

Standard Georgian

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1 Introduction

Georgian is a Kartvelian (South Caucasian) language spoken by 4 to 5 million people in the Republic of Georgia, with small diaspora communities spread out in a few republics of the former Soviet Union, Iran, and Turkey. Shanidze (1973) distinguishes six groups of Georgian dialects: Dasavluri (Imeruli, Guruli, Rachuli, Lechkhumuri); Ingilouri; Kartlur-Kakhuri (Kartluri, Kakhuri, Javakhuri, Meskhuri, Kizikuri); Mtiulur-Pshauri (Mtiulur-Gudamakruli, Pshauri); Pkhouri (Khevsuruli, Mokheuri, Tushuri); and Samkhret-Dasavluri (Acharuli, Imerkheuli). The Kartluri dialect is considered the basis of standard or literary Georgian. It is spoken in Kartli, an eastern Georgian province where Tbilisi, the Georgian capital, is located. Standard literary Georgian is discussed here. One male speaker from Tbilisi (the second author) was consulted for all the data presented in the illustration.

The modern Georgian script (known as Mkhedruli) has been in use since the 11th century. The oldest version of the script, called Asomtavruli, dates back to the fourth century. There is a one-to-one correspondence between the alphabetic symbols and phonemic sounds of Georgian.

2 Consonants

There are 28 phonemic consonants in Standard Georgian, as shown in the chart below.

	Bilabial	Labio-dental	Dental	Alveolar	Post-Alveolar	Velar	Uvular	Glottal
Plosive	p ^h p' b		t ^h t' d			k ^h k' g	q'	
Affricate				ts ts' dz	tʃ tʃ' dʒ			
Nasal	m			n				
Tap/Trill				r/r				
Fricative		v		s z	ʃ ʒ	x ɣ		h
Lateral approximant				l				

The following near-minimal sets (to be read vertically) exemplify the important phonemic contrasts among Georgian consonants. For accompanying recordings, all words were pronounced in the carrier sentence /sit'q'va/ X /davts'εε/ 'I wrote the word X.'

IPA	Georgian	Gloss	IPA	Georgian	Gloss
p ^h uri	ფური	cow	ruxi	რუხი	gray
p'uri	პური	bread	duk ^h ani	დუქანი	shop
bur ^t hi	ბურთი	ball	k ^h ali	ქალი	woman
t ^h alxi	თალხი	black	k ^h ari	ქარი	wind
t'alaxi	ტალახი	mud	vardi	ვარდი	rose
dalak ^h i	დალაქი	barber	sardap ^h i	სარდაფი	cellar
k ^h udi	ქუდი	hat; cap	zari	ზარი	bell
k'udi	კუდი	tail	ɟari	შარი	quibbling
guda	გუდა	leather bag	ɟami	ქამი	time
tseri	ცერი	thumb	xari	ხარი	bull
ts'εო	წერო	crane	xut ^h i	ხუთი	five
dzera	ძერა	falcon	ɣaribi	ღარიბი	poor
tʃixi	ჩიხი	impasse	q'alibi	ყალიბი	mold; cast
tʃ'ik ^h a	ჭიქა	cup	q'ut ^h i	ყუთი	box
dzik ^h i	ჯიქი	panther	q'ava	ყავა	coffee
nɛla	ნელა	slowly	q'avavili	ყვავილი	flower
mɛla	მელა	fox	hava	ჰავა	climate
ludi	ლუდი	beer			

2.1 The uvular ‘stop’

The articulation of the uvular consonant is somewhat controversial. It has been variously transcribed as both [qʰ] and [χʰ], most likely because its articulation (as the only uvular phoneme in Georgian) varies among speakers. The confusion between stop and fricative is also linked to diachronic and dialectological factors. Diachronic evidence suggests that Proto-Kartvelian had both an ejective and a plain uvular stop (Klimov 1998). The old plain uvular stop *q is realized as a posterior fricative in contemporary Georgian (we shall accept it as a velar for the moment and discuss our reasoning in Section 2.2). The old ejective uvular stop *qʰ is now realized as any one of the segments [qʰ qʰʰ χʰ ʔ], as will be demonstrated in this section. Hence, the Common Kartvelian root *qʰel- ‘neck’ is now something like [χʰɛl] or [qʰɛl], etc., in modern Georgian and the root *qel- ‘arm’ is now realized [xɛl]. Since a velar fricative also existed in Proto-Kartvelian (and has remained unchanged in the modern languages), the non-ejective uvular stop is now merged with the ‘new’ velar fricative, resulting in homonymous pairs like modern Georgian [xɛrxi] ‘skill’ and ‘saw’ from Old Georgian *qerxi and *xerxi, respectively (Vogt 1961). Butskhrikidze (2002:80) observes that the opposition between non-ejective [q] and [x] persists in some mountainous dialects of Georgian like Khevsuruli. Likewise, in Svan, a Kartvelian sister language spoken in Northwestern Georgia, all three phonemes /q qʰ x/ coexist, e.g. qä-l ‘length of two outstretched arms’, qʰ-l ‘neck’, and xpʰ- ‘break smash’ (Klimov 1998: 334, 238, 327).

In our recordings of Standard Georgian, we found that [qʰ qʰʰ χʰ ʔ] occur as allophones of /qʰ/, apparently in free variation. From one recording to the next, the same word could be pronounced by the same speaker as a uvular stop with a strong burst, a burst plus a fricative, a uvular fricative alone, or a glottal stop. For example, Figure 1 shows spectrograms of the same word, /qʰɔpɑ/ ‘being, existence’, recorded in the same frame sentence on two separate occasions.

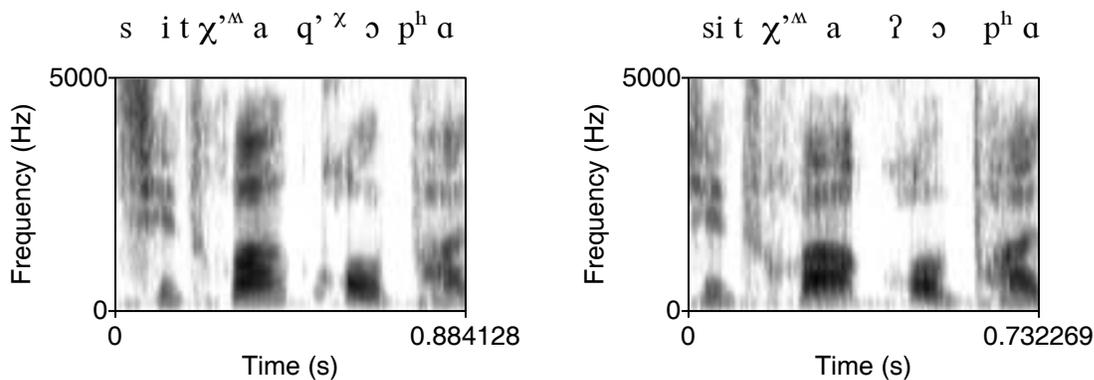


Figure 1. Two recordings of the word /qʰɔpɑ/ ‘being, existence’ demonstrating different phonetic realizations of /qʰ/. Observe the faint burst for [qʰ] on the left and the absence of such a burst on the right.

The tokens are presented with surrounding phonetic material (in this case the preceding word [sit'χ^ʷa] 'word') to ensure that the allophonic difference is not obscured: /q'/ is realized in the left-hand utterance as [q'^χ] and on the right-hand as [ʔ]. Notice (on the left) the single, faint, vertical line indicative of the burst for [q']. The transient stop burst appears slightly more than midway through the signal and is followed by aperiodic high-frequency energy indicative of a fricative offset. By comparison, on the left there is no stop burst and the frication is quieter. The unifying phonetic feature of these diverse realizations is most likely the laryngealization of neighboring vowels, as is evident in both examples of /ɔ/ in Figure 1.

Unfortunately, uvular phonemes cannot be compared in Georgian, since there are no phonemic contrasts at the uvular place of articulation. Therefore, one may wonder whether the ejectives of /q'/ is in fact phonemic. To add some clarity to the problem, we present a brief look at the aerodynamics of the consonant in word-initial position. Recordings were made using a circumferentially-vented pneumotach air mask, manufactured by Scicon R&D, and a Glottal Enterprises PTL-1 transducer (Rothenberg 1977).

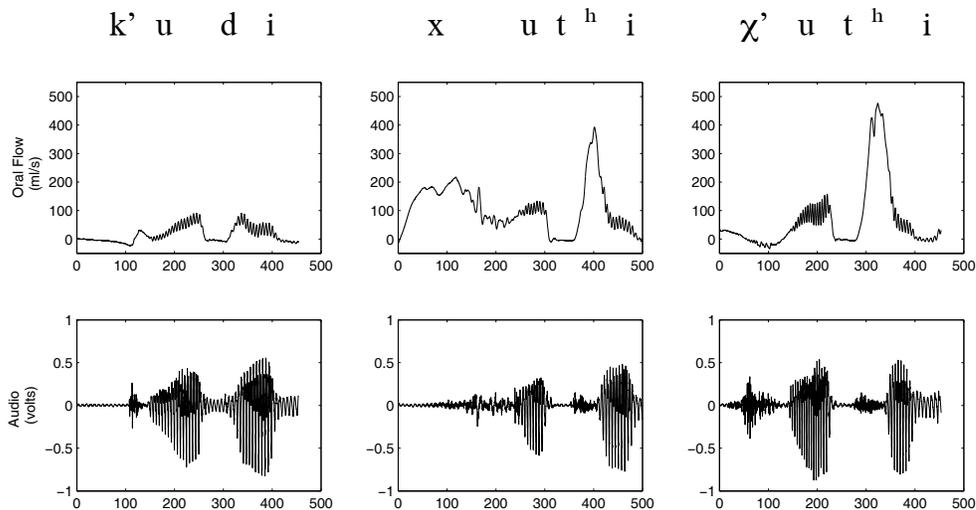


Figure 2. Oral flow and audio signals for /k'udi/ 'tail', /xuti/ 'five', and /q'uti/ 'box'. The oral release of /k'/ is visible as a relatively small peak in both the audio and aerodynamic signals. /x/ is characterized by a high degree of flow centered at around 100 ml/s. /q'/ is unlike either /k'/ or /x/: there are no prominent peaks in airflow at onset despite relatively high amplitude noise in the audio signal, suggesting low-flow frication.

Based on this data, it is difficult to characterize the uvular segment /q'/ as a stop, since there is no oral flow peak (not even an attenuated one, as at the release of /k'/). However, the consonant's low air flow is not indicative of a fricative, either. During this token of /q'/ there is presumably no substantial pressure build-up to cause a sudden burst of air at release, despite the

fact that there is an abrupt change in acoustic amplitude (greater, in fact, than that produced during /k'/ or /x/). Oral air flow during /x/ is much greater than it is during /q'/. There are three tiny spikes in airflow occurring at 100 ms in the uvular token, suggesting something like a trill. Further aerodynamic and acoustic research is needed to accurately categorize the sound, which surfaced in other (non-aerodynamic) recordings with a high-amplitude burst that characterizes prototypical stops (see Figure 3).

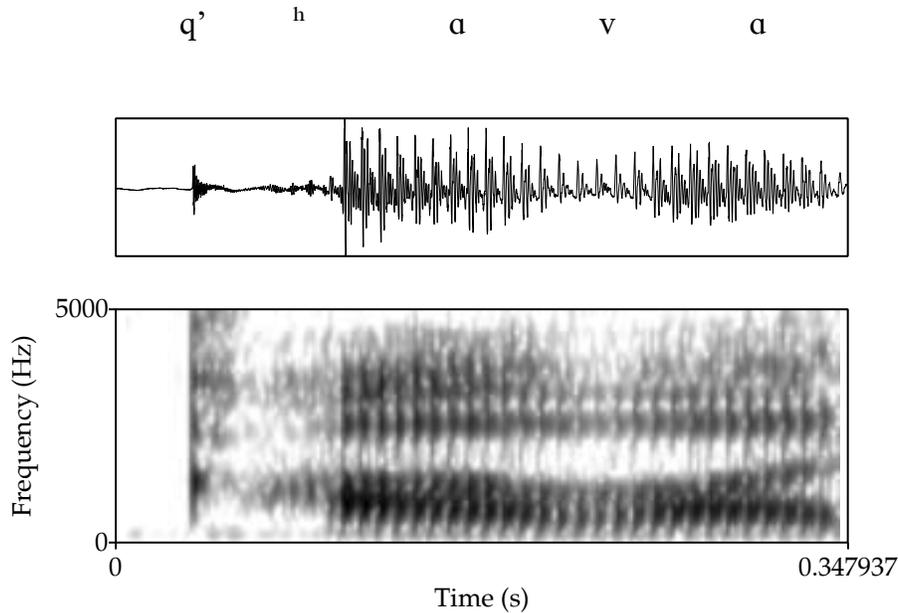


Figure 3. There is no doubt as to the plosive character of the uvular segment in this token. It is pronounced as a prototypical ejective stop with a strong burst and relatively little immediate aspiration in the word /q'avɑ/ 'coffee'.

For now, we conclude that the Georgian uvular consonant may range from a highly-constricted, low-flow, uvular fricative to an ejective uvular stop (with varying degrees of frication at offset) to a glottal stop. Net flow during the articulation of the fricative allophone is presumably reduced due to abduction of the vocal folds, hence the creakiness carried over to the following vowel. We propose a comprehensive study in which the airflow characteristics of /q x k^h k'/ are carefully measured in medial position in order to ensure that the variation seen in Figures 1, 2, and 3 is not merely an artifact of their word-initial position (e.g. Pike 1947).

2.2 The velar fricative

As mentioned earlier, the place of articulation for the back fricative is also the subject of debate. Various authors treat it as a velar (Vogt 1971; Shanidze 1973) while others recommend its classification as a uvular (Žgenti 1956; Fähnrich 1986; Hewitt 2005; Aronson 1997).

Butskhrikidze (2002: 77) uses the IPA symbol for a uvular [χ] and later the velar [x] for the same sound (87). This is probably indicative of inter-speaker variation, compounded by the fact that there is no true phonemic distinction between uvular and velar fricatives in Georgian. When the phonetic uvular fricative occurs it is evidently glottalized, thus introducing another (possibly confounding) variable into the comparison. We believe tokens in the present illustration are characteristically velar, and so employ [x] in the phoneme chart and transcriptions.

To affirm this intuition experimentally, we also undertook a brief investigation of whether vowels surrounding this fricative and the known velar [k^h] might give some better clue as to the fricative's place of articulation. It has been hypothesized that vowels adjacent to posterior consonants will show more evidence of laryngealization than vowels adjacent to less posterior consonants (McCarthy 1994). It is not clear that such a distinction must hold between uvulars and velars, as the distance between the two places is small. However, accepting the hypothesis at face value, one might logically expect the vowels surrounding the Georgian posterior fricative be creakier than the vowels surrounding the velar stop (if the fricative is indeed more posterior than the stop).

Accordingly, nonsense syllables of the type /ik^{hi}/ and /ixi/ were recorded in a frame sentence. Fifty tokens were recorded, balanced for all five vowels in both V1 and V2 positions, then repeated (N=100). At last, a measure of local jitter (a common measure of creak) was taken for both V1 and V2 (Boersma and Weenink 2003; Gordon and Ladefoged 2001). The difference in local jitter between the two articulations /k^h/ and /x/ was insignificant ($p > 0.05$) for both V1 and V2, suggesting that (if one expects vowels near a uvular to be creakier than those near a velar), /x/ is likely velar for the present speaker of Georgian.

It may be that there is some synchronic tension between the variant realization of /q'/ as a glottalized uvular fricative and the variant realization of /x/ as a non-glottalized uvular fricative. If there were a case in which both [χ'] and [χ] occurred in the speech of a single speaker, it seems reasonable to imagine that increased glottalization of the former would serve to perceptually enhance that distinction.

2.3 Characterization of stops and affricates

Wysocki (2003) observes that VOT and burst amplitude generally differentiate initial voiced and voiceless stops in Georgian, but the values for voiceless and ejective consonants overlap. She concludes that noise quality following oral release and voice quality of the subsequent vowel are the most reliable indicators of stop type. For our brief illustration of Georgian stop types, we provide aerodynamic data relating to the issue.

Figure 4 depicts the audio waveform and oral air flow (ml/s) for a near-minimal triplet where C1 = [t' t^h d]. We found that each stop type constitutes a unique air flow regime. For the ejective, the airflow spike is roughly symmetrical, beginning and ending at 0 ml/s. Air has escaped from the space between the closed glottis and recently-opened velar stricture, but this is of course a

much smaller volume of air than that which can potentially exit the lungs and pass through the open glottis (cf. the voiceless token). During Georgian ejectives, it appears that the glottis remains closed while the air leaves the compressed space between oral constriction and the larynx. It opens again only once the air has escaped from the compressed space and flow has fallen to 0 ml/s. In other words, a glottal stop has occurred. When the vocal folds open again, air flow must build up from this zero point. This is demonstrated during the production of [tʰ] in Figure 4.

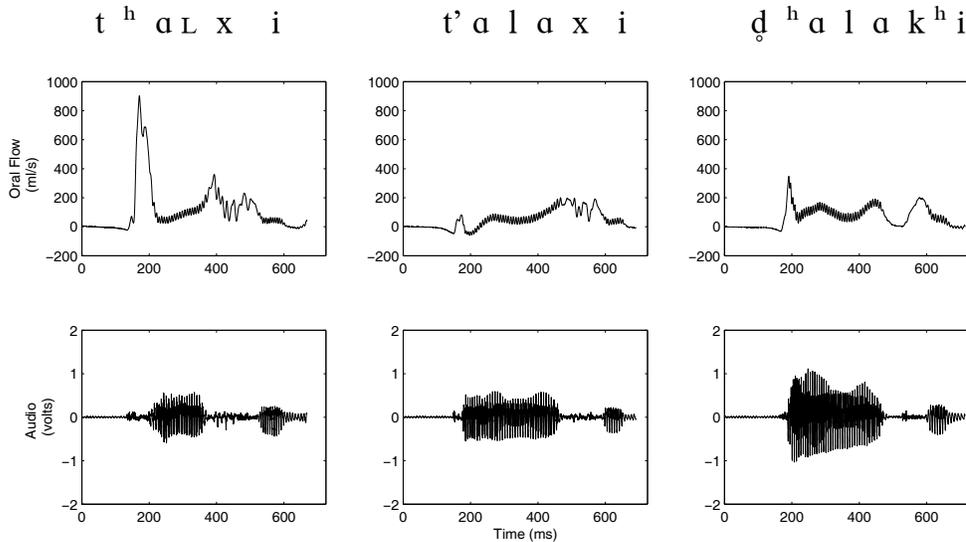


Figure 4. Oral flow and audio signals for /talxi/ ‘black’, /tʰalaxi/ ‘mud’, and /dalaki/ barber. Note the significant aspiration on the voiceless stop, the relatively minor aspiration on the ejective stop, and the slight aspiration (375 ml/s) of the voiced stop.

By contrast, the airflow spikes for the aspirated and voiced consonants in Figure 4 are not as symmetrical because the glottis was not closed at the moment the oral seal was broken. Air flow is relatively high for the voiceless consonant (approximately 900 ml/s). After the release of the voiceless consonant, the vocal folds are spread wide enough for air to flow freely. The aperture is gradually diminished, however, until the moment of voice onset. Resistance is high throughout the voiced articulation, meaning that the air flow spike has a smaller maximum value (approximately 375 ml/s), although it is greater than the spike characterizing ejective oral flow. Our observation of other tokens yields similar generalizations, but precise quantitative analysis will be necessary to provide all the details.

Žgentʹi (1956) found that foreign listeners tended to falsely categorize Georgian voiced obstruents as either voiceless or glottalized due to a relatively “low degree of voicing” on the nominally voiced stops, sparking some speculation that the stops may best be categorized in terms of aspiration instead of voicing (Butskhrikidze 2002: 85). Our evidence suggests that

aspiration is a significant factor in differentiating the Georgian stops and, in the absence of distinctive voicing differences, may be the primary perceptual cue.

It is interesting to note how ejectives affect the oral flow of the Georgian affricates, as well. In Figure 5 we observe high oral flow at the terminus of the affricate [ts], indicative of the fricative portion of the consonant. The voiced affricate [dz] also has an appreciable peak in oral flow at its offset. Note, however, the extreme reduction in oral flow during the ejective [tsʼ] (approximately 75 ml/s), which, though greater than the oral flow peaks in [kʼ] (Figure 2) and [tʼ] (Figure 4), is still much smaller than the peak for either voiceless [ts] or modal [dz].

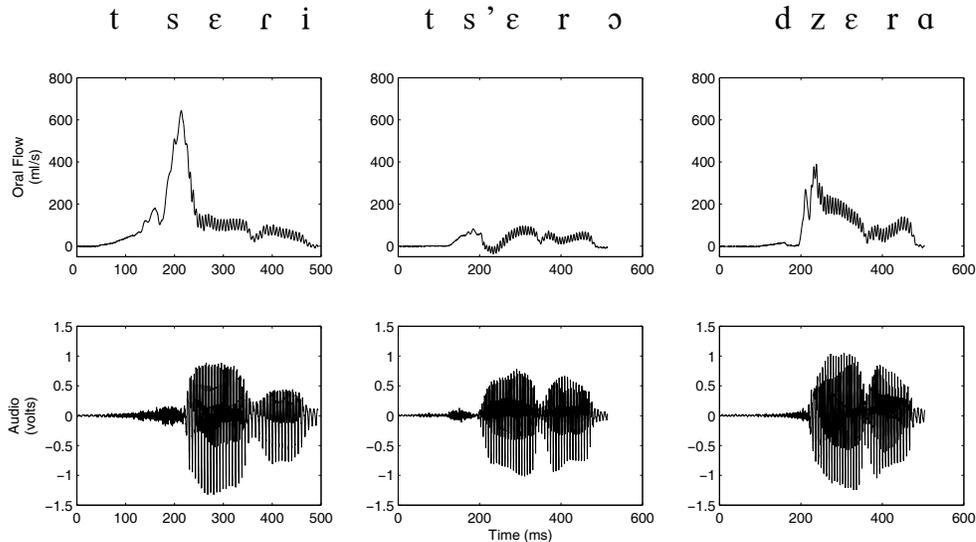


Figure 5. Oral flow and audio signals for /tseri/ ‘thumb’, /tsʼero/ ‘crane’, and /dzera/ ‘falcon’. Note the extreme reduction in airflow at the terminus of the ejective affricate. Also, the rhotic segments in /tsʼero/ and /dzera/ appear to be two-tap trills, suggesting free variation in intervocalic environments.

2.4 Sonorants

As Butskhrikidze (2002: 88) observes, in languages like Georgian which permit long consonant clusters, sonorants are often syllabic. Thus, phonetic description of these sounds may ultimately be helpful in sorting out the complex phonotactics of the language. The sonorants are /l r n m v/.

The rhotic and lateral sounds alternate in regular ways in Standard Georgian, with possibly more alternations to be discovered in other dialects. A certain nominalizing suffix has two variants, *-uri* under most circumstances and *-uli* if there is a rhotic in the base, e.g. /tʰbilisuri/ ‘of Tbilisi (non-person)’ but /kʰartʰuli/ ‘of Georgia (non-person)’ (Hewitt 2005: 282). This regular dissimilation of /l/ gives further evidence of a relationship that seems to exist between laterals and rhotics in many languages (Ladefoged and Maddieson 1996: 243).

Although it has been claimed that the Georgian /r/ may be “rolled”, this does not seem to be the case for the present speaker (Hewitt 2005: 5). In our tokens, the average closure duration for an intervocalic /r/ is quite short, on the order of 20 ms, and there is little evidence for sustained trilling in the audio signal. While the two brief reductions in oral flow observed in Figure 5 may be indicative of a two-strike trill, it is probably safe to say that taps, not multiple-strikes, are the pronunciation norm in Standard Georgian.

The labiodental fricative phoneme /v/ is realized as a canonical voiced labiodental fricative in most cases, e.g. [vgrdznɔb] ‘I feel’, [vardi] ‘rose’, and [hava] ‘climate’. Before voiceless consonants /v/ is realized as [f] or [ɸ], e.g. [ftʃʼam] ‘I eat’ and [ɸprtskʰvni] ‘I peel’; the labiodental and bilabial realizations seem fairly unpredictable. In some cases, /v/ is deleted from this position. The fricative is also optionally dropped when it occurs in word initial position before /u/, e.g. /vutsʼɛr/ → [utsʼɛr] ‘I write for someone’. Butskhrikidze (2002: 88) argues that /v/ is realized as secondary rounding on preceding obstruents, e.g. /qʰvavili/ → [qʰ^wavili] ‘flower’. This is definitely the case after voiceless obstruents. However, since the off-glide is also devoiced, it is practically impossible to differentiate, e.g. (a) [sitʼχʰ^wɑ] from (b) [sitχʰ^wɸɑ] or [sitχʰ^wfa]. Forms (a) and (b) result from two competing analyses. To achieve (b), /v/ simply devoices after voiceless obstruents (variably shifting from labiodental to bilabial place in the process). To achieve (a), /v/ is realized as a secondary feature of rounding and also becomes devoiced. The secondary feature analysis seems not to apply in all post-obstruent cases. After voiced stops, e.g. /gvɛrdi/ → [gvɛrdi] ‘side’, voicing, labiodental contact, and audible frication are all evident in the realization of /v/. Moreover, the second author strongly disapproves of forms like *[g^wɛrdi] where /v/ is realized as a frictionless off-glide of a voiced obstruent. This evidence may be problematic for Butskhrikidze’s (2002) analysis of /v/ as a secondary rounding feature after obstruents, since the generalization does not apply to /v/ when it follows voiced stops.

3 Vowels

Georgian is said to have a five-vowel system. The system is illustrated by the following near-minimal pairs.

	IPA	Georgian	Gloss
i	giraɔ	გირაო	mortgage
ɛ	gɛdi	გედი	swan
ɑ	gadia	გადია	nursemaid
ɔ	gɔra	გორა	hill
u	guda	გუდა	leather bag

While Akhvlediani (1949) claims there are no tense vowels in the inventory, our auditory impression is that the high vowels [i] and [u] are in fact tense and that only [ɛ] and [ɔ] are lax. This may be a fairly recent development. The vowel [ɑ] has a fairly low F2, but does not seem rounded upon visual inspection of the lips. Length and nasalization are not relevant features of the Georgian vowel system. Adjacent vowels are disallowed in monomorphemic words, ruling out the possibility of diphthongs (Butkhrikidze 2002: 83). When adjacent vowels do occur as in [girɑɔ] ‘mortgage’, the vowels are heterosyllabic.

The following vowel chart (Figure 6) was obtained through elicitation of 30 VCV nonsense syllables, with outliers (>2 standard deviations from the mean) disregarded. The consonants in the tokens were distributed equally by place (velar, dental, labial) and by manner (ejective, voiceless). Ellipses are drawn according to the least-squares method, where axis-crossings represent the central tendency of each vowel.

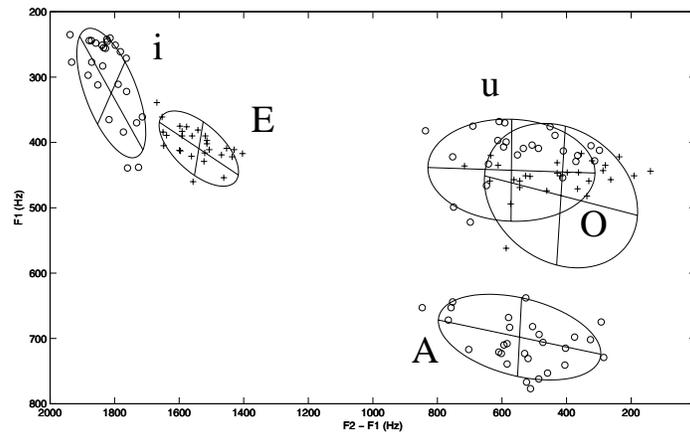


Figure 6. The five-vowel system of Georgian. Tokens were obtained from 30 nonsense VCV utterances where consonantal place of articulation and ejectivity were controlled. The utterances were produced by a male speaker.

4 Transcriptions: The North Wind and the Sun

The phonemic transcription of is an idealized version based on Georgian orthography. By contrast, the narrow phonetic transcription is drawn primarily from the audio recording. Two narratives were recorded, as spoken by the second author. Both versions were transcribed without access to the orthographic version by a non-native speaker of Georgian (the first author) and then compared. Inconsistencies were noted and the transcription was revised upon further study of the sound spectrograms. Of course, the transcription of only one of the narratives is presented here.

In the phonetic transcription, vowel quality and consonant clusters are represented as they sound, which presents us with some unexpected assimilations and reductions. Little is known about the way Georgian consonant clusters, much celebrated for their complexity (e.g.,

Butskhrikidze 2002), seem to be reduced in conversational or even read speech. The phonetic transcription gives some indication of a few processes: Deletion and/or vocalization of nasals, e.g., /ʃetaxmdnen/ ‘they agreed’ → [ʃet^haũymden] and deletion of rhotics, e.g., /tʃrdilɔetis/ ‘north.GEN’ → [tʃt^hiloet^his]. Owing to the complexity of Georgian consonant phonotactics, there are doubtless other strategies of reduction to be discovered as well.

There is at least one case of an increasingly complex structure (at least from the segmental point of view) being built in the transition from the phonemic to the phonetic transcription. The realization of /mzɛ/ ‘sun’ as /mbzɛ/ exemplifies a so-called “emergent stop,” conditioned by the timing of nasal and fricative production in the sequence /mz/. This phenomenon has been discussed extensively by Ohala (1981, 1992, 2005) in terms of a “mechanical” model of the vocal tract. During the articulation of nasal + fricative sequences, there is some probability that both the nasal and oral “exit valves” will be closed simultaneously while switching from nasalization to (oral) frication. Until the stop itself becomes phonologized, there may be no way of accurately predicting when this epiphenomenon will occur in a given utterance. Accordingly, emergent stops are regarded as probabilistic phenomena in the phonetic transcription and are transcribed as they were heard and as they appear under closer examination in the spectrogram.

4.1 Orthographic version

ჩრდილოეთის ქარი და მზე კამათობდნენ თუ რომელი იყო უფრო ძლიერი. ამ დროს გაიარა ერთმა ნაბადწამოხურულმა მგზავრმა. ისინი შეთანხმდნენ უძლიერესად ეცნოთ ის, რომელიც მგზავრს პირველი მოახდევინებდა ნაბადს. ჯერ ჩრდილოეთის ქარმა დაუბერა მთელი ძალ-ღონით, მაგრამ რაც უფრო ძლიერ უბერავდა, მგზავრი მით უფრო მაგრად ეხვეოდა ნაბადში. ბოლოს ჩრდილოეთის ქარი დაცხრა. ახლა მზემ გამოაბრწყინა და დააცხუნა. მგზავრმა ნაბადი მაშინვე მოიხადა. ამრიგად, ჩრდილოეთის ქარი იძულებული გახდა ეღიარებინა, რომ მათ შორს მზე უფრო ძლიერი იყო.

4.2 Phonemic Transcription

tʃrdilɔet^his k^hari da mze k^hamat^hɔbdnen t^hu romeli iq^h’a up^hro dzlieri. am dros gaiara ert^hma nabadts^hamɔxurulma mgzavrma isini ʃet^haxmdnen udzlieresad etsnɔ^h is, romelits mgzavrs p^hirveli mɔaxdevinebda nabadts. dzer tʃrdilɔet^his k^harma daubera mt^heli dzalyɔnit^h, magram rats up^hro dzlier uberavda, mgzavri mit^h up^hro magrad exveɔda nabadʃi. bɔɔs tʃrdilɔet^his k^hari datsxra. axla mzem gamɔabrts^hq^hina da datsxuna. mgzavrma nabadi maʃinve mɔixada. amrigad, tʃrdilɔet^his k^hari idzulebuli gaxda ɛyiarɛbina, rom mat^h ʃaris mze up^hro dzlieri iq^h’a.

4.3 Phonetic Transcription

tʃʰiloetʰis kʰari da mbzɛ kʰamatʰɔbdɛn tʰu rɔmɛli iχʰɔ upʰrɔ dzlieri. am drɔs gajɛra ɛrtʰma nabɔtsʰamɔsxulma ŋgzaurma isini ʃɛtʰaũymɔden udzlieresɑɖ ɛtsnɔtʰ is, rɔmɛlits mgzɑvʉrs pʰirveli muaxɖevineɔɖɑ nabɑɖs. dʒɔ tʃʰiloetis kʰarma daubɛra mtʰɛli dzɑlyɔnit, magram ras upʰrɔ dzlier ubɛravda, gzauri mitʰ upʰrɔ magrɑɖ ɛxveoda nabɑɖʃi. bɔlɔs tʃiloetʰis kʰari datsxra. axla mzem gamɔabrtsʰχʰina da da:tsʰχʰuna. gzaurma nabadi mɑʃinʷɛ mʉjxada. amɛrigɑɖ, tʃʰiloetis kʰari idzulebuli gaxɖɑ ɛyiaɛbinɔ, rɔm mat ʃɔris mze upʰrɔ dzlieri iχʰɔ.

References

- AKHVLEDIANI, G. S. (1949). *Zogadi ponet'ik'is sapudzvlebi*. [Foundations of general phonetics]. Tbilisi: Tbilisis Sakhelmc'ipo Universit'et'is Gamomcemloba.
- ARONSON, H. I. (1997). Georgian phonology. In A. S. Kaye (ed.), *Phonologies of Asia and Africa*. Volume 2. 929–939. Winona Lake, IN: Eisenbrauns.
- BOERSMA, P. & WEENINK, D. (2003). *Praat: Doing Phonetics by Computer*. Version 4.1.1.
- BUTSKHRIKIDZE, M. (2002). *The Consonant Phonotactics of Georgian*. Utrecht: LOT.
- FÄHNRIICH, H. (1993). *Kurze Grammatik der georgischen Sprache*. Langenscheidt: Verlag Enzyklopädie Leipzig.
- GORDON, M. & LADEFOGED, P. (2001). Phonation types: A cross-linguistic overview. *Journal of Phonetics* **29**, 383–406.
- HEWITT, G. (2005). *Georgian: A Learner's Grammar*. Second edition. New York: Routledge.
- KLIMOV, G. A. (1998). *Etymological Dictionary of the Kartvelian Languages*. New York: Mouton.
- LADEFOGED, P. & MADDIESON, I. (1996). *The Sounds of the World's Languages*. Oxford: Blackwell.
- MCCARTHY, J. (1994). The phonetics and phonology of Semitic pharyngeals. In P. Keating (ed.), *Papers in Laboratory Phonology III: Phonological Structure and Phonetic Form*. 191–233. Cambridge: Cambridge University Press.
- OHALA, J. J. (1981). Speech timing as a tool in phonology. *Phonetica* **38**, 204–212.
- OHALA, J. J. (1992). What is the input to the speech production mechanism? *Speech Communication* **11**, 369–378.
- OHALA, J. J. (2005). The marriage of phonetics and phonology. *Acoustical Science and Technology* **26**, 418–422.
- PIKE, K. (1947). *Phonemics*. Ann Arbor: University of Michigan.
- ROTHENBERG, M. (1977). Measurement of airflow in speech. *Journal of Speech and Hearing Research* **20**, 155–176.
- SHANIDZE, A. (1973). *Kartuli enis grammatik'is sapudzvlebi* [Fundamentals of the grammar of the Georgian language] Second edition. Tbilisi: Tbilisis Universit'et'is Gamomcemloba.
- VOGT, H. (1961). *Kartuli enis ponemat'uri st'rukt'ura*. [The phonematic structure of the Georgian Language]. Tbilisi: Tbilisis Sakhelmc'ipo Universit'et'is Gamomcemloba.
- VOGT, H. (1971). *Grammaire de la langue géorgienne*. Oslo: Universitetsforlaget.
- WYSOCKI, T. M. (2003). Acoustic correlates of Georgian stops. *Journal of the Acoustical Society of America* **113**, 2326.
- ŽGENT'I, S. (1956). *Kartuli enis ponet'ik'a* [Georgian phonetics]. Tbilisi: Tbilisis Universit'et'is Gamomcemloba.