Iambicity in Kera

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1. Introduction

   Although Afro-asiatic tone languages typically do not exhibit overt stress in the form of higher pitch or greater intensity, this paper will consider the evidence for a metrical system in Kera (an Eastern Chadic tone language spoken in southern Chad and parts of Cameroon, with 50,000 speakers (Ebert 1979; Pearce 1998, 2003, 2005, 2006)).[1] Iambic feet are constructed over a combination of light and heavy syllables with an obligatory heavy syllable for the head of the foot. Deletion and lengthening of vowels takes place as necessary to form iambic feet which are light-heavy (∪ -) or heavy (-). Inputs of the form /CVCV/ in phrase-medial position undergo deletion of the final vowel to form a monosyllabic, heavy foot (CVC). But in phrase final position, the second vowel undergoes iambic lengthening, giving (CVCV:). Other evidence for the iambic nature of Kera comes from vowel allophony, vowel harmony and tone spreading. This will be demonstrated with acoustic measurements. After a brief survey of the role of weight and iambicity in other Chadic languages, we will conclude that the foot structure is a central part of Kera phonology and that other Afro-asiatic languages may well provide similar insights into the interaction of metrical systems with tone, vowel quality, duration and syllable structure.
   There are three main areas to look at for evidence of iambicity in Chadic languages; the first two pay attention to the fact that iambic systems are quantity sensitive.
   i) *Data showing quantity contrasts.* In several Chadic languages, including Hausa (Newman 1972), quantity distinctions are made and certain syllables are obligatorily heavy. For example, in Hausa plural nouns, the final syllable is always heavy except in reduplicated forms. In general in Chadic languages, there is a clear pattern of weight distinctions, with CVV and CVC as heavy syllables and CV as light syllables (Roberts 2001; Wolff 2001; Jagger and Wolff 2002).
   ii) *Data showing connections between quantity and tones or vowel allophones.* In Hausa, tone contours are permitted on all heavy syllables including CVC but not on light syllables (Gordon to appear). In Heɗe, allophonic variation is determined by the weight of the syllable (Vaibra 2003 and James Roberts p.c.).
   iii) *Data showing foot structure.* Newman (2000) acknowledges the existence of iambs in Hausa even though Hausa has no overt stress (Dresel 1977). Schuh (1989, 1999) also claims iambicity in Hausa poetry. However, there are only a few references to foot structure or iambicity among Chadicist literature.
   These three areas will be considered in more detail later in the paper, both for Kera and for other Chadic languages. The following table shows the areas where weight and foot structure are known to play a role in certain Chadic languages. Data from these languages will be introduced below where relevant.

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(1) *Quantity and foot structure in Chadic*

	Quantity distinction	Quantity sensitive allophones	Quantity affecting tone	Iambic	Quantity Sensitive feet
Kera	✓	✓	✓	✓	✓
Hausa	✓	✓	✓	✓	✓
Tera	✓	✓			✓
Sokoro	✓	✓			
Gœmai	✓	✓			
Bade	✓	✓			
Ngizim	✓	✓			
Migaama	✓		✓		
Kanakuru	✓		✓		
Heɗe	✓			✓	✓
Bole	✓				✓
Mukulu	✓				
Mawa	✓				

As seen in this table, Kera exhibits all five of the traits listed. To see how the metrical system works in Kera, we need first to consider the permissible syllable structures and how these can be combined to form feet.

(2) *Kera syllable structure[2]*

Light syllables:	(C)V		bàa<u>nà</u>	'elephant'
Heavy syllables:	(C)V:	(vowel lengthened)	/tʃáwá/→tʃə́wá:	'fire'
	(C)VV	(lexically long vowel)	<u>bàa</u>ŋà	'elephant'
	(C)VC		<u>kān</u>	'water'

(3) *Possible foot structures*

monosyllabic foot	(CVV)	(CVC)
disyllabic foot	(Cv.CVV)	(Cv.CVC)

Words are made up of these feet with the possibility of a non-footed CV syllable at the right hand edge.

(4) *Word structure with unfooted syllables at the right edge*
   (bàa)ŋà   'elephant'   (gə̀dàa)mɔ́   'horse'

Phrase medially, the unfooted syllable will either be lengthened or combined with the first syllable of the following word so that all syllables belong to a foot. But phrase finally (when not utterance final), these unfooted syllables remain unaltered as short CV syllables. In example (5a) below, the syllable following the underlined <u>nu</u> has the structure CV. This syllable is not a head, so the [nu] syllable lengthens to become a head itself. In (5b), the [ma] syllable combines with the following heavy syllable to form one disyllabic foot.

(5) *CV syllables in the phrase*
   a. /gùl<u>nú</u>   tʃáwáŋ/ 'saw the sun through it'
      looked-it the-sun
   → (gùl)(nú:)(tʃə́wáŋ)

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[2] Throughout this paper, tone is marked only on the first vowel of long vowels. This is sufficient because there are no contour tones in Kera. This should be read as implying a consistent tone throughout the long vowel.

b. /sáamá nīmtí/   'your rope'
   rope   yours
→ (sáa)(mǝnīm)tí

The [ti] syllable in (5b) will remain unfooted if another phrase follows the noun phrase in the example, or it will be lengthened and form a foot if it is utterance final.

2. Evidence for the iamb
2.1. Strategies to avoid light-light feet

The main evidence for feet in Kera comes from the fact that both deletion and lengthening take place in order to avoid a (CVCV) foot. Deletion is used in phrase medial position and lengthening in phrase final position, as shown below:

(6) For an input of /CVCV/:   With definite article, [-ŋ]: no change (CVCVŋ)
                                   Phrase medial: final vowel **deletion** (CVC)
                                   Phrase final: 2nd vowel **lengthened** (CVCV:)

We can see both deletion and lengthening in the specific example below:

(7) /∪∪/ input undergoes deletion or lengthening to make a well-formed foot: /bɛgɛ/
    Definite article: [(bègéŋ)]   *animal-DEF*   'the animals'
    Phrase-medial: [(bèg) (núu)tú]   *animal his*   'his animals'
    Phrase-final: [(bègέ:)]   *animal*   'animals'

The underlying representation of this word must be /bɛgɛ/ because no other form would explain the need to delete a vowel in some circumstances while lengthening the vowel in others. The following graph shows that this deletion and lengthening process applies to all words of the form /CVCV/ (N = 55 words, from two folktales). The first two columns show the surface form of /CVCV/ in non-phrase final position. Observe that the first vowel has an average duration of approximately 50 ms while the second vowel (represented by the dark column) has been deleted. The second two columns show the /CVCV/ word in phrase-final position. Here, the first vowel is shorter in average duration than the example we have just looked at, but the second vowel of this word is much longer.

(8) *First and second vowel duration in 55 /CVCV/ words from 2 folk tales[3]*
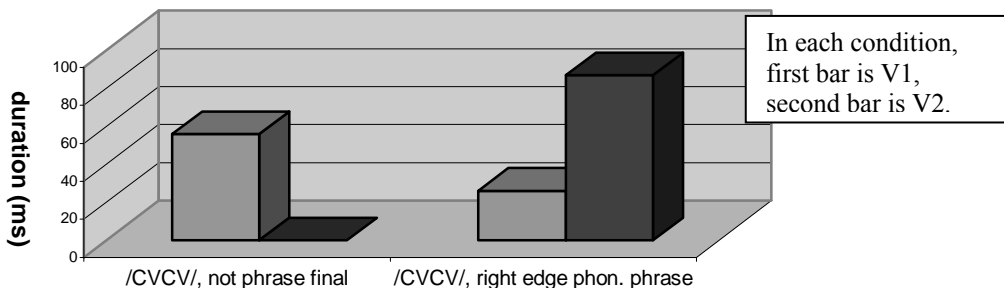
This graph shows that the vowel deletion takes place in phrase medial position to form a CVC syllable, while vowel lengthening takes place in phrase-final position with the surface form CVCV:. The first vowel also shortens, as might be expected if this were an iambic foot (CVCV:), since the lengthening of the head and the shortening of the non-head maximize the contrast between the two syllables.

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[3] These folk tales were recorded during a field trip to Chad in February-April 2004.

There are other examples where vowels appear to have been deleted from the underlying form, or from the form that has been proposed by Stolbova (1996) for the Proto-Chadic form. In each example in (9), the addition of a prefix causes the deletion of the underlined vowel. If that vowel remained, the surface form would include a (CVCV) foot. The fact that it is deleted supports the case that (CVCV) feet are not permitted.

	UR	SR	Unattested form
(9) /paka/ 'bowl'			
Singular:	/páká/	[(páká:)]	*[(pǝka)]
With plural prefix K- (-w):	/K-páká-w/	[(káp)(káw)]	*[(kapa)(kaw)]
Proto-Chadic: *lVgV 'skin'			
With masculine prefix K-:	/K-lɔ̲gɔ̀/	[(gɔ̀l)(gɔ̀:)]	*[(gɔlɔ)(gɔ:)]
Proto-Chadic: *rVmV 'child'			
With masculine prefix K-:	/K-rɔ̲̄mɨ̄/	[(kɔ̄r)(mɨ̄:)] 'son of…'	*[(kɔrɔ)(mɨ:)]
With feminine prefix T-:	/T-rɨ̲̄nɨ̄/	[(tɨ̄r)(nɨ̄:)] 'daughter of…'	*[(tɨrɨ)(nɨ:)]

In order to evaluate the possibility of a (CVCV) foot occurring in Kera, we must also consider longer words which might contain a (CVCV) foot, such as words with the underlying form /CVC.CVC/. These /CVC.CVC/ words include a transition between the two middle consonants. If the transition were shown to be a vowel rather than a transition, this would imply an underlying form of /CVCVCVC/. The only way to parse this into admissible Kera feet is to posit a word-initial (CVCV) foot. So if we find true vowels in between the two middle consonants in words such as these, then we must conclude that Kera has (CVCV) feet. To test for this, the transitions in 85 /CVC.CVC/ words were measured for duration and compared with the underlined vowel in (CVCVC) feet in words of the form: (CVCVC)CV or (CVC)(CVCVC). In words of these forms, the status of the vowel is not in question, but the duration of the vowel is the shortest that can be found in Kera and it therefore makes a good comparison with the transitions.

We could compare absolute values of these vowels and transitions, and if we did so, we would find that all the transitions in /CVC.CVC/ words are less than 20 ms in duration while the underlined vowels all have a duration of 30 ms or more. However, a more meaningful comparison can be made by comparing the ratio of the duration of the vowel or transition with the duration of the following vowel. In feet, this ratio stays reasonably constant, and if the transitions are in fact vowels in the non-head position in a foot, then they should give the same ratio. We can discard the possibility that these transitions are head vowels as they would then have a duration of more than 50 milliseconds, which none of them do.

The ratio calculation is given in (10) for both vowels and transitions. In (10a), we compare transitions in /CVN.CVC/, where N represents a sonorant, with vowels in (NVCVC)CV and (CVC)(NVCVC) words. The ratio for the transition has a mean lower than 0.1 ms. while the vowel transition has a mean of 0.6. In this case it is clear that the transitions are not vowels. In (10b), the same comparison is made but with obstruents preceding the transition or vowel in question and a sonorant following. Although the ratios are closer to each other here, they are still significantly different (with $p<0.001$). In (10c), with obstruents on either side of the transition or vowel, the results are more similar, but the differences are still highly significant (with $p<0.001$). In none of these diagrams could we reasonably claim that the transitions are in fact vowels. The fact that the ratio changes for the transitions depending on the nature of the surrounding consonants is further evidence that we are dealing with transitions. We would expect the duration of true vowels to be reasonably unaffected by the surrounding segments, but transitions by their very nature are highly affected by the surrounding consonants. We can therefore conclude that in the 85 /CVC.CVC/ words tested, there is a transition between the two middle consonants and not a vowel. This does not prove that (CVCV) feet do not exist in Kera, but it does eliminate one possibility of where they may be found. We now know that the surface forms [CVCV] and [CVCVCVC] do not exist in Kera. As the majority of Kera words have up to three syllables, we are not left with many other possibilities where a (CVCV) foot could be

claimed to exist. The simplest conclusion is that [CVCV] and [CVCVCVC] do not exist because the (CVCV) foot is not permitted in Kera. Underlyingly, these sequences can exist, but the Kera speaker employs some strategy so that the surface form does not contain the unacceptable (CVCV) foot.
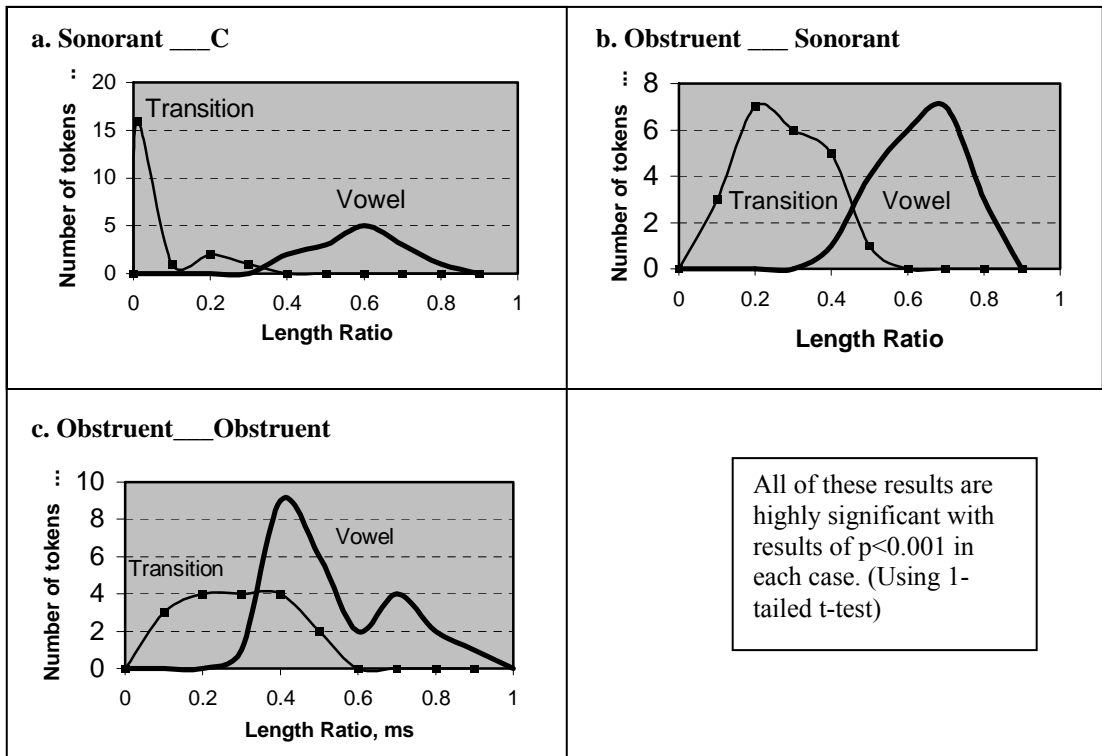
(10) *Comparison of transitions and vowels (using ratio compared with following vowel)*

Vowel ratio = $\dfrac{\text{vowel length (ms)}}{\text{final vowel length (ms)}}$

(Range: 0.4-0.8)

Transition ratio = $\dfrac{\text{transition length (ms)}}{\text{final vowel length (ms)}}$

(Range: 0-0.4)

All of these results are highly significant with results of $p<0.001$ in each case. (Using 1-tailed t-test)

In Kera, we have seen that one of the strategies used to avoid (CVCV) feet is to delete the final syllable. A similar pattern of deletion appears to take place in **Hausa**, at least historically. Hausa nouns are made up of heavy, or light-heavy, feet (with the possible exception of the final syllable).[4] When plurals are compared with singular forms, we can suppose that the historical form had more vowels which have been deleted in different places for the sake of maintaining well-formed feet. In Hausa nouns at least, the constraint which disallows (CVCV) feet seems to be applied as it is in Kera. The data below were taken from Newman (2000). He makes a passing remark about iambicity in Hausa but he does not develop the theme or mark feet in his data. The grouping into feet and the underlying form in the following examples are therefore my addition. The plurals of /haɽus/ and /tárád/ are made by adding the suffix /-aa/ to the root, but in both of these cases, the root plus suffix if unchanged, would be parsed as containing a (CVCV) foot. So the avoidance of a (CVCV) foot could be the motivation for the geminate [ss] in *háɽússàa* and the lengthened [aa] in *táràadáa*, and the deletion of the vowel in the singular and in the alternative plural.

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[4] Investigating the extensive data given in Newman (2000), about 1% of Hausa nouns appear to have a CVCV sequence and most of these are loans or reduplicant forms.

(11) *Hausa singular and plural nouns showing iambic feet*

	root	pl	unattested	gloss
a.	/haɽus/	(háɽús)(sàa)	*(háɽú)(sàa)	'tongue, language'
	/tárád/	(táràa)(dáa)	*(tárà)(dáa)	'head ring'

	root	sg	unattested
b.	/haɽus/	(háɽ)(shèe)	*(háɽú)(shèe)
	/tárád/	(tár)(dèe)	*(tárà)(dèe)

	root	alternative pl	
c.	/haɽus/	(háɽ)(súnàa)	*(háɽú)(súnàa)
	/tárád/	(tár)(dúnàa)	*(tárà)(dúnàa)

In Hausa pluractionals where reduplication is employed, the size of the reduplicant and the use of geminates appear to be motivated by the desire for light-heavy iambic feet. Again, deletion and lengthening are employed to get the desired foot structure. Hausa does not have a complete ban on CVCV sequences, as seen by the simple verbs in (12b and c), but the evidence from singular and plural nouns and pluractional verbs suggests that this constraint does have some place in the language.

(12) *Hausa pluractionals showing that the reduplicant must fill two mora slots*

	root	verb	presumed middle stage	pluractional	
a.	/farau/	fàráutàa	fáráu**fá**ràutáa	(fáráu)(ràu)(táa)	*hunt*
b.	/haɓa/	hàɓákàa	hàɓá**hà**ɓákàa	(hàɓàɓ)(ɓákàa)	*swell*
c.	/ɽiki/	ɽíkìtáa	ɽíkì**ɽí**kìtáa	(ɽíkír)(kìtáa)	*tangle*

In these examples, the two syllables of the root are reduplicated (underscored), but material from the first reduplicated syllable is then deleted (shown in bold). How much of this syllable is deleted depends on the foot structure. Most singular forms like those in (12a) have a light-heavy sequence, so if the first CV of the reduplicant is deleted, the reduplicant does not exceed the two-mora limit which we presume applies. This is the case for *fàráutàa* in (12a) and the whole word is parsable into iambic feet. However in words containing a CVCV sequence like *hàɓákàa* and *ɽíkìtáa* in (12b) and (12c), the form after reduplication has two *CVCV sequences *(haɓa or ɽiki)*. But the output must be made up of well-formed iambs. In *(hàɓàɓ)(ɓákàa)* this is achieved by deleting the first CV of the reduplication and lengthening the ɓ. In *(ɽíkír)(kìtáa)*, this is achieved by deleting just the vowel and keeping the rhotic, which becomes a legal coda r.

These Hausa examples show us that Kera is not the only Chadic language with iambic feet, but it is perhaps the clearest which has been described to date because the avoidance of (CVCV) feet applies across the language. I now turn to effects from foot structure or syllable weight on vowel allophones. We look first at the patterns in Kera, then at other Chadic languages.

2.2. *Vowel allophones*

Kera has 6 vowel phonemes, and the three non-high vowels have allophones as follows:

(13) *Allophones in Kera vowels*

phonemes:	/i/	/ɨ/	/u/	/ɛ/	/a/	/ɔ/
Head (-ATR)	[i]	[ɨ]	[u]	[ɛ]	[a]	[ɔ]
Non-head (+ATR)				[e]	[ə]	[o]

Lexical monosyllabic words always select vowels from the top set: [i] [ɨ] [u] [ɛ] [a] [ɔ]. As monosyllabic words must be feet, it follows that they are also heads. This implies that these vowels are head vowels. On the other hand, the vowels [e] [ə] and [o] are non-head vowels. They are of short

duration and never appear in heads or word-finally. In Kera, allophony and duration both indicate the difference between a head and a non-head vowel.

(14) *Comparison of head and non-head vowels*

    [e] [ə] [o], always of short duration (approx. 30ms, > 100 words), found in non-head position

        e.g.   [pépé:] 'god'   [gòlè:] 'to look' (phrase-final)

    [ɛ] [a] [ɔ], always of longer duration (greater than 50ms, > 100 words), found in head position

        e.g.   [pɛ́p] 'god'   [gɔ̀l]   'to look' (not phrase-final)

                 [pépɛ́:] 'god' (phrase-final) [gòlɔ̀ŋ] 'looked'

In the examples below, the heads in the output are underlined. The choice of allophone is clearly dependant on whether the syllable is the head of a foot or not.

(15) *Possible Kera structures with vowel quality differences in head and non-head*

Input		Output *Heads are underlined*		
∪ -	/ká.bàŋ/	(∪ -)	(ká<u>bàŋ</u>)	'tree'
∪∪	/pé.pé/	(-) (∪ -) (phrase-final)	(<u>pɛ́p</u>) (<u>pé</u>pɛ́:)	'god'
- -	/gòr.nòy/ /kɔ̄ɔ.mɔ̄m/	(-)(-)	(<u>gɔ̀r</u>)(<u>nɔ̀y</u>) (<u>kɔ̄ɔ</u>)(<u>mɔ̄m</u>)	'hyena' 'rat'
- # ∪ -	/tɛ̄n fáláŋ/	(-)(∪ -)	(<u>tɛ̄n</u>)(fə<u>láŋ</u>)	'I found'
- # ∪∪	/tɛ̄n gòlé/	(-)(-) (-)(∪ -) (phrase-final)	(<u>tɛ̄n</u>)(<u>gɔ̀l</u>) (<u>tɛ̄n</u>)(<u>gò</u>lɛ̀:)	'I look'

∪ represents light, - represents heavy

There are durational differences that go along with the allophonic change. Vowels in the foot (CV.CVC) shorten and lengthen respectively, whereas vowels in (CVC).CV do not change in duration. If there was no iambic foot, we would not expect a contrast in these two patterns as they are made up of the same two syllables, simply changing the order. In sum, the length and quality distribution of the vowels is exactly what is expected if the word is parsed into iambic feet, and the head/non-head position controls length and ATR.[5]

2.2.1. Allophony in other Chadic languages

Chadic languages can be categorized into two groups based on changes in vowel quality. In the first group (including Hausa and Heɗe), there is vowel reduction in light syllables.

Hausa has a difference in vowel quality corresponding to length with [i, e, a, o, u] in CVV syllables, but a restriction to [i, a, u] in CV syllables (Newman 1972, 2000; Gordon, to appear; Carnochan 1988). This pattern is not the same as in Kera, but it still demonstrates a link between vowel quality and weight, and cross-linguistically, smaller vowel inventories are usually a sign of non-head position.

Heɗe (Vaibra 2003) has only high vowels in non-heads within the verb. Verbs with the following CV structure have unrestricted vowels (underlined): (C<u>V</u>), (C<u>V</u>C), (C<u>V</u>C)(C<u>V</u>), (C<u>V</u>C)(C<u>V</u>C). But the first (non-head, not underlined) vowel in the following structures must be a high vowel: (CVC<u>V</u>), (CVC<u>V</u>C). This kind of vowel reduction is common in several languages, not just Chadic, including Belarusian, Slovene, Botzetierra Basque, and Polish (Crosswhite 1999).

In the second group, which includes Kera, the same number of vowels is kept in all syllables, but the quality changes. The Chadic languages **Sokoro** (Gordon Martin, pers. comm.) and **Gœmai** (Birgit

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[5] ATR is used here rather than height because the system of allophones is entirely separate from the height harmony which affects /i/, /ɨ/ and /u/.

Hellwig, pers. comm.) show that weight affects the choice of vowel between e/ε and o/ɔ. In the Sokoro example below, [e] and [o] appear in light syllables, while [ɔ] and [ε] are found in heavy syllables.

(16) so.ʔɔl   'guinea fowl'   so.ʔo.li   'guinea fowl (pl)'
    ke.ne   'here'   kε:.ne   'ours'
    (Syllable boundaries marked with full stop)

Schuh (2002) has remarked, without giving any details, that in **Bade** and **Ngizim**, CV and CVV syllables differ in quality as well as duration. Both languages have six vowels, [i, e, ə, a, u, o]. Only the three vowels [i, u, a] show distinctive length and quality, and this contrast is seen in all but word final position. Even though we are not told what the change in quality is, it seems clear that there is some interaction between the quality and duration. Newman (1968, p.c.) has also observed quantity sensitive allophones in **Tera** with alternations between [ə], [i] and Ø for the same phoneme.

2.3. Vowel harmony domains

The boundaries of Kera feet are indicated by the domains of vowel harmony and tone spreading. Kera has several types of harmony, with total harmony on roots and height harmony between roots and suffixes, but also fronting and rounding on central vowels. It is the last of these types that is sensitive to foot structure. Front suffixes cause central vowels in the same foot to front (17a). But between feet, the fronting does not take place (17b). If Kera does not have a foot structure, these harmony facts are hard to explain. Underlining here indicates the affected vowel.

(17) *Fronting within the foot* [6]
    -ε 'imperfective'

    Within feet:
    (a) bàl-έ→(bèlè:) 'love'   bĭŋ-έ→(bĭŋ̄ì:) 'open'   ɨs-έ→(ísî:) 'sit down'

    Between feet:
    (b) bàad-έ→(bàa)dè 'wash'   vĭig-έ→(vĭi)gì 'empty'   ɨsk-έ→(ís)kî 'hear'

There are no equivalent patterns known to me in other Chadic languages.

2.4. Tone spreading

The foot structure is also seen in tone spreading in Kera. In three syllable words with two tones, the domain of the first tone is a foot.[7]

(18) Low High   (gèdàa)(mɔ́:) 'horse'   (dàk)(tɨ́láw) 'bird'   *(gèdáa)(mɔ́)
    High Low   (kɨ́sáa)(bɔ̀:) 'locust'   (mán)(dɨ̀hàŋ) 'sack'   *(kɨ́zàa)(bɔ̀)
    High Mid   (kúɓúr)(sī:) 'coal'   (sáa)(tɨrāw) 'cat'   *(kúɓūr)(sī)

The domain of the first tone cannot be determined by counting syllables. Instead, the first foot is the domain for the first tone, and the domain for the second tone starts with the second foot.

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[6] These examples also contain height harmony -ε→-i, which is not restricted by foot structure.
[7] Bisyllabic feet with a single high tone are actually realized with the high tone on the non-head first syllable lowered to mid. This implies that high tone does not spread.

2.4.1. Interaction between tone and syllable weight in other Chadic languages

In **Hausa** (Newman 2000, Lahrouchi 2005), within each class of plural nouns (following the traditional classification by the vowel melody (Newman 2000)), the syllable weights are always the same. For example, class 5, as classified by the melody aXu (where both vowels are heavy), is always a light-heavy foot followed by a heavy foot, e.g. (dúwàa)(tsúu). In all classes, the last syllable is heavy and often the penult too. The tone patterns do not give direct evidence for the foot here, but the link between weight, quality and tone in defining the class suggests that a metrical structure may be involved here. Although the evidence is not as strong as it is for Kera, the following examples of the plural classes shows that weight certainly plays a role in Hausa, and probably feet too. The tone spreads from right to left associating one tone with each syllable and then the leftmost tone spreads. The foot structure in the plural column is my addition, and not necessarily agreed upon by Newman or Lahrouchi. In the 'weight' column, 'h h' means the final two syllables must be heavy. (The chart in (19) omits the classes 12-15 which are reduplicated forms. 'X' indicates an unspecified consonant (or cluster) or an unspecified tone.)

(19)

Class	tone	final Vs	weight	Sg	pl	gloss
1	H	-oXi	-hh	ƙáagúwáa	(ƙáa)(gúwóo)(yíi)	'crab'
2	LH	-ai	-h	ɗáalìbíi	(ɗàa)(lìbái)	'student'
3	HLH	-aXe	-hh	Gárkáa	(gáràa)(kée)	'enclosure'
4	HLH	-Xa	-hh	mánòomíi	(mánòo)(máa)	'farmer'
5	HLH	-aXu	-lhh	Dúutsèe	(dúwàa)(tsúu)	'jungle'
6	HL	-uXa	-h	Gáatáríi	(gáa)(túràa)	'axe'
7	LH	-aXi	-h	Góonáa	(gòo)(nàkíi)	'farm'
8	HLHH	-aXi	-lXh	Gányée	(gán)(yày)(yákíi)	'leaf'
9	LH	-u/-i	h	bùkáatáa	(bùkàa)(túu)	'need'
10	XH	-	h	Zúmùu	(zúmái)	'friend'
11	XH	-awa	hh	bàdùukùu	(dùu)(kàa)(wáa)	'leather worker'

The correlation between tone and weight and vowel quality in Hausa plurals as just described suggests that there is some connection between tones and feet. A further claim about tone and feet in Hausa has been made by Leben (1997, 2002). In loanwords from English, Hausa constructs a maximally bisyllabic foot starting on the syllable that bears main stress in English. A H is placed on the stressed syllable and generally followed by L.

(20)   (gwámnà)   'governor'
        gàrà(tíi)   'guarantee'
        (tân)(kíifàa)   'timetable'

Leben's 'tonal foot' is not affected by weight and is therefore not to be confused with the iambic metrical foot as described by Newman (2000). Space does not permit further investigation of Hausa, but it is clear that there is at least some interaction between tone, weight and vowel quality.

There is not much written about the relationship of tone and feet in other Chadic languages, but certain observations have been made. In **Migaama**, Roberts (2005) shows that H tone generally occurs on the first heavy syllable of the verb. Throughout the language, a long vowel is often found on the second syllable, implying the possible presence of an initial iamb. In **Kanakuru**, Newman (1972) shows that verbal nouns have H tone on light syllables and HL on heavy syllables. He has also observed that in **Bole**, monosyllabic feet in verbs have L while disyllabic iambic feet have H. Certainly outside of the Chadic language family there is evidence in certain languages for a relationship between tone distribution and feet. These include Bambara (Leben 2003, Weidman and Rose 2006), Chilungu (Bickmore 2003) and Ayutla (de Lacy 2002).

2.5. Slow speech pause breaks

When a Kera speaker was asked to say certain phrases slowly, he produced a surprising result. Instead of lengthening each segment, he introduced pauses between each foot. This suggests he treats each foot as a minimal word and that the foot is psychologically real to him.

(23) /Tɛn asaŋ kul(i) nuutuŋ/   'I saw his house'
    (a) (slow): (Tɛ̄n)..... (ásáŋ)......(kūl)..... (núu)....(túŋ)
    (b) (slow): (Tɛ̄n)..... (ásāŋ)......(kūl).......(lī:)..... (núu)....(túŋ)
    (c) (slow): (Tɛ̄n)..... (ásáŋ)......(kū:).......(lī:)...... (núu)....(túŋ)

A similar result arose when two other men were asked to clap 'important beats' while saying phrases. They clapped only the heads of feet. In tests with nonce words, they were also able to assign the correct tone to a syllable according to its position within the foot. Although this is anecdotal evidence, it suggests that at least on some level, the Kera are aware of the foot in terms of rhythm, parsing and in tone spreading domains. Together with the other evidence already presented, it makes a strong case for the existence of the foot in Kera.

3. Conclusion

The main evidence that Kera has iambic feet comes from the deletion and lengthening of vowels to avoid the badly-formed (CVCV) foot. The claim is further supported by the choice of vowel allophones and the duration of heads and non-heads. In addition, the vowel harmony and tone spreading domains suggest that the foot is an important structure in Kera. Finally, we have seen that the foot is psychologically real for Kera speakers. We therefore conclude that the iambic foot is important in several areas of Kera phonology.

We have also looked at evidence for feet in other Chadic languages. We know that several Chadic languages are quantity sensitive and show some signs of having feet. Some may well have a metrical structure that could give new insights into tone spreading domains, vowel spreading and allophony, and maybe other elements of the phonological structure. The findings of this paper suggest that further research into the metrical structure of other Chadic languages would be beneficial for the understanding of the phonology of each language and the motivation for some of the language changes within Chadic.

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