Mora alignment and multiple foot types in K'ichee'

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0. Introduction

This paper presents an analysis of the stress system in the Nahualá dialect of K'ichee' (a Mayan language spoken in Western Guatemala) and discusses the theoretical implications of K'ichee' stress. In K'ichee', quantity sensitivity is dependent on position within a word rather than syllable structure. The analysis of K'ichee' suggests the need for a uniform analysis of foot structure within OT so that stress is always dependent on foot structure rather than syllable structure (with the effects of quantity sensitivity resulting from the equation of a foot with a single syllable). The proposed analysis is applied to the case of Hixkaryana, which has been problematic for OT models of stress (cf. Halle and Idsardi 2000), showing that the analysis proposed here overcomes many of the problems found in Kager's (1999) analysis of stressed-syllable lengthening in Hixkaryana.

1. Stress patterns in K'ichee'[1]

In K'ichee' roots and stems, word-final CVC and CVV syllables receive primary stress. Secondary stress occurs in words of three or more syllables and falls on the initial syllable and consecutive alternating syllables moving left to right. Secondary stress does not occur on the penultimate or antepenultimate syllable (i.e. stress clash between secondary and primary stress is not allowed). Examples are shown in 1) below:

1) K'ichee' stress on roots without clitics:
(primary stress marked = ó, secondary stress = ò)

porór	"lung"
kaχjíb'	"two"
aχtsíb'	"writer"
tìnamít	"town"
k'òlok'ík	"spherical"
ètamab'ál	"science"
kàwunùnwutík	"it beats" (noise of a drum)

[1] Data are from field notes (cf. Barrett 1993) and represent the Nahualá dialect of K'ichee'. Thanks to Gregorio Tum for his help in my understanding of K'ichee' phonology.

Although the syllable receiving primary stress must be heavy (CVC or CVV), secondary stress is quantity insensitive as shown in 2) below:

2) Quantity insensitive secondary stress in K'ichee'

tìkoonijél	"farmer"
àwiiʃoqíl	"your wife"
kàtikrìkiʔník	"it crows" (sound of a rooster)
kàtoqtòqiʔník	"it clucks" (sound of a hen)
xìnts'ib'àχapaník	"I wrote to him/her."

CVC clitics on verbs show different forms depending on their position with regard to syntax (cf. Barrett 1993). When adjacent to the boundary of a syntactic clause, final consonants are lost. Glottal consonants display compensatory lengthening. Other consonants end in a light syllable, with primary stress falling on the penultimate syllable as shown in 3) below:

3) Stress patterns for cliticized verb forms in K'ichee'

a) Forms adjacent to S-boundary (clitic boundaries represented by "=")

<u>glottal-final</u>	<u>other-C-final</u>
ʃ ìmb'e=wíh "I went"	ʃ ìmb'e=bík "I went away"
kìmb'e=na=lóʔ "I might go"	kìmb'e=tʃík "I go again"

b) Clitics on phrase-medial forms (clitic boundaries same as above)

glottal-final	other C-final
ʃ ìmb'ewíi "I went"	ʃimb'éb'i "I went away"
kìmb'enalóo "I might go"	kimb'étʃi "I go again"

The phrase-medial cliticized forms demonstrate that the primary stress is actually a moraic trochee aligned at rightmost edge. The feet for secondary stress are syllabic trochees moving left to right. Stress clash and degenerate feet are prohibited

1.1 Mixed quantity sensitivity in K'ichee' as mora alignment

CVV and CVC syllables in K'ichee' only count as "heavy" when they are word final.[2] The constraints typically used to handle quantity sensitivity in OT are Weight by Position (**WBP**) (cf. Hayes 1989), Weight-to-Stress Principle (**WTS**) (cf. Prince 1990), and the Stress-to-Weight Principle (**STW**). **WBP** states that coda consonants receive moras, while **WTS** and **STW** both govern the relationship between stress and heavy syllables, with **WTS** requiring stressed syllables to be heavy and **STW** requiring heavy syllables to receive stress. These constraints, however, cannot handle quantity sensitivity that is dependent on position such as the word-final moraic foot in K'ichee'. In words where the only heavy syllable is word-final, crucial ranking between STW and Parse(s) produces the proper pattern of stress in K'ichee' as shown in the tableau in 4):

4). (kàtoq)(tòqi)(ník) *is better than* ka(tòq)toqi(ník), so Parse(σ) >> STW

katoqtoqinik	FT-BIN	*CLASH	Parse(σ)	STW
☞(kàtoq)(tòqi)(ník)				*
ka(tòq)toqi(ník)			***!	
ka(tòq)(tòqi)(ník)		*!	*	
(kàtoq)to(qínik)			*!	**
(kàtoq)(tò)(qínik)	*!	*!		

In words with more than one heavy syllable, however, this ranking predicts the wrong output as shown in 5):

5). ètamab'ál *is better than* ètamáb'al…

etamab'al	FT-BIN, *CLASH	Parse(σ)	WBP
(èta)ma(b'ál)		*!	
☹ (èta)(máb'al)			*
(èta)(mà)(b'ál)	*!	*	

Quantity sensetive feet in K'ichee' must be accounted for by something other than STW (or WBP). Alignment constraints (McCarthy and Prince 1993) may be used to regulate the distribution of foot structure in K'ichee'. Specifically, the proper

[2] For discussion of other cases of position-dependent determination of "heavy" syllables see Hayes (1992) and Rosenthall and Van der Hulst (1999).

outputs would result from an alignment constraint requiring that the right edge of a word must be aligned with a mora as shown in 6):

6). Algin Word (R), μ R – Align a mora at the right edge of a word

This mora alignment will ensure that a word final consonant will be moraic (although other consonants will not). The stress pattern of K'ichee' can thus be handled with the constraint ranking in 7) as shown in the tableaus in 8) and 9).

7). Constraint rankings: Algin Word (R) μ R, *CLASH, FT-BIN >> Parse(σ)

8). ʃkib'etʃi "they went again"

kib'etʃi	Align μ, Wd	*CLASH	FT-BIN	Parse(σ)
☞ ʃki(b'étʃi)				*
(ʃkì)(b'étʃi)		*!		
(ʃkìb'e)(tʃí)			*!	

9). etamab'al "science"

etamab'al	Align μ, Wd	*CLASH	FT-BIN	Parse(σ)
☞ (èta)ma(b'ál)				*
(èta)(máb'al)	*!			
(èta)(mà)(b'ál)		*!	*!	

The direction of footing is then easily handled with the full constraint ranking in 10) as shown in the tableaus in 11) and 12):

10): Full constraint ranking for K'ichee':

RH-Trochee, RIGHTMOST, AlignWd R, μ R, FT-BIN, Parse σ >> All-Feet-Left

11.ètamab'ál

etamab'al	Al-Wd, μ	FT-BIN	Parse(σ)	ALL-Ft-Left
☞ (èta)ma(b'ál)			*	****
(èta)(máb'al)	*!			
(è)(tàma)(b'ál)		*!		****

12. kib’ántʃi “they did again”

kib’antʃi	Al-Wd, μ	FT-BIN	Parse(σ)	ALL-Ft-Left
(kìb’an)(tʃí)		*!		**
ki(b’án)tʃi	*!		**	*
☞ ki(b’ántʃi)			*	*

The distinction between QI and QS feet in K’ichee’ is regulated by alignment rather than a constraint relating codas or long vowels directly to stress. Stress in K’ichee’ is directly related to foot structure (rather than being related to syllable structure as assumed by constraints such as **STW**). The theoretical implications of this fact are discussed in 2.0.

2.0 Stress and foot structure within OT

In K’ichee’, the relationship between stress, syllable weight and foot structure can be handled without the “QS constraints” (**STW**, **STW**, or **WBP**). This set of constraints, however, does not fully handle cases of quantity sensitivity. For example, the determination of what “counts” as weight in **WTS** (CVV vs. CVN vs. CVC, etc) must be independently regulated through other constraints on which segments can receive moras in a given language (e.g. *μ/CONS Sherer 1994, Zec 1995, etc). The pattern found in K’ichee’ suggests that quantity sensitivity might be dealt with through alignment constraints (Align μ R, σ R) which are already a basic part of constraint inventory.

One problem with the QS constraints is that stress assignment is not uniformly related to other aspects of phonology, so that different constraints regulate stress assignment for different types of stress systems. For quantity sensitive systems, WTS relates stress directly to segments within a syllable with no direct reference to foot structure, but for quantity insensitive systems stress is dependent entirely on foot structure (i.e. trochee vs. iamb) with no direct reference to syllable structure. Thus, there is an asymmetry in the analysis of stress such that quantity insensitive systems are analyzed in terms of feet and quantity sensitive systems are analyzed in terms of syllables. There are, of course, cases where foot-structure is restricted by syllable types, such as the preference for LH iambs. Attempts to encode these types of preferences in OT (such as Kager’s (1999) Rhythm-Countour and Uneven Iamb constraints) have been problematic. This is especially true in the analysis of iambic lengthening. As Halle and Idsardi (2000) note in their critique of Kager’s analysis of Hixkaryana, the constraints proposed by Kager, the lengthening of stressed vowels in

Hixkaryana must be due to the fact that the vowels are stressed and not due to the fact that they occur in iambic feet.

If we were to assume that (as in K'ichee') stress is directly tied to foot structure rather than syllable shape, we cannot depend on QS constraints such as WTS/STW, as these constraints make no reference to foot structure whatsoever. The current inventory of constraints used for dealing with quantity sensitivity in stress systems is a mix of markedness constraints on foot-stress combinations (such as RH-IAMB vs. RH-TROCHEE) and markedness constraints on syllable-stress combinations (such as WTS, WBP, etc). Thus, markedness constraints such as WTS/STW never play a role in determining stress in quantity-insensitive systems. If the set of constraints in OT actually represent some aspect of UG, one would hope that a single set of constraints handled foot-syllable-stress combinations rather than having a unique set of constraints that are able to handle QS languages but are not involved at all in the constraint rankings for QI languages (other than being dominated by all other constraints). One possible approach is discussed in section 3.0.

3.0 A uniform foot inventory

One way to have a single set of constraints for both systems would be to have stress assignment directly related to foot structure and assume that the phenomena handled by QS constraints such as WTS/STW must be dealt with in terms of foot structure (rather than syllable type). Such an assumption would mean that all (non-degenerate) feet are binary at the *moraic* level (and hence only bisyllabic in cases where both syllables are monomoraic). In other words, the inventory of foot types would be reduced from the current limited set of feet (Hayes 1995) to only two basic types, LL and H, representing quantity insensitive and quantity sensitive feet respectively.

Having only two basic feet types would be quite problematic for issues like the preference for LH iambs. Van der Vijver (1998) has proposed an analysis in which iambic feet do not occur. Instead, the appearance of iambs arises directly from constraint interaction between TROCHEE (requiring that all feet be trochaic) and *EDGEMOST (edge-adjacent elements may not be prominent). Van der Vijver's analysis has the foot typology found in 13) below:

13) van der Vijver's rankings for foot types:

Iambs - *EDGEMOST >> TROCHEE
Trochees – TROCHEE >> *EDGEMOST

Van der Vijver's claim that iambic feet can all be analyzed as non-initial trochees is dependent on several assumptions about the universal nature of iambs:

a) iambs occur only left to right
b) iambic systems avoid final and initial stress
c) the leftmost syllable in disyllabic words is stressed in iambic languages
d) the canonical iamb (LH) is not a primitive in prosodic morphology

Van der Vijver states that his claim against the existence of iambs is dependent on the non-existence of R→ L iambic footing. However, this very system has been proposed for Paumari (Everett 2002). Sipakapense (Barrett 1999), a Mayan language related to K'ichee', also has this type of stress system. Sipakapense has a very straight-forward stress system of quantity-insensitive R → L iambs that display many of the features van der Vijver claims to be universally prohibited. The Sipakapense system is historically based on the K'ichee' system, arising from a re-analysis based on roots with an even number of syllables (which have the same surface stress pattern in the two languages). Examples of Sipakapense stress are given in 14) below:

14) Sipakapense stress:

kuwìts'ulíχ	"Come hug him/her!"
kùχuwìts'ulíχ	"Come hug us"
ʃkàtktsulíχ	"They hugged you"
ʃkatìntsulíχ	"I hugged you"
atʃí	"man"
iiʃáq	"woman"
kiib'ék	"they are going"

Thus iambs seem to actually exist, but van der Vijver's suggestion that Hixkaryana doesn't have iambic feet may be useful in making a direct connection between stress and foot structure in language that display a preference for (what have been assumed to be) LH iambs.

If we assume that quantity sensitivity is a result of different types of feet (rather than syllables), we are faced with the problem of how to handle quantity sensitive iambic systems.Although the effects of WBP can be handled through alignment, the distinction between (CVV) feet and (CVCV) feet must due to something other than alignment (as both types align moras and feet in the same way). This distinction could, however, be handled through an equivalence constraint equating feet and syllables:

15) FT=σ - A foot must equal *exactly* one syllable. (i.e. feet must not cross syllable boundaries).

The interpretation of FT=σ differs slightly from that of a constraint like GrWd=PrWd (Grammatical Word = Prosodic Word) in that FT=σ requires exact equivalence in order to satisfy the constraint. GrWd=PrWd is satisfied in cases where the grammatical word is larger than the minimal prosodic word (i.e. it is actually GrWd ≥ PrWd). A similar constraint, σ=μ, would require quantity insensitivity with FT-BIN restricting the occurrence of degenerate feet. Assuming that stressed heavy syllables are actually bimoraic feet would produce the following typology of stress systems:

16: Typology of quantity sensitivity

a) Weight-by-position: Align μR σR >> *μ/CONS

Quantity Senstive Feet:

b) CVV and CVC are both heavy feet: FT=σ, FT-BIN, Align μR σR >> Parse(σ)

c) CVV is heavy, but CVC is light: *μ/CONS, FT-BIN >> FT=σ, Align μR σR

Quantity Insensitive feet (neither CVV nor CVC is heavy):

d) QI without degenerate feet: σ=μ, FT-BIN, *μ/CONS >> FT=σ, Align μR σR

e) QI with degenerate feet: σ=μ, FT=σ, *μ/CONS >> FT-BIN, Align μR σR

The following section provides an example from Mam (another Mayan language), applying these constraints to a typical quantity sensitive stress system.

4.0 **Quantity sensitivity without WTS/STW – Mam**

Mam (England 1983) has a quantity sensitive stress system with a hierarchy of “heaviness.” Syllables with long vowels are treated as heavy and receive stress. If a word contains no long vowels, a syllable with a [Vʔ] nucleus receives stress. If neither type of heavy syllable occurs, stress falls on the rightmost vowel preceding a consonant. Examples from England (1983) and Maldonado et al. (1981) are given in 17) below:

17) stress in Mam:

ʔadú:ntl	"work"	waqná:ya	"I worked"
puʔláʔ	"dipper"	spík^{y}'a	"clear"
ʃpitʃáq	"raccoon	é:b'aʔlata	"be quiet!
á:ʃlataχ	"maybe"	q'ulq'áχ	"warm"
Má:tʂ̩'etʂ̩'e	place name	aχkína	"that" (demonstrative)
suk'án	"to be nauseous"		

The stress pattern for Mam may be summarized as follows (England 1983):

1) Stress (rightmost) long vowel.
2) If no long vowel then stress CVʔ
3) If no long vowel or CVʔ, stress rightmost vowel followed by a C (consonant need not be in same syllable)

The stress system of Mam can be handled with the following constraints:

GrWd ≥ PrWd - Every grammatical word must be larger than or equal to a foot.
CULMINATIVITY – Only one stress per prosodic word.
FT=σ – Feet may not cross syllable boundaries
Align μ R, σ R – Align a mora with the right edge of every syllable
***μ/CONS** – No moraic consonants
***μ/[α place]** – Moras may not be marked for place of articulation (i.e. must be vowel or glottal stop)
ALL-FT-RIGHT – The right edge of *every* foot coincides with the right edge of a Prosodic Word. (cf McCarthy and Prince 1993)

The constraint rankings for Mam are as follows:

18) Constraint rankings for Mam:

CULMINATIVITY, GrWd=PrWd, Align μ R, σ R >> *μ[place], FT=σ >> *μ/CONS >> All-Ft-Right, Parse(σ)

Long vowels will be the target of stress when they occur, due to the ranking of mora alignment and *μ/[place] dominating *μ/CONS as shown in 19) and 20):

19) e:b'aʔlata "be quiet"

e:b'aʔlata	Al. μ, σ	*μ/[place]	FT=σ	*μ/CONS	All-FtRt
☞(é:)b'aʔlata					***
e:(b'áʔ)lata				*!	**
e:b'aʔ(láta)			*!		

20. a:ʃlataχ "maybe"

a:ʃlataχ	CULM	Alignμ	*μ/[place]	FT=σ	*μ/CON	AllFtRt
a:ʃla(táχ)			*!		*	
☞(á:)ʃlataχ						**
a:ʃ(látaχ)		*!		*		
(á:)ʃla(táχ)	*!		*		*	**
(á:)(ʃlátaχ)	*!			*		**

The occurrence of stress in words without long vowels or Vʔ-combinations is handled by the equivalent ranking of FT=σ and *μ/[place] as demonstrated in the tableaus in 21)-23). This co-ranking has the result that stress will not fall on a CVC syllable unless it is word-final (cf 23 below).

21) q'ulq'áχ "warm"

q'ulq'aχ	CULM	Alignμ	*μ/[place]	FT=σ	*μ/CONS	AllFtR
(q'úl)(q'áχ)	*!		**		**	*
(q'úlq'aχ)		*!		*		
☞q'ul(q'áχ)			*		*	

22). spik^y'a "clear"

spik^y'a	PrWd> GrWd	CULM	FT-BIN	Align-μ	*μ/[place]	FT=σ
spik^y'a	*!					
☞ (spík^y'a)						*
spi(k^y'á)			*!			

23) aχkina

aχkina	CULM	Alignμ	*μ/[place]	FT=σ	*μ/CONS	All-Ft-Rt
☞aχ(kína)				*		
(áχ)kina			*		*!	**
(áχ)(kína)	*!					**

5.0 Strong syllable-lengthening and FT=σ

One problem with QS constraints as used in OT has been the linking of lengthened stressed syllables to particular foot types as in Kager's (1999) analysis of Hixkaryana. Halle and Idsardi (2000) present several criticisms agains this analysis (including the fact that it predicts the wrong outputs). The Hixkaryana pattern (Kager 1999 from Hayes 1995) is as follows:

24). Hixkaryana stress pattern:

a) No underlying vowel length, length only on stressed syllables.
b) In words with only two syllables, stress falls on the first syllable.
c) In roots with only open syllables, stress alternates L → R, starting with the second syllable
d) Stress occurs on every CVC syllable.
e) In words with more than one CVC syllable, all are stressed regardless of clash.
f) In multiple CVC words, stress on CV syllables follows the regular L → R alternating pattern, allowing for clash adjacent to CVC syllables.

Examples of the pattern are given in 25):

25) Examples of Hixkaryana stress:

<u>disyllabic root</u>
kwá:ja "red and green macaw"

<u>initial closed-syllable</u>
ákmatá:ri "branch"
tóhkur^{j}é:hona "to Tohkurye"
tóhkur^{j}é:honá:haʃá:no "finally to Tohkurye"

<u>other closed syllables</u>

k^haná:níhno	"I taught you"
nákɲóhjátʃkená:no	"they were burning it"
mɨhá:nanɨ́hno	"you taught him"

<u>open syllables only</u>

toró:no	"small bird"
nemó:kotó:no	"it fell"
atʃó:wowo	"wind"

The Hixkaryana system is almost always accepted as an iambic system (Hayes 1995, Kager 1999, Halle and Idsardi 2000). There are several problems with an iambic analysis, however, particularly within OT. First, there is an asymmetry in the types of feet given in an iambic analysis. CVV syllables are treated as heads of LH iambs while CVC syllables are treated as moraic trochees. In Hixkaryana, disyllabic words are stressed on the first syllable, so that (in addition to CVC syllables) some roots have trochees while others have iambs. (cf. van der Vijver 1998). Finally, as Halle and Idsardi note, STW does not account for the length of heavy syllables, requiring an additional constraint Uneven-Iamb, which states that (LH) is preferred over (LL) and (H), which are in turn preferred over (HL) and (L). The Uneven-Iamb constraint is problematic because it ties lengthening to the presence of iambic feet even though the two may exist independently (Halle and Idsardi 2000).

The set of constraints proposed here (particularly FT=σ), however, actually overcome many of the problems presented by Halle and Idsardi. In fact, these constraints produce an analysis of Hixkaryana stress that depends on fewer constraints than those used by Kager (1999) while producing the proper forms in the cases that are incorrectly predicted by Kager's analysis (those words beginning with LLH). The constraint ranking for Hixkaryana is given in 26).

26) Constraint ranking for Hixkaryana:

FT-BIN, FT=σ >> *EDGEMOST >> Align Ft L Wd L >> *CLASH >> Parse(σ)

In this analysis, strong syllable lengthening result from the fact that FT-BIN and FT=σ are undominated so that every foot must be both binary and monosyllabic. The alternating pattern of stress typically attributed to the presence of uneven iambs is cause by clash avoidance rather than actual LH feet. The "iambic" pattern is thus not due to shifted trochees per se (as in Van der Vijver 1998), but is due to interaction between *EDGEMOST and *CLASH, with each heavy syllable in the output being exactly equivalent to a single foot (moraic trochee). In addition, the foot found in the case of disyllabic roots (as in 31 below) is the same type of foot found elsewhere in Hixkaryana, preventing the to analyze the language as having both iambic and trochaic feet (a problem that still persists in Halle and Idsardi's rule-based analysis). These rankings are demonstrated in tableaus 27-31 below. The problematic case for Kager (#LLH) is in 30) and the disyllabic case is in 31).

27) /atʃowowo/

atʃowowo	Al-μ, σ	FT=σ	FT-BIN	*EDGE	Al-Ft,Wd	*CLASH	Parse(σ)
atʃo(wó:)wo					**!		***
a(tʃó)wowo			*!				***
(atʃó)wowo		*!		*			**
☞a(tʃó:)wowo					*		***
atʃo(wó:)wo					**!		***
á:tʃowó:wo				*!			**

28). nákɲóbyátʃkená:no

nakɲobyatʃkenano	Al-μ, σ	FT=σ	FT-BIN	*EDGE	*CLASH	Parse(σ)
nákɲobyátʃke(ná:)no	*!					***
☞nákɲóbyátʃke(ná:)no				*	**	**
nákɲóbyátʃkenano				*	**	***!
nákɲóbyátʃ(ké:)nano				*	***!	**
nákɲóbyátʃke(ná)no			*!			**
nákɲóbyátʃ(kená)no		*!				**

29). ákmatá:ri

akmatari	Al-μ, σ	FT=σ	FT-BIN	*EDGE	Al-Ft,Wd	*CLASH	Parse(σ)
akmá:tari	*!						
☞ákma(tá:)ri				*		*!	**
ák(má:)tari				*			
ákmatari				*			***!

30). k^hananihno

k^hananihno	Alμ, σ	FT=σ	FT-BIN	*EDGE	Al-Ft,Wd	*CLASH	Parse(σ)
(k^há:)na(níh)no				*!			**
k^hana(níh)no					**!		***
k^ha(ná:)nihno	*!				*		***
☞k^ha(ná:)(níh)no					*	*	**
k^ha(ná:)nihno	*!				*		***

31). k^wa:ja

k^waja	Al-μ, σ	FT=σ	FT-BIN	*EDGE	Al-Ft,Wd	*CLASH	Parse(σ)
k^wá:já:				**!		*	
☞ k^wá:ja				*			*
k^wajá:				*	*!		*
(k^wajá)		*!					

5.0 **Conclusion**

This paper has shown that the relationships between stressed and heavy syllables typically handled by WTS and STW may be analyzed in terms of constraints on alignment and foot structure without the need for specific constraints relating stressed syllables and quantity sensitive feet. In the case of Hixkaryana, this analysis overcomes many of the problems with previous OT analyses that result from different types of analysis for quantity sensitive versus quantity insensitive systems.

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