Metrical Stress in Dinka

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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.
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### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>1st Person</td>
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<tr>
<td>D</td>
<td>Declarative</td>
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<td>FOC</td>
<td>Focus</td>
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<td>FUT</td>
<td>Future</td>
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<td>NEG</td>
<td>Negative</td>
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<td>NF</td>
<td>Non-Finite</td>
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<td>P</td>
<td>Preposition</td>
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<td>PAS</td>
<td>Passive</td>
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<tr>
<td>PL</td>
<td>Plural</td>
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<tr>
<td>PST</td>
<td>Past</td>
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<tr>
<td>SG</td>
<td>Singular</td>
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</tbody>
</table>
1 Introduction

Dinka\(^1\) is on record 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>
<thead>
<tr>
<th>Consonants</th>
<th>Vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td>p  t ̣  t  c  k  [ʔ]</td>
<td>i  u</td>
</tr>
<tr>
<td>b  ɗ  d  j  ɲ</td>
<td>e  [ə]  o</td>
</tr>
<tr>
<td>m  ɲ  n  ɲ  ɲ</td>
<td>e  [ɜ]  ɔ</td>
</tr>
<tr>
<td>w  ɾ  l  j  ɰ</td>
<td>a</td>
</tr>
</tbody>
</table>

Diacritics

Tones: á à â ā  mid-centralised: [á],[ê] etc.
Breathy: ɬ etc. (ɬ is always breathy)  intensity: [ŋ],[n]
Diphthongs: jo, ɭɔ̃ 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

\[
\begin{array}{cccc}
  c̈ïn & c̈i'n & c̈i'n & c̈i:n \\
  ‘hands’ & ‘hand’ & ‘intestines’ & ‘intestine’ \\
\end{array}
\]

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 [ ̽]. 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 [ ] in the short stem. There are three recent proposals to account for these alternations:

Three Proposals

1. **Stressed-Unstressed Alternation** (Gilley 2003)

\[
\begin{array}{cccc}
  x & x & x & x \\
  \mu & \mu & \mu & \mu \\
  | | \checkmark & \checkmark & \checkmark \\
  cin & cin & cin & cin \\
\end{array}
\]


\[
\begin{array}{cccc}
  \mu & \mu & \mu & \mu & \mu & \mu & \mu & \mu \\
  | \checkmark & \checkmark & \checkmark & \checkmark & \checkmark \\
  cin & cin & cin & cin & cin \\
\end{array}
\]

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

\[
\begin{array}{cccc}
  \mu\mu & \mu & \mu & \mu & \mu & \mu \\
  | \checkmark & \checkmark & \checkmark & \checkmark & \checkmark \\
  cin & cin & cin & cin & cin \\
\end{array}
\]

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

<table>
<thead>
<tr>
<th>Short</th>
<th>Medium</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. cîn</td>
<td>cíín</td>
<td>'hands, hand'</td>
</tr>
<tr>
<td>b. tṳ́ŋ</td>
<td>tṳ́ŋ̃</td>
<td>'horns, horn'</td>
</tr>
<tr>
<td>c. cɔ̀k</td>
<td>cɔ́ɔ́k</td>
<td>'feet, foot'</td>
</tr>
<tr>
<td>d. dɔ̤̀k</td>
<td>dɔ̀ɔ́k</td>
<td>'boy, boys'</td>
</tr>
<tr>
<td>e. téŋ</td>
<td>té̤́ŋ̃</td>
<td>'is wiping, to wipe'</td>
</tr>
<tr>
<td>f. tér</td>
<td>té̤́ér</td>
<td>'is sharpening, to sharpen'</td>
</tr>
<tr>
<td>g. dɔ̤̃m</td>
<td>dɔ̤̃m̃</td>
<td>'is catching, to catch'</td>
</tr>
<tr>
<td>h. ć̤</td>
<td>ć̤́</td>
<td>Negative (NEG), Negative Passive (NEG:PAS)</td>
</tr>
<tr>
<td>i. à</td>
<td>àà̤̃</td>
<td>Declarative (D), Declarative Plural (D:PL)</td>
</tr>
<tr>
<td>j. c̤ín</td>
<td>c̤íñ</td>
<td>'intestines, intestine'</td>
</tr>
<tr>
<td>k. káám</td>
<td>káààm</td>
<td>'forearms, forearm'</td>
</tr>
<tr>
<td>l. dɔ̀ɔ́l</td>
<td>dɔ̀ɔ́ɔ́l̃</td>
<td>'boys, boy' (Padang dialect)</td>
</tr>
<tr>
<td>m. dòòt</td>
<td>dòòòt̃</td>
<td>'stones, stone'</td>
</tr>
<tr>
<td>n. bììt̃</td>
<td>bìì̤̃̃</td>
<td>'fishing spear, fishing spears'</td>
</tr>
<tr>
<td>o. ĺ̤āl̤̃</td>
<td>ĺ̤āl̤̃̃</td>
<td>'ceremonial spear, ceremonial spears'</td>
</tr>
<tr>
<td>p. tɔ̀ɔ́ŋ</td>
<td>tɔ̀ɔ́ɔ́ŋ̃</td>
<td>'war spear, war spears'</td>
</tr>
<tr>
<td>q. ẃ̤é̤c</td>
<td>ẃ̤é̤é̤c̃</td>
<td>'is sweeping, to sweep'</td>
</tr>
<tr>
<td>r. ḿ̤ĩ̤̃t̃</td>
<td>ḿ̤ì̤ĩ̤̃t̃̃</td>
<td>'is pulling, is pulled'</td>
</tr>
</tbody>
</table>

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. 'à ̤́ ́cé ̤́ ́pàáɲ ́t̤é̤́ŋ̃
   PST wall wipe:NF
   'He has wiped the wall.'

   b. 't̤úŋ ́à ̤́ ́cé ̤́ ́d̤àám ́p̤i̤ŋ
   PST horns catch:NF:PAS hold:NF
   'The horns have been caught hold of.'

   c. ^è̤ ́ŋà ̤́ ́j̤é̤ ́t̤úŋ̃ ́d̤ɔ̤̃m̃
   PST who 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 ['à] ['pàáɲ] ['t̤é̤́ŋ̃] 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), [cɘ̤̀] is heard halfway between ['à] and ['pàáɲ], 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:

<table>
<thead>
<tr>
<th>Light-Light</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>('σ₁σ₂)</td>
<td>('σ₁σ₂)</td>
</tr>
<tr>
<td>μ</td>
<td>μ</td>
</tr>
<tr>
<td>μ</td>
<td>μ</td>
</tr>
<tr>
<td>VCV</td>
<td>VCV</td>
</tr>
<tr>
<td>[ˈáɛ]</td>
<td>[ˈáɛ]</td>
</tr>
</tbody>
</table>

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), ['bɪ̊t̪] ['àà] ['máàr] are the rhythmically prominent syllables occurring at regular intervals. ['àà] and [cɘ̤̀] do not divide the foot in half as before; instead [cɘ̤̀] 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 ['àà] occupies the first two-thirds and monomoraic [cɘ̤̀] occupies the final third.

(5) Trimoraic Foot Pattern:

a. ˈbɪ̊t̪ ˈàà ː cɘ̤̀ ˈmáàr | b. ˈláààl ˈàà ː cɘ̤̀ ˈmáàr

s p e a r s D:PL- PST l o s t :NF:PAS

'The fishing 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:
Trimoraic Foot Types:

**Superheavy** (ˈσμμμ) μ μ μ

\[\begin{array}{c}
\text{CVC} \\
\end{array}\] [ˈbúlt]

**Heavy-Light** (ˈσμμσμ) μ μ μ

\[\begin{array}{c|c}
\text{V C V} \\
\end{array}\] [ˈbííít̪]

\[\begin{array}{c|c}
\text{V C V} \\
\end{array}\] [ˈàààt̪]

In practice, of course, Dinka sentences contain words of all vowel lengths, and therefore potentially both bimoraic and trimoraic 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)

<p>| | | | | | | | | | | | | |</p>
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<td>L</td>
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</tr>
<tr>
<td>a. ˈaː n-à ˈwiːcc bɔ̀ ˈrííí ŋ ˈwɔ̀ɔɔ̀c à ˈkóól ˈbà là ˈɟɛ́kk ˈtìaaŋ ɡe</td>
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<tr>
<td>1SG -D want come meat buy today FUT go give woman:my</td>
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<td></td>
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<tr>
<td>‘I want to come and buy meat today to go and give it to my wife.’</td>
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<th>S</th>
<th>H</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. ˈtíík ɜ́ ˈcì̤l à ˈt̪ṳ́ṳ́ʋ́g ˈàà ˈkóól</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>woman D NEG go markets today</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>‘The woman is not going to market today.’</td>
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</tbody>
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<tr>
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<th>L</th>
<th>S</th>
<th>H</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. ˈtíík ɜ̀ ˈcì̤l à ˈt̪ṳ́ɬ̣gˈ à à ˈkóól</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>woman D PST go Markets today</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘The woman has gone to market today.’</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 [ˈcí] and the Past auxiliary [ˈcì] contrast for tone, yet both can be stressed as in (7b,c). 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 ([ˈcí]) 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 [ˈcí] là (7b) with breathiness on the stressed syllable, and [ˈ’à cè̤] (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

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2In 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) | 'Pol ly 'put the 'ket tle 'on
    | 'Pol ly 'put the 'ket tle 'on
    | 'Pol ly 'put the 'ket tle 'on
    | 'all 'have 'tea

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 'lát 'môc 'láát 'She is insulting her man.’
    d insult man

    a.ii. á 'cè 'môc 'láát 'She has insulted her man.’
    d PST man insult:NF

    b.i. á 'dâm 'wèŋ 'dáàm 'He is catching a cow.’
    d PST man insult:NF

    b.ii. á 'cè 'wèŋ 'dáàm 'He has caught a cow.’
    d PST man insult:NF

    c.i. á ’uğál 'râp 'uğáîl 'She is pounding sorghum.’
    c.ii. á 'cè 'râp 'uğáîl 'She has pounded the sorghum.’
    c PST man insult:NF

    d.i. á ’tèèr 'pâál 'tèèr 'He is sharpening a knife.’
    d.ii. á 'cè 'pâál 'tèèr ‘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, /ˈàcè/. 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-bjók aléél [á 'bjókkɔ̀ 'léél] ‘He is throwing a stone.’
b. á-lát áráp [á 'láttʂ́ 'ráp] ‘She is sieving sorghum.’
c. á-uʃáá áráp [á 'uʃáddɔ̀ 'ráp] ‘She is pounding sorghum.’
d. á-téŋ əˈʃɔɔ́ar [á 'tɛŋŋɔ̀ 'ʃɔɔ́ar] ‘He is wiping dust off the book.’
e. á-tál əbík [á 'tɔlɔ́ 'bík] ‘She is cooking flour.’
f. á-guár áráp [á 'guárrɔ̀ 'ráp] ‘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. á-mííít əkóɔ́n [á 'mííítɔ̀ 'kóɔ́n] ‘He is dragging an elephant.’
b. á-téël əkóɔ́n [á 'téëlɔ́ 'kóɔ́n] ‘He is pulling an elephant.’

daughter, 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. á-cɛ́ bióók aléél ['ɛcè 'bjoɔɔkɔ̀ 'léél] ‘He threw a stone.’
b. á-cɛ́ láát áráp ['ɛcè 'láatɔ́ 'ráp] ‘She sieved sorghum.’
c. á-cɛ́ uʃáá áráp ['ɛcè 'uʃáddɔ́ 'ráp] ‘She pounded sorghum.’
d. á-cɛ́ tééŋ əˈʃɔɔ́ar ['ɛcè 'tɛɛŋŋɔ̀ 'ʃɔɔ́ar] ‘He wiped dust off the book.’
e. á-cɛ́ tɔɔ́ abík ['ɛcè 'tɔɔ́ɔ́ 'bík] ‘She cooked flour.’
f. á-cɛ́ guárr áráp ['ɛcè 'guárrɔ̀ 'ráp] ‘She ground sorghum.’
g. á-cɛ́ mǐíí kóɔ́n ['ɛcè 'mǐííɔ́ 'kóɔ́n] ‘He dragged an elephant.’
h. á-cɛ́ tɛɛɛl kóɔ́n ['ɛcè 'tɛɛɛlɔ́ 'kóɔ́n] ‘He pulled an elephant.’

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

(13)

a. á-cɛ́f[pp] kóɔ́n ‘He is chasing an elephant.’
b. á-cɛ́f[p] kóɔ́n ‘He is being chased by an elephant.’
c. á-nɔ́kk kóɔ́n ‘He is killing an elephant.’
d. á-nɛɛ[k] kóɔ́n ‘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-t[iŋŋ] ákòòn  ‘He is watching an elephant.’  
à-t[iŋŋ] ákòòn  ‘He is being watched by an elephant.’  
d. à-b[r] ákòòn  ‘He is taking along an elephant.’  
à-b[r] ákòòn  ‘He is being taken along by an elephant.’  
e. à-m[i][t] ákòòn  ‘He is dragging an elephant.’  
à-m[i][t] ákòòn  ‘He is being dragged by an elephant.’  
f. à-t[ɛɛ] ákòòn  ‘He is pulling an elephant.’  
à-t[ɛɛ] ákòòn  ‘He is being pulled by an elephant.’  

Similarly, there is no gemination of the final consonant of the negative past auxiliary verb /kɛɛ/  
(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-kɛ̀[cc] àbáàɲ   ‘He is tasting a bitter plant.’  
b. à-kɛ̀[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 cɘ̀ | ˈtṳ́ŋ | ˈdàám | ˈpiŋ  ‘I have caught hold of the horn.’  
a.ii. ˈànn cɘ̀ | ˈtṳ́ŋ | ˈdàám | ˈpiŋ  ‘I have caught hold of the horns.’  
b. i. ˈdààk ɜ̀ | ˈké̤́é̤ɟ lɜ̀ | ˈt̪ṳ́viewport̪  ‘The boys have not gone to the market.’  
    b. ii. ˈdɔ̀ɔ̀ɔ̀[l] ɜ̀ | ˈké̤́é̤ɟ lɜ̀ | ˈt̪ṳ́viewport̪  ‘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 gemination as seen in (16):  

(16)  
a. ‘bîll[t] | ˈà cɘ̀ | ˈmáàr  ‘The fishing spears have been lost.’  
    bîll[t] | ˈà cɘ̀ | ˈmáàr  ‘The fishing spear has been lost.’  
b. ‘dɔ̀ɔ̀ɔ̀[l] | ˈké̤́é̤ɟ lɜ̀ | ˈt̪viewport̪  ‘The boy has not gone to the market.’  
    ‘dɔ̀ɔ̀ɔ̀[l] | ˈké̤́é̤ɟ lɜ̀ | ˈt̪viewport̪  ‘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 ˈwícccc bɔ̀ ˈ ɡ á l à m ˈwɔ̀ɔ̀c  
    1SG - D need come pen buy  
    ‘I need to buy a pen.’  

b. ˈànn bɘ̀ ˈ l á  ò  ˈni̯áá lít ˈni̯áàk  
    1SG:D FUT go P God tomorrow  
    ‘I am going to church tomorrow.’  

---

7The 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 /ˈɡá.làm/ ‘pen’ divides the foot equally, indicating that moras are only found on its two short vowels, producing a Light-Light foot. Similarly /ˈn̪i̯áa.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 /ˈn̪i̯áa.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

\[
\begin{array}{c}
\text{a. } & \emptyset \rightarrow \mu & [\mu \_\text{word}] \\
\text{b. } & \mu & \mu \mu \\
\text{c. } & \mu & \mu \mu \\
\end{array}
\]

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

\[
\begin{array}{c}
\sigma & \sigma & \sigma & \sigma \\
\mu & \mu & \mu & \mu \\
\text{a lat t a rap} \\
[\text{a } \text{lat3 } \text{rap}] & \text{‘She is sieving sorghum.’}
\end{array}
\]

While the gemination of the final consonant of the verb intervocally 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\'[lát |ˈmóc ‘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):
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 /a-ča ɣət/ ‘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. 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 'lát t r̩̃p]
   a-lát a-r̩̃p
   D-pound sorghum
   ‘She is pounding the sorghum.’

   b. [ˈt̪ɪff k ɛt l t̪i ˈk̩l]
   t̪ɪff à-ɛt là t̪i ˈk̩l àk̩l
   woman D-PST go markets today
   ‘The woman has gone to the markets today.’

---

Bert Remijsen (personal communication) advises that the difference between short and medium vowels in open syllables (ci̤:ci̤i̤) is particularly difficult for non-mother-tongue-speakers to perceive. This difference would precipitate a stress difference in auxiliary verbs e.g. /a-ci̤/ vs /a-či̤/, so that auxiliaries are prime testing material for the mother-tongue perception of stress.
c. [ˈànn bɘ́ ˈlá ò ˈnjáált̪ ˈńjààk]
   àn a-bɘ́ lá ò ńjáált̪ ńjààk
   1SG D-FUT go P Goda tomorrow
'I will go to church tomorrow.'

d. [á ˈbi̯ó̤ó̤k ˈrà̤à̤à̤n ɘ̤́ ˈdó̤ò̤ò̤ò̤t]
   a-bi̯ó̤ó̤k ràà̤à̤n è dóò̤ò̤ò̤t
   D-throw person P stone
'He is throwing a stone at a person.'

e. [á ˈbi̯ó̤kkɘ̤́ ˈdò̤ò̤ò̤t]
   a-bi̯ó̤k è dòò̤ò̤ò̤t
   D-throw P stones
'He is throwing stones.'

We have examples of [ə] that are reflexes of the declarative particle /a/ or of /a/-initial nouns, and
eamples of [ɘ̤] that are reflexes of the preposition /e/. 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→V̽ / [ˈσμμ(μ)   __μ\foot]

The Uneven Foot Vowel Centralisation 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-kë ‘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, but not if the foot is even:

(23)

a.i. ˈbììt ̪ ˈ à  c è ˈmáààr 'The fishing spear has been lost.'
   spear D- PST lost:NF

a.ii ˈbìììt ̪ ˈ à à cɘ̀ ˈmáààr 'The fishing spears have been lost.'
   spears D:PL- PST lost:NF

b.i. ˈɛ̀n cè ˈtùŋ ˈdòòm 'I have caught the horns.'
   1SG- PST horns catch:NF
   (in answer to ‘what have you caught?’)

b.ii. ˈɛ̀ɛ̀n cɘ̀ ˈtùŋ ˈdòòm 'I have caught the horns.'
   1SG:FOC PST horns catch:NF
   (in answer to ‘who has caught the horns?’)

9Uneven 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 [bi̯ó̤k] ‘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 /be/ is added to the foot in (17b), it is parsed as an uneven trochee [ˈann.bɘ̤] 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-ˈráp] ‘She is pounding sorghum.’
b. [ʔá-ˈbi̯ó̤k ‖ ˈrà̤à̤à̤n ‖ ʔé̤-ˈdó̤ò̤ò̤ò] ‘He is throwing a stone at a person.’
c. [ʔá-ˈbi̯ó̤k ‖ ʔè̤-ˈdó̤ò̤ò] ‘He is throwing stones.’

Here, the short vowels of noun-initial /a-/ and preposition /e̤-/ 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    ‖ ˈt̪ṳ́vt̪] ‘The woman is going to the markets.’
b. [ˈtíík  ‖ ʔà-cì̤-ˈlà̤̂ ‖ ˈt̪ṳ́vt̪̂ ‖ ʔàà-ˈkóól] ‘The woman has gone to the markets today.’

(26) Stress retracts in connected speech

a. [ˈtíík ˈlà̤̂ ˈt̪ṳ́vt̪] ‘The woman is going to the markets.’
b. [ˈtííkɜ̃ ˈcì̤-ˈlà̤̂ ˈt̪ɐ̃vt̪̂ ˈàà-ˈkóól] ‘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. 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 /ci̽n̤/ ‘hands’, the intensity occurs on the final consonant; in the stressed open monosyllable /là/ ‘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).

10It 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, ciˑn] ‘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 | a-це là cīl pé̤ɲ | [à ˈce ̤́llɜ̀ ˈcììl ˈpé̤ɲ] | ‘He is not going to grow in the ground.’ |
| a.ii | a-cīl abāɲ pé̤ɲ | [à ˈcìllɜ̀ ˈbáːɲ ˈpé̤ɲ] | ‘He is growing plants in the ground.’ |
| b.i | à-çe tà pé̤ɲ | [à ˈce ̤̀ttɜ̀ ˈpé̤ɲ] | ‘It was on the ground.’ |
| b.ii | à-ci̤ːt abāɲ | [à ˈcí̤ttɜ̀ ˈbáːɲ] | ‘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 pronunciation on the right.

In another strategy (Rek speaker), the past auxiliary11 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:

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11This 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).
Vowel Quality in the Past Auxiliary Verb (Rek speaker)

<table>
<thead>
<tr>
<th>Foot position</th>
<th>Form</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. stressed in even</td>
<td>ċǐ</td>
<td>26b. 'tífk ə-ćǐ-là ˈt̪ùùùùg 'The woman has gone to the markets.'</td>
</tr>
<tr>
<td>trochee (ˈLL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. unstressed in even</td>
<td>ċè</td>
<td>23b. ˈɛn-će̤ ˈt̪ùŋ ˈdòòm 'I have caught the horns.'</td>
</tr>
<tr>
<td>trochee (ˈLL)</td>
<td></td>
<td>(in answer to ‘what have you caught?’)</td>
</tr>
<tr>
<td>c. unstressed in uneven</td>
<td>ċà</td>
<td>23b. ˈɛn-će̤ ˈt̪ùŋ ˈdòòm 'I have caught the horns.'</td>
</tr>
<tr>
<td>trochee (ˈHL)</td>
<td></td>
<td>(in answer to ‘who has caught the horns?’)</td>
</tr>
</tbody>
</table>

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**

\[
\begin{array}{c}
\text{ø} \\
\text{μ} \\
\text{μ} \text{ [word]} \\
\text{VC}
\end{array}
\]

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 | cînn ‘hands’ |
| Medium-vowel stem | CVC | cin ‘hand’ | cîn ‘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).
References


