Lund University, Dept. of Linguistics
Working Papers 42 (1994), 241-250

A Spectrographic Analysis of Vowel Allophones in Kabardian

Sidney A. J. Wood

This article, a revised version of a paper given at the Maikop symposium of the Societas Europeae Caucasiologica in 1992, reports some preliminary results from an investigation of the spectra of vowel allophones in the NW Caucasian language Kabardian. It is concluded that the environment for palatal vowel allophones consists only of the palatal semivowel and not of other consonants with a palatal component, and that the unrounded palatovelar environments need further investigation.

Introduction

The phonemic analysis of the Kabardian vowels is controversial and this study is being undertaken in order to clarify some of the problems involved. Recent contributions on this topic have been published by Anderson 1991, Choi 1991, Colorusso 1988 (chapts. 3, 8), Smeets 1984 and Wood 1991a. The issue is central to phoneme theory since it concerns the validity of Trubetzkoy's 1939 doctrine that all phoneme systems must consist of a consonant system and a vowel system, and that any system must contain at least three contrasting elements. The alternative is to disregard that doctrine and push the analysis as far as the data will allow, arriving at a result that was anathema to Trubetzkoy and his followers, i.e. one or two vowel phonemes contrasting syntagmatically with all consonants, or no vowel phoneme at all, vowels in speech being epenthetic. Two typical exponents of these approaches are illustrated in Figs. 1 and 2. Catford 1942 conforms to the standard vertical three-phoneme solution from Trubetzkoy (i.e. a *high* phoneme versus a *mid* phoneme versus a *low* phoneme). Kuipers 1960 disregards the Trubetzkoy doctrine and, following Jakovlev 1923, proposes a two-phoneme system with *mid* and *low* vowels in complementary distribution. Jakovlev had identified the traditional 'short *a*' as *mid*, and 'long *a*' as *low*, the timbre contrast being predictable from quantity, whereas Kuipers was now proposing an underlying syntagmatic contrast of /ha/ vs. /a/ that surfaces after metathesis as [ɑ] vs. [a].

	VOWEL ASSIMILATION ENVIRONMENT			
	palatal j	rounded kw qw etc	plain uvular q etc	elsewhere
high	i	u/ʊ	ə	ɨ
mid	e	o/ɔ	ʌ	ɐ
low		ɒ	ɑ	a

Figure 1. An example of the three-phoneme solution, based on the narrow transcription of the *North wind and the sun* in Catford 1942. This particular solution does not admit complementary distribution between *mid* allophones and *low* allophones.

	VOWEL ASSIMILATION ENVIRONMENT				
	palatal c ç j etc	rounded kw qw etc	plain uvular q etc	pharyngeal ħ	elsewhere
high	i	ü/u	ɯ		ə
mid low	e	ö/o	ɑ	ɑ	a

Figure 2. An example of a two-phoneme solution (Kuipers 1960), showing complementary distribution between *mid* and *low* allophones of a non-*high* phoneme.

The variety of vowel allophones arises by perseveratory lingual and rounding assimilation to prevocalic palatal, palatovelar and uvular consonants, and by anticipatory lingual and rounding assimilation to postvocalic rounded palatovelars and uvulars. The consonants of Kabardian are listed in Table 1.

An analysis of vowel spectra cannot resolve the controversy concerning the status of minimal vowel systems. That is a theoretical issue and is a matter of linguistic creed, depending on whether or not one accepts the Trubetzkoy doctrine of systems. A believer will halt the analysis once a three phoneme system is reached. What spectral analysis can do is offer physical correlates for identified allophones, especially evidence for or against complementary distribution.

Table 1. Kabardian consonants according to Catford 1942 and Kuipers 1960, Bagov et al. 1970 and Smeets 1984, retranscribed according to IPA conventions with the guidance of notes in the sources (from Wood 1991a). Assimilation environments according to Kuipers are (2-4,5,6,7,8), and according to Catford /j/ at (3), and (5,6). Kuipers classifies *j*, *w* as *hj*, h^w respectively. The character *ʝ* at (4) denotes a voiced palatal fricative.

	glottal	*voiceless*	*voiced*	*sonorant*	
	p'	p	b	m	
	f'	f	v		
	t'	t	d	n r	Catford interprets *ʦ*
	ʦ'	ʦ	ʣ		and *ʣ* as *t+s* and *d+z*
		s	z		
(1)	ɕ'	ɕ	ʑ		
		ʃ	ʒ		
(2)	ʎ̥'	ʎ̥	ʎ		
(3)	c'	c	ɟ	j	
(4)		ç	ʝ		
(5)		x^w			
	k^w'	k^w	g^w	w	
(6)	q'	q			Catford has *q*, q^h
	q^w'	q^w			and q^w, q^{wh} instead
		χ	ʁ		
		$χ^w$	$ʁ^w$		
(7)			ħ		
(8)	ʔ	h			
	$ʔ^w$				

Background

Phoneme analysis

Trubetzkoy's 1925 criticisms of Jakovlev's solution were partly diachronic (Kabardian 'long *a*' and 'short *a*' have different origins and thus represent different phonemes) and partly synchronic (the distinction between 'long *a*' and 'short *a*' is no longer one of quantity and there is now a phonemic opposition of 'sonorance' between them).

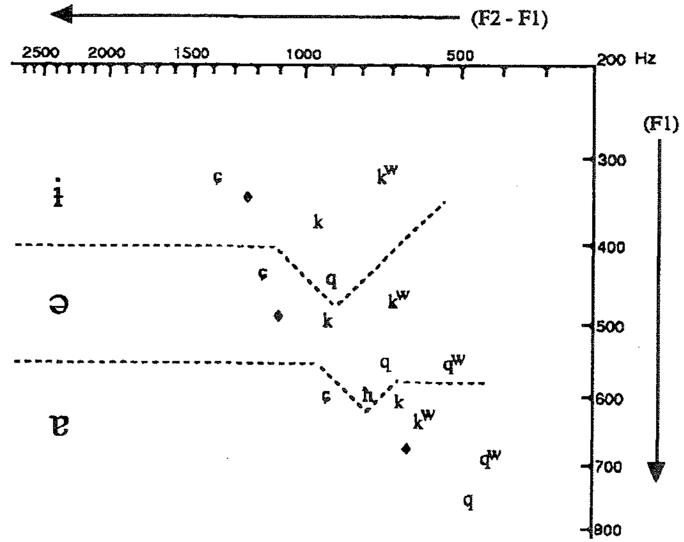

Figure 3. Choi's 1991 spectral analysis of Kabardian vowel allophones. The characters represent the average spectrum of pooled tokens in the respective environments: 'ç' postalveolars, 'k' unrounded velars, 'kʷ' rounded velars, 'q' unrounded uvulars, 'qʷ' rounded uvulars, 'ħ' pharyngeals, '◆' the default allophones.

Catford 1977 provided experimental confirmation of Trubetzkoy's observation on the quantity contrast, by comparing the durations of these two vowels and demonstrating there was no greater a difference between them than would be expected from the regular correlation between duration and degree of opening. Choi 1991 repeated the same experiment with different data and came to the same conclusion. However, that experimental approach is not effective against Kuipers's solution since he is not offering a surface contrast of quantity between 'long *a*' and 'short *a*' but an underlying syntagmatic contrast of /ha/ vs. /a/. Kuipers's solution can only be refuted by either denying the generative model (which is a matter of creed again) or by attacking the justification for the postulated /ha/ and metathesis (which is a matter of whether the language data allows that interpretation). Kumaxov 1984 queries the validity of the *ha>ah>a* interpretation, and Choi quotes Catford's arguments on the same theme. The issue remains as controversial as ever.

Spectral analysis of Kabardian vowels

Choi 1991 measured the spectra of Kabardian vowels by three speakers of the Terek dialect who read a piece of continuous prose twice (taken from Šagirov 1967:182). All tokens were pooled and sorted according to prevocalic environment, using Catford's analysis of the consonants and vowels. His results (Figure 3) show a full complement of allophones at each of the three heights, similar to Catford's solution (Figure 1). Unfortunately, the vowel spectra in Choi's material are subject to other influences in addition to the lingual and labial articulations being studied, and these potential sources of bias are worth looking at more closely.

(1) The numerical values of formant frequencies for a given timbre vary between speakers due to individual differences of vocal tract morphology and can therefore only function contrastively within the speech of the person who uttered them. Pooling data from several speakers unnecessarily adds between-speaker spectral variation to the within-speaker variation being observed. This can be avoided by reporting each subject individually.

(2) Spectra are also expected to vary with degree of accentuation and focus. Languages may certainly differ in the extent of reduction related to accentuation, but the possibility of formant frequency averages being biased by pooling accented and unaccented tokens should not be overlooked.

(3) Nasal contexts were included in Choi's material. The problem here is that the introduction of antiresonance and nasal formants from nasal coupling during vowels adjacent to nasals can mask the oral resonances related to the lingual and labial environments that are the object of the study. The formant frequencies measured under nasal conditions will not reflect the articulations being studied under non-nasal conditions. It would be appropriate to reject the vowel tokens from the nasal environments, or at least deal with them separately.

(4) It is well known that different consonant environments bias vowel formant frequencies, but these contextual effects do not always give rise to the experience of different vowel allophones. In the case of Kabardian the vowels are said to be assimilated into identifiable allophones that can be allotted appropriate characters from the phonetic alphabet. The formant frequency average captures the contextual bias from the consonant, but it is not an indicator of the independence of an allophone from its neighbouring vowel allophones. A scatter plot of the original tokens is a better indicator of how far an allophone is distinct from or confused with its neighbours.

These effects are taken into account in the study reported here.

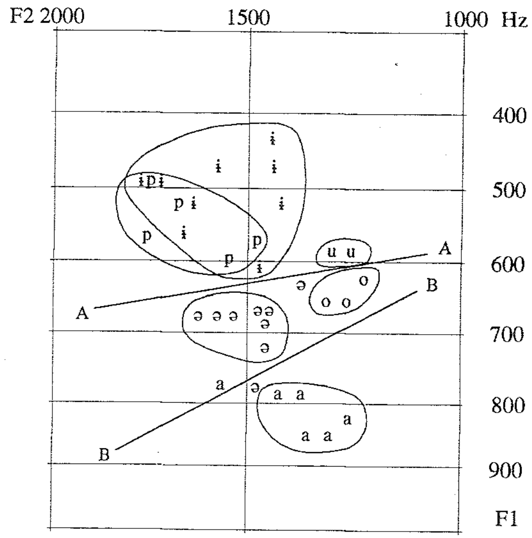

Figure 4. Frequencies of F1 and F2 of accented Kabardian vowels in the present study. The characters represent different consonant environments: 'p' palatal (2,3,4 in Table 1), 'ɨ' default *high* allophone, 'u' rounded (5,6), 'ə' default *mid* allophone (Jakovlev's 'short *a*'), 'o' rounded (5,6), 'a' default open allophone (Jakovlev's 'long *a*'). The lines AA and BB divide *high* from *mid* from *low*. The frequencies are compressed to the Mel scale.

Procedure

Recordings were made from native speakers of Kabardian in Moscow, Maikop and Tbilisi (residents or visitors). The subject reported here is a male speaker of Kuban Kabardian, a postgraduate student at the Moscow Academy of Sciences.

The material consisted of the list of words given by Kumaxov 1981:44 as exemples of the vowel phonemes in a variety of consonant environments (but not all). The words were ordered randomly and read both in isolation and framed in focal position in a carrier sentence. One reading in isolation by one subject is reported here.

Accented vowels were analysed, excluding those in nasal contexts. The formants were measured by locating a cursor in a broadband spectrogram, based on FFT slices, displayed on the screen of a PC computer (Ternström 1987, 16-bit Ariel DSP, at Umeå) and reading the coordinates of the cursor position. The formants were measured at the point in the vowel where F1 reached a maximum, as experience from working with X-ray films and synchronised sound showed that this was the point on which the articulator gestures for a vowel converge, before the mandible begins to close again for the next consonant (Wood 1979, 1989, 1991b).

Linear prediction would have been preferred but the Lund ILS system was inaccessible following the sudden and untimely demise of the main-frame lab computer, and replacement desktop systems based on Macintosh, PC and Sun had not yet been installed. That is also the reason why so little of the material was analysed at that time, just sufficient to satisfy one's curiosity and whet the appetite for more. The Lund lab is now back in business again and processing will be resumed.

Results and discussion

The formant frequencies obtained are summarised in Figure 4 for comparison with Choi's results in Figure 3. Note that Choi follows Ladefoged's practice of plotting F2-F1 rather than just F2. Figure 4 shows that the tokens for each environment form distinct allophone islands, except that the palatal allophones ('p') of the close phoneme are hardly distinguishable from the default allophones ('ɨ'), by F1 and F2 at least, and hardly seem to warrant the status of an independent allophone. At the same time, these tokens tend to accumulate in the upper half of the F2 range of the default allophone, and would thus have a higher average F2.

The Kabardian consonants include rounded velars and uvulars (see [5,6] in Table 1) that constitute environments for rounding vowels and velarising or uvularising them, yielding [u] or [o] as the case may be. There are clear examples of these in Figs. 3 and 4. Choi also has examples of a *low* rounded allophone [ɒ] (there were no candidates for this in my limited data).

The *high*, *mid* and *low* vowels are distinguished by low, middle and high F1 frequencies, which is expected from acoustic theory (both widening the anterior end of the vocal tract and narrowing the posterior end raises F1).

The data available here only permit a more penetrating discussion of the palatal allophones and what constitutes the palatalising environment in Kabardian.

Palatal allophones

The available descriptions have us expect an [i]-like allophone for the *high* phoneme in the palatal envirnoment, i.e. an F2 of at least 2000 Hz, but this has not materialised. F2 of these tokens in Figure 4 ranges 1400-1750 Hz and the corresponding set in Figure 3 ('ç', Choi's postalveolar environment) has an average F2-F1 of 1400 Hz (i.e. mean F2 around 1750 Hz). This result can be partly explained by our having included different consonants in this environment.

My palatal set 'p' in Figure 4 theoretically comprises consonants from [2,3,4] in Table 1, i.e. laterals, unrounded palatovelar stops and fricatives (said to be produced as palatal affricates and fricatives) and the palatal semivowel, but there were in fact no tokens with the semivowel in the present set of data. Catford 1942, on the contrary, reports only the semivowel yielding allophones [i,e], the rest producing the default allophones. Figure 4, which shows F2 ranging 1400-1700 Hz in my lateral and unrounded palatovelar environment 'p', suggests he is correct in counting only the semivowel in the palatalising environment.

Choi's palatal set (that he calls postalveolar) does not include the laterals or palatalised velars, but instead it includes alveopalatals /ç', ç, ʑ/ and palato-alveolars /ʃ, ʒ/ from (1) in Table 1. His data does include examples with the semivowel /j/, which presumably explains why the average F2 for this group is as high as 1750 Hz. I would now expect that his tokens in the semivowel environment were indeed [i]-like with F2 around 2000 Hz, while the alveoplatals and palato-alveolars yield the default allophone rather than the palatal allophone (which consequently pulled his average F2-F1 down for the palatal context).

The present material has no example of /j/ with a *mid* vowel, that yields [ɛ], but Choi's does. Once again, his average F2-F1 is very low, 1100 Hz, (i.e. mean F2 around 1550 Hz). Something like 1800 Hz would be expected for an [ɛ]-like timbre, and the discrepancy presumably once again reflects the fact that alveopalatals etc. are not part of the palatalising environment.

Choi also has a palatal set among the low vowels. None of the sources, including Catford, reports a palatal allophone of a *low* vowel (compare e.g. Figs. 1 and 2), and the absence of a low palatal allophone was part of Jakovlev's argument for complementary distribution between *mid* and *low* vowels – his default 'long *a*' is [a], default 'short *a*' is [ə] and in the palatal environment they are [ɛ(ː)]. A proponent of the three-phoneme solution might instead argue that there is an accidental gap in the lexikon so that /j/ never occurs with /a/. So what is Choi's palatal environment with /a/? Presumably the same alveopalatals etc. again, which now seem not to belong there.

The results in Figs. 3 and 4 agree that many of the tokens in the respective palatalising environments for the *high* vowel have F2 much lower than expected for an [i]-like timbre, so low in fact that they coincide with the tokens in the default environment. This indicates that we should reconsider what constitutes the palatalising environment in Kabardian, and that laterals, alveopalatals, palato-alveolars and unrounded palatovelars are not part of it, despite the palatal component in their articulations. That leaves just the palatal semivowel, as in Catford 1942.

The default environment consists of the labials and alveolars that remain after removing the palatal, velar and uvular assimilation environments. The common feature of the laterals, alveopalatals and palato-alveolars, that must now also be included in the default environment, is that they are coronal, like the alveolars already there. The palatalising environment is simply the non-coronal palatal, i.e. just /j/.

What about the plain palatovelars, that are said to be so palatalised? They certainly did not palatalise vowels in my data, and Choi never had them as palatalising environments anyway. Do they belong to the default environment that yields [ɨ] or do they belong to a velarising environment that yields [ɯ], along with the unrounded uvular environment? This requires further clarification.

References

Anderson, J.M. 1991. 'Kabardian disemvowelled, again'. *Studia Linguistica* 45, 18-48.

Bagov, P. M., B. X. Balkarov, T. X. Kuaševa, M. A. Kumaxov & G. B. Rogova (eds.). 1970. *Grammatika kabardino-čerkesskogo literaturnogo jazyka; 1 fonetika i morfologija* [Grammar of literary Kabardino-Circassian, part 1, phonetics and morphology]. Moscow: Nauka.

Catford, J. C. 1942. 'The Kabardian language'. *Maître Phonétique* 3rd Series 78, 15-18.

Catford, J. C. 1977. 'Mountain of tongues: the languages of the Caucasus'. *Annual Review of Anthropology* 6, 283-314.

Choi, J.-D. 1991. 'An acoustic study of Kabardian vowels'. *Journal of the International Phonetic Association* 21, 4-12.

Colarusso, J. 1988. *The Northwest Caucasian languages, a phonological survey*. New York: Garland.

Jakovlev, N. 1923. *Tablitsy fonetiki kabardinskogo jazyka*. Moscow: Oriental Institute.

Kuipers, A. H. 1960. *Phoneme and morpheme in Kabardian*. The Hague: Mouton.
Kumaxov, M. A. 1981. *Sravnitelno-istoričeskaja fonetika adygskix (čerkesskix) jazykov*. [Comparative and historical phonetics of the Adyge (Circassian) languages]. Moscow: Nauka.
Kumaxov, M. A. 1984. *Očerki obščego i kavkazskogo jazykoznanija* [Studies in general and Caucasian linguistics]. Nal'čik: Izdatel'stvo El'brus.
Šagirov, A. K. 1967. 'Kabardinskij jazyk'. In E. A. Bokarev & K. V. Lomtatidze (eds.), *Jazyki narodov SSSR*, Vol 4, *Iberijsko-kavkazskie jazyki*, 165-183. Moscow: Nauka.
Smeets, H. J. 1984. *Studies in West Circassian phonology*. Leiden: Hakuchi Press.
Ternström, S. 1987. *Swell soundfile editor*. Stockholm: Soundswell Music Acoustics.
Trubetzkoy, N. 1925. Review of Jakovlev 1923. *Bulletin de la Société de Linguistique de Paris* 26, 277-286.
Trubetzkoy, N. 1939. *Grundzüge der Phonologie*. Prague: Travaux du Cercle Linguistique de Prague VII.
Wood, S. A. J. 1979. 'A radiographic analysis of constriction locations for vowels'. *Journal of Phonetics* 7, 25-43.
Wood, S. A. J. 1989. 'The precision of formant frequency measurement from spectrograms and by linear prediction'. *Speech Transmission Laboratory Quarterly Progress Report* STL/QPSR 1/1989, 91-93. Stockholm: Royal Institute of Technology.
Wood, S. A. J. 1991a. 'Vertical, monovocalic and other impossible vowel systems: a review of the articulation of the Kabardian vowels'. *Studia Linguistica* 45, 49-70.
Wood, S. A. J. 1991b. 'X-ray data on the temporal coordination of speech gestures'. *Journal of Phonetics* 19, 281-292.

The Department of Linguistics and Phonetics 1993–94

Staff

General linguistics

Mats Eeg-Olofsson	Lecturer
Barbara Gawrońska	Research assistant
Marianne Gullberg	Research student
Gisela Håkansson	Lecturer
Kristina Hansson	Research assistant
Arthur Holmer	Research student
Merle Horne	Lecturer
Robert Jarvella	Lecturer
Christer Johansson	Research student
Ann Lindvall	Research student
Ulrika Nettelbladt	Lecturer
Anders Nordner	Research assistant
Thore Pettersson	Lecturer
Bengt Sigurd	Professor emeritus
Jan-Olof Svantesson	Lecturer
Revaz Tchantouria	Research assistant
Karina Vamling	Research fellow

Phonetics

Gösta Bruce	Professor
Eva Gårding	Professor emeritus
Kerstin Hadding	Professor emeritus
David House	Research fellow
Kurt Johansson	Lecturer
Eva Magnusson	Lecturer
Bertil Malmberg	Professor emeritus
Duncan Markham	Research student
Yasuko Nagano-Madsen	Research assistant
Kerstin Nauclér	Lecturer
Paul Touati	Research fellow
Mechtild Tronnier	Research student
Sidney Wood	Lecturer