RECONSIDERING FAVORED PHONOTACTIC PATTERNS FOR EJECTIVE AND IMPLOSIVE CONSONANTS

Shelece Easterday

University of Hawai‘i at Mānoa
shelece@hawaii.edu

ABSTRACT

This study quantitatively examines an influential generalization from Greenberg (1970): that syllable-initial position is favored for glottalic consonants. In a diverse sample of 106 languages having ejectives and/or implosives, the phonotactic distribution of these consonants was characterized. While Greenberg's generalization holds, it does not capture some stark crosslinguistic differences in the distributional patterning of the two consonant types: for example, while only 4/25 (16%) languages with implosives and word-final stops feature implosives in this position, over half the languages with ejectives and word-final stops feature ejectives in this position (33/55, 60%). Further qualitative comparison of reported phonetic processes affecting ejectives and implosives suggests that a plausible interpretation of Greenberg's generalization – that glottalic consonants are frequently subject to neutralizing deglottalization in codas – should be reconsidered.

Keywords: ejectives, implosives, typology, sound change

1. INTRODUCTION

Approximately 28% of the world's spoken languages have glottalized consonants, which involve a "[tight] constriction of the vocal folds and/or a movement of the larynx a short distance up or down in the throat" [1]. Since Greenberg's influential 1970 study [2], two of these consonant types, ejectives and implosives (henceforth 'glottalic consonants'), have been the subject of synchronically- and diachronically-oriented crosslinguistic investigation [3, 4, 5, 6].

Most of the synchronic generalizations in [2] illustrate how ejective and implosive consonants differ from one another in their crosslinguistic patterning with respect to voicing, place of articulation preferences, and their relation to other series of consonants within phonological inventories. One of the few generalizations made by [2] concerning the two consonant types jointly is the following: "Syllabic initial position is favored for glottalic consonants in general. In almost every language studied they occur in syllable initial position, while in many they do not occur in syllable final even when the corresponding plain consonants do." While this generalization is often cited in works on glottalic consonants, it leaves out key details. The generalization was not quantitatively characterized in [2], and it is unclear from its formulation whether ejective and implosive consonants are purported to favor initial position to the same extent, or disfavor non-initial positions to the same extent.

Further, the above generalization has been interpreted to suggest that glottalic consonants are likely to be deglottalized through active processes of phonological neutralization in coda position [4]. Some crosslinguistic properties of the deglottalization and loss of implosives were explored in [2] and a study on glottalic consonants in Austronesian [3], but almost entirely with respect to place of articulation preferences in implosive inventory structure. These works do not explicitly examine ongoing phonetic processes or historical sound changes involving the deglottalization of implosives with respect to the stated preference for initial over final position or discuss them with respect to putative coda neutralization patterns. Processes of ejective deglottalization have been studied in a sample of moderate size in [4] with an eye towards investigating laryngeal neutralization in coda position. To date no study has considered and compared the properties of deglottalization processes affecting implosives and those affecting ejectives.

2. RESEARCH QUESTIONS

The current study seeks to address the following open questions regarding the synchronic and diachronic details of the distributional properties of glottalic consonants: (1) To what extent do ejectives and implosives exhibit a similar (dis)preference for initial and final positions within the syllable and the word? (2) How common is complete active phonological neutralization of ejective or implosive consonants in coda position? (3) To what extent are variable phonetic processes which deglottalize ejective or implosive consonants conditioned by position in the syllable or word?

These research questions are addressed within a survey of genealogically and geographically diverse languages which are reported to have ejective and/or implosive consonants.

3. METHOD

3.1. Language sample

The language sample consists of 106 languages reported to have contrastive ejective consonants, contrastive implosive consonants, or both (Table 1). The languages represent 84 families according to the classifications in [7], and diverse subgroupings wherever a family is represented by more than one language. Altogether, 72 languages in the sample are reported to have ejectives and 51 are reported to have implosives. Both consonant types are present in 17 languages. The sample was constructed to maximize geographic diversity; however, given the well-known skewed regional distributions of both consonant types [1, 5], the ejective and implosive portions of the sample represent largely non-overlapping regions of the world. Over half of the languages with ejectives belong to small language families in North and South America, while over half of the languages with implosives belong to families of large and moderate size in Africa and Southeast Asia and Oceania.

EJECTIVES (72 lgs)																
Language	**(i)**	**(ii)**	**(iii)**	**(iv)**	**Language**	**(i)**	**(ii)**	**(iii)**	**(iv)**	**Language**	**(i)**	**(ii)**	**(iii)**	**(iv)**
Abkhaz	✓	✓	✓	✓	Itonama	✓	✓			Shabo	✓	✓	-	-
Berta	✓	✓	✓		Klamath-Modoc	✓	✓	nt.	nt.	Shasta	✓	✓	✓	✓
Caddo	✓	✓	-	-	Komo (Sudan)	✓	✓	nt.		S. Haida	✓	✓	-	✓
C. Aymara	✓	✓	✓	✓	Kutenai	✓	✓	✓	✓	S. Nambikuára	✓	✓		-
C. Mazahua	✓	✓		-	Lake Miwok	✓	✓	-	✓	Squamish	✓	✓	✓	✓
Chimariko	✓	✓	✓	✓	Lakota	✓	✓	-	-	Taos N. Tiwa	✓	✓	-	
Chipaya	✓	✓	-	-	Lezgian	✓	✓	✓	✓	Tehuelche	✓	✓	✓	✓
Coahuilteco	✓	✓	✓	-	Me'en	✓	✓	-	-	Tigre	✓	✓	✓	✓
Cusco Quechua	✓	✓	-	-	Molale	✓	✓	-	-	Tlingit	✓	✓	✓	✓
Dawro	✓	✓			Mpade	✓	✓			Tojolabal	✓	✓	✓	-
Digor Ossetian	✓	✓	-	-	Nisga'a	✓	✓	✓	✓	Tol	✓	✓	✓	✓
Dizin	✓	✓	✓	-	Nivaclé	✓	✓	nt.	nt.	Trumai	✓	✓	✓	✓
E. Oromo	✓	✓	✓	✓	N.E. Maidu	✓	✓	-	-	Ts'ixa	✓	✓		
E. Pomo	✓	✓	✓	✓	N. Gumuz	✓	✓	✓		W. !Xoon	✓	✓		
Emberá-Catío	✓	✓			N. Yokuts	✓	✓	✓	✓	W. Itelmen	✓	✓	✓	✓
Ganza	✓	✓	✓	✓	N. Yukian	✓	✓	nt.	nt.	W. Keres	✓	✓		
Georgian	✓	✓	✓	✓	N.W. Sahaptin	✓	✓	✓	✓	W. Niger Fulfulde	✓	✓		
Hadza	✓	✓			Nuu-chah-nulth	✓	✓	✓	✓	Witsuwit'en	✓	✓	-	-
Hamer-Banna	✓	✓	✓		Patwin	✓	✓	-	-	Yana	✓	✓	✓	✓
Hanis	✓	✓	✓	-	Piaroa	✓	✓			Yapese	✓	✓	✓	-
Hausa	✓	✓	-	-	Puelche	✓	✓	-	-	Yuchi	✓	✓		
Huehuetla Tepehua	✓	✓	-	-	Qawasqar	✓	✓	-	-	Yurok	✓	✓	✓	✓
Ik	✓	✓			Quileute	✓	✓	✓	✓	Zulu	✓	✓		
Ineseño	✓	✓	✓	nt.	Sandawe	✓	✓			Zuni	✓	✓		-
IMPLOSIVES (51 lgs)																
Language	**(i)**	**(ii)**	**(iii)**	**(iv)**	**Language**	**(i)**	**(ii)**	**(iii)**	**(iv)**	**Language**	**(i)**	**(ii)**	**(iii)**	**(iv)**
Aja	✓	✓			Keiga	✓	✓	-	✓	N.E. Maidu	✓	✓	-	-
Berta	✓	✓	✓		Khmer	✓	✓	-		N. Burun	✓	✓	-	
Brao	✓	✓	-		Khmu	✓	✓	-	-	N. Gumuz	✓	✓	✓	
C. Mazahua	✓	✓		-	Kimaragang	✓	✓	-	-	Otoro	✓	-		
Dar Daju Daju	✓	✓		-	Komo (Sudan)	✓	-	-		Paumari	✓	✓		
Dawro	✓	✓			Kwaza	✓	✓			Pwo N. Karen	✓	✓		
Doyayo	✓	✓	-	-	Lakkia	✓	✓	-	-	Sabanê	✓	✓		
E. Oromo	✓	✓	-	-	Lele	✓	✓			Shabo	✓	✓	-	-
Ese Ejja	✓	✓			Ma'di	✓	✓			Sindhi	✓	✓		
Gabogbo	✓	✓			Mandari	✓	✓	-		S. Kisi	✓	✓		
Gbagyi	✓	✓			Mann	✓	✓			Tese	✓	✓	-	-
Hamer-Banna	✓	✓	✓		Me'en	✓	✓	-	-	Tojolabal	✓	✓	✓	-
Hausa	✓	✓	nt.	✓	Movima	✓	✓	-	-	Tsat	✓	✓	-	-
Huehuetla Tepehua	✓	✓	-	-	Mpade	✓	✓			Tsou	✓	✓		✓
Ik	✓	✓			Mubi	✓	✓	nt.	nt.	Tukang Besi N.	✓	✓		
Kambera	✓	✓			Ngambay	✓	✓	-	-	W. Niger Fulfulde	✓	✓		✓
Karajá	✓	✓			Ngbaka Manza	✓	✓			Zulu	✓	✓		

Table 1: Languages in the sample with glottalic consonants, coded for properties (i)-(iv) (see 3.2). ✓ = Glottalic Cs occur in this position; **-** = Glottalic Cs do not occur in this position; **nt.** = Glottalic Cs are deglottalized through complete active neutralization in this position; shaded cell = non-glottalic counterparts do not occur in this position.

3.2. Data collection and coding

The inventory of contrastive ejective and/or implosive consonants in each language was gathered from phonological descriptions. For each language, it was noted whether the phonotactics permit corresponding non-glottalic consonants (usually stops) to occur word-finally or in word-medial codas.

For each language, it was noted whether any of the relevant glottalic consonant types occur in the following positions: (i) word-initially; (ii) word-medially in intervocalic position; (iii) word-finally; and (iv) in a word-medial coda. It was also noted whether glottalic consonants are analyzed as being actively neutralized to non-glottalic counterparts in positions (iii) or (iv), as supported by evidence from morphophonemic alternations in the description.

The coding for the language sample can be found in Table 1. It is exemplified as follows: In Ma'di, which has an implosive inventory of /ɓ ɗ ƒ/ and no codas of any kind, implosives may occur (i) word-initially, /ɓà/ 'home', and (ii) word-medially in intervocalic position, /màɗí/ 'Madi' [8]. In Eastern Pomo, which has an ejective inventory of /p' t̪' t' ts' tʃ' k' q'/ and allows stops/affricates in coda positions, ejectives occur (iii) word-finally, /t͡sét͡s'/ 'dandelion', and (iv) in word-medial codas, /xa.ʃaːk'.le/ 'killed, they say' [9]. In Klamath-Modoc, which has an ejective inventory of /p' t' tʃ' k' q'/ and word-medial and word-final stop/affricate codas, all word-final stops are actively neutralized to aspirated voiceless stops: cf. /nt͡ʃ'ek'/ [nt͡ʃ'ekʰ] 'in little bits' and [nt͡ʃ'ek'aːni] 'small, little' [10, 11].

In addition to the above properties, processes reported in the reference materials which have the effect of deglottalizing ejective or implosive consonants were noted. These include variable phonetic processes conditioned by the phonological environment, speech rate, or social factors, and fully neutralizing phonological processes that affect some or all members of the ejective/implosive inventory.

4. RESULTS

4.1. Distributional properties of glottalic consonants

The distributional properties of glottalic consonants in the language sample are shown in Figure 1. The figure shows the percentage of relevant languages in which ejectives and implosives occur, do not occur, or are subject to complete active neutralization in positions (i)-(iv) (see 3.2 for definitions). Note that only languages with the relevant phonotactic possibilities are represented in Figure 1: for example, the percentages for (i) are calculated over all 72 languages with ejectives and all 51 languages with implosives; however, for (iii) the percentages are calculated over only the languages in which non-glottalic counterpart consonants, usually stops, can occur in word-final position (55 languages with ejectives and 25 languages with implosives).

In this sample, ejectives and implosives can occur word-initially in all languages which have them. This is nearly the case for word-medial intervocalic position, as well: the exceptions are Komo, in which implosives are limited to word-initial position [12], and Otoro, in which the sole implosive /ɗ/ is reported to be extremely rare and is illustrated only in word-initial contexts in [13].

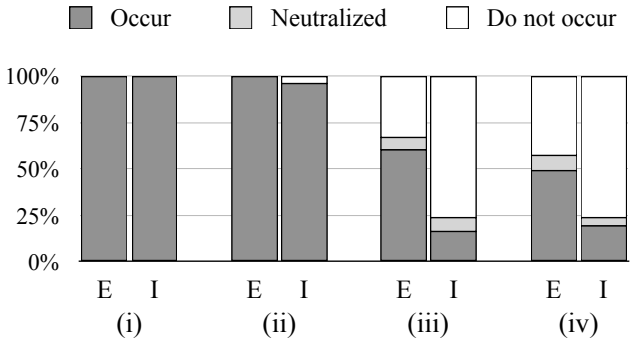

Figure 1: Percentage of relevant languages in which ejectives (E) and implosives (I) (do not) occur or are neutralized, by position in syllable or word (see 3.2).

Ejectives occur in word-final position in 33/55 (60%) of the languages for which that pattern is relevant. In four other languages – Klamath-Modoc [10], Komo [12], Nivaclé [14], and Northern Yukian [15] – ejectives are reported to be subject to complete active neutralization in word-final position. Implosives occur word-finally in only 4/25 (16%) of the relevant languages: Berta [16], Hamer-Banna [17], Northern Gumuz [18], and Tojolabal [19]. Word-final implosives are neutralized to plain voiceless stops in Hausa [20] and to unreleased voiceless stops in Mubi [21].

Ejectives occur in word-medial coda position in 26/53 (49%) of the languages with the relevant phonotactic patterns. Ejectives are fully neutralized in this position in four other languages: Ineseño [22], Klamath-Modoc [10], Nivaclé [14], and Northern Yukian [15]. Implosives occur in word-medial codas in 4/21 (19%) of the relevant languages: Hausa [20], Keiga [23], Tsou [24], and Western Niger Fulfulde [25]. Implosives are neutralized to unreleased voiceless stops in this position in Mubi [21].

To summarize, word- and syllable-initial positions are clearly crosslinguistically favored for glottalic consonants. However, among languages in which non-glottalic counterparts may occur word- and syllable-finally, ejectives are much more likely to occur in these positions than implosives.

4.2. Processes deglottalizing ejectives

Variable phonetic processes which deglottalize ejectives are reported in 14/72 languages with ejectives. None of these occur exclusively in word- or syllable-final environments.

The most common environment for the variable deglottalization of ejectives is in fact intervocalic, or more generally word-medial, position (five languages). For example, all ejectives can be realized as plain voiced stops intervocalically in Komo [12]. Other phonological factors conditioning variable deglottalization include an adjacent glottalized consonant (Central Aymara [26]), and strikingly, initial position: in Tol, a glottalized stop onset of a stressed syllable varies with a plain stop followed by a laryngealized vowel [27]. Variable deglottalization of ejectives is often not phonologically conditioned: it is conditioned by factors such as speech rate and speaker age in five languages, including Ik [28]. Unconditioned variable deglottalization of ejectives is reported for Ineseño [22] and Qawasqar [29].

Apart from the complete neutralization processes affecting entire ejective inventories in coda position discussed in 4.1, near-neutralization to slightly aspirated voiceless stops is reported for word-final ejectives in Nisga'a [30]. In three additional languages, a subset of the ejective series is neutralized in some environment, but just one such process is conditioned by coda position: in Ganza, word-final ejective stops, but not fricatives, are neutralized to their plain voiceless counterparts [31].

4.3. Processes deglottalizing implosives

Variable phonetic processes which deglottalize implosives are reported for 9/51 languages with implosives. These are conditioned by a syllable- or word-final environment in just one language: in Northern Gumuz, /ɗ/ tends to weaken to a flap post-vocalically, and /ɓ/ tends to weaken to an unreleased voiced bilabial stop word-finally [19]. The seven other languages which have coda implosives (Table 1) are not reported to have phonetic processes which deglottalize them in this position.

Variable deglottalization of implosives is conditioned by intervocalic position in four languages, including Sabanê [32]. Variable deglottalization occurs in unstressed syllables in Kwaza [33] and in postconsonantal position in Southern Kisi [34]. Speech rate and age (partially) condition variable deglottalization of implosives in four languages, including Hamer-Banna [17].

As discussed in 4.1, Hausa and Mubi have complete neutralization processes which deglottalize all implosives in coda positions. No additional languages here were reported to have deglottalization processes which fully neutralize a subset of the implosive inventory.

5. DISCUSSION

The results of the crosslinguistic survey fill in important details of Greenberg's generalization that syllable-initial position is preferred for glottalic consonants, but they also complicate its usual diachronic interpretation.

While ejective and implosive consonants pattern very similarly in that they occur in word-initial and word-medial intervocalic position in nearly all languages which have them, they differ starkly in their distribution in word-medial and word-final codas. In languages in which non-glottalic counterparts occur in these positions, ejectives are much more likely than implosives to be permitted in codas. Thus, while the generalization in [2] holds with respect to initial position, the dispreference for final position may be somewhat overstated for ejectives. Here it is worth noting that languages with ejectives and those with implosives tend to have different phonotactic profiles in general: this is apparent from the patterning of the shaded cells in Table 1. Further, a strong correlation has previously been established between syllable complexity and the presence of contrastive ejectives [35], but the precise motivation behind this correlation is not yet known.

Although the generalization in [2] has been interpreted to suggest that entire glottalic consonant series are susceptible to active phonological neutralization processes in final position, only seven languages in the sample show this pattern. Even disregarding languages without stops in the coda, this low rate may seem surprising given how prominently the phenomenon of laryngeal neutralization features in the phonological literature [36, 37, 38]. As noted by [4], complete neutralization is a powerful theoretical device entailing a long diachronic process and is therefore not necessarily straightforward to glean from synchronic descriptions. However, a survey of reported variable processes deglottalizing ejective and implosive consonants in the language sample turned up very few which target these consonants in final positions. Deglottalization processes most often apply intervocalically, a position in which the distribution of glottalic consonants is mostly unrestricted. Additionally, many reported variable deglottalization processes are not phonologically conditioned. These results, gathered from qualitative descriptions, should be verified by systematic phonetic studies, but they suggest that assumptions regarding the susceptibility of word- and syllable-final glottalic consonants to neutralizing deglottalization should be reconsidered.

7. REFERENCES

[1] Maddieson, I. 2013. Glottalized consonants. In: Dryer, M. S., Haspelmath, M. (eds.), *The World Atlas of Language Structures Online*. Max Planck Institute for Evolutionary Anthropology. (Available online at http://wals.info/chapter/7, Accessed on 2023-01-02.)

[2] Greenberg, J. 1970. Some generalizations concerning glottalic consonants, especially implosives. *International Journal of American Linguistics* 36, 123–145.

[3] Blust, R. 1980. More on the origins of glottalic consonants. *Lingua* 52, 125-156.

[4] Fallon, P. D. 2002. *The synchronic and diachronic phonology of ejectives*. Routledge.

[5] Urban, M., Moran, S. 2021. Altitude and the distributional typology of language structure: Ejectives and beyond. *PLoS ONE* 16: e0245522.

[6] Easterday, S., Bybee, J. In press. Diachronic phonological typology: understanding inventory structure through sound change dynamics. *Linguistic Typology* 27. (Published online ahead of print 2023).

[7] Hammarström, H., Forkel, R., Haspelmath, M., Bank, S. 2022. *Glottolog 4.7*. Max Planck Institute for Evolutionary Anthropology. (Available online at http://glottolog.org, Accessed on 2023-01-02.)

[8] Blackings, M., Fabb, N. 2003. *A grammar of Ma'di* (Mouton Grammar Library, 32). Mouton de Gruyter.

[9] McLendon, S. 1975. *A grammar of Eastern Pomo.* (University of California Publications in Linguistics, 74.) University of California Press.

[10] Barker, M. A. R. 1963. *Klamath dictionary*. (University of California Publications in Linguistics, 31.) University of California Press.

[11] Blevins, J. 1993. Klamath laryngeal phonology. *International Journal of American Linguistics* 59, 237-279.

[12] Otero, M. A. 2019. A historical reconstruction of the Koman language family. (Ph.D. dissertation, University of Oregon.)

[13] Stevenson, R. C. 2009. A grammar of Otoro. In Schadeberg, T. C. (ed.), *Tira and Otoro: Two Kordofanian grammars*. Rüdiger Köppe Verlag, 115-326.

[14] Gutiérrez, A. 2019. Nivaĉle (shiichaam lhavos variety). *Journal of the International Phonetic Association* 49, 401-417.

[15] Balodis, U. I. J. 2011. Yuki grammar in its area context with sketches of Huchnom and Coast Yuki. (Ph.D. dissertation, University of California at Santa Barbara.)

[16] Andersen, T. 1993. Aspects of Berta phonology. *Afrika und Übersee* 76, 41-80.

[17] Petrollino, S. 2016. A grammar of Hamar, a South Omotic language of Ethiopia. (Ph.D. dissertation, Rijksuniversiteit te Leiden.)

[18] Ahland, C. A. 2012. A grammar of Northern and Southern Gumuz. (Ph.D. dissertation, University of Oregon.)

[19] Supple, J., Douglass, C. M. 1949. Tojolabal (Mayan): Phonemes and verb morphology. *International Journal of American Linguistics* 15, 168-174.

[20] Newman, P. 2000. *The Hausa language: An encyclopedic reference grammar*. Yale University Press.

[21] Prickett, D. 2012. Phonology and morphology of verb forms in Mubi. (MA thesis, University of North Dakota.)

[22] Applegate, R. B. 1972. Ineseño Chumash grammar. (Ph.D. dissertation, University of California at Berkeley.)

[23] Reh, M. 1994. A grammatical sketch of Deiga. *Afrika und Übersee* 77, 197-261.

[24] Wright, R., Ladefoged, P. 1994. A phonetic study of Tsou. *UCLA Working Papers in Phonetics* 87, 67-89.

[25] Alkali, A. A. 2019. A description of the phonology and morphology of Sokoto Fula. (Ph.D. dissertation, University of Hong Kong.)

[26] Coler, M. 2014. *A Grammar of Muylaq' Aymara: Aymara as spoken in Southern Peru*. Brill.

[27] Holt, D. 1999. *Tol (Jicaque)*. (Languages of the World/Materials, 170.) Lincom Europa.

[28] Schrock, T. 2014. A grammar of Ik (Icé-tód): Northeast Uganda's last thriving Kuliak language. LOT. (Ph.D. dissertation, Rijksuniversiteit te Leiden.)

[29] Clairis, C. 1985. *El qawasqar: Lingüística fueguina, teoría y descripción.* (Estudios Filológicos: Anejo, 12.) Universidad Austral de Chile.

[30] Tarpent, M.-L. 1989. A grammar of the Nisgha language. (Ph.D. dissertation, University of Victoria.)

[31] Smolders, J. 2016. A phonology of Ganza (Gwàmì Nánà). *Linguistic Discovery* 14, 86-144.

[32] Antunes de Araujo, G. 2004. A grammar of Sabanê: A Nambikwaran language. 94. LOT. (Ph.D. dissertation, Vrije Universiteit Amsterdam.)

[33] van der Voort, Hein. 2004. *A grammar of Kwaza.* (Mouton Grammar Library, 29.) Mouton de Gruyter.

[34] Childs, G. T. 1995. *A grammar of Kisi: A Southern Atlantic language.* (Mouton Grammar Library, 16.) Mouton de Gruyter.

[35] Easterday, S. 2019. *Highly complex syllable structure: A typological and diachronic study* (Studies in Laboratory Phonology 9). Language Science Press.

[36] Lombardi, L. 1991. Laryngeal features and laryngeal neutralization. (Ph.D. dissertation, University of Massachusetts, Amherst.)

[37] Steriade, D. 1997. Phonetics in phonology: the case of laryngeal neutralization. Unpublished ms, UCLA.

[38] Blevins, J. 2004. *Evolutionary phonology: The emergence of sound patterns*. Cambridge: Cambridge University Press.