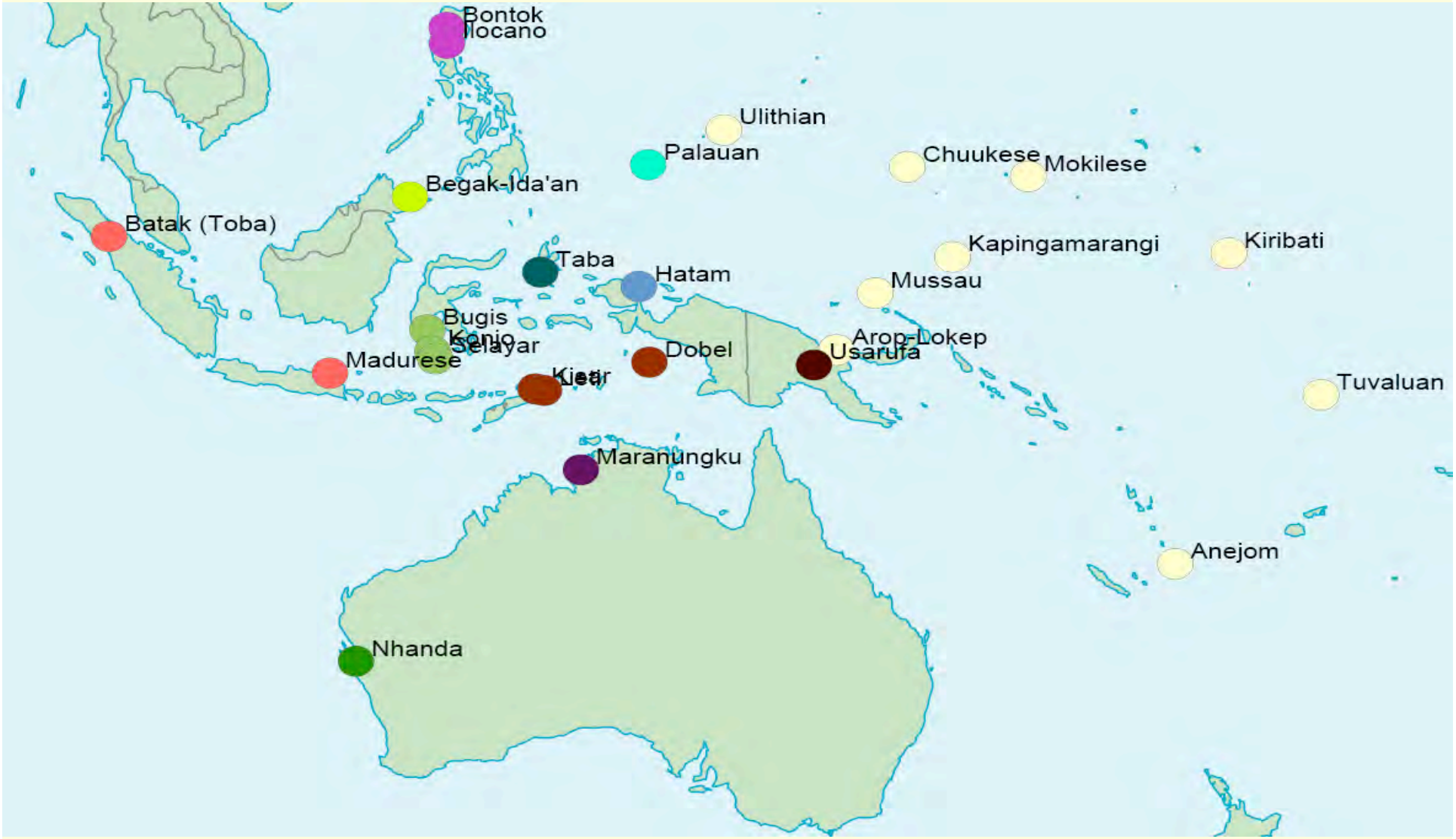
notes on geminate inventory

	- allows initial

notes on geminate evolution

- historical *n > l, + syncope, assimilation chiull < PMP *qalunan 'wooden headrest, pillow' chull 'rain' < <churVl, chudVl PMP *quzan	Josephs, Lew Hawai Press. Joseph, Lewi Press.

Geminate Inventory Database: Specialist's View



Diversity in Geminate Inventories: Central Question

Given multiple pathways of geminate evolution, is it possible to explain the diversity of geminate inventories in terms of their historical origins?

Geminate Evolution: 8 Natural Pathways

(Blevins 2004, 2005)

1. Assimilation in consonant clusters
2. Assimilation consonant + vowel/glide clusters
3. Vowel syncope between identical consonants
4. Lengthening under stress
5. Expressive lengthening
6. Boundary lengthening
7. Reinterpretation of an obstruent voicing contrast
8. Reanalysis of identical C-C sequences
9. Language contact

Pathway 1: Assimilation in Consonant Clusters

Schematic change: CiCj > CiCi or CjCj

Predictions

Geminate inventory will be limited to assimilating clusters. Since assimilations of this type are common, this should be a common source of geminates.

Facts

Many small geminate inventories arise in this way (Palauan, Wichita), but large ones can too (Hausa). In each case, it is the generality of the assimilatory process which determines make-up of the geminate inventory.

Assimilation in Consonant Clusters: Examples

Language:	Palauan
Singletons:	p t k ð s m n ŋ l r w ʔ
Geminates:	l: r:
Sound changes:	*rl > ll, *lr > rr

Language:	Wichita
Singletons:	t k k^w ts s ɾ̃ w j h ʔ
Geminates:	ts: s: ɾ̃:
Sound changes:	*{r,j,h} > s/ {s,ts}_; t > ts/_ts

Exs. in database: 16/73

Pathway 2: Assimilation in Consonant V/G

Schematic change: CiX, XCi > CiCi, X = {i,u,j,w}

Predictions

Geminate inventory will be limited to assimilating clusters. Since assimilations of this type are not common, this should not be a common source of geminates.

Facts/Notes

All known cases are with {i,j}. Difficult to distinguish some of these from coronal-coronal assimilations, or assimilation of C to *h, since 'super-high' vowels may be associated with similar noise.

Assimilation in Consonant V/G: Examples

Language:	Kiribati
Singletons:	p p^w t k m n m^w ŋ ɾ w
Geminates:	m: n: ŋ:
Sound change:	*ni > nn

Language:	Luganda
Singletons:	p b t d k g ʧ ʤ f v s z m n ɲ ŋ r l w j
Geminates:	p: b: t: d: k: g: ʧ: ʤ: f: v: s: z: m: n: ɲ: ŋ:
Sound change:	*įC > CC (į = superhigh vowel)

Exs. in database: 3/73

Pathway 3: Syncope between identical Consonants

Schematic change: …CiVCi… > CiCi

Predictions

Full geminate inventory should arise. Since sound change is sensitive to independent structural conditions (disyllabic output, CV transition constraints), resulting geminate inventories may be limited to certain language families.

Facts

Multigenesis in Austronesian (at least 12 independent cases); rare elsewhere. Full, near-full inventories.

Syncope in CiVCi: Examples

Language:	Dobel
Singletons:	b t d k^w ɸ s m n ŋ l r w j ʔ
Geminates:	b: t: d: k^w: ɸ: s: m: n: ŋ: l: r: w: j: ʔ:
Sound change:	*V > ø/Ci_Ci

Language:	Chuukese
Singletons:	$p^ɣ$ p t c k g f s m $m^ɣ$ n r w j
Geminates:	$p^ɣ$: p: t: c: k: g: f: s: m: $m^ɣ$: n: r:
Sound change:	*V > ø/Ci_Ci

Exs. in database: 3/73 (+5 w/ syncope + assimilation)

Pathway 4: Lengthening under stress

Schematic change: …Ci… > CiCi

Predictions

Full geminate inventory should arise. In order to be phonologized, subsequent changes must take place (e.g. neutralization of vowel contrast, stress shift, etc.). These subsequent changes can skew inventory towards more random distributions.

Facts

Many languages have allophonic gemination in this context; few show phonologization.

Lengthening under stress: Examples

Language:	Konjo
Singletons:	p t k b d g ʧ ʤ s m n ɲ ŋ r l h ʔ
Geminates:	p: t: k: s: m: n: ŋ: r: l:
Sound change:	*əCV > əC:V, *ə > a

Language:	Zuni
Singletons:	p t ts ʧ k k^w s ʃ ɬ m n l w j h ʔ
Geminates:	p: t: ts: ʧ: k: k^w: s: ʃ: ɬ: m: n: l: w: j: h: ʔ:
Sound change:	*VCV > VC:V

Exs. in database: 4/73

Pathway 5: Expressive Lengthening

Schematic change: …Ci… > CiCi (under emphasis)

Predictions

Small random inventory should arise, based on class of words produced under special expressive or emphatic conditions.

Facts

Many languages have allophonic gemination in this context; few show phonologization. Phonologization typically targets one-word utterances (emphatic pronouns, deictics, vocatives etc.). All known cases have pre-existing singleton/geminate contrasts.

Expressive Lengthening: Examples

Language: West Greenlandic Eskimo
Singletons: p t k q v s ɣ ʁ m n ŋ l j
Geminates: p: t: k: q: v: s: ɣ: ʁ: m: n: ŋ: ɴ: l:
Sound change: …Ci… > CiCi ’ikka ‘look yonder!’

Language: Brahui
Singletons: p t ʈ k b d ɖ g ʧ ʤ f s z ʃ ʒ x ɣ m n ɲ l ɬ r ɽ w j h ʔ
Geminates: p: t: ʈ: k: b: d: ɖ: g: ʧ: ʤ: f: s: z: ʃ: ʒ: x: ɣ: m: n: ɲ: l: ɬ: r: ɽ: w: j: h: ʔ:
Sound change: …Ci… > CiCi kas: ‘kinsman’

Exs. in database: 3/73

Pathway 6: Boundary Lengthening

Schematic change: …Ci… > CiCi

Predictions

Full geminate inventory should arise.

Facts

Phonetic phrase-final lengthening is a feature of all languages studied to date. Some cases of boundary lengthening may be a phonologization of this. Like expressive lengthening, it is strongly associated with pre-existing singleton/geminate contrasts. A well studied example is Italian raddoppiamento sintattico.

Boundary Lengthening: Examples

Language:	Mokilese
Singletons:	p t c k p^w ʤ m n ŋ m^w s l r
Geminates:	p: t: c: k: p^w: ʤ: m: n: ŋ: m^w: s: l: r:
Sound change:	…Ci… > CiCi

Language:	Qafar
Singletons:	b t d ɖ k g s f m n r l w j ħ ʕ h
Geminates:	b: t: d: ɖ: k: g: s: f: m: n: r: l: w: j: ħ: ʕ:
Sound change:	…Ci… > CiCi

Exs. in database: 2/73 (+ Wolaytta)

Pathway 7: Reinterpretation of Obstruent Voicing

Schematic change: T vs. D > T: vs. T (Blevins 2004:175-77)

Predictions

Geminate inventory restricted to voiceless obstruents.

Facts

In most languages, voiceless obstruents are significantly longer than their voiced counterparts. Given this, the change above seems possible. It was proposed by Emeneau (1968): Proto-Dravidian T, D > T:, T in Malayalam and Tamil. Similar mappings are found in Swiss German loanword phonology (1/73).

Reinterpretation of Obstruent Voicing: Example

Language: Thurgovian (Swiss German dialect)

Singletons: p t k f s ʃ x pf ts kx m n l w j ʀ

Geminates: p: t: k: f: s: ʃ: x: m: n: ŋ: l:

Loan phonology: T vs. D >> T: vs. T

Geminates were inherited from Old Allemanic in medial and final position. Word-initial geminates have entered the language through loans. Swiss German does not have a voicing contrast. In loans, the length contrast is mapped to the voicing contrast, as in:

Ballast >> /palaʃt/ Palast >> /p:alaʃt/

Exs. in database: 1/73 (Kraehenmann, 2001)

Pathway 8: Reanalysis of identical C+C sequences

Schematic change: Ci + Ci > C: (Blevins 2004:177-78)

Predictions

- Random inventory of geminates, depending on morpheme-initial/final segments.

Facts

- Only detailed historical phonologies allow these to be disambiguated from assimilations at morpheme boundaries and/or boundary lengthening.

Reanalysis of identical C+C sequences: Example

Language:	Wichita
Singletons:	t k k^w ts s ɾ̃ w j h ʔ
Geminates:	ts: s: ɾ̃:
Reanalysis:	s+s > s: (cf. Pawnee > s-c)
	ts+ts > ts:
	r+r > r: (cf. Pawnee > rir, r)

Whether reanalysis is dependent on pre-existing geminates derived via assimilation is unclear. Related Pawnee has neither historical assimilation nor reanalysis, and shows dissimilation, epenthesis or degemination in similar contexts.

Exs. in database: 1/73

Conclusions

There appears to be a correlation between geminate inventory and historical source of geminate consonants. Given multiple pathways of geminate evolution, it is possible to explain many aspects of the diversity of geminate inventories in terms of their historical origins.

Future Research: Universal Tendencies

As the database grows, and more ‘origin’ fields are filled in, we will be in a better position to assess the role of universal tendencies in shaping geminate inventories. For example, at present, 21/73 languages lack rhotic geminates. However, in some of these languages, small geminate inventories are a consequence of local assimilations which did not target rhotics, and in others, the origins of geminates are unknown.

Future Research: Rare Inventory Types

As the database grows, we will also be in a better position to assess the nature of rare inventory types. For example, at present Somali is the only language in the database that has voiced geminate obstruents, but lacks voiceless ones. Is this a direct consequence of historical progressive voice assimilation in consonant clusters at morpheme boundaries, - itself a rare sound pattern?

Special thanks to Bodo Winter, University of Cologne, for his assistance on this project during a recent internship in our department. And to Mauro Tosco for sharing his expertise on Cushitic with us.

And thank you for your attention!

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