Ablaut in Dinka Nouns: A Preliminary Study*

MICHAEL J. KENSTOWICZ
Massachusetts Institute of Technology

1 Introduction

Dinka is well known in the recent phonology-phonetics literature for its remarkable vowel contrasts and the role they play in the language's morphology. Noun and verb roots are canonically CVC; singular-plural distinctions in nouns and various inflectional contrasts in the verb are signaled not by affixation, but rather through changes in the root vowel. These vocalic alternations involve the dimensions of length, tone, vowel height, and voice quality. They have been documented and analyzed by a number of linguists including Anderson (1993), Edmonson and Elsing (2006), Remijsen and Gilley (2008), Remijsen and Ladd (2008), and Remijsen (2013), building on earlier work by Malou (1988) and Denning (1989). In this squib, we report some of the findings of an analysis of a corpus of c. 250 words, principally singular – plural noun pairs. They were elicited from a female speaker of the Bor dialect (Duk Nyaarweng, SE Sudan). The data was collected over the course of three months in the context of a field methods class and recorded in a laboratory setting. They were analyzed phonetically in Praat (Boersma and Weenink 1993-2013, version 5.3.39).

2 Length

Dinka root vowels exhibit three grades of length: short, long, and overlong. Singular-plural pairs alternate among all three grades, in both directions. However, the most common type appears to be short vs. long. Some examples of various types appear below.

(1)	singular	plural	
	cíin	cìn	'hand'
	lɛ̰̤̰̤c	lɛ̰̀c	'tooth'
	cól	cʊ̂ɔl	'mouse'

*Thanks to Abiar Markɔ̰ɔ̰r Guɔt for sharing her language with us.

làŋ	là̰aŋ	‘berry’
côol	côool	‘charcoal’
wéeŋ	wɛ̀ɛɛŋ	‘cow’
kúuur	kṵ̀r	‘mountain’

In (2) we present the raw duration scores and ratios for a sample of nouns recorded in singular – plural pairs and elicited in list format. The CVC and CVVC contrast is relatively stable while the CVVC vs. CVVVC contrast is less so, due to the fact that our speaker tended to drawl out the overlong vowel. Expressive lengthening has been noted for Japanese by Kawahara and Braver (2012).

(2) Vowel duration in milliseconds for 20 singular and plural noun pairs; averages and standard deviations

CVC	CVVC	ratio
80 ms (10)	157 (31)	1.96 (.4)

CVVC	CVVVC	
204 (57)	644 (209)	3.3 (1.2)

Through comparison with related Nilotic languages, one can see that the length grades probably arose from compensatory lengthening due to the loss of a word-final vowel (3). As mentioned above, the vast majority of Dinka roots are CVC. Data source Hieda (2009).

(3)	singular	plural	singular	plural	
‘tree’	tîm	tíim	en-tîm	in-tímì	Maasai
‘egg’	tūoŋ	tóŋ	tɔŋo	toŋ	Shilluk
‘hand’	cíin	cìn	cino	cin	Shilluk
‘tooth’	lɛ̰̰̂ɛc	lɛ̰̀c	lɛjo	lɛk	Shilluk
‘blood’	riim	rim	rɛ̀mɔ́	rɛ̀m	Anywa
‘fish spear’	bît	bḭ̄it	ō-bìth	ō-bīdhī	Anywa

It is interesting that nouns denoting entities found in pairs or in groups often have the short grade for the plural and a lengthened grade for the singular, suggesting that the latter is derived from the former. Compare singular-plural pairs in Arabic formed by the singulative suffix *-a*, as in *baqar* ‘cows’ vs. *baqar-a* ‘a cow’.

(4)	singular	plural	
	cíin	cìn	‘hand’
	nyìin	nyin	‘eye’
	lɛ̰̰̂ɛc	lɛ̰̀c	‘tooth’
	ṭ̰ò̰k	ṭ̰ô̰ok	‘mouth’
	kúuur	kṵ̀r	‘mountain’

A number of Arabic loanwords have been integrated into the length gradation (Idris 2004).

(5)	singular	plural			
	gālám	gālâam	‘pen’	cf. Arabic	qalam
	cá̤a̤at	cét	‘witness’		šaahid
	rêeet̪	rét̪	‘president’		raʔiis
	t̪úuk	t̪úuuk	‘market’		suuk
	déec	dêi	‘army’		jeeš

The overlong vowels of *cá̤a̤at* and *rêeet̪* probably arose from the loss of the intervocalic laryngeal consonants in the original Arabic words. Dinka lacks fricatives in its phonological inventory. Arabic /š/ is adapted as the affricate /c/ while /s/ is adapted with the dental /t̪/ instead of alveolar /t/.

3 Tone

In a study of Dinka Bor, Remijsen (2013) finds evidence for a four-way tonal contrast consisting of a high rising tone, a mid, and two falls: an early fall with an inflection point at the onset of the vowel and a later fall aligned with roughly the mid point of the vowel. The former is a variant of an underlying low tone. He also shows that the tonal contrasts are defined over the syllable and hence can occur with the three length grades. The tonal contours exhibited by our speaker also evidence a contrast between the two falls as well as a high rise and a level tone realized in the middle of the speaker’s pitch range. A few examples appear in (6).

(6)	singular	plural	
	nɔ̌ɔk	nâ̰ak	‘feather’
	pěm	pèem	‘chest’
	děen	dèn	‘loan’
	wěl	wɛ̰̀ɛ̰l	‘guinea fowl’
	cǒl	cûɔ̰l	‘mouse’

The chart below shows the averaged pitch curves for the four tonal types in isolation (citation) form based on 10-15 samples per type.

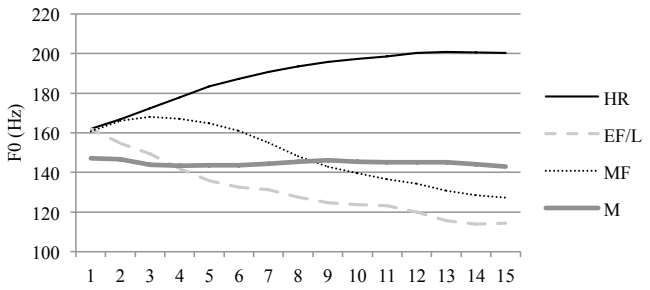


Figure 1 Averaged F0 contours of four contrastive tones in citation form; HR = High Rise, EF/L = Early Fall/Low, MF = Mid Fall, M = Mid

They were derived by using a Praat F0 normalization script written by Xu (2007). The window for each syllable was marked at the beginning of the vowel and the end of the syllable; F0 values were extracted at fifteen equally spaced points. The tonal contours obtained correspond rather well with a similar chart in Remijsen (2013). We shall assume here that the High Rising tone is a phonological high (H), the level tone a Mid (M), and the early fall a low (L).

We solicited about 20 nouns followed by the numerals *tɔ̀k* 'one' and *kjɛ́ɛ́rɔ̀* 'two'. The latter had a stable tonal shape regardless of the preceding stem, while *tɔ̀k* varied its F0 level, often appearing as raised after a mid tone. When preceding these numerals, the nouns take a special stem form in which the final consonant may be altered compared to the citation form, often changing a stop into a nasal. The tone of the stem is also frequently changed compared to the citation form. Some examples follow.

(7)	bánj tɔ̀k	bâan kjɛ́ɛ́rɔ̀	'chief'
	dɔ̀m tɔ̀k	dʊ̰̀ʊ̰m kjɛ́ɛ́rɔ̀	'garden'
	lén tɔ̀k	lèt kjɛ́ɛ́rɔ̀	'tooth'
	ɣɔ̀n tɔ̀k	ɣʊ̰́ʊ̰t kjɛ́ɛ́rɔ̀	'house'
	cḭ̄in tɔ̄k	cîn kjɛ́ɛ́rɔ̀	'hand'
	bìn tɔ̀k	bḭ̄it kjɛ́ɛ́rɔ	'fishing spear'
	cúl tɔ̀k	cuə̰̀l kjɛ́ɛ́rɔ	'mouse'
	bṵ̄uut tɔ̀k	buə̄t kjɛ́ɛ́rɔ̀	'bush'
	kḭ̄iir tɔ̄k	kḭ̄ir kjɛ́ɛ́rɔ̀	'tree sp.'
	gə̰̀l tɔ̄k	gə̰̀l kjɛ́ɛ́rɔ̀	'wild dog'
	gwɛ́n tɔ̀k	gwɛ̀t kjɛ́ɛ́rɔ̀	'bead'
	jɔ̄n tɔ̄k	jɔ̄t kjɛ́ɛ́rɔ̀	'ring'
	káaan tɔ̀k	kɛ́ɛn kjɛ́ɛ́rɔ̀	'proverb'
	mā̰n tɔ̄k	mḭ̄t kjɛ́ɛ́rɔ̀	'child'
	nyál tɔ̀k	nyāl kjɛ̄ɛ̄rɔ̀	'knee'

4 Voice Quality

The most remarkable vowel contrasts in Dinka involve voice quality. Using laryngoscopic video imaging, Edmonson and Esling (2006) document four contrasting types in the speech of five speakers of the Bor dialect. They encompass modal, breathy, and two compressed like sounds, termed harsh and faucalized. For the latter two, Denning (1988) used the terms creaky and hollow, respectively, which we follow here. Edmonson and Esling (2006) find that in breathy voiced vowels, the larynx is lowered and there is only partial adduction of the glottal folds, leading to greater airflow and lowering of the higher harmonics. For the harsh (creaky) vocal register, the larynx is raised and the pharyngeal walls are narrowed; in faucalized (hollow) voice, the opposite gestures occur, so that the larynx is lowered and the pharyngeal wall is separated from the epiglottis and aryepiglottic folds.

For our speaker the breathy vowels were easily separated from the rest. They are distinguished from modal vowels, by visual inspection of the spectrogram, with their weaker formants. Their FFT's show a sharper drop in spectral energy that is reflected in higher values for the difference between the first and second harmonics.

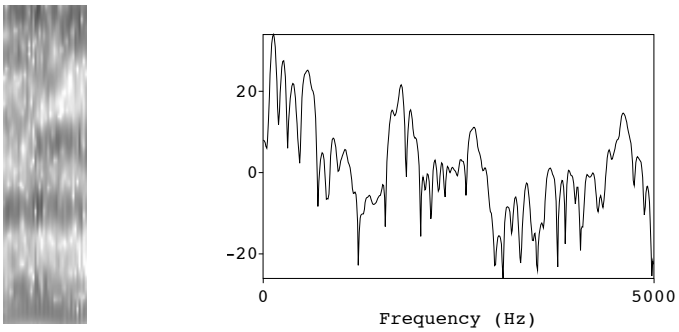


Figure 2 spectrogram and FFT of breathy voice vowel in we̤l ‘word’

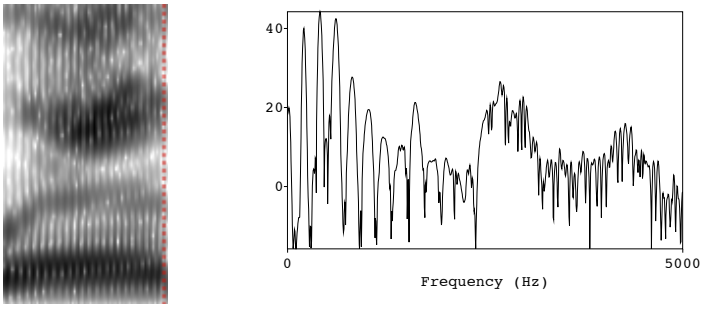


Figure 3 spectrogram and FFT of modal voice vowel in wél ‘guinea fowl’

Malou (1988) found that the breathy vowels lowered the first formant compared to their modal voice counterpart. For the most part, we also observed this effect. The table in (8) below shows the values for the H1 – H2 reflex of the modal vs. breathy contrast (negative vs. positive) and the corresponding F1 values for the vowel pairs for which we had enough data to make a meaningful comparison. We see that the breathy vowels have lower F1 values compared to their modal counterparts. The one exception is the high back vowel, where there is little overall difference between the vowel found in the verb and the verbal noun, a morphological context that frequently requires a breathy vowel according to Malou (1988). He also finds an absence of contrast for the /u/ vowel. These data were elicited from corresponding infinitival vs. gerundial verb forms as well as from some nominal minimal pairs.

(8)

	H1 – H2 (dB)	F1 (Hz)		H1 – H2 (dB)	F1 (Hz)
a	-2.7	907	ɛ	-4.7	664
a̤	4.2	869	ɛ̤	6.05	612
e	-6	579	u	3.35	358
e̤	1.95	415	ṳ	5.5	365

As for the two pressed voice qualities, creaky voice is quite noticeable and reminds one of the sound made when dragging a stick along a picket fence. The FFT spectrum is flattened and there is a low harmonics to noise ratio.

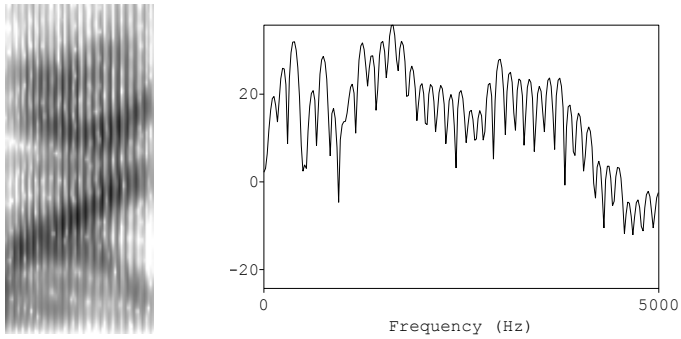


Figure 4 spectrogram and FFT of creaky voice vowel in mạ̀c 'fire'

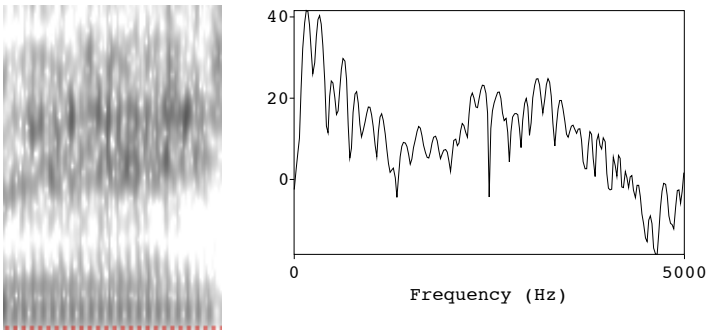


Figure 5 spectrogram and FFT of hollow voice vowel in mẽẹ̰i 'fires'

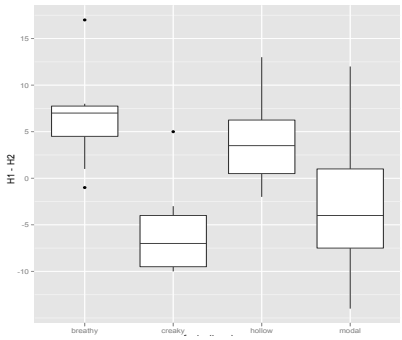
In a sample of 54 words from our corpus, we found the following reflexes of the four voice qualities. H1 – H2 indicates the difference in amplitude between the first and second harmonics. They were made across a 30 ms. window in the center of the vowel. As expected, breathy and creaky voice vowels appear at the opposite ends of this dimension. For our speaker, modal voice is on the creaky side and hollow voice on the breathy side. The Harmonics to Noise Ratio (HNR) factor helps to distinguish the creaky and breathy voice from modal and hollow voice. It was made across the entire duration of the vowel.

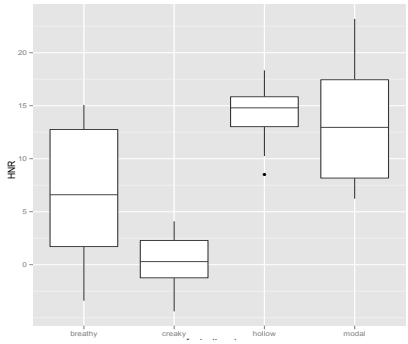
(9)

	H1-H2	HNR
breathy	6.21	6.9
creaky	-6.1	.33
hollow	4.0	14.34
modal	-2.9	13.25

Below in (10) are boxplots showing the distribution of the four voice quality categories for these two phonetic dimensions in our data.

(10)





T-test comparisons as well as anova modeling with multiple comparisons found that these two phonetic correlates separate out the means of the four categories rather well.

(11)

H1-H2	t	df	p	Tukey
breathy vs. creaky	6.95	20	<0.000	<0.000
breathy vs. hollow	1.17	18	0.250	0.765
breathy vs. modal	4.66	30	<0.000	<0.000
creaky vs. hollow	-4.94	18	<0.000	<0.000
creaky vs. modal	-1.52	27	0.140	0.425
hollow vs. modal	3.12	25	0.004	0.012

HNR	t	df	p	Tukey
breathy vs. creaky	3.57	17	0.002	0.006
breathy vs. hollow	-3.83	20	0.001	0.002
breathy vs. modal	-3.09	24	0.004	0.002
creaky vs. hollow	-11.14	17	<0.000	<0.000
creaky vs. modal	-9.13	27	<0.000	<0.000
hollow vs. modal	0.70	26	0.490	0.93

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Based on these results we may tentatively propose that our speaker's voice quality contrasts can be characterized with two acoustic features, as suggested in the table below.

(12)

	H1-H2	HNR
breathy	+	–
creaky	–	–
hollow	+	+
modal	–	+

5 Summary

In this squib we have reported the results of an analysis of the Dinka root vowel contrasts in a corpus of c. 250 words, chiefly singular-plural noun pairs, elicited from a female speaker of the Bor dialect. Overall, our results agree with those reported in the literature for the Bor dialect. Tasks for future research include more in-depth study of the lexical distribution of the ablaut alternations as well as a better understanding of the phonetic correlates of the voice quality contrasts.

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