EXPLAINING FINAL OBSTRUENT VOICING IN LEZGIAN: PHONETICS AND HISTORY

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In Lezgian, a Nakh-Daghestanian language, final and preconsonantal ejectives and voiceless unaspirated obstruents are voiced in certain monosyllabic nouns. This article offers acoustic evidence confirming that the two coda-voicing series are indeed voiced in final position. Based on comparative evidence, it is demonstrated that this phonetically aberrant neutralization pattern is the result of a series of phonetically natural sound changes. Such 'crazy rules' (Bach & Harms 1972) undermine any direct phonetic licensing approach to phonology, such as LICENSING BY CUE (Steriade 1997).*

1. INTRODUCTION. In recent years, the field of phonology has witnessed increased interest in incorporating the articulatory and perceptual constraints in speech to account for crosslinguistic sound patterns synchronically and formally (e.g. Boersma 1998, Flemming 1995, Gafos 1999, Hayes 1999, Hayes & Stivers 1996, Hume & Johnson 2001, Jun 1995, Kirchner 1998, 2000, Silverman 1995, Steriade 1993, 1995, 1997, Walker 1999). For instance, in her pioneering work on the role of perceptual factors in synchronic phonology, Steriade (1993), building on Ohala 1981 and Kingston 1985, claims that phonological contrasts are neutralized in environments with poor perceptual cues. Conversely, such contrast is maintained in perceptually salient contexts. Steriade later dubbed this hypothesis 'Licensing by Cue' (henceforth, LBC; Steriade 1997). The phenomenon often cited to illustrate this point is laryngeal neutralization. Laryngeal neutralization (LN) occurs when certain laryngeal contrasts are suppressed in certain environments. A celebrated example of LN is the case of syllable-final devoicing. In German, for example, while voiced and voiceless obstruents are allowed word-initially and intervocalically (1a), only the voiceless variety appears in word-final position (data taken from McMahon 2000).

(1) a. Tier [tiːr] 'animal' vs. dir [diːr] 'to you'
leiten [laitən] 'lead' vs. leiden [laidən] 'suffer'
b. Rat [rat] vs. Rates [ratəs] 'advice'
Rad [rat] vs. Rades [radəs] 'wheel'

Previous typological studies on laryngeal neutralization (LN) have concluded that while preconsonantal and final devoicing is commonplace in the world's languages, the flip side of this, namely preconsonantal and final voicing, is nonexistent (see Lombardi 1991, McMahon 2000). As a result, theorists in the past have attempted to generate theories to explain the apparent gap in the phonological typology of LN (Lombardi 1991, Blevins 1993, Steriade 1997).

Recently, Steriade (1997) proposes an account of voicing neutralization from a phonetically driven phonological perspective. She postulates a scale of voicing perceptibil-

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ity according to contexts based on evidence from previous phonetic research and her survey on the typology of the contexts in which voicing neutralization generally occurs (Steriade 1997). The perceptibility scale is reproduced in 2. The sign ▷ indicates that voicing in one context is more perceptible than in the context to its right.

(2) Scale of obstruent voicing perceptibility according to context
V__[+son] ▷ V__# ▷ V__[−son] ▷ {[−son]__[−son], [−son]__#, #__[−son]}

Steriade further postulates that constraints in phonology should be the direct projection of the perceptibility scale. Thus, in the case of the distribution of voicing, the constraint ranking in the first column of 3 is posited. Each constraint in 3 corresponds to a context occupying a distinct position on the perceptibility scale; the downward arrow indicates that the constraint above is ranked higher than the one below. According to Steriade, '[t]he constraints are universally ranked in the order of inverse perceptibility: the lower the context is on the perceptibility scale, the higher ranked the corresponding *[α voice]/X__Y constraint'. The universal and fixed nature of the constraint hierarchy 'precludes the existence of grammars in which voicing is neutralized finally but not before obstruents and more generally grammars in which voicing is licensed in a less informative context than the ones where it is neutralized' (Steriade 1997:13).

(3)

	⇐ *Preserve[α voice]* (3a)
*α voice/[−son]__[−son], [−son]__#, #__[−son]	'Voice licensed in all positions'
⇓	⇐ *Preserve[α voice]* (3b)
*α voice/V__[−son]	'Voice licensed after V and before sonorants'
⇓	⇐ *Preserve[α voice]* (3c)
*α voice/V__#	'Voice licensed before sonorants and word finally'
⇓	⇐ *Preserve[α voice]* (3d)
*α voice/V__[+son]	'Voice licensed before sonorants'
	⇐ *Preserve[α voice]* (3e)
	'No voicing contrast'

As argued in Steriade 1997, voicing neutralization within LBC is handled through the interaction between constraints that are projected based on the perceptibility scale that targets the realization of voicing (e.g. *α voice/V__# 'a voicing contrast is not licensed in final position') and featural preservation constraints such as *Preserve[α voice],* which demands the value of [voice] in the input be the same in the output. This analysis predicts five distribution/neutralization patterns of [voice]. The right column of 3 indicates the possible combination of the *Preserve[α voice]* constraint and the resulting effect of the particular ranking. The constraint permutation predicts systems with unrestricted licensing of voicing features in all positions (3a) to the most restrictive scenarios where voicing is licensed only before sonorants (3d) or not at all (3e).

This article addresses a major prediction of this direct phonetic licensing theory of voicing neutralization: LBC forces neutralization toward voiceless invariably (i.e. the loss/nonpreservation of [voice] in the output). In Lezgian, a Nakh-Daghestanian language, final and preconsonantal ejectives and voiceless unaspirated obstruents are voiced in certain monosyllabic nouns, as demonstrated here with acoustic evidence, thus violating this major prediction of the LBC approach. Moreover, based on comparative evidence, this phonetically aberrant neutralization pattern can be shown to be the result of a series of phonetically natural sound changes. Such 'crazy rules' (Bach & Harms 1972), which often emerge as a by-product of history, undermine the direct phonetic licensing approach to phonology, such as LBC.

2. BACKGROUND. Lezgian is a Nakh-Daghestanian language spoken in southern Daghestan and northern Azerbaijan in the eastern Caucasus. All data presented here are drawn directly from Haspelmath 1993. The consonant inventory is shown in 4. Note that there are no implosive or voiced aspirated segments in this language.

(4) Consonant inventory of Lezgian.

b	d					g	g^w		
p^h	t^h	t^{hw}	ts^h	ts^{hw}	$tʃ^h$	k^h	k^{hw}	q^h	q^{hw}
p	t	t^w	ts	ts^w	tʃ	k	k^w	q	q^w
p’	t’	$t’^w$	ts’	$ts’^w$	tʃ’	k’	$k’^w$	q’	$q’^w$
	l		z	z^w	ʒ			ʁ	$ʁ^w$
f	r		s	s^w	ʃ	x		χ	$χ^w$
m	n								
w					j			h	ʔ

Obstruents in Lezgian have a four-way laryngeal distinction: ejective (5a), voiceless aspirated (5b), voiced (5c), and voiceless unaspirated (5d). But this four-way contrast surfaces only in prevocalic position. This distribution is especially prevalent in pretonic position (i.e. immediately preceding a stressed vowel).

(5) a. Ejective obstruents
wa'**k’**a ‘pig’
a'**q’**altun ‘go up, appear on’
i'**c’**i ‘raw’

b. Voiceless aspirated obstruents
xa'**t**^{h}ur ‘respect’
e'**k**^{h}naq^h ‘in the morning’
ga'**p**^{h}ur ‘dagger’

c. Voiced obstruents
ru'**g**ud ‘seven’
di'**d**e ‘mother’
'**b**ade ‘grandmother’

d. Voiceless unaspirated obstruents
a'**q**at^{h}un ‘come out’
q^{w}e'**t**er ‘partridges’
ta'**k**^{w}ar ‘turnips’

The four-way laryngeal contrast is suspended in final and preconsonantal positions. That is, as shown in 6, only a three-way laryngeal contrast is found in coda position in Lezgian.

(6) a. Voiced
k’y**d** ‘nine’
da**ʁ** ‘mountain’
p’u**z** ‘lip’
tʃ’i**ʒ** ‘bee’

b. Ejective
ja**k’**^{w} ‘axe’
ki**ts’** ‘dog’
k’u**k’** ‘peak’
k’wa**t’** ‘lump, ball’

c. Aspirated
k^{h}a**t**ʃ^h ‘bitch’
ne**k**^{h} ‘milk’
ne**t**^{h} ‘louse’
pe**q**^{h} ‘crow’

Table 1 summarizes what has been shown so far. **D** is used here to represent all voiced obstruents, **T** for all voiceless unaspirated obstruents, **T’** ejectives, and **T^h** voiceless aspirated obstruents.

	__V	**V__#**	**__CV**
a. **/D/**	D	D	D
b. **/T’/**	T’	T’	T’
c. **/T^h/**	T^h	T^h	T^h
d. **/T/**	T		

TABLE 1. Interim summary of obstruent distribution in Lezgian.

The first three series (a–c) are attested in prevocalic, word-final, and preconsonantal positions. The T series (d), which is referred to from here on as the plain series, appears in prevocalic position. Nothing has yet been said about the realization of the T series in final and preconsonantal positions. I consider this next.

3. DATA.

3.1. WORD-FINAL UNASPIRATED VOICING IN MONOSYLLABIC NOUNS. Haspelmath (1993) reports that plain stops become voiced in word-final position in certain monosyllabic nouns (see also Trubetzkoy 1931, Topuria 1974, Meilanova & Talibov 1987). No such alternation is found in polysyllabic nouns and other lexical categories. Some examples of word-final voicing are shown in 7, with the relevant segments in boldface.[1]

(7) Underlying word-final unaspirated voiceless stops in monosyllabic nouns

a.	pa**b**	pa**p**-a	'wife'	d.	ju**ʁ**	ju**q**-ar	'day'
	ra**b**	ra**p**-uni	'needle'		my**ʁ**	my**q**-y	'bridge'
	se**b**	se**p**-erar	'curse'		naʁ^{w}	na**q**^{w}-adi	'tear'
b.	ra**d**	ra**t**-uni	'intestine'	e.	la**z**	la**ts**-adi	'kaolin, china clay'
	ga**d**	ga**t**-u	'summer'		me**z**	me**ts**-i	'tongue'
	pa**d**	pa**t**ar	'side'		tsa**z**	tsa**ts**-uni	'thorn'
c.	le**g**^{w}	le**k**^{w}-e	'tub'				
	ru**g**	ru**k**^{w}-adi	'dust'				
	pa**g**^{w}	pa**k**^{w}-ar	'rib'				

However, further investigation reveals that the voicing of plain obstruents also occurs in preconsonantal position, as shown in 8. The only exception where plain obstruents do not voice in preconsonantal position is when the suffix is an approximant, as shown in 9.

(8) Underlying voiceless stops as voiced in preconsonantal position

xe**b**-mal	'animal-cattle'	vs.	x**p**-er	'sheep.PL'
qa**b**-mab	'boxes and similar things'	vs.	qa**p**-uni	'box.ERG'
ju**ʁ**-di	'all day'	vs.	ju**q**-ar	'day.PL'
ga**d**-di	'all summer'	vs.	ga**t**-u	'summer.ERG'

(9) tse**g**^{w} tse**k**^{w}-re 'ant.ERG'
war**z** wa**ts**-ra[2] 'moon/month.ERG'

3.2. WORD-FINAL EJECTIVES VOICING IN MONOSYLLABIC NOUNS. Haspelmath (1993) also observes that underlying ejectives become voiced word-finally in a number of monosyllabic nouns whose initial consonants are also ejectives (10) (Fallon 1995).[3] One example is found in Haspelmath 1993 where the underlying ejective becomes voiced in coda position. This is shown in 11.

(10)

q'e**b**	q'e**p'**-ini	'cradle'
t'a**b**	t'a**p'**-uni	'block, log'
t'u**b**	t^{hw}**p'**-u	'finger'
t'i**b**	t^{hj}**p'**-er	'owl'
tʃ'i**b**	tʃ^{h}**p'**-er	'span'
q'y**d**	q^{h}y**t'**-yz	'winter'
ts'i**b**	ts^{hj}**p'**-er	'pot'
ts'i**g**	ts^{hj}**k'**-er	'middle'

(11) q'y**d**-di 'all winter' vs. q^{h}y**t'**-yz 'in the winter'

[1] The phenomenon of coda voicing is only a partial description of the whole story. I have nothing to say about the issue of final spirantization in this paper. According to Haspelmath, historical affricates become present-day voiced fricatives. The voiced counterparts of the voiceless uvular stops are functionally the voiced uvular fricatives.

[2] The 'r' in CVrC stem is deleted when an r-initial suffix is attached.

[3] Note that a very recent and independent development in Lezgian has resulted in the devoicing of high vowels that precede a stressed vowel.

The laryngeal contrasts in Lezgian are summarized in 12. First, note that the preconsonantal and word-final environments are now collectively being referred to as coda position. Second, the table shows that there are two series of obstruents that alternate. The plain series (12d) surfaces as voiced in coda position. The series in 12e represents the obstruents that surface as ejectives in prevocalic position, but voiced in coda position. This series is, from now on, referred to as the coda-voicing ejective and is represented similarly to the nonalternating ejective, but with the subscript 2.

(12)

		__V	**V__]$_\sigma$**	**Nomenclature**
a.	**/D/**	D	D	Voiced
b.	**/T'/**	T'	T'	Ejective
c.	**/T^h/**	T^h	T^h	Aspirated
d.	**/T/**	T	D	Plain
e.	**/T'$_2$/**	T'	D	Coda-voicing ejective

3.3. CODA-EJECTIVE ASPIRATION IN LEZGIAN. As if the picture is not already complicated enough, there is one additional laryngeal alternation in Lezgian that requires consideration. In certain monosyllabic nouns, final ejectives alternate with their aspirated counterparts in word-final position. This is demonstrated in 13.

(13)

Absolutive plural	Absolutive singular	
me**t'**-er	me**t**^{h}	'knee'
ne**t'**-er	ne**t**^{h}	'louse'
ja**k'**-ar	ja**k**^{h}	'meat'
ha**q'**-ar	ha**q**^{h}	'truth'
re**q'**-er	re**q**^{h}	'way'

With this final piece of data given, a quick summary is now in order, given in 14. The earlier series are in 14a–e. The only difference from before is the new series in 14f, the coda-aspirating ejective, which is represented here similarly to the coda-voicing ejective but with the subscript 3.

(14)

		__V	**V__]$_\sigma$**	**Nomenclature**
a.	**/D/**	D	D	Voiced
b.	**/T'/**	T'	T'	Ejective
c.	**/T^h/**	T^h	T^h	Aspirated
d.	**/T/**	T	D	Plain
e.	**/T'$_2$/**	T'	D	Coda-voicing ejective
f.	**/T'$_3$/**	T'	T^h	Coda-aspirating ejective

Given this state of affairs, many intriguing problems and questions naturally emerge. First, the fact that plain obstruents and ejectives become voiced in coda position is highly unusual both typologically and phonetically. In particular, how did such a pattern develop historically, and why does this alternation affect only a subset of monosyllabic nouns? The theoretical implications of this finding are also far-reaching. This alternation does not lend itself naturally to any articulatory or perceptual explanation. Particularly, such a pattern is predicted to be impossible by the LBC theory of voicing

neutralization since final and preconsonantal positions are among the worst environments for the maintenance and perception of voicing. Recall that constraints projected based on the perceptibility scale target the realization of voicing (e.g. *α voice/V__# 'a voicing contrast is not licensed in final position'). Since neutralization is handled within LBC through the interaction between these cue-based constraints and featural preservation constraints such as *Preserve[α voice]*, such a grammar necessarily forces neutralization toward voiceless.[4] Lezgian final obstruent voicing clearly violates this major prediction of the LBC approach. Thus, coda voicing in Lezgian presents a serious challenge to any theory of phonology that insists on incorporating phonetic motivations in the synchronic phonological analysis.

With these issues in mind, for the remainder of this article I address the phonetic reality of the coda-voicing patterns, accompanied by a historical explanation of this state of affairs. The need for an acoustic study is obvious. Only through an in-depth examination of the acoustic records can one confirm the existence of the coda-voicing alternations. In relation to the phonetics, a thorough understanding of the historical origin of this pattern not only is relevant to theories of sound change that maintain phonetic naturalness as one of their key tenets, but also provides an instructive illustration of the agnostic nature of synchronic phonological systems with respect to issues of phonetic naturalness and grammar optimization.

4. DOES CODA VOICING REALLY EXIST? AN ACOUSTIC STUDY. When a linguist is confronted with highly unnatural alternations such as coda-plain stop voicing and coda-ejective voicing, an entirely legitimate response is to question the very existence of such patterns. That is, while the coda obstruents might be described as voiced by grammarians, they could very well have been phonetically voiceless. In what follows, I report an acoustic investigation which demonstrates that coda voicing does indeed exist in Lezgian. But the results of the study raise some intriguing questions about the proper phonological representation of the obstruents in question.

4.1. METHOD. The data presented in this section come from field recordings of a male, middle-aged, native speaker of Lezgian living in Maxachkala in Daghestan. The recordings were made using a SONY MZ-R70 minidisk recorder and a Sky Tronic 173.623 microphone. A list of words was presented to the speaker in Russian. The speaker was asked to recite the words in Lezgian. Each word was uttered in the singular, plural, and sometimes the ergative forms. The singular forms provided the word-final context, while the plural and ergative forms provided the intervocalic contexts. For the list of tokens recorded and analyzed see Appendix A.

The recordings were digitized at a sampling rate of 22,050 Hz using PRAAT 3.9, a speech analysis program produced by Paul Boersma and David Weenink. Spectrograms and the various temporal interval measurements were also performed using PRAAT.

Since the main interest here is whether coda voicing exists, I have nothing to say about the phonetics of the other alternating obstruents in Lezgian here. I therefore concentrate on the acoustic values of the segment types in 15. The nonalternating series serves as the control against which I base my comparisons.

[4] According to Steriade, the result of voicing neutralization is the lack of 'both the invariant auditory properties associated with [+voice] or [−voice] and the articulatory gestures used to implement these auditory targets' (Steriade 1997:23).

(15) Abbreviations used

NONALTERNATING SERIES	ABBREVIATION
Voiced	Voiced
ALTERNATING SERIES	
Coda-voicing voiceless unaspirated	Plain-CV
Coda-voicing ejectives	Ejective-CV

The following temporal intervals were measured on the waveforms and the spectrograms (definitions based partly on Dinnsen & Charles-Luce 1984).

- Duration of voicing into the stop closure (VOI-LAG): the interval representing glottal pulsing into the beginning of the consonant from the offset of vowel duration until energy was no longer detected.
- Stop closure duration (C-DUR): the interval from offset of vowel and onset of consonant constriction to burst, typified by a distinct perturbation in the waveform or a sudden increase in amplitude. All tokens were released.
- Duration of the vowel preceding the consonant in question (V1-DUR): the interval from onset of periodicity in the waveform to sudden drop in amplitude.
- Duration of the stop release (RELEASE): the interval of noisy aspiration beginning at the release burst at the end of the stop. For ejectives, the duration of release includes both the oral and glottal release phases.
- Voice onset time (VOT) for stops in intervocalic position only.

Analysis of variance was performed on all measurements using the SPSS statistical package. The results are presented in two parts. I first look at the acoustic properties of the coda-voicing plain obstruents and the coda-voicing ejectives. I then consider the neutralization between these two series of coda-voicing obstruents and the nonalternating voiced obstruents.

4.2. THE ACOUSTICS OF CODA VOICING. The results of the measurement of the two coda-voicing series in intervocalic and final positions are summarized in Table 2. In Figure 1, voicing is clearly observable during the stop closure of the final [d] in the word *pad* 'side' (upper waveform), while there is little voice lag into the closure of the intervocalic [t] in *pata* 'side.ERG' (lower waveform).[5] This voicing difference is consistently observed across different tokens.

A similar voicing distinction is found with the coda-voicing ejectives. In final position, these coda-voicing ejectives, like the coda-voicing plains, maintain voicing well into the stop closure (Figure 2, upper waveform), but little glottal pulsing is found in the intervocalic environment (lower waveform).[6] The fact that there is a dramatic drop of amplitude after the oral release is indicative of a glottal constriction, which, in turn, supports the existence of an ejective in intervocalic position.

[5] The fact that a plain obstruent is partially voiced in intervocalic position is not unexpected phonetically. A similar pattern has been reported in various other languages (e.g. Keating et al. 1983).

[6] The term INTERVOCALIC is used very loosely here. Phonetically, there is no indication of the presence of a vowel between the first two consonants. This is due to an independent high-vowel devoicing process in Lezgian in unstressed syllables.

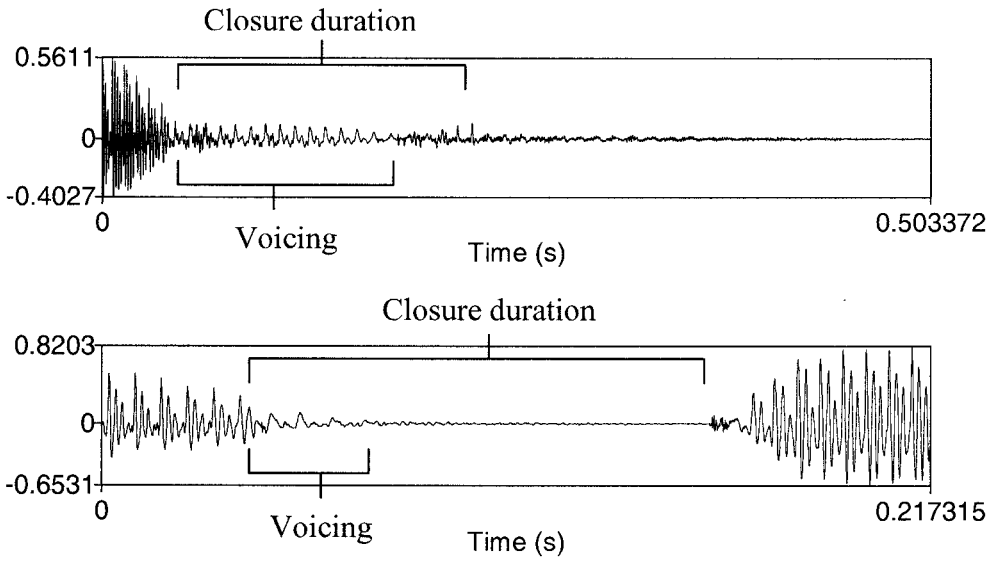


FIGURE 1. Example waveforms of [d] in [pad] 'side' and [t] of [pa'ta] 'side.ERG'.

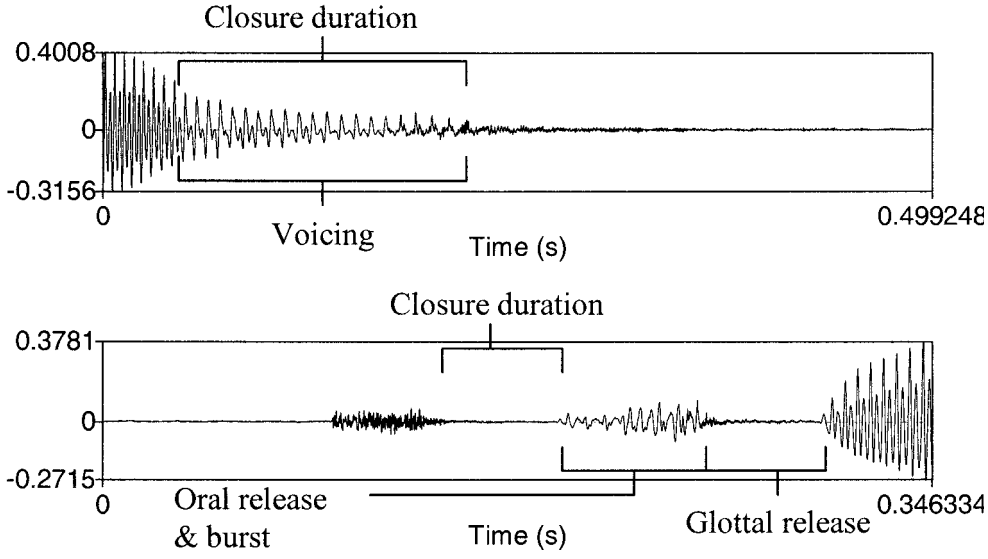


FIGURE 2. Example waveforms of [b] in [t'ub] 'finger' and [p'] in [t^hp'u] 'fingers'.

		FINAL POSITION	INTERVOCALIC POSITION
	Series	Mean (SD)	Mean (SD)
VOI-LAG	Plain-CV	150 (31) (N = 48)	32 (24) (N = 56)
	Ejective-CV	140 (52) (N = 14)	3 (9) (N = 14)
C-DUR	Plain-CV	151 (31)	118 (21)
	Ejective-CV	158 (41)	59 (23)
V1-DUR	Plain-CV	197 (45)	72 (29)
	Ejective-CV	206 (49)	12 (31)
RELEASE	Plain-CV	174 (89)	27 (54)
	Ejective-CV	184 (97)	75 (29)
VOT	Plain-CV		16 (14)
	Ejective-CV		57 (40)

TABLE 2. Summary of various durational measurements of the coda-voicing plains and the coda-voicing ejectives in two environments.

There is no significant difference between the two coda-voicing series when they are in final position (i.e. all $F(1,62) < 1$), thus substantiating the claim that laryngeal neutralization toward voicing in final position exists in Lezgian. I turn now to a comparison of these coda-voicing series with the nonalternating voiced stops.

4.3. (INCOMPLETE) NEUTRALIZATION OF VOICING. The waveforms of the final and intervocalic [d] in the words *dad* 'taste' and *daduni* 'taste.ERG' are shown in Figure 3. As indicated, voicing is maintained more than three quarters of the way into the stop closure word-finally. In the intervocalic context, however, voicing is sustained throughout the entire duration of the stop closure.

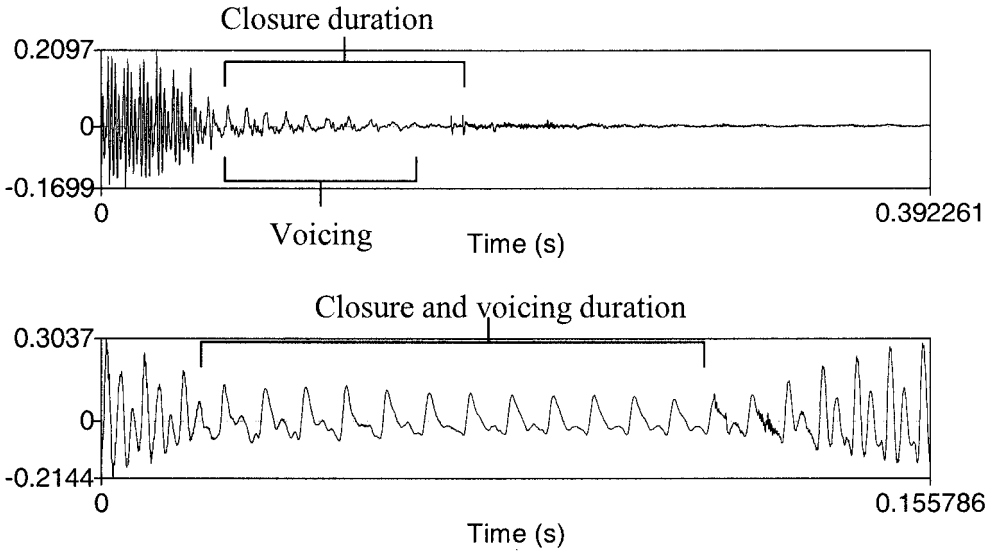


FIGURE 3. Example waveforms of the second [d] in [dad] 'taste' and [da'duni] 'taste.ERG'.

Table 3 summarizes the measurements of the voiced series in final and intervocalic positions.

		FINAL POSITION	INTERVOCALIC POSITION
	Series	Mean (SD)	Mean (SD)
VOI-LAG	Voiced	116 (21) (N = 14)	95 (29) (N = 15)
C-DUR	Voiced	126 (20) (N = 14)	95 (29) (N = 15)
V1-DUR	Voiced	212 (34)	79 (28)
RELEASE	Voiced	171 (73)	10 (13)
VOT	Voiced		0 (0)

TABLE 3. Summary of various durational measurements of coda-voicing plain stops and nonalternating voiced stops in two environments.

As expected, a series of one-way ANOVA tests (see Table 4) confirms that, intervocalically, the nonalternating voiced stops and coda-voicing plains are not likely to belong to the same phonetic category. In final position, however, these two series remain significantly different in terms of the duration of voicing into the stop closure ($p = 0.000$) and the closure duration ($p = 0.005$). These two parameters, however, are correlated ($r = 0.948$, $p \leq 0.01$).

	FINAL POSITION		INTERVOCALIC POSITION	
VOI-LAG	$F(1,62) = 15.115$	$p = 0.000$	$F(1,71) = 75.951$	$p = 0.000$
C-DUR	$F(1,62) = 8.554$	$p = 0.005$	$F(1,71) = 11.570$	$p = 0.001$
V1-DUR	$F(1,62) = 1.322$	$p = 0.225$	$F(1,71) = 10.695$	$p = 0.407$
RELEASE	$F(1,62) = 0.017$	$p = 0.895$	$F(1,71) = 1.546$	$p = 0.218$
VOT			$F(1,71) = 19.248$	$p = 0.000$

TABLE 4. Significances of durational differences between the coda-voicing plain and underlying voiced stops in two environments.

Turning to the contrast between the nonalternating voiced series and the coda-voicing ejectives, they differ significantly in final position in terms of their stop-closure durations ($F(1,28) = 6.939$, $p = 0.014$; see Table 5). Nonalternating voiced stops are significantly shorter than the voiced variant of the coda-voicing ejectives.

	FINAL POSITION		INTERVOCALIC POSITION	
VOI-LAG	$F(1,28) = 2.596$	$p = 0.119$	$F(1,29) = 128.547$	$p = 0.000$
C-DUR	$F(1,28) = 6.939$	$p = 0.014$	$F(1,29) = 14.153$	$p = 0.001$
V1-DUR	$F(1,28) = 0.123$	$p = 0.729$	$F(1,29) = 38.105$	$p = 0.000$
RELEASE	$F(1,28) = 0.187$	$p = 0.669$	$F(1,29) = 63.676$	$p = 0.000$
VOT			$F(1,29) = 30.483$	$p = 0.000$

TABLE 5. Significances of durational differences between coda-voicing ejective and underlying voiced stops in two environments.

4.4. DISCUSSION. In the previous sections, I have looked at how the coda-voicing obstruents compare to the nonalternating voiced obstruents in the language. The comparisons between the two coda-voicing series and the nonalternating voiced stops reveal that the coda-voicing plain series differs from the voiced series in terms of the duration of voicing into the stop closure and closure duration. Specifically, voicing is sustained longer during the stop closure of the coda-voicing plain stops than during that of the underlying voiced stops. Likewise, the stop closure is significantly longer in the coda-voicing plain stops than in the underlying voiced ones.[7] The coda-voicing ejective

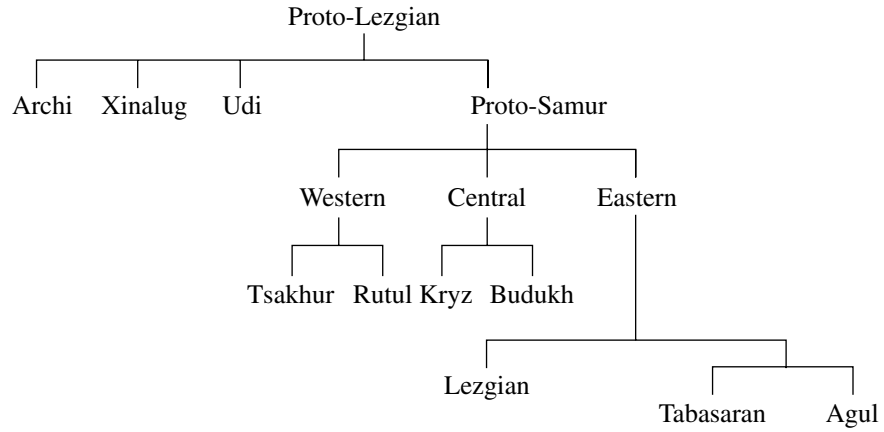
[7] One interesting aspect of the experimental results also worth mentioning is that, while previous studies have shown that the duration of the preceding vowel often helps differentiate underlying voiced series from others (e.g. Chen 1970), it does not seem to contribute much in the case of Lezgian, except to differentiate the underlying plain from the coda-voicing plain stops.

series also differs from the voiced series in terms of stop-closure duration. Underlying voiced stops are significantly shorter than the voiced variants of the coda-voicing ejectives. In sum, the acoustic study reveals that, while the coda-voicing alternations neutralize the contrast between the coda-voicing plain and ejective series, their contrast with the underlying voiced series is maintained. The incomplete neutralization between the two coda-voicing series and the nonalternating voiced stops is puzzling and warrants additional investigation. However, since this has no direct bearing on my main concern here, I leave the discussion of this aspect of Lezgian laryngeal neutralization for another occasion.

Through the examination of the acoustic data, I have now established that coda voicing does indeed exist in Lezgian. This finding undermines the appeal of the LBC approach to phonology, at least with respect to voicing neutralization. But before addressing further the implications of the Lezgian data for the direct phonetic licensing approach to phonology, the puzzle of why such alternations should occur at all must first be resolved. Related to this is the question of why this phenomenon is not found more frequently. The answer lies in the historical development of laryngeal contrasts in modern Lezgian. In what follows, I demonstrate that the origin of coda voicing has its root in a series of phonetically well motivated but, crucially, independent sound changes. The synchronic situation is the result of the intricate interplay between the independent development of the phonological and the morphological systems of the language.

5. HISTORICAL ORIGIN OF CODA VOICING. Lezgian, as mentioned earlier, is a Nakh-Daghestanian language spoken in southern Daghestan and northern Azerbaijan in the eastern Caucasus. It belongs to the Lezgic branch of the Daghestanian family. The genetic relationships among the various languages within the Lezgic family, reproduced from Schulze 1994, are given in 16.

(16)



In this section, I first consider the reconstruction of the coda-voicing plain obstruents, followed by the reconstruction of the coda-voicing ejectives. I conclude by considering the sources of the apparent exceptions to the coda-voicing patterns. But before diving into the historical discussion, I must note that this is by no means an attempt to reconstruct the phonetic inventory of Proto-Lezgian. The reconstruction proposed below is limited to the final segment of roots only. No attempt is made to systematically reconstruct the other segments.

5.1. CODA UNASPIRATED VOICING EXPLAINED. The comparative cognate set is based on the comparative lexicon found in Kibrik & Kodzasov 1990. In keeping with the transcription used in this study, all data is translated from the Russian Caucasianist orthography into a broad IPA transcription, based on the detailed phonetic description that appears in Kibrik & Kodzasov 1990. For the purpose of illustration, only a subset of the data is presented here in Table 6. The complete comparative database appears in Appendix B. The database amassed consists of examples from seven Lezgic languages. Each word is listed in both the absolutive and plural instantiations. In the absence of any alternation, only the plural suffix is given. For ease of reference, the segments of interests are boldfaced.

	LEZGIAN	AGUL	TABASARAN	BUDUK	KRYZ	TSAKHUR	RUTUL	PS
'awl'	ri**b**/-riˈ**p**ar	re**b**/-ˈar	ri**b**/-ˈar	re**b**/-ri	re**b**/-ri	ra**b**/-bɨ	ra**b**/-ɨr	***b**
'needle'	ra**b**/raˈ**p**ar	ru**b**/-ˈar	ru**b**/-ˈar	ru**b**/-ri	ri**b**/-ri	wiː**b**a/-ar	ru**b**/-ɨr	***b**
'water'	ja**d**/jaˈ**t**ar	xe**d**/xiˈ**tt**ar	ʃi**d**/ʃ**tt**ar	xə**d**/-ri	xæ**d**/-ri	xʲa**n**/*	xe**d**/-bɨr	***d**
'summer'	ga**d**/gaˈ**t**ar		xa**d**/-ˈar					***d**
'tongue'	me**z**/meˈ**ts**ar	me**z**/-ˈar	mel**ʒ**/-ˈar	mæ**z**/-ri	me**z**/-ri	mi**z**/-eːr	mi**z**/-bɨr	***dz**
'moon'	war**z**/warˈ**ts**ar	wa**z**/-ˈura	wa**z**/-ˈar	və**z**/-ri	væ**z**/-ri	wa**z**/wuzaːr	wa**z**/-bɨr	***dz**
'dust'	ru**g**/ruˈ**k**ar	ru**g**/-ˈar			ru**g**/-im		ru**g**/-bɨr	***g**
'bridge'	mi**ʁ**/miˈ**q**ær	mu**ʁ**ʕ/-ˈar				jɨ**ʁ**ʕ/-aːr		***G**
'day'	ju**ʁ**/ju**q**ar	ja**ʁ**/-ˈar	ji**ʁ**/-ˈar	jɨ**ʁ**/-ri	ji**ʁ**/-ri	jɨ**ʁ**/-bɨ	jɨ**ʁ**/-bɨr	***G**

TABLE 6. Comparative data on the coda-voicing plain series in Lezgian.

There are no voiced affricates in present-day Lezgian. Historical affricates are today voiced fricatives (Haspelmath 1993). As shown by the cognate sets in Table 6 and those in Appendix B, only three languages, namely, Tabasaran, Agul, and Lezgian, display some form of root-final obstruent alternation. In the case of Lezgian, a root-final voiced obstruent alternates with its voiceless counterpart intervocalically, as discussed above. In Agul, root-final voiced obstruents become voiceless geminates in intervocalic position (e.g. *xe**d*** 'water', *xi*ˈ***tt****ar* 'water.PL'). A similar alternation can be observed in Tabasaran (e.g. *ʃi**d*** 'water', *ʃ**tt**-ar* 'water.PL').

Consider next the voicing status of the root-final segments of each word in these cognate sets. Since the final consonant of each of the roots is voiced across all the languages, it can be established that the Proto-Samurian form for each of these words must contain a voiced final segment. This can be most clearly illustrated by the cognate set for the word 'awl'. The final segment is a voiced bilabial stop in all seven languages. It is only in Lezgian that this voiced labial stop appears as voiceless unaspirated intervocalically. It is beyond doubt that the Proto-Samur word for 'awl' must contain a final ****b.*** The important point illustrated by these data is that similar analyses can be posited for all forms that contain the so-called coda-voicing plain obstruents in Lezgian. The reconstructed final segments of each of the forms in Table 6 in Proto-Samur are given in the end of each row.

This analysis, which posits that the coda-voicing obstruents were historically voiced, is strengthened by the fact that there is independent evidence to reconstruct a separate historical voiceless series that remains voiceless in all modern Lezgic languages (Table 7).[8]

[8] Note that Kibrik and Kodzasov (1990) transcribe the Lezgian forms with a medial plain stop, reproduced here, rather than with an ejective, as given in Haspelmath 1993 (e.g. *nek*^{h}*/nek'er* 'milk/PL'). Since my informant's pronunciation confirms Kibrik and Kodzasov's transcription, their transcription is adopted here.

	LEZGIAN	AGUL-RI	TABK	BUDUK	KRYZ	TSAKHUR	RUTUL
'wild boar'	wa**k**^{h}/wa'**k**ar			və**k**^{h}/-ri	va**k**^{h}/-ri	wo**k**^{h}/wo**k**aːr	
'louse'	ne**t**^{h}/ne'**t**er	ne**t**/-'ar	ni**ts**/-'ar				
'yoke'	we**k**^{h}/we'**k**er				u**k**ar/-bi	oʕ**k**/-bɨ	
'honey'	yr**t**^{h}/yr'**t**er	i**t**^{w}/-'ar	ji**tʃ**^{w}/-'ar	ji**t**/-ri	ji**t**/-ri	u**t**^{hj}/*	i**t**/-bir
'milk'	ne**k**^{h}/ne'**k**er	ne**k**/-'ar	ni**k**/-'ar			n^{j}a**k**^{h}/*	ne**k**^{h}/-bir
'door'	ra**k**^{h}/ra'**k**arar	ra**k**/-'ar	—/ra'**k**ar		ræ**k**^{h}/-imbi		ra**k**^{h}/-bir
'field'	ni**k**^{h}/ni'**k**er			ni**k**^{h}/-imber	ni**k**^{h}/-imbi	ne**k**^{hj}/-bɨ	
'road'	ræ**q**^{h}/ræ'**q**ær	ra**q**ʕ/-'ar	ra**q**ʕ/-'ar	ri**χ**/-imber	ri**χ**/-imbi	ja**q**ʕ^{h}/ja**q**ʕaːr	ra**q**ʕ^{h}/-bir
'ice'	mɨr**k**^{h}/mɨr'**k**ar	mer**k**^{w}/-'ar	mer**k**/-'ar	mu**k**^{h}/-ri	mɨ**k**^{h}/—	mɨ**k**^{h}/—	mɨ**k**^{h}/-bir
'ashes'	ry**q**^{h}/ry**q**ær	ru**q**ʕ/-'ar	ru**q**ʕ/-'ar	re**q**^{h}/-ri	ræ**q**^{h}/—	jɨ**q**ʕ^{h}/—	rɨ**q**ʕ^{h}/-bir

TABLE 7. Comparative data on the aspirate series in Lezgian.

I cannot provide a complete reconstruction of all forms found to display the coda-voicing alternation, though many are presented in Appendix B. Still, given the evidence presented thus far, it is plausible to hypothesize that nouns that participate in the coda-voicing alternation must originally have had a root-final voiced obstruent in Pre-Lezgian, if not in Proto-Samur. If this is the case, then the present-day Lezgian coda-voicing alternations must not be the proper characterization of the historical development. I tentatively refer to this historical development as a case of INTERVOCALIC DEVOICING.

Intervocalic devoicing, like coda voicing, remains a phonological process that is typologically unexpected and phonetically unmotivated. Crucially, it counters the prediction of the LBC hypothesis. Given that markedness constraints are projected based on the perceptibility scale, it follows that a loss of contrast in an environment that allows maximal cue realization entails the loss of the contrast in environments where cues are harder to recover. Thus, in this case, if devoicing were to have occurred in intervocalic position—the best location for realizing voicing cues in obstruents—LBC predicts that one should find coda devoicing also, since final and preconsonantal position are less optimal contexts for maintaining and perceiving voicing than the intervocalic position.

More importantly, there is no synchronic evidence of intervocalic devoicing in Lezgian. As shown by the examples in 17, there are ample synchronic examples of underlying intervocalic voiced obstruents that do not devoice.

(17) q'a**b**ul 'accept' 'k^{h}u**d**un 'exhaust' i'ranbu**b**a 'father-in-law'

The typological and phonetic rarity of intervocalic devoicing notwithstanding, there is also independent evidence to suggest that a one-step intervocalic devoicing sound change is not the source of the coda-voicing pattern. The answer appears to reside elsewhere. In the following sections, the origin of the intervocalic devoicing process in Lezgian is explicated.

5.2. PRETONIC DEVOICING IN PRE-LEZGIAN. Topuria (1974) and Giginejshvili (1977), in their treatments of the transition from Proto-Samurian to Pre-Lezgian, independently propose that there was a process of pretonic gemination. That is, historical voiced stops devoiced and merged with the fortis voiceless geminates immediately preceding a stressed vowel (18).

(18) *b > pp *dz^{h} > tts^{h}
*d > tt *g > kk
*dz > tts

While Topuria assumes that pretonic gemination applied only in intervocalic position, comparative evidence suggests that the pretonic gemination was much more widespread. Examples cited in Topuria 1974 reflect an earlier version of Lezgian where geminates, including initial ones, were still commonplace (19). Crucially, Lezgian forms with initial geminates correspond to forms in other Lezgic languages with initial voiced segments.

(19) ˈ**qq**ab **qq**app-ˈu/ˈini ‘vessel, thing’ (Kryz/Budukh *Gab* Tabasaran *ʁab*)
ˈ**tt**yd **tt**ytt-y ‘throat’ (Tabasaran *dyd*)
ˈ**tt**saz **tt**satts-ˈuni ‘thorn’ (Agul/Tabasaran/Rutul *zaz*)
ˈ**kk**ard **kk**att-ˈra ‘falcon’ (Budukh *Gartal*)
ˈ**pp**ag^{w} **pp**akk-ˈu ‘side, rib’ (Rutul *beg*^{j}, Kryz *beg*, Agul *bag*^{w})

Given this information, it is possible to explain the intervocalic devoicing as a result of two phonological processes. That is, the actual historical scenario begins with a change of voiced obstruent singletons turning into voiceless geminates in pretonic position. The situation resulting from this sound change was preserved intact in S. Tabasaran and several Agul languages, at least in the monosyllabic nouns. Geminates were subsequently eliminated in Lezgian’s phonemic inventory, resulting in the present-day voiced vs. voiceless singleton alternation.

The above scenario leaves a crucial question unanswered, however: why is the alternation restricted to a limited set of monosyllabic nouns? In order to understand that, the facts about the stress system of Lezgian, its nominal inflectional morphology, and the interface between the two must first be introduced.

5.3. General stress assignment in Lezgian. The general location of stress placement is on the second syllable in nonmonosyllabic forms. According to Haspelmath (1993), the tendency for stress on the second syllable is so strong that even Russian loanwords are sometimes stressed on the second syllable. For example, Russian *karan-ˈdaš* ‘pencil’ is pronounced as *ka*ˈ*randaš* in Lezgian.

Suffixes are either stress-attracting or stress-neutral in Lezgian. The stress-attracting suffixes can usually attach either only to monosyllabic roots (which results in ordinary second-syllable stressed words) or to roots of any length. Most of the stress-attracting suffixes that attach only to monosyllabic roots are plural and ergative suffixes. The significance of this becomes apparent in the next sections. As for the stress-neutral suffixes, they are almost all inflectional suffixes (e.g. local cases, tense and mood suffixes, etc.). Given the fact that the placement of stress can be partially determined by the properties of individual suffixes and that the location of stress is crucial to the understanding of the pretonic gemination phenomenon, it is, therefore, of paramount importance to understand the types of suffixes nominal roots generally admit and their respective stress properties.

5.4. Nominal inflectional morphology in Lezgian. Nouns in Lezgian can appear alone with no overt suffixes when they are in the absolutive case. The plural morpheme is suffixed directly to the nominal stem. With the exception of the ergative case marking, all other case markings must apply onto the oblique stem. The oblique stem consists of the bare nominal stem plus the ergative case suffix. Thus, in order to understand the interaction between the final obstruent of nouns in Lezgian with the nominal suffixes, one only needs to consider two inflectional categories: plurality and oblique stem formations.

In Lezgian, the default plural suffix is the stress-neutral *-ar*. However, this suffix applies mostly to polysyllabic nouns (20).

(20) muh'man muh'man-ar 'guest'
bal'k'an bal'k'an-ar 'horses'
pen'žer pen'žer-ar 'windows'

Most monosyllabic nouns that end in a consonant form their plural by suffixing the stress-attracting -'*Ar*, which surfaces variably as -'*ar* or -'*er* as determined by palatal vowel harmony (21).

(21) tar tar-'ar 'tree' rib rip-'er 'awl'
tum tum-'ar 'tails' pel pel-'er 'hands'

This pattern also applies to many, but not all, monosyllabic loanwords, such as *park-'ar* 'parks' and *fil-'er* 'elephants'.

As mentioned earlier, the absolutive case is normally morphologically unmarked. The ergative case is marked by one of the five different types of ergative suffixes. All other cases (e.g. genitive, dative, etc.) are formed by the addition of suffixes onto the stem-plus-ergative complex, commonly referred to as the oblique stem or the stem augment. The oblique stem is formed with one of the following ten affixes (22).

(22) a. -di -a -i -u b. -'Adi -'rA -'Uni -'A -'U
-'ci/-c'i/-či/-č'i/-žI

The default oblique stem suffix is *-di*. Almost all polysyllabic nouns, monosyllabic words ending in a vowel, and monosyllabic loanwords form their oblique stems with *-di* or one of the other suffixes in 22a. The six oblique stem suffixes in 22b are used only with monosyllabic nouns and they are all stress-attracting. Since the exact morpho-syntactic distribution of each of these oblique suffixes is not directly relevant to the present discussion, I refer the reader to the discussion provided in Schulze 1984.

5.5. STRESS-INDUCED GEMINATION AND MONOSYLLABIC NOUNS. Recall that the general location of stress placement in present-day Lezgian is on the second syllable in non-monosyllabic roots. Judging from the comparative data available on stress, it is plausible to hypothesize that stress was also on the second syllable in Pre-Lezgian, at least for nouns. Thus, since native Lezgian nonverbal roots are mostly monosyllabic, when a monosyllabic nonverbal root undergoes some form of suffixation, the stress automatically lands on the suffix immediately following the root. In this precise circumstance, the final obstruent of the root would be in the environment to undergo the pretonic gemination process. This scenario is schematized in 23a. Even though I do not know exactly when this pretonic gemination process was active, it is still possible to understand why final obstruents in polysyllabic forms do not undergo this gemination process. That is, even if the gemination process post-dated the introduction of Arabic and Turkic loanwords, which are the main sources of polysyllabic roots in today's Lezgian, the final obstruents of polysyllabic roots would never be subjected to pretonic gemination since these final obstruents would not be immediately followed by a stressed nucleus. This is illustrated schematically in 23b.

(23) A hypothetical situation in Pre-Lezgian

a. Monosyllabic root				b. Polysyllabic root			
root	suffix		root-suffix	root	suffix		root-suffix
'CV**D**	+ V	>	CV**TT**-'V	CV'CV**D**	+ V	>	CV'CCV**D**-V

In order to complete the story, it must be posited that Lezgian subsequently eliminated all geminates, which then resulted in the present-day situation where final voiced obstruents alternate with their voiceless unaspirated counterparts in intervocalic position. This explanation not only captures the intriguing relationship between the morphological system of Lezgian and the pretonic gemination process, but also provides a princi-

pled account of why only monosyllabic roots participate in the coda-voicing alternation. In addition, this account might shed some light on the historical origin of the stress-attracting suffixes in Lezgian. That is, these stress-attracting suffixes were not attracting stress at all. They are stressed because the default stress location is on the second syllable of nonmonosyllabic forms. Since most of the stress-attracting suffixes attach only to monosyllabic forms, it requires no additional mechanism to explain why these suffixes bear inherent stress. The story of the origin of all the stress-attracting suffixes, however, is actually more complicated than can be explicated here and is thus postponed to future work.

5.6. CODA-EJECTIVE VOICING. So far, I have been concerned with the coda-unaspirated voicing pattern. I have yet to account for the other coda-voicing alternation, namely, coda-ejective voicing. Here, I argue that these coda ejectives were also historically voiced, which can be established by considering the comparative data given in Table 8.

	LEZGIAN	AGUL	TABASARAN	BUDUK	KRYZ	TSAKHUR	RUTUL
'large span'	tʃ'i**b**/tʃ^{h}**p'**er	tʃ'eʕ**b**/-ˈar	tʃ'i**b**/-ˈar	ts'i**p'**/-ri		tʃ'u**m**-mɨ	tʃ'u**b**/-ɨr
'finger'	t'ɨ**b**/t^{h}**p'**ar	t'u**b**/-ˈar	t'u**b**/-ar			t'u**b**/-aːr	
'owl'	t'i**b**/t^{hj}**p'**er		t'i**pp**/-ˈar		t'u**b**/-ni		t'ɨ**b**/-ˈar
'cradle'	q'æ**b**/q'æˈ**p'**er	q'ʕa**b**/-ˈar	q'ʕa**b**/-ˈar				q'ʕa**b**/-ɨr
'window'	t'a**g**/t'aˈ**k'**ar	daˈ**g**ar/-ar					
'winter'	q'y**d**/q^{h}**t'**ar	q'ʕur**d**/-ˈer	q'ʕur**d**/-ˈar	q'a**dʒ**redʒ/-er	q'u**d**/-ni	q'ʕɨ**d**ɨm/-mɨ	

TABLE 8. Comparative data on the coda-voicing ejective series in Lezgian.

Root-final obstruents are generally realized as voiced. Lezgian is the only language that displays systematic alternations.[9] I can, therefore, conclude that the so-called coda-voicing ejectives were historically voiced, similar to the coda-voicing plains, and have undergone the same INTERVOCALIC DEVOICING process. This interpretation is strengthened by the fact that the comparative evidence in Table 9 demonstrates that the nonalternating ejectives in Lezgian were historically ejectives.

	LEZGIAN	AGUL	TABASARAN	BUDUK	KRYZ	TSAKHUR	RUTUL
'navel'	pi**ts'**/-er			bɨ**ts'**/-ri	bɨ**ts'**/-ri		
'heart'	ri**k'**/-ˈar	ir**k'**^{w}/-ˈar	ju**k'**/-ˈar	ji**k'**/-ri	ji**k'**/-ri	ji**k'**^{j}/-bɨ	ji**k'**^{j}/-bɨr
'liver'	li**q'**/-ˈer	le**k'**^{j}/-ˈer		læ**q'**/-ri			la**q'**/-bɨr
'fox'	si**k'**/-ˈer			so**k**^{h}ul/-ber	sa**k**^{h}ul/-bi		di**k'**^{j}/-ˈeːr
'fly'	t'^{w}a**t'**/-ˈar	t'u**t'**/-ˈar		t'u**t'**-ri	t'ɨ**t'**/-ni	t'o**t'**/-aːr	di**d**/-ˈar
'grass'	wæ**q'**/-ær	u**k'**^{j}/-u**k'**ar	u**k'**/-ˈar			o**k'**/*	u**q'**/-bɨr
'millet'	tsy**k'**/ts^{h}**k'**er	du**k'**/*	du**k'**/-ˈar			di**k'**^{j}/*	dy**k'**^{j}/-bɨr
'final point'	k'e**k'**/-ˈer	k'e**k'**^{w}/-ˈar	k'a**k'**/-ˈar	k'e**k'**/-ri			k'eʔ/-bɨr

TABLE 9. Comparative data on the nonalternating ejective series in Lezgian.

The question that remains, therefore, is how a voiced stop became an ejective. A reexamination of the data provides a potential answer. The tokens that participate in coda-ejective voicing are given here again in 24.

(24)	q'e**b**	q'e**p'**-ini	'cradle'	tʃ'i**b**	tʃ^{h}**p'**-er	'span'
	t'a**b**	t'a**p'**-uni	'log'	q'y**d**	q^{h}y**t'**-yz	'winter'
	t'u**b**	t^{hw}**p'**-u	'finger'	ts'i**b**	ts^{hj}**p'**-er	'pot'
	t'i**b**	t^{hj}**p'**-er	'owl'	ts'i**g**	ts^{hj}**k'**-er	'middle'

[9] The realization of the root-final consonant in the word 'owl' as a voiceless geminate in Tabasaran and in the word 'large span' as an ejective in Budukh appears to be exceptional. These forms might be due to interdialectal borrowing.

Note that all of these stems contain an initial ejective. I hypothesize that the intervocalic voiceless unaspirated stop 'assimilated' to the preceding ejective. This ejective-spreading process was apparently applicable only to voiceless unaspirated obstruents. Word-final voiced obstruents do not turn into ejective obstruents. While ejective spreading has been observed in various languages (e.g. Bolivian Aymara, Hausa, Tzujutil (MacEachern 1997), Yucatec Maya (Straight 1976, Yip 1989), and Chaha (Banksira 2000, Rose & Walker 2001)), no phonetically sound explanation has yet been advanced, however. Many phonetic scenarios are plausible. For example, one might attribute this to the fact that voiceless unaspirated obstruents are acoustically more similar to ejectives than to voiced obstruents. If sound change can be the result of misperception, as argued by Ohala (1981, 1983, 1993) and many others, it is not surprising that voiceless unaspirated stops would be misinterpreted as ejectives in the appropriate environment. Another scenario might be that the pretonic high vowel deletion process mentioned earlier (e.g. [t'**i**b] 'owl' vs. [t^{hj}p'er] 'owls') produces a consonant cluster. This then forces the glottal release to be realized on the second obstruents. Unfortunately, this explanation fails to account for why ejective 'assimilation' is also observed in forms where pretonic high vowel deletion is irrelevant (e.g. [t'**a**b] 'log' vs. [t'**a**p'uni] 'log.ERG'.

5.7. RESIDUAL PROBLEMS. In the previous sections I advanced a historical explanation for the synchronic coda-voicing alternations. Recall, however, that in §2, there are nouns with final voiced consonants that do not show a voiceless counterpart in the intervocalic environment. A complete explanation of coda voicing must also be able to explain away these apparent counterexamples. These nonalternating forms are considered problematic because the historical account presented above predicts that all monosyllabic nouns with a final voiced consonant would have a voiceless allophone in intervocalic position, as sound change should apply uniformly without prejudice, according to the regularity of sound change hypothesis of the Neogrammarians.

Upon a close examination, I discover that these nonalternating nouns fall into one of the following three categories. To begin with, the forms in 25 are borrowings from Turkic or Arabic sources.

(25)	da**d**	da'**d**-uni	'taste'	[Turkic *tat*]
	da**ʁ**	da'**ʁ**-uni	'mountain'	[Turkic *dayˠ*]
	bi**ʒ**	bi'**ʒ**-uni	'illegitimate child'	[Turkic *pis*]

Lezgian, as mentioned above, is spoken in southern Daghestan and in north Azerbaijan. It is not surprising to see massive borrowings from the neighboring Turkic language, Azeri. The Arabic borrowings could potentially come from two sources: Azeri and Ottoman Turkish, which have many Arabic loanwords, or Arabic itself since Daghestan was conquered by the Arabs in the seventh and the eighth centuries. It is as a result of the massive lexical borrowing from the Turkic and Arabic sources that the once productive intervocalic devoicing alternation became a subregularity in the language as a whole.

Consider now the forms in 26. These are numerals. The final *-d* turns out to be historically a gender marker (Haspelmath 1993). The final *-d* surfaces only when the numeral is used alone, which means that the final *-d* would never occur in pretonic position, and pretonic gemination is thus not expected.

(26)	wa**d**	'five'
	qa**d**	'twenty'
	k'y**d**	'nine'

The remaining forms to be explained are shown in 27.

(27) a. p'u**z** p'u'**z**-a 'lip'
tʃ'i**ʒ** tʃ'i'**ʒ**-re 'bee'
gur**z** gur'**z**-ar 'big hammer'
b. mir**g** mir'**g**-i 'deer'
tʃʰi**g** tʃʰi'**g**-er 'dew'
ger**g** ger'**g**-er 'oat'
zar**b** zar'**b**-uni 'quickness'

Let us first look at the available comparative data on these forms (Table 10). The comparative data suggest that the final fricatives in the roots in 27a were etymologically fricatives. Since the pretonic gemination process applies only to stops, I naturally do not expect these forms to alternate.[10] The forms in 27b are genuinely aberrant. It is conceivable that they were borrowings from neighboring related Lezgic languages, since they are in very close contact with each other.[11] This is admittedly ad hoc, but given the compelling evidence that the intervocalic devoicing process was once prevalent in the Pre-Lezgian lexicon, it is more plausible to relegate these exceptions to other sources than to reevaluate the intervocalic devoicing process completely.[12]

	LEZGIAN	AGUL	TABASARAN	BUDUK	KRYZ	TSAKHUR	RUTUL
'lip'	p'ɨ**z**/-'ar[a]				p'ɨ**z**/-ri	p'ɨ**z**/-bɨ	p'ɨ**z**/-'bɨr
'big hammer'	gur**z**/-'ar			gɨr**z**/-ɨmber	gur**z**/-im		
'deer'	mir**g**/-'er	mur**x**ʲ/mur'**x**er	mirʃ/-'ar				mix^{j}/-'er
'oat'	ger**g**/-'er		ɣar'ɣar/ɣar'ɣrar			ɣarɣar/*	'ɣarɣal^{j}/-bɨr
'dew'	tʃʰi**g**/-'er		tʃɨ**g**/-'ar		tʃʰi**g**/-ri	tʃʰi**ː**/—	

[a] Haspelmath (1993) transcribes this as [p'uz] (see 27a), while Kibrik and Kodzasov (1990) give [p'ɨz]. This might reflect a dialectal difference between their respective informants.

TABLE 10. Comparative date on the nonalternating voiced root-final obstruents in Lezgian.

6. DISCUSSION AND CONCLUSION. This article introduces a peculiar phenomenon of coda voicing of plain obstruents and ejectives in Lezgian, a unique addition to the typology of laryngeal neutralization found in the world's languages. The acoustic study presented in §4 confirms the phonetic reality of coda voicing: the two types of coda-voicing obstruents (plains and ejectives) are indeed voiced in final position. The resulting voiced obstruents completely neutralize with respect to each other in final position. The direction of neutralization is the reverse of what is expected by an LBC analysis of voicing neutralization. Since neutralization within LBC is handled through the interaction between these cue-based constraints and featural preservation constraints such as *Preserve[α voice]*, in the event of contrast neutralization, a feature such as voicing can only be lost, not introduced. Lezgian final obstruent voicing clearly violates this major prediction of LBC.[13]

[10] It is important to recall that there is neutralization between the historical voiced affricates and the historical voiced fricatives. Present-day voiced fricatives have two possible sources.

[11] Brian Joseph points out that the word *mirg* 'deer' might have been a *Wanderwort*, possibly related as a borrowing to Sanskrit *mṛga-* 'deer'.

[12] Thus far, I have been silent on the origin of the coda-aspirating ejectives. This, unfortunately, is a reflection of the dearth of published comparative data that can shed light on this issue. I hope to return to this topic in the future.

[13] A reviewer suggests that the coda-voicing patterns observed in Lezgian are better considered as morphological in nature since coda voicing occurs only in certain monosyllabic nouns and not others; as such they

Some might argue that the Lezgian pattern conforms to the letter of the law of LBC since voicing neutralization, after all, occurs in preconsonantal and final positions. But the spirit of the theory is clearly lost. The location of contrast maintenance/neutralization is specific to the phonetic feature in question. Steriade 1993, for example, argues that neutralization of a place contrast in postvocalic position can be explained by the fact that a VC transition is less informative than a CV transition. However, Steriade 1995 points out that, at least for retroflexion, VC transitions are vital, while CV transitions are much less informative. Thus, the same context can be considered both perceptually informative and uninformative, depending on the phonetic feature involved. Even within the domain of laryngeal contrasts, preconsonantal and final position can be perceptually more informative than presonorant position, as in the distribution of pre-aspiration. Since final and preconsonantal position are impoverished perceptually with respect to voicing, it makes little sense to claim that Lezgian voicing neutralization is consistent with LBC, ignoring the fact that the contrast in question is voicing.

LBC proponents might also suggest that, while the force of phonetically driven phonological constraints is important in the grammar, the counterforce of contrast maintenance is to blame for any seemingly unnatural phonological alternations (e.g. Kirchner 2000 in response to the existence of postnasal devoicing). For the sake of argument, let us assume that contrast maintenance does play a role in synchronic phonology—an issue that remains controversial. It is unclear why the voicing of plain and ejective stops in final position should help maintain the contrast with the other laryngeal categories. While it is true that the two coda-voicing series do not neutralize with the underlying voiced one completely, the contrast between the two coda-voicing series per se remains obscured. No possible advantage, be it perceptual or contrastive, can be gained by voicing a plain or ejective stop in final position.

Recent research has demonstrated other problems with the LBC approach. One major advantage of the LBC has been its ability to eliminate the need to refer to the notion of the syllable in the treatment of various phonological patterns (i.e. LICENSING-BY-PROSODY). Gerfen 2001 takes this claim to task and demonstrates that the LBC is unable to account for the phenomenon of obstruent licensing in Eastern Andalusian Spanish (EAS). In this language, phonemic /s/ aspirates word-finally (e.g. /ganas/ 'desire' → [ga.na^{h}]) with additional gemination word-internally (e.g. Standard Peninsular Spanish [es.la.βo] 'Slavic' ~ EAS [e^{h}1.1a.βo]). Assuming that /s/ is licensed in EAS only when the transition into the following segment is clear (i.e. when /s/ is followed by a vowel), Gerfen offers two main arguments against such a cue-based approach to *s*-aspiration. First, sibilants have strong internal cues for place identification; CV transition plays

would not bear on the predictions of the LBC approach. I, however, argue otherwise. Steriade explicitly couches her theory within optimality theory (Prince & Smolensky 1993), which assumes that there is only a single ranking of constraints per language. Thus, the issue of morphological conditioning does not arise, at least not under the classical monostratal version of OT (Prince & Smolensky 1993, McCarthy & Prince 1993, 1995; but see Orgun 1996, Inkelas et al. 1997, Yu 2000, and Kiparsky 2004 for alternatives). Moreover, Steriade proposes that only two kinds of constraints are needed in modeling voicing neutralization: phonetically projected constraints and faithfulness constraints. This means that the constraints handling phonologically conditioned laryngeal neutralization ought to be the same constraints as those handling morphologically conditioned ones. In this light, the restrictive nature of the Lezgian alternations does not weaken their bearing on the LBC hypothesis.

only a secondary role in licensing fricatives. Moreover, other obstruents do not aspirate before a sonorant (e.g. [aklara] 's/he/it clears up') even though CV transition is more crucial to obstruent place identification than sibilant place identification. In light of these arguments, Gerfen contends that the simplest characterization of both word-internal and word-final aspirations is by referring to coda position.

Mielke 2002 finds that, contrary to the prediction of LBC, [h] is deleted in Turkish in otherwise salient environments (i.e. before liquids and nasals), while it is maintained in less salient positions (before voiceless stops and affricates). Given the fact that the hierarchy of perceptibility-based projected constraints is fixed universally, an LBC analysis of *h*-deletion in Turkish precludes the existence of a grammar in which [h] is deleted before liquids and nasals while it is licensed in less informative contexts, such as before voiceless obstruents. But instead of rejecting the LBC approach, Mielke proposes that the perceptibility scale remains useful in making typological predictions but should be established language-internally. While I concur with Mielke that perceptual factors may shape phonological patterns (Ohala 1983, 1993; see also Blevins 2004a, Blevins & Garrett 1998, 2004, Barnes 2002, Kavitskaya 2001), it does not follow that the perceptibility scale has any reality in the individual grammar—an important tenet of the LBC hypothesis. In addition, if the perceptibility scale were a language-specific property, it follows that the perceptibility scale of one language cannot shed light on the perceptibility scale of another language. Thus, the relevance of the LBC hypothesis remains dubious.

Comparative evidence reveals that the seemingly unnatural voicing alternations in Lezgian arose from a series of natural sound changes. The two coda-voicing series are found to be historically voiced. The present-day situation is a result of a pretonic gemination process and a subsequent total elimination of geminates in Lezgian. The lexical restriction of this pattern can be explained by the interaction between the intrinsic morphology of Lezgian and its stress assignment properties. The history of Lezgian coda voicing illustrates an important lesson: Language change need not result in 'grammar optimization' (Kiparsky 2000) nor does it necessarily result in phonetically optimal and natural alternations (Steriade 1997, Flemming 1995). While synchronic phonological patterns are the reflex of diachronic changes, the mapping from diachrony to synchrony is not always direct. As articulated in Blevins 2004b, 'recurrent sound patterns are argued to be a direct consequence of recurrent types of phonetically based sound change. Common phonological alternations . . . are shown to be direct results of phonologization of well-documented articulatory and perceptual phonetic effects'. Following a long line of scholarship in this area (e.g. Anderson 1981, Blevins 2004a, b, Dolbey & Hansson 1999, Hyman 2001, Hale & Reiss 2000, Janda 2001, McMahon 2000, Silverman 2000, 2003), this study serves as an additional piece of critical evidence arguing that the incorporation of the phonetic constraints, or what Hyman (2001) termed the 'phoneticization' of synchronic phonology, is misleading and can be shown to be too restrictive. The conceptual distinction between the phonetic motivations in phonological alternation and the formal mechanism that accounts for such alternation must be maintained.[14]

[14] As pointed out by the editor, one possible interpretation of this view of phonology is that 'phonology' is a self-destructive discipline. That is, the conventional sense is no longer viable; instead, 'phonology' is either explained in terms of phonetics, or else to be relegated to the morphological component of a grammar.

Appendix A: Recorded tokens

	SINGULAR	PLURAL/OBLIQUE	GLOSS
1.	tʃeb	tʃep-edi	‘clay’
2.	ʁab	ʁap-u	‘handful’
3.	jab	jap-u	‘ear’
4.	jeb	jep-ini	‘rope string’
5.	pab	pap-a	‘wife’
6.	qab	qap-uni	‘vessel, box’
7.	qib	q^{h}ip-re	‘frog’
8.	qib	q^{h}ip-i	‘yolk, yellow color’
9.	rab	rap-uni	‘needle’
10.	tab	tap-uni	‘lie, falsehood’
11.	xeb	xp-er	‘sheep’
12.	seb	sep-erar	‘abuse, curse’
13.	rib	rip-er	‘awl’
14.	rad	rat-uni	‘intestine’
15.	gad	gat-u	‘summer’
16.	ʁed	ʁet-re	‘star; fish’
17.	ʁud	ʁut-u	‘fist’
18.	jad	jat-ar	‘water’
19.	kard	kat-ra	‘falcon’
20.	pad	pat-a	‘side’
21.	tyd	tyt-yni	‘throat’
22.	fid	fit-e	‘dung, manure’
23.	mug	mukar	‘nest’
24.	meg	meker	‘hair’
25.	leg^{w}	lek^{w}-e	‘tub’
26.	tseg^{w}	tsek^{w}-re	‘ant’
27.	rug	ruk^{w}-adi	‘dust’
28.	pag^{w}	pak^{w}-ar	‘side, rib’
29.	tʃ’ug	tʃ’ug-uni	‘pulling’
30.	q’eb	q’ep’-ini	‘cradle’
31.	t’ab	t’ap’-uni	‘block, log’
32.	t’ub	tup’-u	‘finger’
33.	t’ib	t^{hj}p’-er	‘owl’
34.	tʃ’ib	tʃ^{h}p’-er	‘span’
35.	q’yd	q^{h}yt’-yz	‘winter’
36.	ts’ib	ts^{hj}p’-er	‘pot’
37.	ts’ig	ts^{hj}k’-er	‘middle’
38.	χak^{h}	χak-uni	‘pale’
39.	χat^{h}	χat-uni	‘bead’
40.	katʃ^{h}	katʃ-a	‘bitch’
41.	q^{hw}eq^{h}	q^{hw}eqe	‘cheek’
42.	tup^{h}	tupar	‘ball; cannon’
43.	tsyk^{h}	tsyk^{w}er	‘flower’
44.	tʃit^{h}	tʃiter	‘cotton’
45.	tʃyk^{h}	tʃyker	‘kind of soup’
46.	sat^{h}	sater	‘hour; clock’
47.	χwat^{h}	χutar	‘plum’
48.	ts’ap^{h}	ts’ap-adi	‘manure’
49.	k’wat’	k’wat’ar	‘lump, ball’
50.	kap’	kup’-ar	‘prayer’
51.	laˈpag	lapag-ar	‘sheep and goats’
52.	kaˈka	kaˈka-jar	‘egg’
53.	dad	dad-uni	‘taste’
54.	mirg	mirg-i	‘deer’
55.	jug	jug-arar	‘reaped grain’
56.	tʃig	tʃig-edi	‘dew’
57.	t^{h}up^{h}	t^{h}upar	‘ball, cannon’
58.	tʃ’ut^{h}	tʃ’ut^{h}-ar	‘flea’

	SINGULAR	PLURAL/OBLIQUE	GLOSS
59.	k^hek^h	k^hek^h-er	‘fingernail’
60.	$k^{hw}ak^h$	kuk^w-ar	‘worm’
61.	kap^h	kap^h-ar	‘palm (of the hand)’
62.	$kats^h$	$kats^h$-ar	‘cat’
63.	lak^h	lak^h-ar	‘a piece of cow dung’
64.	peq^h	peq^her	‘crow’
65.	qat^h	qat^h-ar	‘layer’
66.	jak^h	jak’-ar	‘meat’
67.	met^h	met’-er	‘knee’
68.	net^h	net’-er	‘louse’
69.	rat^h	rat’-ar	‘(threshing) floor’
70.	$wirt^h$	wirt’-er	‘honey’
71.	nik^h	nik’-er	‘field’
72.	jak^h	jak’-ar	‘meat’
73.	rak^h	rak’-ar	‘door’
74.	wik^h	wik’-er	‘yoke’
75.	nek^h	nek’er	‘milk’
76.	haq^h	haq’-ar	‘truth’
77.	req^h	req’-er	‘way’
78.	jak'^w	jak'^w-ar	‘axe’
79.	kits’	kits’-ar	‘dog’
80.	k’uk’	k’uk’-ar	‘peak’
81.	k’wat’	k’wat’-ar	‘lump, ball’
82.	muqajat^h		‘careful’
83.	ʁu'ts^{h}ar		‘god’
84.	q’abul		‘accept’
85.	'k^{h}udun		‘exhaust’
86.	i'ranbuba		‘father-in-law’
87.	kit’iz		‘rot’
88.	xalq’-ar		‘people-PL’
89.	dide		‘mother’
90.	k’yd		‘nine’
91.	wad		‘five’
92.	ts’ud		‘ten’
93.	qad		‘twenty’

APPENDIX B: COMPARATIVE SAMUR WORD LIST

	PAGE/#*	LEZGIAN	AGUL	TABASARAN	BUDUK	KRYZ	TSAKHUR	RUTUL
‘awl’	141/301	ri**b**/-ri'**p**ar	re**b**/-'ar	ri**b**/-'ar	re**b**/-ri	re**b**/-ri	ra**b**/-bi	ra**b**/-ir
‘needle’	142/302	ra**b**/ra'**p**ar	ru**b**/-'ar	ru**b**/-'ar	ru**b**/-'ri	ri**b**/-ri	wi:**b**a/wi:**b**a:r	ru**b**/-ir
‘vessel, thing’	166/357	qa**b**/qa'**p**ar	—/qa**b**ar	ʁa**b**-ʁa'dʒaʁ/-'ar	Ga**b**-Gadʒaʁ/*	Ga**b**/-ni	*/Ga**bb**i	—/'Ga**b**ir
‘ear’	12/6	je**b**/je'**p**er	ja'**b**ur/-ar	i**b**/-'ar	i**b**ir/i**b**rimer	i**b**ir/i**b**r-im		u**b**ur/u**b**rabir
‘frog’	87/171	qi**b**/q^j**p**er			Gu**b**laʁa/-rber	Gu**b**/-ni	q’ul^j**b**aʁa/-bi	ʁʕi**b**/-'ar
‘sheep’	62/117	χæ**b**/χ^j**p**er	χʕu**b**/ χʕu'**pp**ar			k’æ**b**æl/ -bi		χʕi**b**/-ir
‘wife’	59/111	pa**b**/pa'**p**ar		χ**pp**ir/χ^w**pp**ar				
‘rope, string’	143/306	je**b**/je'**p**er	ʕu**b**/-'ar			ʕæ**b**i/-jær		
‘water’	202/430	ja**d**/ja'**t**ar	xe**d**/xi'**tt**ar	ʃi**d**/ʃ**tt**ar	xə**d**/-ri	xæ**d**/-ri	x^{j}a**n**/*	xe**d**/-bir
‘fist’	27/41	χu**d**/χtar	χur**d**/-'ar	ʁur**d**/-'ar		χi**d**/-ri	χu**d**/-a:r	χu**d**/-bir
‘plum’	106/220	χ^{w}a**d**/χ^{w}tar	χu**t**/-'ar	χu**d**/χ^w'ttar	χe**d**/*	χe**d**/-ni		
‘partridge’	84/165	q^{w}æ**d**/q^{w}æ'**t**ar	ʁʕu**d**/-'ar	ʁʕu**d**/-'ar			ʁʕo**n**/-a:r	ʁʕu**d**/-er
‘throat’	17/20	ty**d**/t^h**t**er		dy**d**/-'er				
‘intestine’	37/63	ra**d**/ra'**t**ar	ru**d**/-'ar	u'**d**ar/u**d**r-'ar				ru**d**/-bir
‘summer’	209/449	ga**d**/ga'**t**ar		xa**d**/-'ar				
‘tongue’	15/15	me**z**/me'**ts**ar	me**z**/-'ar	mel**ʒ**/-'ar	mæ**z**/-ri	me**z**/-ri	mi**z**/-e:r	mi**z**/-bir
‘month, moon’	198/420	war**z**/war'**ts**ar	wa**z**/-'ura	wa**z**/-'ar	və**z**/-ri	væ**z**/-ri	wa**z**/wu**z**a:r	wa**z**/-bir
‘thorn’	104/213	tsa**z**/tsa'**ts**ar	za**z**/-'ar	za**z**/-'ar				za**z**/-bir
‘dust’	199/425	ru**g**/ru'**k**ar	ru**g**/-'ar	bu'ʃu ru**g**		ru**g**/-im		ru**g**/-bir

	PAGE/#*	LEZGIAN	AGUL	TABASARAN	BUDUK	KRYZ	TSAKHUR	RUTUL
'garlic'	110/229	ser**g**/ser'**k**er	ser**g**/-'ar	ʃar**ʃ**/-'ar		sar**g**/-ilbi		
'nest'	86/169	mi**g**/mi'**k**ar	mu**g**/-'ar	mu**q**'/-'ar				
'hair'	42/74	me**g**/me'**k**er	ma**ʕg**^{j}/-'er					me**g**/-bɨr
'day'	210/452	ju**ʁ**/ju**q**ar	ja**ʁ**/-'ar	ji**ʁ**/-'ar	ji**ʁ**/-ri	ji**ʁ**/-ri	ji**ʁ**/-bɨ	ji**ʁ**/-bɨr
'bridge'	190/401	mi**ʁ**/mi'**q**ær	mu**ʁ**/-'ar					
'tear'	50/93	na**ʁ**^{w}/na'**q**^{w}ar	ne**ʁ**^{w}/-'ar	niw**qq**/-'ar			na**ʁ**/-bɨ	na**ʁ**^{w}/-bɨr

* Page number and the entry number as it appears in Kibrik & Kodzasov 1990. Only forms believed to be cognate of the Lezgian form are cited here.

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