Pulaar's Stress System: A Challenge for Theories of Weight Typology[1]

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1. Introduction

Many typologies of quantity-sensitive stress, whether moraic (e.g., McCarthy and Prince 1986, Broselow, Chen, and Huffman 1997) or syllabic (Blevins 1995), do not allow four levels of weight. However, Pulaar, a dialect of Fula, requires four values to determine primary stress: CVVC > CVV > CVC > CV (Niang 1997), while making only a two-way distinction in applying secondary stress (CVVC, CVV, CVC vs. CV). I use Pulaar to support accounts that formalize structural measures of prominence for weight distinctions (Hayes 1995, Walker 1996, de Lacy 1997, Gordon 2002); such an approach is compared to Morén's (2000) analysis in which some weight distinctions occur only under coercion (cf. also Rosenthall and van der Hulst 1999).

I first present the data on primary stress in Pulaar and sketch two possible analyses. I then show how the secondary stress facts require adoption of the first analysis, referring to structural measures of prominence in determining primary stress, and provide a detailed analysis for both primary and secondary stress. I conclude with a discussion of how the prominence-based approach provides for an OT analysis of primary and secondary stress in parallel, with restricted typological predictions.

2. Primary Stress

Pulaar is a dialect of Fula which is generally classified as a member of the West Atlantic branch of the Niger-Congo family, and is spoken in Mauritania, Senegal, The Gambia, Mali, and Guinea. The generalizations for primary stress in Pulaar are provided in (1), based on the data and descriptions of Niang (1997):

(1) Primary stress in Pulaar (Niang 1997)[2]

a) if all syllables are CV, stress the first:
['ba.la.be] 'shoulders' ['a.du.na] 'world' ['a.ba.bo] 'type of grass'

b) the heaviest syllable (CVVC > CVV > CVC > CV) gets primary stress; a heavier syllable pulls stress away from the first syllable:

CVC leftmost	['hal.ku.de]	'to kill'	['jol.nu.de]	'to put in'
CVC beats CV	[bo.'nan.de]	'harm'	[he.'lir.de]	'to break with'
CVV leftmost	['pii.la.gol]	'tying of a scarf'	['baa.bal.ˌnaa.jo]	'person from Baabal'
CVV beats CV	[da.'raa.de]	'to stand'	[he.'ɗaa.de]	'to listen'
CVV beats CVC	[hal.'kaa.de]	'to perish'	[fer.'laa.de]	'to squat'
	[jal.'too wo]	'a person who is going out'		
CVVC leftmost	['joof.nu.de]	'to complete'	['ɗaan.ki.ˌnaa.de]	'to pretend to sleep'
CVVC beats CVV	[naa.'naal.de]	'salted area'	[jaa.'taar.naa.jo]	'person from Jaataar'

[1] I thank Fiona McLaughlin, Paul deLacy, Bruce Morén, José Elias Ulloa, and Abdoulaye Kane for data and helpful comments on earlier versions of this paper. Any and all errors found in this version are mine.

[2] Niang argues that previous descriptions of Pulaar stress (Taylor 1953, Arnott 1970, McIntosh 1984, Prunet and Telier (1984) do not accurately or completely cover his data, though this may be due to differences in the dialects being described. I assume Niang has accurately described his own dialect.

 Selected Proceedings of the 35th Annual Conference on African Linguistics, ed. John Mugane et al., 181-192. Somerville, MA: Cascadilla Proceedings Project.

c) if two syllables tie as heaviest, stress the leftmost:

leftmost CVC	['tak.kor.di]	'glue'	['tal lor de]	'place for rolling'
	['gol.lor.de]	'work place'	['jam.min.de]	'give directions'
leftmost CVV	['poo.laa.ɗo]	'defeated person'	['daa.gaa.de]	'to walk slowly'
leftmost CVVC	['haal.pu.ˌlaar.ʔen]	'speakers of Pulaar'		

d) final syllables are not stressed, regardless of weight, except monosyllables:

non-final	['deb.buus]	'stick'	['noo.gaas]	'twenty'
monosyllables	['ar]	'come'	['mool]	'musical instrument'

2.1 PkProm style analysis: 4 degrees of weight

One type of analysis would be to follow the account of Kelkar's Hindi in Prince and Smolensky (1993) (citing Kelkar 1968 and Hayes 1991). That account relies on the constraints in (2), with Align-Hd-L for Pulaar rather than Align-Hd-R as in Hindi.

(2) Constraints for PkProm style analysis

a) Nonfinality: The prosodic head of the word does not fall on the word-final syllable (Prince and Smolensky 1993: 40).
b) PkProm: Peak(x)≻Peak(y) if |x|>|y|, "By PkProm, the element x is a better peak than y if the intrinsic prominence of x is greater than that of y" (Prince and Smolensky 1993: 39) Here |CVVC|>|CVV|>|CVC|>|CV| (formalized differently in §4).
c) Align-Hd-Left: Align the head syllable of a prosodic word (PW) to the left of the PW (Alignment version of Edgemost from Prince and Smolensky 1993: 39: "A peak of prominence lies at the L|R edge of the Word")

If PeakProminence is defined for a four way contrast, with |CVVC| > |CVV| > |CVC| > |CV|, then ranking Nonfinality » PkProm » Align-Hd-Left correctly determines primary stress in Pulaar. This ranking is established in Tableaux (3)-(6). First, in Pulaar, the final syllable is not stressed even if it outweights all preceding syllables (Tableau 3). This indicates that Nonfinality outranks PkProm. Next, because a heavier syllable later in the word will attract stress away from initial position, PkProm must outrank Align-Hd-Left (Tableau 4). Finally, evidence for the importance of Align-Hd-Left comes from cases in which two equally heavy non-final syllables appear in the same word; in such cases, the first, more leftmost syllable, receives primary stress (Tableau 5). This ranking also correctly determines stress in forms with all light syllables (Tableau 6).

(3) Nonfinality » PkProm

/asamaan/ 'sky'	Nonfinality	PkProm
a.sa.'maan	*!	CVVC
☞ 'a.sa.maan		V

(4) PkProm » Align-Hd-Left

/bonande/ 'harm'	PkProm	Align-Hd-Left
'bo.nan.de	CV!	
☞ bo.'nan.de	CVC	*

(5) ALIGN-HD-LEFT decides only if there's a tie

/maamaare/ 'ancestor'	NONFINALITY	PKPROM	ALIGN-HD-LEFT
☞ 'maa.maa.re		CVV	
maa.'maa.re		CVV	*!
maa.maa.'re	*!	CV	

(6) All light, so again ALIGN-HD-LEFT decides

/balabe/ 'shoulders'	NONFINALITY	PKPROM	ALIGN-HD-LEFT
☞ 'ba.la.be		CV	
ba.'la.be		CV	*!
ba.la.'be	*!	CV	**

To show that it is necessary to refer to four degrees of weight in evaluating PKPROM for Pulaar, we consider forms in which each type of syllable is pitted against the type claimed to be one step lighter on the weight scale. Because PKPROM outranks ALIGN-HD-LEFT, a heavier syllable to the right draws stress away from a lighter syllable in initial position in each case, as in Tableau 7a-c:

(7) Evaluating PKPROM

a) CVC > CV	/bonande/	NONFIN	PKPROM	ALIGN-HD-LEFT
'harm'	'bo.nan.de		CV!	
	☞ bo.'nan.de		CVC	*
b) CVV> CVC	[fer.'laa.de]	NONFIN	PKPROM	ALIGN-HD-LEFT
'to squat'	'fer.laa.de		CVC!	
	☞ fer.'laa.de		CVV	*
c) CVVC> CVV	/jaataarnaajo/	NONFIN	PKPROM	ALIGN-HD-LEFT
'person from	'jaa.taar.naa.jo		CVV!	
Jataar'	☞ jaa.'taar.naa.jo		CVVC	*

The constraints in (2) were developed for Kelkar's Hindi. This variety of Hindi differs in three ways from Pulaar: a) stress is aligned towards the right, so that ALIGN-HD-R breaks ties between the top two constraints, rather than ALIGN-HD-L; b) PKPROM outranks NONFINALITY, so that a final syllable will be stressed if heaviest; c) PKPROM refers to only three distinctions of weight, with CVVC,CVCC > CVV,CVC > CV. That the same basic constraints apply in a different ranking adds to the typological support for this type of analysis. An alternative formulation for PKPROM is taken up in §4.

2.2 Coerced weight à la Morén (2000)

Two recent proposals have been made within OT to account for the weighting of CVC syllables as intermediate between heavier CVV and lighter CV in stress assignment: Rosenthall and van der Hulst (1999) and Morén (2000). In both, the weight of a CVC syllable depends on the context of the word it is in as well as the language specific ranking of constraints, so that a CVC syllable sometimes is bimoraic and sometimes is monomoraic in the same language. I will discuss Morén (2000)'s account here because he focuses on the primary stress system of Kashmiri, which parallels that of Pulaar. First, a quick review of the generalizations he provides for Kashmiri, reorganized to parallel the description in (1), is presented in (8) to show that the system is the same as Pulaar's:

(8) Primary stress in Kashmiri (Morén 2000, citing Kachru 1969, 1973, Bhatt 1989)

a) if all syllables are CV, stress the first:
[ˈa.ni.ga.tɨ] 'darkness' [ˈpʰi.ki.ri] 'to understand' [ˈku.ni.vi.zi] 'sometime'

b) the heaviest syllable (CVVC > CVV > CVC > CV) gets primary stress;
a heavier syllable pulls stress away from the first syllable:
CVC beats CV [ʃo.ˈkɨr.vaar] 'Friday'
CVV beats CVC [vah.ˈraa.vun] 'to spread' [dar. ˈvaa.zɨ] 'door'
CVVC beats CVV [boo.ˈdees.var] 'Lord'

c) if two syllables tie as heaviest, stress the leftmost:
leftmost CVC [ˈjəm.bɨr.zal] 'narcissus'
leftmost CVV [ˈbaa.laa.dər] 'balcony'

d) Never on final syllable, regardless of weight:
[ˈna.kɨ.voor] 'nostril' ['baa.sun] 'to seem' ['kəə.pʰii] 'enough'

As the primary stress generalizations seem identical, we can apply the constraints as ranked above for Pulaar to account for Kashmiri, as exemplified in Tableau 9:

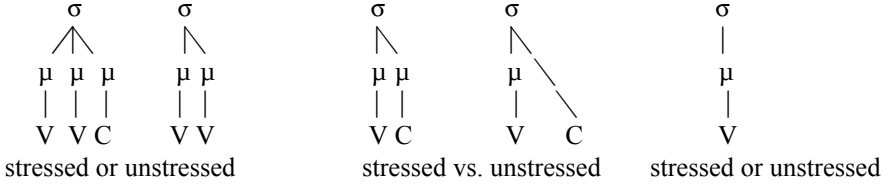
(9) Kashmiri: [vah.ˈraa.vun] 'to spread' cf Pulaar: [hal.'kaa.de] 'to perish'

/vah.raa.vun/	NONFINALITY	PKPROM	ALIGN-HD-LEFT
[ˈvah.raa.vun]		CVC!	
☞ [vah.ˈraa.vun]		CVV	*
[vah.raa.ˈvun]	*!	CVC	**

This analysis is actually proposed in Kenstowicz (1993) and Walker (1996), who analyze the typological variation resulting from the interaction of PKPROM with other constraints.[3]

However, in his analysis of Kashmiri stress, Morén raises the issue of what it means to have levels of weight like CVV > CVC > CV, seeing it as a problem that CVC syllables sometimes attract stress, when compared only with CVs, but are less attractive when a CVV syllable is present in the same word. If both CVC and CVV are heavy and bimoraic, why does CVV win over CVC? And if CVC is not bimoraic, why does it win stress over CV? His answer is clever: he proposes that CVC syllables become bimoraic on the surface only under coercion; otherwise they are monomoraic. The surface representation of stressed vs. unstressed CVC syllables is thus different, as illustrated in (10), while all other syllable types have a constant representation, regardless of stress:

(10) Surface representations of syllable types (Morén 2000)



The fact that CVVC syllables attract stress in preference to CVV syllables he treats as CVVC being trimoraic and CVV as bimoraic[4]. Although bimoraic CVV generally outweighs monomoraic CVC, CVC syllables are coerced into being bimoraic (hence outweighing CV) when no heavier syllables are present. The most important constraints of Morén's account are provided in (11), with (a-c) the relevant faithfulness constraints and (d-e) the markedness constraints. In a language with a

[3] Though neither discusses the superheavy syllables referred to in Morén (2000).

[4] Most researchers assume a trimoraic representation for such syllables, such as Hayes (1995), Broselow et al (1997), and Gordon (2002). As discussed in §4.3, Morén argues that the trimoraic syllables require the presence of PKPROM as well, in order to determine the placement of primary stress in Kashmiri.

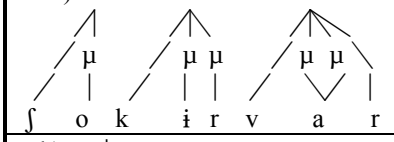
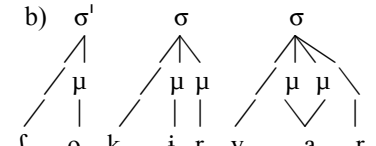
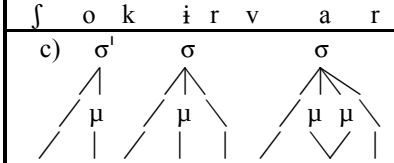
vowel length contrast, the high ranking constraint MAXLINK-μ[VOC] preserves the input moras of the vowels, so that long vowels keep two moras. WSP provides for stress on these long vowels.

(11) a) MAXLINK-μ [VOC]: Do not delete an underling mora from a vowel.
b) DEPLINK-μ [CONS]: Do not add a mora to a Cons that it did not have in input.
c) *MORA[CONS]: Do not associate a mora with a consonant.
d) WEIGHTTOSTRESS (aka WSP) Heavy syllables are prominent, i.e., 'bi- μ syllables are stressed' (Prince & Smolensky 1993, from Prince 1990).
e) WEIGHTBYPOSITION Coda consonants surface as moraic (Hayes 1989).

As Kashmiri does not have an underlying consonant weight contrast, consonants do not have moras in input. The coerced weight of a CVC syllable arises from an interaction of WEIGHTTOSTRESS and WEIGHTBYPOSITION. In a word with only short vowels and CVC syllables, WSP and WBP are both satisfied by making the CVC syllables bimoraic. However, if a syllable with a long vowel and a syllable with a coda consonant are both present in the same word, WSP and WBP cause a conflict: if the coda consonant has weight, WSP will be violated unless CVC and CVV are both stressed. WSP outranks WBP to enforce momomoraicity in CVCs in this case.

WSP also plays the role of PKPROM, in that its ranking above ALIGNHD-L results in the attraction of stress from initial position to heavier syllables, whether CVV or CVC. In a case in which no (non-final) long vowels are present in the word, the leftmost non-final CVC becomes heavy due to WEIGHT-BY-POSITION and stressed due to WSP, as illustrated in Tableau 12. The final syllable cannot be stressed due to the highest ranking NONFINALITY constraint, left off the tableaux here.

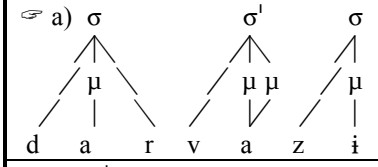
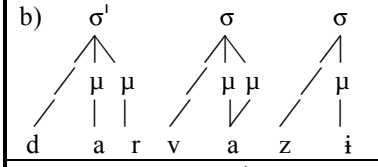
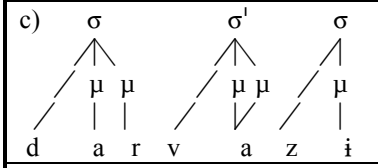
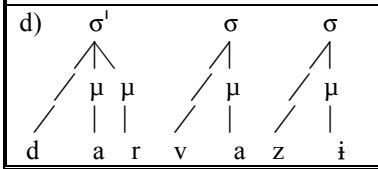
(12) Kashmiri [ʃo.ˈkɨr.vaar] 'Friday' (Morén p381) cf Pulaar: [bo.ˈnan.de] 'harm'

/ʃoᵘkɨᵘrvaᵘᵘr/	WSP	WBP	*μC, DEPLINKμC	ALIGN-HD-L
☞ a) σ σˈ σ 	*	*	*	*
b) σˈ σ σ 	**!	*	*	
c) σˈ σ σ 	*	**!		

Adding the mora to the consonantal coda, in order to satisfy WBP violates additional faithfulness constraints (*MORA[CONS], DEPLINK-μ[CONS]); however, the decision is determined already by the higher ranking WSP and WBP, which favor adding a mora and stressing the bimoraic result.

In a word in which a long vowel is present, CVC remains monomoraic. Thus, in the Kashmiri word [dar.ˈvaa.zɨ] 'door' (Tableau 13), which is parallel in structure to Pulaar's [hal.ˈkaa.de] 'to perish', the ranking of WEIGHT-BY-POSITION below WEIGHT-TO-STRESS and the high ranking of the constraint MAXLINK-μ[VOC] results in light CVC syllables. That is, the ranking ensures that it is better to preserve contrastive vowel length than to have bimoraic CVC syllables and satisfy ALIGN-HD-L. By the same analysis, if there are multiple CVC syllables in a word, only the first (leftmost) can be bimoraic. Crucial to this approach is that unstressed CVC syllables are monomoraic when long vowels or closed syllables to the left are present in the same word, so that the WSP is violated minimally at the expense of WBP violations.

(13) Kashmiri [dar.ˈvaa.zɨ] ‘door’ (Morén 383) cf Pulaar [hal.'kaa.de] ‘to perish’

/da$^{\mu}$r va$^{\mu\mu}$ zɨ$^{\mu}$/	MAXLINK-μ-V	WSP	WBP	ALIGN-HD-L
☞ a) 			*	*
b) 		*!		
c) 		*!		*
d) 	*!			

Rosenthall and van der Hulst (1999) independently present the same kind of analysis for Kashmiri, in the context of arguing for CVC as generally heavy but contextually light in some languages, and generally light but contextually heavy in others. They provide only a sketch of Kashmiri (p. 516-518), and do not mention how to treat CVVC syllables in their system. Otherwise, although they use slightly different constraints (e.g., *APPEND=no nonmoraic appendix, instead of WBP), the analysis for Kashmiri CVC is basically the same as Morén’s. Such analyses would work for primary stress in Pulaar, superheavy CVVC syllables aside; however, the secondary stress facts of Pulaar, to which I now turn, prove problematic.

3. Secondary Stress

Niang (1997) states that secondary stress occurs on all other heavy syllables in Pulaar, except when a clash would result. As seen in the data in (14), heavy syllables include CVVC, CVV, and CVC:

(14) Secondary stress on heavy syllables unless clash would result

a) CVCs:	['ar.ti. ˌroy.de]	‘to go and bring back’
	[ˌjol.ti.'noo.wo]	‘person who takes or puts out’
	[ˌwos.to.ndi.'ree.de]	‘to exchange with another person’
	[ˌgar.ti. ˌroy.tu.'noo.ɗo]	‘person who goes to get someone/thing back’
	[ˌhur.to.'yaa.de]	‘to move to the husband’s compound’
b) CVVs:	['ɗaa.no.to.ˌnoo.ɗo]	‘person who used to sleep’
	[ˌkaa.sa.'maas.naa.jo]	‘person from Casamance’
	['gaas.to.to.ˌnoo.ɗo]	‘person who takes soil out of a hole’
c) clash:	['baa.bal.ˌnaa.jo]	‘person from Baabal’
	[ham.'maa.ya.ro.yel]	‘kingfisher’
	['naat.naat.to.ˌndir.de]	‘to mix together, as in two groups mixing’

In accounts that assign weight to CVC syllables only under coercion, such syllables should remain monomoraic when another syllable (CVV or CVVC anywhere; or CVC to the left) receives primary stress. However, for the purposes of secondary stress in Pulaar, where some other syllable has received primary stress, CVC syllables do count as heavy and attract secondary stress along with CVV and CVVC syllables. The coercion accounts do not predict or explain the attraction of secondary stress to CVCs in forms such as [ˌjol.ti.'noo.wo] or [ˌgar.ti.ˌroy.tu.'noo.ɗo], as these syllables are crucially monomoraic so that they do not attract primary stress.

4. Constraints evaluating syllable weight

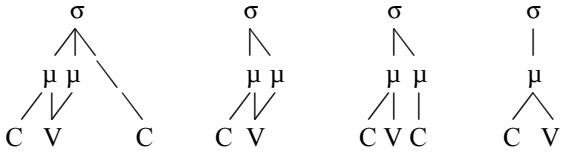
I therefore pursue an account in which syllable moraicity is constant and prominence is evaluated based on internal structure.[5] One important observation motivating prominence constraints is that elements other than mora count can determine or influence the kinds of weight distinctions used in assigning primary stress (see Kenstowicz 1993, Hayes 1995, Walker 1996, and de Lacy 1997 for numerous examples).

There have been many proposals regarding the distinction between weight as mora count vs. prominence; Hayes (1995), for example, proposes that there are two distinct aspects of syllable weight, quantity and prominence. Quantity depends on moraic content and is used for foot construction, while prominence refers to phonetically salient properties, used for determining primary stress, for which Hayes builds a prominence grid (Hayes 1995: Chapter 7). This kind of approach, which does not refer to constituent structure, does not provide a clear definition of what types of salience can be translated into phonologized prominence, and thus tends to be open to the criticism that it is unconstrained. Similarly, the definition of PKPROM refers to "intrinsic prominence" (see (2b)), without specifying what constitutes this prominence. Gordon (2002) develops phonetically grounded structural measures, but these are insufficient to handle the whole range of attested cases, including Pulaar. I turn instead to a fully articulated account that relates the prominence distinctions used in primary stress systems to formal internal structural distinctions among syllables, moras, and segments.

4.1 Primary Stress

de Lacy (1997) proposes such a formal phonological account of prominence distinctions based on constraint families that evaluate internal structure. Such accounts share in common with previous formal accounts the notion that "branching" plays an important role in weight (Blevins 1995), but also allows other factors, such as tone and sonority, to play a role in primary stress assignment. While de Lacy does not discuss Pulaar's exact four-way contrast, his constraints predict it. The constraints will refer to the following surface syllable representations in Pulaar, given in (15)[6]:

(15)



These representations limit well-formed syllables to being maximally bimoraic, yet allow for distinct structures for the CVVC, CVV, and CVC type syllables. The weight or prominence of each syllable for the purposes of determining primary stress is based on how well their structure satisfies a set of constraints from two families: EXIST and NOTMIN. The relevant members of these families for Pulaar are given in (16).

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[5] Elias Ulloa (2001) independently proposes a similar account for Kashmiri stress, also based on de Lacy's (1997) constraint system.

[6] See de Lacy (1997:14-20) for arguments to justify these representations, in particular the attachment of onsets to the first mora.

(15) de Lacy (1997) constraints

a) EXIST('σ,seg)	the number of associations between the primary stressed syllable and segment nodes is one (or more) (a syllable with a non-moraic coda satisfies; a syllable with a moraic coda or no coda does not).
b) NOTMIN('σ,μ)	the number of associations between the primary stressed syllable and mora nodes is greater than one (i.e., bimoraic satisfied; mono-moraic does not).
c) NOTMIN(seg, 'μ)	the number of associations between segment and the mora node dominated by the primary stressed syllable is greater than one (long vowels satisfy; short do not).

de Lacy motivates the families of EXIST and NOTMIN type constraints by referring to the distinctions found in assigning stress in a wide variety of languages. The constraints allow for phonology's ability to distinguish between zero and one, by EXIST, which is used in cases in which the presence or absence of an element is crucial. Furthermore, phonology can distinguish between one and more than one, by NOTMIN, which covers cases in which branching is crucial.[7] These constraints cannot, however, distinguish among values higher than one, and so, for example, cannot make a distinction between trimoraic and bimoraic syllables.

Tableau 17 shows the evaluation for each type of syllable represented in (15). CVVC satisfies all three; CVV satisfies all but EXIST('σ,seg); CVC violates both EXIST('σ,seg) and NOTMIN(seg, 'μ); and CV violates all three. Thus the three constraints correctly distinguish the four-way contrast used by Pulaar.

(17) Evaluation of Pulaar syllable types as optimal for primary stress

	NOTMIN('σ,μ)	NOTMIN(seg, 'μ)	EXIST('σ,seg)
'CV$^{\mu\mu}$C	OK	OK	OK
'CV$^{\mu\mu}$	OK	OK	*
'CV$^{\mu}$C$^{\mu}$	OK	*	*
'CV$^{\mu}$	*	*	*

The heaviest syllable is the one that best satisfies the weight constraints of the language. Ranking these constraints in the position previously held by PKPROM provides for the results seen in Tableaux 7 above and 18 below; the heaviest syllables receive primary stress so long as they are not final, with the leftmost heavy preferred. Replacing [hal.'kaa.de] 'to perish' with an identically structured word from Kashmiri, such as [dar.ˈvaa.zɨ] 'door' provides for the correct result in Kashmiri as well. It is not yet crucial that CVC be bimoraic, as shown the Tableau 18, but the secondary stress system depends on it.

[7] The NOTMIN family resembles constraints proposed in Gordon (2002), based on phonetic grounding as well as structural simplicity. It is not clear whether the EXIST family has any correlate in the system proposed by Gordon (2002), though it plays a vital role in Pulaar and Tiberian Hebrew, among others.

(18) Pulaar [hal.ˈkaa.de] ‘to perish’ (cf Kashmiri [dar.ˈvaa.zɨ] ‘door’)

/ ha$^{\mu}$l ka$^{\mu\mu}$ de$^{\mu}$ /	NON FIN	NOTMIN (ˈσ,μ)	NOTMIN (seg, ˈμ)	EXIST (ˈσ,seg)	ALIGN-HD-L
a) ˈσ σ σ \ \ | μ μ μ μ μ /| | /\/ /| h a l k a d e			*!	*	
☞ b) σ ˈσ σ \ \ | μ μ μ μ μ /| | /\/ /| h a l k a d e				*	*
c) σ σ ˈσ \ \ | μ μ μ μ μ /| | /\/ /| h a l k a d e	*!	*	*	*	*

4.2 Secondary stress

The concept of “weight” seems to be defined differently for primary and secondary stress, cross-linguistically. As in many languages, secondary stress in Pulaar depends only on the monomoraic vs. bimoraic distinction, and thus makes fewer distinctions for secondary stress than primary stress. In fact, de Lacy (1997:155) suggests that no language has more than a two-way distinction for secondary stress. I will use the WSP constraint to refer to weight as mora count, satisfied by any kind of stress (primary or secondary). Looking back to the definition of WEIGHTTOSTRESS of (11d): ‘bimoraic syllables must be stressed’ (Prince and Smolensky 1993, based on Prince 1990), we see that this matches the original formulation of the principle, that bimoraic syllables are stressed in some way.

All syllables larger than CV are treated as bimoraic in Pulaar, according to the structures in (15), so the WSP constraint favors assigning some stress to CVVC, CVV, and CVC. The two constraints in (19) must also be ranked relative to WSP.

(19) *CLASH: No stressed syllables are adjacent. (Kager 1999: 165)
*GRIDSTRUC Do not have grid structure (Walker 1996: 41)

(20) Ranking: *CLASH >> WEIGHT-TO-STRESS >> *GRIDSTRUC

The ranking in (20) allows for secondary stresses to be realized on all bimoraic syllables, unless a clash would result. First, *CLASH must outrank WSP so that adjacent heavies are not both stressed. The WSP itself must outweigh a constraint like *GRIDSTRUC (Walker 1996), which ordinarily limits additional stresses by incurring a violation for each grid mark. *GRIDSTRUC penalises any appearance of stress in a word, but is ranked low in Pulaar, so that it prevents only the stressing of CV syllables, which does not increase optimality relative to any constraint. Furthermore, given the reference to moraic content in the WSP constraint, the WBP, *MORAC, and DEPLINK-μ-C of Morén’s analysis are also integrated into the ranking.[8] At this point, the crucial rankings are that the WBP outranks *MORA[CONS], DEPLINK-μ[CONS], so that coda weight is normal for CVC syllables in Pulaar; the WBP also outranks ALIGN-HD-L, as will be demonstrated in the following Tableaux.

[8] Left off for lack of space is a maximum limit of two mora per syllable, *μμμ, which is ranked above the WBP constraint so that CVVC syllables do not become trimoraic to satisfy WBP.

Tableau 21 illustrates the assignment of secondary stress, assuming other constraints are fixing the location of primary stress:

(21)[9] ['naat.naat.to.ˌndir.de] 'to mix together, as in two groups mixing'

na$^{\mu\mu}$t.na$^{\mu\mu}$t.to$^{\mu}$.ndi$^{\mu}$r.de$^{\mu}$	*CLASH	WBP	WSP	*µC, DEPLINKµC	*GRIDSTR
'na$^{\mu\mu}$t.ˌna$^{\mu\mu}$t.to$^{\mu}$.ˌndi$^{\mu}$r$^{\mu}$.de$^{\mu}$	*!	**		**	***
☞ 'na$^{\mu\mu}$t.na$^{\mu\mu}$t.to$^{\mu}$.ˌndi$^{\mu}$r$^{\mu}$.de$^{\mu}$		**	*	**	**
'na$^{\mu\mu}$t.na$^{\mu\mu}$t.to$^{\mu}$.ndi$^{\mu}$r.de$^{\mu}$		***!	*		*
'na$^{\mu\mu}$t.na$^{\mu\mu}$t.to$^{\mu}$.ndi$^{\mu}$r$^{\mu}$.de$^{\mu}$		**	**!	**	*

WBP is necessarily violated by "superheavy" syllables to satisfy a high ranked *µµµ constraint. The first candidate, with all bimoraic syllables stressed in some way, is rejected because of the *CLASH violation. The final candidate, with only primary stress, falls short on WSP. The penultimate candidate, which tries to satisfy the WSP by failing to give the coda consonant in the CVC a mora, creates an additional WBP violation relative to the winner, showing that WBP outranks *MORAC and DEPLINK-µ-C for Pulaar. The winning candidate, with stress on the first and penultimate syllables, shows that CVC syllables will receive secondary stress when possible, even though the same word contains syllable(s) with a long vowel. Due to the position of another CVVC syllable adjacent to the primary stressed syllable, this word provides an example in which a CVC syllable receives (secondary) stress while a CVVC syllable is not stressed at all.

The use of structural constraints for prominence, and the unchanging bimoraicity of CVC syllables in Pulaar, allows for a simultaneous computation of primary and secondary stress, as shown in Tableau 22-23.

(22) [ˌkaa.sa.'maas.naa.jo] 'person from Casamance'

ka$^{\mu\mu}$sa$^{\mu}$ma$^{\mu\mu}$sna$^{\mu\mu}$jo$^{\mu}$	NOTMIN ('σ,µ)	NOTMIN (seg,'µ)	EXIST ('σ,seg)	CLASH	WBP	WSP	ALIGN -HD-L	*GR STR
☞ ˌka$^{\mu\mu}$.sa$^{\mu}$'ma$^{\mu\mu}$s.na$^{\mu\mu}$.jo$^{\mu}$					*	*	**	**
ˌka$^{\mu\mu}$.sa$^{\mu}$'ma$^{\mu\mu}$s.ˌna$^{\mu\mu}$.jo$^{\mu}$				*!	*		**	***
'ka$^{\mu\mu}$.sa$^{\mu}$ˌma$^{\mu\mu}$s.na$^{\mu\mu}$.jo$^{\mu}$			*!		*	*		**
ka$^{\mu\mu}$.sa$^{\mu}$'ma$^{\mu\mu}$s.na$^{\mu\mu}$.jo$^{\mu}$					*	**!	**	*

Tableau 22 shows long vowels receiving secondary stress, while Tableau 23 shows that CVC still attracts secondary stress, satisfying WSP, while not winning the competition for primary stress. The constraint against final stress is left off due to space constraints:

(23) [.ˌwos.to.ndi. 'ree.de] 'to exchange with another person'

wo$^{\mu}$s to$^{\mu}$ ndi$^{\mu}$ re$^{\mu\mu}$ de$^{\mu}$	NOTMIN ('σ,µ)	NOTMIN (seg, 'µ)	EXIST ('σ,seg)	CLA SH	WBP	WSP	ALIGN-HD-L	*GR STR
'wo$^{\mu}$s$^{\mu}$.to$^{\mu}$.ndi$^{\mu}$ˌre$^{\mu\mu}$de$^{\mu}$		*!	*					**
☞ ˌwo$^{\mu}$s$^{\mu}$.to$^{\mu}$,ndi$^{\mu}$'re$^{\mu\mu}$de$^{\mu}$			*				***	**
wo$^{\mu}$s.to$^{\mu}$.ndi$^{\mu}$'re$^{\mu\mu}$de$^{\mu}$			*		*!		***	*
wo$^{\mu}$s$^{\mu}$.to$^{\mu}$.ndi$^{\mu}$'re$^{\mu\mu}$de$^{\mu}$			*			*!	***	*

[9] Though not indicated correctly in the tableaux, the relative ranking of WBP to the WSP is not determined. Dotted lines between the two would incorrectly imply a tie between WSP and CLASH as well, and so the solid line appears here and elsewhere.

4.3 Typology

It has often been assumed that there are only two weights, distinguished by mora count -- e.g. McCarthy and Prince (1986:7) "Light syllables contain one mora, heavy syllables two". This assumption has led to problems in accounting for systems with more than two-way distinction for primary stress. In the Blevins (1995) syllable model, three distinctions are accomodated, based on branchingness of the rhyme or nucleus, but the model cannot easily be extended to cases in which other factors play a role, such as sonority, features, onsets, etc., or where more than a three-way distinction is made. Hayes (1995), Walker (1996) and de Lacy (1997) discuss many cases where a three way distinction (or greater) is made or the distinction is not solely moraic, e.g. Ayutla Mixtec in de Lacy (2002).

Although a typology based on constraints such as those in (16) allows a wide range of variation in prominence systems, many of the predicted systems are attested. Furthermore, de Lacy (1997) argues that it is more important for an adequate theory to provide enough possibilities, rather than to limit the typology so far as to rule out attested systems. His typology is limited by the types of distinctions that can be made; weight for the purposes of primary stress can be distinguished based on two characteristics only: prosodic structure and segmental sonority. The constraint families involved are limited to EXIST and NOTMIN, and the arguments these constraint families can refer to are limited to syllables, moras, segments, tones, and sonority. The typology does not allow weight constraints to refer directly to features of segments, and can only evaluate zero vs. one and one vs. more than one, so that it cannot compare two to three (bimoraic vs. trimoraic) or higher. Some of the extra possibilities generated by the typology would presumably be ruled out by extragrammatical considerations such as learnability, complexity, computation, etc.[10]

Morén also discusses the typological consequences of his account. One prediction he notes is that it is impossible to rerank his constraints to produce a language in which CVC is heavy while CVV is not (Morén 2000: 391); the same prediction is made also by Blevins (1995) in her syllabic model and seems to originate from Jakobson (1962). In the present account, such a language is predicted to exist; if a language has non-moraic coda consonants, then the constraint EXIST('σ,seg) favors stress for CVVC and CVC syllables over CVV and CV syllables. Such languages do exist; de Lacy (1997:72ff) discusses Tiberian Hebrew as one example. McCarthy (1979) states the generalization for primary stress in Tiberian Hebrew as stressing the ultima if it ends in a C, otherwise the penult (1979:139); interestingly, primary stress does not fall on the ultima if it has a long V but no coda. Secondary stress refers to long vowels only and not to CVC, which suggests CVC is not bimoraic. CVC and CVVC, with their coda C attached directly to the syllable node, satisfy EXIST('σ,seg). For secondary stress, both CVV and CVVC will be bimoraic and attract stress. It is thus not an advantage for an analysis to generate a typology ruling such a language out.

A final comment on Morén's approach to Kashmiri. Although one goal of using coercion to account for the intermediate value of CVC's weight was to limit the representational possibilities, Morén represents the CVVC syllables as trimoraic, thus opening up additional possibilities. Furthermore, Morén argues that the trimoraic syllables would not be correctly stressed using only the WSP, because it treats bimoraic and trimoraic equally, so he reintroduces PKPROM into his analysis of primary stress in Kashmiri (2000: 390). PKPROM, in his statement of it, distinguishes trimoraic >> bimoraic >> monomoraic, but cannot make a four way distinction, so the WSP, PKPROM, and coercion together determine just the location of primary stress.

The account proposed here also requires constraints of both types. The WSP, which refers to weight in the sense of mora count, results in secondary stress when ranked above *GRIDSTRUC, while the replacements for PKPROM, EXIST('σ,seg), NOTMIN('σ,μ), and NOTMIN(seg,'μ), determine the optimal syllable for primary stress. However, syllables maintain a uniform structure regardless of their surroundings, and the two types of constraints are used to determine both primary and secondary stress.

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[10] The use of these families of constraints also solves problems with predictions about geminate Cs and their moraicity, which have been difficult to handle within moraic accounts of weight (1997:106).

5. Conclusions

In this analysis, primary stress is sensitive to internal structure, while secondary stress is concerned only with mora count, so that both can be evaluated in parallel. Unlike alternative approaches, syllables are limited to being monomoraic or bimoraic and do not change their weight under coercion. The analysis presented here provides an OT account of Pulaar's four-way primary and two-way secondary stress contrasts that fits into a typology of quantity-sensitive metrical systems that is not overly restricted but is cross-linguistically motivated.

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