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Abstract

This paper investigates stress in Dinka, a Western Nilotic language of South Sudan, with particular concern for the relationship between stress and the three contrastive vowel lengths of Dinka. Starting from impressionistic observation of the timing of syllables, it is argued that Dinka stress is predictable and not contrastive, and that Dinka utterances are parsed into feet of the moraic trochee type, which is extended in a straightforward way to accommodate syllables with three degrees of vowel length. In this parse, monosyllabic stems with a short vowel unexpectedly function as heavy syllables, with evidence of a mora on the final consonant in addition to the mora on the vowel. Postulating the foot in Dinka phonology is defended on the basis of its role in vowel centralisation and raising, intensity and high tone placement, consonant gemination, minimal word size, and the historical development of Dinka's fusional morphology. It is argued that the realisation of Dinka stress does not use the same salient feature on all stressed syllables, but that in syllables with a medium or long vowel, stress is realised by the intrinsic durational prominence of the vowel, and in syllables with a short vowel, stress is realised by intensity on the final mora or by other prominence-enhancing features.

Contents

Abbreviations

1	1st Person
D	Declarative
FOC	Focus
FUT	Future
NEG	Negative
NF	Non-Finite
P	Preposition
PAS	Passive
PL	Plural
PST	Past
SG	Singular

1 Introduction

Dinka[1] is on record has having one of the more complex syllable structures in the world, with three contrastive vowel lengths. The length contrasts are independent of other prosodic contrasts in both tone and breathy/creaky voice (Andersen 1987), and they are supported by a number of grammatical alternations in length (Andersen 1993, 1994, Ladd, Remijsen and Manyang 2009), and by instrumental phonetic evidence (Remijsen and Gilley 2008). The current orthography of Dinka, however, makes a two-way distinction between single and double vowel letters (Tucker 1939, Malou 1992).

Some authors have also noted stress in Dinka (Tucker 1939, Malou 1988, Gilley 2003). Since Dinka is a highly monosyllabic language, stressed syllables must be observed relative to unstressed syllables within an utterance rather than within a word. But now that the three-way vowel length contrast is established by a variety of studies, we may ask how stress relates to vowel length, and in particular whether Dinka stress might fit into contemporary metrical theory, according to which the mora determines both segmental length and stress placement in many languages (Hayes 1989, 1995; Kager 1999, 2007).

The transcription of stress in this paper is an impressionistic record of the perceived "beats" of the language (Halliday 1985), but it is also argued that the stress pattern has concrete support in Dinka phonology from observations such as that going back to Tucker (1939:2) that vowel centralisation is conditioned by the position of the vowel in the foot. The impressionistic stress data here awaits confirmation from introspection by mother-tongue linguists (Chomsky and Halle 1968:25), from measurement of the time intervals of the different types of foot (Halliday 1985:271), and from song and poetry data (Hayes 2011:280). I am releasing this paper so that the analysis can be tested in these ways.

The inventory of symbols used in transcriptions is given in table 1. This is essentially the phoneme inventory for Dinka given in Andersen (1987) or Remijsen and Manyang (2009) plus some other IPA symbols which will be helpful for certain non-phonemic phenomena.

Table 1. Symbols

Consonants						**Vowels**		
p	t̪	t	c	k	[ʔ]	i		u
b	d̪	d	ɟ	ŋ		e	[ɘ]	o
m	n̪	n	ɲ	ŋ		ɛ	[ɜ]	ɔ
w		l	j	ɯ			a	
		r						
Diacritics								
Tones: á à â ǎ					mid-centralised: [ǎ],[ě] etc.			
Breathy: i̤ etc. (ṳ is always breathy)					intensity: [a̤],[n̤]			
Diphthongs: i̯o, u̯ɔɔ etc.								

[1]I am grateful to the Dinka language consultants whom I worked with for this study, and to Leoma Gilley, Bert Remijsen, John Duerksen, Helga Schröder, Torben Andersen, and Gerrit Dimmendaal for their advice. I am also grateful for comments received from an audience at the 8th Nilo-Saharan Colloquium in Paris, 2007, where an earlier version of this paper was presented.

2 Stress in the Dinka literature

Of the authors who have described Dinka phonology, three make reference to stress. Thus, Tucker (1939:2) notes briefly that some vowels fall "in unaccented positions" whereas others are "long or stressed". Malou (1988:9–10) states that in Dinka "each phonological word has one and only one stress", adding that stress is neither contrastive nor used for semantic emphasis. Gilley (2003), however, claims that there is indeed contrastive stress which marks grammatical distinctions in the language, distinguishing number on nouns and object focus on verbs. The words in (1) are of this kind.

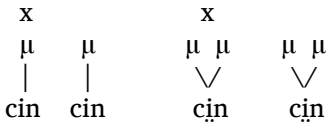
(1)

Short stem		Long stem	
[cǐn̈]	[ciˑn]	[cn̤ˑn]	[cn̤ːn]
'hands'	'hand'	'intestines'	'intestine'

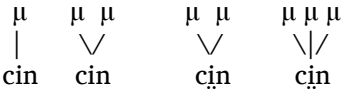
The short-stem vowel alternates between short and half-long, the long-stem vowel alternates between half-long and long. The short vowel also becomes centralised [ɘ̆]. Earlier authors claimed that final consonants were unreleased in the shorter alternants (Tucker and Bryan 1966, Malou 1988, Gilley 2003), but Remijsen and Gilley (2008) find that the consonant is not unreleased but more intense [n̈] in the short stem. There are three recent proposals to account for these alternations:

Three Proposals

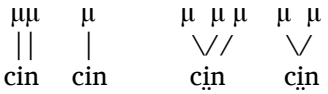
1. Stressed-Unstressed Alternation (Gilley 2003)



2. Vowel Length Alternation (Andersen 1987 *et seq*, Remijsen and Gilley 2008)



3. Coda-Consonant Weight Alternation (minimal evidence: Remijsen and Gilley 2008)



In proposal 1., Gilley (2003) proposes that contrastive stress produces intensity and shortens the vowel. In proposal 2., Remijsen and Gilley (2008) and others propose that the alternation is essentially one of vowel length, with vowels lengthening from 1 mora to 2 moras, or from 2 moras to 3. In proposal 3., which is considered but abandoned by Remijsen and Gilley (2008), the coda consonant alternates between a mora and no mora, strengthening the consonant in the plural alternant with a concomitant vowel shortening effect. On measurement of Luac dialect speakers, Remijsen and Gilley find only a tiny increase in the mean duration of the consonant for nasals and laterals and nothing for obstruents. However, they do find an increase in intensity of the final consonant in short stems only, and the final consonant in short stems will feature once again in the analysis of this paper.

All of these proposals have been employed to try to capture internal changes within the syllable. But stresses or moras in representations also have implications for the rhythmic relationship of the syllable to the others in the utterance. Stress-marks imply the relative prominence of the syllable over other syllables in the utterance, and the number of moras in a syllable determines stress placement in many languages (Hayes 1995, Kager 2007). But Dinka stress has not yet been described within a syntagmatic framework of this kind. Therefore, a general investigation of the stress system provides an extra avenue for evaluating these proposals.

3 Dinka foot types

More examples of the phonological alternation that I will consider here are given in (2). The grammatical distinctions marked by length alternations include Plural-to-Singular and Singular-to-Plural in nouns, and Present Continuous to Non-Finite and Passive in verbs.

(2) Vowel Length Alternations

	Short	*Medium*	
a.	cîn	cíín	‘hands, hand’
b.	tu̱̱ŋ	tu̱̱ú̱̱ŋ	‘horns, horn’
c.	cɔ̀k	cɔ́ɔ̀k	‘feet, foot’
d.	ɖà̱k	ɖàà̱k	‘boy, boys’
e.	téŋ	téèŋ	‘is wiping, to wipe’
f.	tér	téèr	‘is sharpening, to sharpen’
g.	dɔ̱̀m	dɔ̱̀ɔ̀m	‘is catching, to catch’
h.	cí	cíí	Negative (NEG), Negative Passive (NEG:PAS)
i.	à	àà	Declarative (D), Declarative Plural (D:PL)

	Medium	*Long*	
j.	cíín	cîîn	‘intestines, intestine’
k.	káám	káààm	‘forearms, forearm’
l.	ɖɔ́ɔ́l	ɖɔ̀ɔ̀ɔ̀l	‘boys, boy’ (Padang dialect)
m.	dòòt	dóòòt	‘stones, stone’
n.	bìì̱t	bîìì̱t	‘fishing spear, fishing spears’
o.	láál	láàà̱l	‘ceremonial spear, ceremonial spears’
p.	tɔ́ɔ̀ŋ	tɔ́ɔ̀ɔ̀ŋ	‘war spear, war spears’
q.	wɛ́ɛ̱̱c	wɛ́ɛ́ɛ̱̱c	‘is sweeping, to sweep’
r.	mìì̱t	míííì̱t	‘is pulling, is pulled’

Authors have used different terms for these vowel lengths, long-medium-short (Anderson 1987, Remijsen and Manyang (2009), long-halflong-short (Anderson 1994), long-short-extrashort (Gilley 2003), long-short-centralised (Malou 1988) or long-normal-short (Malou 1988). But all these authors agree on the phonetic reality of three distinct vowel lengths. Following the instrumental measurements in Remijsen and Gilley (2008), I will distinguish them as short, medium, and long.

Since many nouns and verbs in Dinka are monosyllabic, no relative prominence between syllables can be discerned in words. Stress is best investigated over sentence utterances in Dinka. In (3), we see utterances organised in terms of the timing of syllables.

(3) a. | ˈà | cɛ̱̀ | ˈpàáɲ | ˈtéèŋ |
D PST wall wipe:NF
‘He has wiped the wall.’

b. | ˈtu̱̱ú̱̱ŋ | ˈà | cɛ̱́ | ˈdàám | ˈpìì̱ŋ |
horns D PST catch:NF:PAS hold:NF
‘The horns have been caught hold of.’

c. | ˆ | è | ˈŋà | ɟɛ̱̀ | ˈtu̱̱ú̱̱ŋ | ˈdɔ̱̀ɔ̀m |
who PST horns catch:NF
‘Who has caught the horns?’

The utterances are broken up into intervals marked by the vertical lines. The prominent syllables, marked with an apostrophe stroke, are the first syllables after the interval lines. Thus in (3a), the prominent syllables [ˈà] [ˈpàáɲ] [ˈtéèŋ] are equidistant from each other in time. In classical terminology,

this interval is a trochee: a foot in which the first syllable is prominent (Halliday 1985:12). Some of the feet have two syllables divided by a dotted vertical line. In (3a), [cɛ̤] is heard halfway between [ˈà] and [ˈpàáŋ], dividing the foot in half. Throughout (3abc) there is a difference between Heavy syllables which occupy a foot on their own, and Light syllables which occupy half a foot. And the Light syllables are characterised by short vowels, while the Heavy syllables are characterised by medium vowels. In (3c), there are three light syllables followed by two heavy syllables, so two of the Light syllables occupy a foot, and the first Light syllable is interpreted as being in the second half of a foot with a silent beat in the first half, transcribed [^] (Halliday 1985:273).

To account for the difference in behaviour between Heavy and Light syllables, I analyse a short vowel as having a single mora, and a medium vowel as having two moras. This gives two types of foot as in (4), a sequence of two Light syllables, or one Heavy syllable (Hayes 1995). In both cases the foot has two moras, or is bimoraic, and the difference is whether a single syllable supplies both moras, or whether the moras are distributed between two syllables:

(4) Bimoraic Foot Types:

Light-Light	($\sigma_{\mu}\sigma_{\mu}$)	μ μ | | VCV	[ˈàcɛ̤]
Heavy	($\sigma_{\mu\mu}$)	μ μ \ / CVC	[ˈtʊ̱ʊ̱ŋ]

The Light-Light and Heavy feet belong to the moraic trochee language type (Hayes 1995). The occurrence of these foot types, which we shall see repeatedly throughout the paper, calls into question descriptions of Dinka in which medium vowels (the middle of the three contrastive vowel lengths) have been called “short” to contrast them with long vowels (Malou 1988, Gilley 2003). Rhythmically, the medium vowels do not behave as short vowels do: their syllable occupies the same foot interval that is occupied by two syllables with short vowels. Hence, medium vowels are distinguished from true short vowels by having two moras instead of one.

Medium vowels also contrast with the even-longer long vowels (Andersen 1987, Remijsen and Manyang 2009), and since the distinction is contrastive, long vowels must be distinguished by having three moras instead of two. Utterances with three moras to a foot are given in (5). In (5a), [ˈbíìì̱t̪] [ˈàà] [ˈmáàà̱r] are the rhythmically prominent syllables occurring at regular intervals. [ˈàà] and [cɛ̤] do not divide the foot in half as before; instead [cɛ̤] is heard to occupy the final third of the foot interval. This is explained if feet divide according to the mora count: with a total of three moras in the foot, bimoraic [ˈàà] occupies the first two-thirds and monomoraic [cɛ̤] occupies the final third.

(5) Trimoraic Foot Pattern:

a.	ˈbíìì̱t̪	ˈàà	cɛ̤	ˈmáàà̱r		b.	ˈláàà̱l	ˈàà	cɛ̤	ˈmáàà̱r
	spears	D:PL-	PST	lost:NF:PAS			spears	D:PL -	PST	lost:NF:PAS
	‘The fishing spears have been lost.’						‘The ceremonial spears have been lost.’			

This gives us two more foot types in (6), the Superheavy syllable of three moras, a Heavy-Light sequence. Languages that have bimoraic Heavy feet and Light-Light feet vary as to whether they also admit Heavy-Light feet since some languages only allow feet with two moras (Kager 1999, 2007). In Dinka, where one syllable alone can have three moras for a long vowel, it stands to reason that the language can also accept Heavy-Light feet of three moras:

(6) Trimoraic Foot Types:

Superheavy ($^{l}\sigma_{\mu\mu\mu}$)	μ μ μ |/ CVC	[ˈbíîìt̪]
Heavy-Light ($^{l}\sigma_{\mu\mu}\sigma_{\mu}$)	μ μ μ ∨ | VCV	[ˈàà cə̪̀]

In practice, of course, Dinka sentences contain words of all vowel lengths, and therefore potentially both bimoraic and trimoaric foot types can appear in one utterance as in (7). We shall even see Superheavy-Light combinations in some utterances. The stressed syllables are determined by parsing syllables into Light-Light, Heavy, Heavy-Light, Superheavy, or Superheavy-Light feet, and the first syllable of each foot interval is interpreted as rhythmically prominent or stressed:

(7)

	L	*L*	*H*	*L*	*S*	*H*	*L*	*H*	*L*	*L*	*H*	*H*	*L*
a.	ˈa	n-à	ˈwi̪cc	bɔ̀	ˈríííŋ	ˈwɔ̀ɔ̀c	à	ˈkóól	ˈbà	là	ˈɟɛ́kk	ˈt̪aaŋ	ge
	1SG	-D	want	come	meat	buy	today		FUT	go	give	woman:my	

‘I want to come and buy meat today to go and give it to my wife.’

	H	*L*	*L*	*L*	*S*	*H*	*H*
b.	ˈtíík	ɜ́	ˈcí̪	là	ˈt̪úú̪ú̪́g	ˈàà	ˈkóól
	woman	D	NEG	go	markets	today	

‘The woman is not going to market today.’

	H	*L*	*L*	*L*	*S*	*H*	*H*
c.	ˈtíík	ɜ̀	ˈcì	là	ˈt̪úú̪ú̪́g	ˈàà	ˈkóól
	woman	D	PST	go	Markets	today	

‘The woman has gone to market today.’

We can now distinguish the rhythmic stress of Dinka from other salient features of the language. Stress is not the same as High Tone, since the Negative particle [ˈcí̪] and the Past auxiliary [ˈcì̪] contrast for tone, yet both can be stressed as in (7b,c).[2] We also see unstressed syllables with high tone in (7b), and in (3c). Stress is not the same as Vowel Length, for short vowels may be stressed ([ˈcì̪]) or unstressed ([là]), depending on their ability to form feet with the surrounding syllables. Stress is not the same as Peripheral (non-central) Vowel Quality, for although there are centralised vowels transcribed here, unstressed [là] in (7b,c) has a peripheral open vowel quality. We shall return to vowel centralisation below, however. Stress is not the same as Breathiness, the marked voice quality in Dinka that contrasts with unmarked creakiness; i.e., for [ˈcì̪ là] (7b) with breathiness on the stressed syllable, and [ˈà cə̪̀] (3a) with breathiness on the unstressed syllable, are both possible. In addition, stress is not the same as Syntactic Headship—see unstressed [là] ‘go’ in (7b,c).

Neither do stressed syllables usually have greater intensity (loudness, amplitude), although we shall see this in certain contexts later. Thus, stress here is not a matter of identifying a unique salient phonetic feature present in all stressed syllables, rather it is primarily a matter of timing, that each stressed syllable initiates a new foot interval. In interpreting stress this way in Dinka, we follow Halliday who claims: “Natural speech in all languages is highly rhythmic; it tends to have a regular beat. But it may be rhythmic in different ways, depending on the language…” (Halliday 1985:271). Similarly, in generative phonology stress is usually identified with the head syllable of a foot constituent, which is defined in different ways for different language types (Kager 2007). In Dinka, timing structure is noticeable not only from one foot to the next but also within a foot, where the syllables are spaced according the

[2]In this paper and in Gilley (2003), the negative particle has high tone and the past auxiliary has low tone in Rek Dinka. In Andersen (2007), the past auxiliary has high tone and the negative particle has low tone in Agar Dinka.

number of moras by dividing Light-Light feet into two halves, and Heavy-Light feet into two-thirds and one-third.

The precise foot length in Dinka varies since foot types with a greater number of moras occupy slightly longer time intervals, but I still find an impression of prominence at the beginning of each quasi-regular interval. Similarly in English, it is not unusual for the precise foot length to vary in natural speech, since the most pedantically uniform foot tempo in English-speaking culture is reserved for children's verse (Halliday 1985:8,271) as seen in (8):

(8)

ˈPol	ly	ˈput	the	ˈket	tle	ˈon	
ˈPol	ly	ˈput	the	ˈket	tle	ˈon	
ˈPol	ly	ˈput	the	ˈket	tle	ˈon	we'll
ˈall		ˈhave		ˈtea		ˆ	

4 Final consonants of short stems

In many languages, closed syllables behave as Heavy syllables, and so are analysed as having a mora on the coda consonant in addition to one on the vowel (Hayes 1989). Many of the Heavy syllables we have seen in Dinka have been closed, but the heaviness of these syllables has been attributed to two moras on the vowel itself. I now determine whether final consonants can have moras in Dinka.

Considering the verb alternations in (9), for each alternation (a,b,c,d), a present continuous sentence is given first using an unmarked verb stem (i), followed by a past perfect sentence using an auxiliary and a non-finite verb stem (ii):

(9)

a.i.	á	ˈlát	ˈmôc		'She is insulting her man.'
	D	insult	man		
a.ii.		ˈà cɛ̰	ˈmôc	ˈlɑ́ɑ̀t	'She has insulted her man.'
		D PST	man	insult:NF	
b.i.	á	ˈdâm	ˈwɛ̌ŋ		'He is catching a cow.'
b.ii.		ˈà cɛ̰	ˈwɛ̌ŋ	ˈdɑ́ɑ̀m	'He has caught a cow.'
c.i.	á	ˈɯ́ál	ˈrə̰̂p		'She is pounding sorghum.'
c.ii.		ˈà cɛ̰	ˈrə̰̂p	ˈɯ́ɔ̀l	'She has pounded the sorghum.'
d.i.	á	ˈt̰ér	ˈpàál		'He is sharpening a knife.'
d.ii.		ˈà cɛ̰	ˈpàál	ˈt̰éèr	'He has sharpened a knife.'

The verbs in the present continuous sentences (i) are spaced one whole interval away from the next stressed syllable, which is the object noun. This is described in Gilley (2003:104) as a short pause after the alternant with the short vowel. Likewise in the past perfect sentences (ii), the non-finite verb is spaced one whole interval after the object noun. This means that both the present-continuous verb and the non-finite verb are rhythmically stressed. Thus, we find no rhythmic alternation between stressed and unstressed as was proposed in Gilley (2003). Furthermore, both alternants occupy a foot interval alone. The present-continuous verb stem does not form a foot in combination with the Declarative particle */ˈálát/—as does the Past auxiliary in the perfect past sentences, /ˈàcɛ̰̀/. Rather, in occupying the foot alone, the present-continuous verb stem still behaves as a Heavy syllable, and so must be interpreted

as having two moras. Since the vowel alternates in length between one and two moras, the second mora of the foot appears to be on the final consonant.[3]

This is confirmed by the data in (10). When followed by an object noun with an initial vowel, the final consonant of a present-continuous verb is in an intervocalic context in the utterance. In this context, the consonant geminates:

(10)

a.	á-bi̱ö̱k alɛ̱̈ɛ̱̈l	[á ˈbi̱ö̱kkɜ̀ ˈlɛ̱̈ɛ̱̈l]	‘He is throwing a stone.’
b.	á-lát árä̱p	[á ˈláttɜ́ ˈɾä̱p]	‘She is sieving sorghum.’
c.	à-ɯ́ád árä̱p	[à ˈɯ́áddɜ́ ˈɾä̱p]	‘She is pounding sorghum.’
d.	á-téŋ ȧ̱ɔ́ɔ́r	[á ˈtéŋŋɜ̀ ˈt̪ɔ́ɔ́ɾ]	‘He is wiping dust off the book.’
e.	á-t̪ál ábîk	[á ˈt̪állɜ́ ˈbîk]	‘She is cooking flour.’
f.	à-guà̱r árä̱p	[à ˈgu̱à̱rrɜ́ ˈɾä̱p]	‘She is grinding sorghum.’

A geminate consonant has a mora, and this distinguishes it from a short intervocalic consonant (Hayes 1989:257). However, although there is gemination in a verb with a short vowel, there is no gemination found in verbs with a medium vowel, as seen in (11):

(11)

a.	à-míít àkóòn	[à ˈmíítɜ̀ ˈkóòn]	‘He is dragging an elephant.’
b.	à-t̪éél àkóòn	[à ˈt̪éélɜ̀ ˈkóòn]	‘He is pulling an elephant.’

Also, no gemination occurs when the verb root vowel is lengthened from short to medium or medium to long, as in the Non-Finite form of the verb. This is shown in the following perfective past sentences (Padang speaker) in (12) that use AuxVO order, unlike perfect past which has AuxOV order:[4]

(12)

a.	à-cɛ̱̀ bi̱ö̱ö̱k alɛ̱̈ɛ̱̈l	[ˈàcɛ̱̀ ˈbi̱ö̱ö̱kɜ̀ ˈlɛ̱̈ɛ̱̀l]	‘He threw a stone.’
b.	à-cɛ̱̀ láát árä̱p	[ˈàcɛ̱̀ ˈláátɜ́ ˈɾä̱p]	‘She sieved sorghum.’
c.	à-cɛ̱̀ ɯ́áád árä̱p	[ˈàcɛ̱̀ ˈɯ́áádɜ́ ˈɾä̱p]	‘She pounded sorghum.’
d.	à-cɛ̱̀ téén ȧ̱ɔ́ɔ́r	[ˈàcɛ̱̀ ˈtéénɜ̀ ˈt̪ɔ́ɔ́ɾ]	‘He wiped dust off the book.’
e.	à-cɛ̱̀ t̪ȁ̀l àbík	[ˈàcɛ̱̀ ˈt̪ȁ̀lɜ̀ ˈbík]	‘She cooked flour.’
f.	à-cɛ̱̀ guà̱à̱r árä̱p	[ˈàcɛ̱̀ ˈgu̱à̱à̱rɜ́ ˈɾä̱p]	‘She ground sorghum.’
g.	à-cɛ̱̀ mííít ákóòn	[ˈàcɛ̱̀ ˈmíítɜ́ ˈkóòn]	‘He dragged an elephant.’
h.	à-cɛ̱̀ t̪ɛ́ɛ́él ákóòn	[ˈàcɛ̱̀ ˈt̪ɛ́ɛ́élɜ́ ˈkóòn]	‘He pulled an elephant.’

Likewise in passive verbs[5] which have a lengthened vowel, there is no accompanying consonant germination (13):[6]

(13)

a.	à-cɔ́[pp] ákóòn	‘He is chasing an elephant.’
	à-cɔ́ɔ́[p] ákóòn	‘He is being chased by an elephant.’
b.	à-ná̱[kk] ákóòn	‘He is killing an elephant.’
	à-nɛ̱́ɛ̱́[k] ákóòn	‘He is being killed by an elephant.’

[3]Likewise, the object noun behaves as a Heavy syllable even when its vowel is short, because the non-finite verb is spaced one whole interval after it; so it too appears to have a second mora on the final consonant.

[4]I have no explanation for the tone change on the auxiliary.

[5]This construction has been interpreted as a topical object construction (Andersen 1991), or as a focussed object construction (Gilley 2003) because it can have a fronted object, whereas Dinka language consultants have translated this construction as a passive in which the object is promoted to subject. A full evaluation of these alternatives is beyond the scope of this paper, but I have provisionally used the syntactic label of passive.

[6]The tones in the examples in (13) are unexpectedly neutralised to a single contour, even in the unmarked stems, despite the verbs having different underlying tones (Norton 2012). This appears to be an instance of the pattern of association of high tone with the stressed syllable of the verb, also seen in (20c, 24a) and discussed following (24a).

c. à-tɻ̈[ŋŋ] ákóòn ‘He is watching an elephant.’
à-tɻ̈ɻ̈[ŋ] ákóòn ‘He is being watched by an elephant.’
d. à-bá[rr] ákóòn ‘He is taking along an elephant.’
à-bɛ́ɛ́[ɾ] ákóòn ‘He is being taken along by an elephant.’
e. à-míí[t] ákóòn ‘He is dragging an elephant.’
à-mííí[t] ákóòn ‘He is being dragged by an elephant.’
f. à-ṯéé[l] ákóòn ‘He is pulling an elephant.’
à-ṯééé[l] ákóòn ‘He is being pulled by an elephant.’

Similarly, there is no gemination of the final consonant of the negative past auxiliary verb /kɛ̌ɐɟ/ (14a), unlike the phonetically similar verb ‘taste’ which has a short vowel and which does geminate in the same sentence context in (14b):

(14)

a. á-kɛ́[cc] àbáàɲ ‘He is tasting a bitter plant.’
b. à-kɛ̌ɛ̌[ɟ] àbáàɲ kɛ́ɛ̀ɟ ‘The plant has not tasted bitter.’

Consistently, we see that the final consonant of a verb is moraic whenever the vowel is short, but not when the vowel is medium or long.

Number alternations on nouns also show the same pattern. In (15), singular and plural alternants show no stressed-unstressed alternation in either subject (a) or object (b) position. In fact, they are both (rhythmically) stressed, and the same time interval obtains between the Singular or Plural form and the next stressed syllable, even though one of the alternants has a shorter vowel:

(15)

a.i. ˈànn cə̰ | ˈtʊ́ʊ̰̀ŋ | ˈdàám | ˈpììŋ ‘I have caught hold of the horn.’
a.ii. ˈànn cə̰ | ˈtʊ́ŋ | ˈdàám | ˈpììŋ ‘I have caught hold of the horns.’
b.i. ˈḍààk ɜ̀ | ˈkɛ̌ɛ̌ɟ lɜ̀ | ˈtʊ́ʊ́g ‘The boys have not gone to the market.’[7]
b.ii. ˈḍɔ̀kk ɜ̀ | ˈkɛ̌ɛ̌ɟ lɜ̀ | ˈtʊ́ʊ́g ‘The boy has not gone to the market.’

The same spacing of syllables for both alternants reveals that both have two moras. The moras both fall on the vowel if the vowel is medium-length, or if the vowel is short. Then one mora is on the vowel and one on the consonant.

But where the noun vowel alternates between medium and long, there is no parity in foot length, nor is there consonant germination as seen in (16):

(16)

a. ˈbíìì[ṯ] | ˈàà cə̰ | ˈmáààr ‘The fishing spears have been lost.’
ˈbìì[ṯ] | ˈà cə̰ | ˈmáààr ‘The fishing spear has been lost.’
b. ˈḍɔ̀ɔ̀ɔ̀[l] ɜ̀ | ˈkɛ̌ɛ̌ɟ lɜ̀ | ˈtʊ́ʊ́g ‘The boy has not gone to the market.’
ˈḍɔ̀ɔ́[l] ɜ̀ | ˈkɛ̌ɛ̌ɟ lɜ̀ | ˈtʊ́ʊ́g ‘The boys have not gone to the market.’

Also, disyllabic nouns show no mora on the final consonant, as in the following examples in (17):

(17)

a. | ˈà | n-à | ˈwɻ̈cc | bɔ̀ | ˈgá | làm | ˈwɔ̀ɔc |
1SG - D need come pen buy
‘I need to buy a pen.’

b. | ˈànn | bə̰ | ˈlá | ò | ˈn̰ḭáá | lìṯ | ˈn̰ḭàák |
1SG:D FUT go P God tomorrow
‘I am going to church tomorrow.’

[7]The forms in (15b) and (16b) are from the Padang dialect, in which singular and plural forms of the noun can be compared in the same environment since Padang uses a short Declarative /a/ for both singular and plural, and not the lengthened Declarative Plural /aa/ found in other dialects.

The disyllabic noun /ˈgá.làm/ ‘pen’ divides the foot equally, indicating that moras are only found on its two short vowels, producing a Light-Light foot. Similarly /ˈn̪i̪áa.lɪc/ ‘God’ occupies a Heavy-Light foot with no sign of a mora on the final consonant. There is no rhythmic delay—indeed there is assimilation of the final consonant in /ˈn̪i̪áa.lɪc/ ‘God’ to the dental place of the immediately following consonant. Hence, only monosyllabic nouns have a mora on the final consonant, not disyllabic nouns.

In general, then, in both nouns and verbs, monosyllabic stems that contain a short vowel have an additional mora on the final consonant. But disyllabic nouns, and nouns and verbs with a medium or long vowel, have no mora on the final consonant. Thus, in Dinka final consonants can be moraic or non-moraic. The consonants that take a mora in Dinka are picked out by a rule of “weight by position” (Hayes 1989:258), in which a mora is assigned to the postvocalic consonant after a short vowel. However, in Dinka this weighting applies only in monosyllabic words as in (18):

(18) **Final Consonant Weighting**

a. ø→μ / [μ _]$_{word}$
| |
VC

b.	μ	μμ
	|	||
	lat	lat

‘is sieving’

c.	μ	μμ
	|	||
	tu̪ŋ	tu̪ŋ

‘horns’

Gemination of moraic consonants may be graphically represented as in (19). In connected speech, a word-final consonant links to the following syllable, if it lacks an onset consonant of its own. In a present-continuous verb stem with a short vowel, the final consonant is moraic, and according to Hayes (1989:258) a moraic consonant that closes one syllable and opens the next is realised as long:

(19) **Final Consonant Gemination**

σ σ σ σ
| ∧ /| ∧
μ μ μ / μ μ μ
| | |/ | ∨
a la t a rạp

[a ˈlattɜ ˈrạ̪p] ‘She is sieving sorghum.’

While the gemination of the final consonant of the verb intervocalically marks it out as having a mora, this does not mean that the consonant will geminate in environments other than intervocalic. A moraic consonant can also be a short consonant after a vowel, if the consonant qualifies for a mora merely by virtue of its position rather than its length (Hayes 1989:258), and this too is what we see in Dinka as in (9a.i) á|ˈlát |ˈmôc ‘She is insulting her man.’. Then the manifestation of the mora is the rhythmic delay before the start of the next foot, not the length of the consonant itself. By appealing to mora theory, with its insight that geminate consonants have a mora but are only lengthened between vowels and not before a consonant, we have an answer which works for the data, and which offers to resolve the controversy in existing Dinka literature as to whether final consonants are lengthened (or unreleased) or not (Tucker and Bryan 1966, Andersen 1987, Gilley 2003, Remijsen and Manyang 2009).

This completes our rhythm-based assessment of the alternations accounted for in other sources either as a stressed-unstressed alternation (proposal 1, Gilley 2003), a vowel length alternation (proposal 2, Remijsen and Gilley 2008 and others) or a coda consonant weight alternation (proposal 3, considered by Remijsen and Gilley 2008). The rhythmic approach does not support a stress alternation analysis, because both alternants are always rhythmically stressed, and instead supports a vowel length alternation analysis, but with a coda-consonant weight alternation analysis as well in short stems only, as summarised in (20):

(20) **Vowel Length Alternation (proposal 2)**
with Coda-Consonant Weight Alternation (proposal 3) in short stems only

a.	μμ	μ μ	b.	μ μ	μ μ μ
	||	\/		\/	\\|/
	lat	lat		mit	mit
	/latt/	/laat/		/miit/	/miiit/
c.	μ μ	μ μ	d.	μ μ	μ μ μ
	| |	\/		\/	\\|/
	tu̱ŋ	tu̱ŋ		ḍɔl	ḍɔl
	/tu̱ŋŋ/	/tu̱uŋ/		/ḍɔɔl/	/ḍɔɔɔl/

5 The foot in Dinka phonology

I have argued that the rhythm pattern of Dinka supports the vowel length alternation analysis, with coda-consonant weights alternation as well in short stems. This assessment rests on the view that Dinka utterances are composed of feet. Feet have served in the analysis essentially as groupings of moras, and as such have assisted in the identification of moras on both vowels and final consonants. But the practice of transcribing stress and feet impressionistically is open to the charge of subjectivism, especially when stress cannot be equated with a salient phonetic feature such as amplitude. Are feet really a fact of Dinka, or the result of a mind that filters Dinka through the rhythms of English?

In fact, one of the Dinka language consultants who supplied much of the data in this paper could swing his hand at each prominent syllable in a sentence, indicating the successive beats in the rhythm of a sentence from the perspective of a mother-tongue speaker. In addition, the Dinka linguist, Job Malou, has cited phrases such as /aca ˈɣa̱ṯ/ ‘I have taken it.’ where he judges a given syllable as stressed (Malou 1988:10). But these introspective judgements by Dinka speakers are not extensive, and the way is open for Dinka linguists to critically review and extend the existing material on stress patterns of Dinka utterances.[8] Nevertheless, the foot can be defended as a constituent of Dinka phonology, in the following ways.

5.1 Vowel centralisation

First, the foot plays a role in centralisation of vowels. Several vowels have been transcribed as centralised in the course of the paper, and some of these examples are reproduced in (21a–c) along with some further examples. All these vowels follow heavy or superheavy syllables.

(21) a. [á ˈlátt ɜ́ ˈrập]

a-lát	a-rập	
D-pound	sorghum	
‘She is pounding the sorghum.’		

b. [ˈtíík ɜ̀ ˈcə̀ là ˈṯṵṵṵṵg ˈàà ˈkóól]

tíík	à-cə̀	là	ṯṵṵṵṵg	ààkóól
woman	D-PST	go	markets	today
‘The woman has gone to the markets today.’				

[8]Bert Remijsen (personal communication) advises that the difference between short and medium vowels in open syllables (ci̱:ci̱i̱) is particularly difficult for non-mother-tongue-speakers to perceive. This difference would precipitate a stress difference in auxiliary verbs e.g. /ˈa-ci̱/ vs /a-ˈci̱i̱/, so that auxiliaries are prime testing material for the mother-tongue perception of stress.

c. [ˈànn bə̀ ˈlá ò ˈn̪ìáálìt̪ ˈn̪ìààk]

àn	a-bə̀	lá	ò	n̪iáálìc	n̪ìààk
1SG	D-FUT	go	P	God[a]	tomorrow

‘I will go to church tomorrow.’

[a]The final consonant of ‘God’ assimilates to the dental place of articulation of the following consonant.

d. [á ˈbi̪o̪o̪k ˈrà̪à̪àn ò̪ ˈdò̪ò̪ò̪t]

a-bi̪o̪o̪k	rà̪à̪à̪n	è̪	dò̪ò̪ò̪t
D-throw	person	P	stone

‘He is throwing a stone at a person.’

e. [á ˈbi̪o̪kkò̪ ˈdò̪ò̪t]

a-bi̪o̪k	è̪	dò̪ò̪t
D-throw	P	stones

‘He is throwing stones.’

We have examples of [ɜ] that are reflexes of the declarative particle /a/ or of /a/-initial nouns, and examples of [ə̪] that are reflexes of the preposition /e̪/. Since the centralised vowels are always found following a heavy or superheavy syllable, vowel centralisation is rhythmically conditioned to occur at the end of an uneven foot. This is described by the following rule, using the IPA diacritic [˕] for mid-centralised vowel quality:

(22) **Uneven Foot Vowel Centralisation**

$V \rightarrow \breve{V} \ / \ [\text{ˈ}\sigma^{\mu\mu(\mu)} \ \_^{\mu}]_{\text{Foot}}$

The Uneven Foot Vowel Centalisation rule in (22) captures the observation of A.N. Tucker that centralisation is characteristic of vowels “in unaccented positions” as opposed to vowels that are “long or stressed” as in rɛɛr-kë̱ ‘Stay (pl)!’ (Tucker 1939:2). By comparison, centralisation of short vowels does not occur in evenly divided Light-Light feet. The following sentences in (23a.i,a.ii) and (23b.i,bii) show minimal distinctions between Light-Light and Heavy-Light, with vowel centralisation if the foot is uneven:[9]

(23)

a.i. | ˈbìì̱t̪ | ˈà ⋮ cə̪̀ | ˈmáààr | ‘The fishing spear has been lost.’

spear	D-	PST	lost:NF	

a.ii | ˈbíì̱ì̱t̪ | ˈàà ⋮ cə̪̀ | ˈmáààr | ‘The fishing spears have been lost.’

spears	D:PL-	PST	lost:NF	

b.i. | ˈɛ̀n ⋮ cə̪̀ | ˈt̪ú̱ŋ | ˈdòòm | ‘I have caught the horns.’

1SG-	PST	horns	catch:NF	(in answer to ‘what have you caught?’)

b.ii. | ˈɛ̀ɛ̀n ⋮ cə̪̀ | ˈt̪ú̱ŋ | ˈdòòm | ‘I have caught the horns.’

1SG:FOC	PST	horns	catch:NF	(in answer to ‘who has caught the horns?’)

[9]Uneven Foot Vowel Centralisation here and in Tucker (1939:2) should be distinguished from other vowel centralisation observed by other authors affecting the short vowels in noun or verb stems such as [bi̪ò̪k] ‘is throwing at’ (Malou 1988, Remijsen and Gilley 2008). It remains to be seen whether this is also rhythmic, in the sense of occurring in some foot types and not in others.

In one case seen earlier in (17), the uneven foot employs even further vowel reduction. When the 1SG pronoun forms a foot with the declarative particle in (17a), the result is an even trochee [ˈa.n-a]. But when the future auxiliary /bɛ̰/ is added to the foot in (17b), it is parsed as an uneven trochee [ˈann.bɐ̰] with centralised final vowel, and the declarative vowel reduced to gemination of the preceding /n/.

Further support for Uneven Foot Vowel Centralisation comes from data showing that the vowels concerned centralise in connected speech but not in word-by-word speech. The sentences in (24) contain word-by-word renditions of (21a,d,e).

(24)

a.	[ʔá-ˈlát ‖ ʔá-ˈrâ̰p]	‘She is pounding sorghum.’
b.	[ʔá-ˈbḭó̰k ‖ ˈrà̤à̤à̰n ‖ ʔɛ̰́-ˈdó̰ɔ̰̀ɔ̰̀t]	‘He is throwing a stone at a person.’
c.	[ʔá-ˈbḭó̰k ‖ ʔɛ̰̀-ˈdɔ̰̀ɔ̰̀t]	‘He is throwing stones.’

Here, the short vowels of noun-initial /a-/ and preposition /ɛ̰-/ relate morphosyntactically to one another, and so are bracketed with the following word. An initial glottal inserted before a vowel, ∅→ʔ / ‖_V, marks the beginning of these groupings, and there is no centralisation of the vowel. There is also no gemination of word-final moraic consonants. It is only when feet are constructed across the entire utterance in connected speech in (21) that these short vowels re-group with the preceding heavy or superheavy syllable, and only then that they undergo centralisation. It is also only then that any preceding moraic consonant falls into an intervocalic environment and geminates.

5.2 Intensity or high tone

Observe also that the placement of stress itself may vary between connected speech and word-by-word production. In (25), it is shown that word stress does not retract onto clitic vowels even when the syllable structures might suggest it. The stress is only retracted in connected speech in (26).

(25) Clitics do not take word stress

a.	[ˈtíík ‖ ʔà-ˈlá ‖ ˈṯṵ̈ṵ̈ṵ̈g]	‘The woman is going to the markets.’
b.	[ˈtíík ‖ ʔà-cɨ̈-ˈlɜ̰̈ ‖ ˈṯṵ̈ṵ̈ṵ̈g ‖ ʔàà-ˈkóól]	‘The woman has gone to the markets today.’

(26) Stress retracts in connected speech

a.	[ˈtíík ˈàlà ˈṯṵ̈ṵ̈ṵ̈g]	‘The woman is going to the markets.’
b.	[ˈtííkɜ̀ ˈcɨ̈là ˈṯṵ̈ṵ̈ṵ̈g ˈààˈkóól]	‘The woman has gone to the markets today.’

It is, of course, less immediately clear how to construe syllables in (25) as stressed outside of the rhythm of connected speech. However, one of the Dinka language consultants was able to indicate the rhythmically stressed syllables in word-by-word speech by waves of the hand back and forth while speaking.[10] Furthermore, the monosyllabic verb /là/ ‘go’ is marked by unexpected high tone in stressed position in (25a)—also seen in (21c)—and moreover the same verb is louder than surrounding syllables in (25b).

We have seen (in section 3) that intensity and tone are not features of stressed syllables in Dinka in general, but we now observe that they are realisations of Dinka stress under limited conditions. The other case of intensity reported in Dinka is on the final consonant of a stem with a short vowel (Remijsen and Gilley 2008). In both contexts, the intensity occurs on a monosyllabic stem with a short vowel. In the closed monosyllable /cɨ̈ɲ̈/ ‘hands’, the intensity occurs on the final consonant; in the stressed open monosyllable /lɜ̰̈/ ‘go’, the intensity occurs on the vowel itself. The generalisation is that in a stressed syllable with a short vowel, stress is realised by intensity on the final mora of the syllable, whether the final mora is the vowel itself (in an open syllable) or the coda consonant (in a heavy closed syllable).

[10]It seems likely here that the “word-by-word” production was achieved by use of silent beats between the words, with a rhythm maintained subvocally in the mind (Halliday 1985:273), as a way of structuring the task of producing each word of the sentence with pauses between them. However, the language consultant did not indicate any silent beats between words with his hand.

Thus, although stress in Dinka is not associated with a salient phonetic feature in general, stress can be realised by greater intensity on syllables with short vowels only. Alternatively, stress is realised by high tone on the short vowel, in (25a, 21c).

No such effects are seen on syllables with a medium or long vowel. I therefore propose that moraic trochees in Dinka parse the contrastive vowel lengths in the following way:

a) Syllables with a medium or long vowel have intrinsic durational prominence, and thus are always stressed in the moraic trochee parse. Their prominence is not marked by any further salient features beyond their intrinsic durational prominence.
b) Syllables with a short vowel lack intrinsic durational prominence, and are not always stressed in the moraic trochee parse, but when they occur stressed as the first syllable of an even trochee, their prominence is enhanced by the addition of other salient features.

Thus, it is proposed that stress is in fact always realised on Dinka moraic trochees, either by intrinsic duration or by added enhancement through other features. As a result, the earlier claim in Gilley (2003) of contrastive stress on shorter alternants can now be understood as an alternate realisation of stress. Thus, in [ciˑn, ciɲ] ‘hand, hands’, stress is realised by intrinsic vowel duration in the medium-vowel alternant, but by final consonant intensity on the short-vowel alternant. The alternative realisations of stress accompany the grammatical vowel length alternation. However, in a longer stem such as [ci̤ːn, ci̤ˑn] ‘intestine, intestines’, stress is realised by intrinsic vowel duration in both alternants, so there is no alternation in the realisation of stress, only a vowel length alternation.

5.3 Changes to stressed auxiliary verbs

More effects of stress on syllables with short vowels are observed in auxiliary verbs. Monosyllabic auxiliary verbs occur in stressed position when followed by a monosyllabic verb stem, creating a moraic trochee. In this position, the past auxiliary is strengthened in one of two ways. One strategy is to augment the auxiliary by gemination of the following consonant (Padang speaker):

(27)

a.i.	à-cé̤ là cìil pé̤é̤ɲ	[à ˈcé̤llɜ̀ ˈcìil ˈpé̤é̤ɲ]	‘He is not going to grow in the ground.’
a.ii.	à-cìll abáàŋ pé̤é̤ɲ	[à ˈcìllɜ̀ ˈbáàŋ ˈpé̤é̤ɲ]	‘He is growing plants in the ground.’
b.i.	à-cè̤ tà pé̤é̤ɲ	[à ˈcè̤ttɜ̀ ˈpé̤é̤ɲ]	‘It was on the ground.’
b.ii.	à-cí̤tt abáàŋ	[à ˈcí̤ttɜ̀ ˈbáàŋ]	‘It looks like a plant.’

The sentences with augmented auxiliaries (a.i,b.i) are shown with phonetically similar sentences (a.ii, b.ii) that control for gemination. Each control sentence (ii) has a lengthened consonant which is a final stem consonant, lengthened by Final Consonant Gemination (19). Each auxiliary sentence (i) also has a lengthened consonant, producing a similar pronunciation to the control sentences. However, in each auxiliary sentence, it is the initial consonant of the following word that is lengthened. This strategy enhances the moraic trochee headed by an auxiliary verb from an even trochee (LL) as would be expected from the underlying forms on the left, to an uneven trochee (HL) in surface pronounciation on the right.

In another strategy (Rek speaker), the past auxiliary[11] has a high vowel when in stressed position (see also Tucker and Bryan 1966:430). In combination with the effect of Uneven Vowel Centralisation in uneven (HL) trochees, the past auxiliary then alternates between three vowel qualities, depending on its position in the foot:

[11]This auxiliary verb is glossed as “past” in Tucker and Bryan (1966) but as “perfect” in Andersen (2007). In this paper, I assume a past perfect meaning except in the sentences in (12).

(28) **Vowel Quality in the Past Auxiliary Verb** (Rek speaker)

	Foot position	Form	Example	
a.	stressed in even trochee (ˈL̲L)	cì̤	26b. ˈtíík ɜ̀-ˈcì̤-là ˈt̪ṳ́ṳ́ṳ́g	‘The woman has gone to the markets.’
b.	unstressed in even trochee (ˈLL̲)	cè̤	23b. ˈɛ̀n-cè̤ ˈt̪ṳ́ŋ ˈdòòm	‘I have caught the horns.’ (in answer to ‘what have you caught?’)
c.	unstressed in uneven trochee (ˈHL̲)	cə̤̀	23b. ˈɛ̀ɛ̀n-cə̤̀ ˈt̪ṳ́ŋ ˈdòòm	‘I have caught the horns.’ (in answer to ‘who has caught the horns?’)

The vowel /e̤/ occurs in many grammatical morphemes in Dinka (Andersen 2007:99,111), so the high vowel found in stressed position is a marked departure from this default vowel. Other short auxiliary verbs (Andersen 2007) may be checked for similar alternations of vowel raising or consonant gemination in the various Dinka dialects.

We have now seen that stress on a syllable with a short vowel may be realised in verbs by high tone, intensity of the vowel in an open syllable, or intensity of the coda consonant in a closed syllable, and in auxiliary verbs by raising the height of the default vowel, or gemination of a following consonant. All of these strategies compensate for the lack of intrinsic durational prominence in short stressed vowels.

5.4 Weighted final consonants and minimal word size

The foot also provides a principled explanation for the restricted distribution of weighted consonants in Dinka (section 4). The only words we have observed with a mora on a consonant are the closed monosyllabic stems with short vowels, as stated in (18a) Final Consonant Weighting.

(18a, repeated) **Final Consonant Weighting**

$$\varnothing \rightarrow \mu \;\; / \;\; \begin{array}{l}[\mu\ \_]_{\text{word}}\\ \;|\;\;\,|\\ \text{VC}\end{array}$$

The augmentation of the mora on the short vowel by a second mora on the coda consonant in (18) is an instance of the minimal word phenomenon, in which content words cross-linguistically tend to have a minimum of two moras in moraic trochee languages (Kager 1999:175). The explanation for this minimal word effect is that (a) feet are formed on content words, and (b) feet normally require a minimum of two moras, avoiding rhythmically isolated single light syllables. This tends to ensure that content words have two moras. In Dinka, the formation of feet on nouns and verbs is enforced on a stem with a short vowel by adding a mora to the final consonant. As for content words with medium or long vowels, and content words that are disyllabic, we can explain their lack of a mora on the final consonant by the fact that there is no pressure from foot structure for them to have one: they already have two or three moras, which is already sufficient to form a foot. The only limitation of Final Consonant Weighting as a strategy for ensuring that content words have two moras is that there are a few open monosyllabic verbs with just one mora, /là/ ‘go’, /bɔ̀/ ‘come’, /tà/ ‘be present’. These cannot be augmented by Final Consonant Weighting, and so they remain exceptional monomoraic verbs. As we saw in 5.2, alternative strategies of intensity or high tone are applied to give more prominence to these rhythmically light verbs.

5.5 Morphological type

In addition to the roles of the foot in current Dinka phonology given here, Dimmendaal (2012) proposes that Dinka’s highly distinctive fusional morphology—as seen in the various grammatical alternations in vowel length within stems—is one of the historical developments of the moraic trochee in Nilotic

languages. What were once even (LL) trochees of root and suffix CVC-V have become heavy (H) monosyllabic CVVC stems in Dinka. As described in Norton (2012), many Dinka verb suffixes consist only of moras and tones having lost all their phonemic content, and these moraic suffixes contribute to the stem syllable in the form of vowel lengthening. This innovative morphology serves to reinforce the prominence of the stressed verb stem by increasing its weight.

6 Conclusion

We have seen that the moras of a syllable in Dinka determine not only internal vowel length but also the rhythm of Dinka utterances. Dinka utterances are parsed into extended moraic trochees: a heavy or superheavy syllable alone, two light syllables in an even trochee, a heavy and a light syllable in an uneven trochee, or a superheavy and a light syllable in an uneven trochee. The distinct rhythmic behaviour of light and heavy syllables confirms the length contrast between short and medium vowels. Stress in Dinka is not realised by the same salient feature whenever it occurs, but by intrinsic duration in medium and long vowels, and by intensity or other prominence-enhancing features in syllables with short vowels.

The foot has detectable effects in Dinka phonology and can be pursued further as a constituent of the language. The moraic trochee is implicated in vowel centralisation and raising, placement of intensity and high tone, consonant gemination, minimal word size, and even the historical development of Dinka's distinctive fusional morphology. In addition, stress can shift between connected speech and word-by-word speech, producing variation in foot-based processes.

We observed that there is a mora on the final consonant of a monosyllabic stem with a short vowel, whose effects are lengthening of the consonant before a following vowel, a short delay before a following consonant, and greater intensity. The weighting of the final consonant could be relevant to the analysis of other Nilotic languages, since it may occur again on cognate short stems in other languages (Andersen 1990). In Dinka itself, the weighting of the final consonant could be represented in the written language in order to reduce under-differentiation in the existing orthography. Long vowels are written with two vowel letters (Tucker 1939, Malou 1992), so doubling the final consonant after a short vowel would be one way to differentiate short-vowel stems from medium-vowel stems consistently:

Short-vowel stem	*CVCC*	*cinn* 'hands'	
Medium-vowel stem	*CVC*	*cin* 'hand'	*cïn* 'intestines'
Long-vowel stem	*CVVC*		*cïïn* 'intestine'

In fact, one Dinka language consultant I met wrote the Dinka language this way. It corresponds to the use of double consonants after short vowels in English orthography (*hill, egg, add, fuss, loss, bull,* etc.). There are other ways that these stems could be distinguished in writing (Gilley 2004), and the Dinka community will decide.

This impressionistic record of Dinka stress awaits confirmation from introspection by mother-tongue linguists (Chomsky and Halle 1968:25), from measurement of the time intervals occupied by the different foot types (Halliday 1985:271), and from song or poetry data (Hayes 2011:280).

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