The stress system of Rarámuri: a single-level optimality theoretic account

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Languages exhibiting stress patterns that appear markedly different among portions of the lexicon present a significant challenge to traditional optimality theoretical phonology. Investigating such languages provides insight into the diversity of possible stress systems and affords an opportunity to improve optimality theory to better describe the world's languages. In Choguita Rarámuri, a semi-agglutinative Uto-Aztecan language of Chihuahua, Mexico described in Caballero (2008), each word has a single stressed syllable, which must fall within the first three syllables of the word. Surface stress may be affected by certain morphological contexts, including stress shifting suffixation. This paper presents a single-level phonological analysis of the stress pattern of Raramuri verbs, in contrast to Caballero's (2008) cophonology account. My analysis treats stress-shifting suffixes as carrying lexical stress, and employs *MAP (Zuraw 2007) and positional faithfulness (Beckman 1998) constraints to limit the possible surface stress pattern of input forms based on their underlying stress.

1 Language background and data

Rarámuri (Western Tarahumara, ISO 639 code tac) is a semi-agglutinative Uto-Aztecan language of Chihuahua, Mexico. The data and description in this paper are from Caballero (2005, 2008), excellent works documenting the language of the Choguita community. Rarámuri is an endangered language, with about 85,000 speakers across varieties (Lewis 2009), and about 250 speakers of the Choguita variety (Caballero 2005).

Each word in Rarámuri has a single stressed syllable, which must fall within the first three syllables of the word. Verbal roots are between one and three syllables in length, and there may or may not be lexical stress on any root syllable. If there is no lexically assigned stress, stress falls on the second syllable of the root, or the only syllable of the monosyllabic root. Verbal suffixes come in two varieties: stress neutral and stress shifting; the stress shifting suffixes have no effect when affixed to roots with phonemic stress, but when attached to roots without phonemic stress, they result in a rightward shift of the stressed syllable, resulting in third-syllable stress when affixed to polysyllabic roots. (Caballero 2005). Roots have a maximum length of three syllables. A very small percentage of the roots in Caballero's corpus have four syllables, but they are at least historically internally complex (Caballero 2008).

The table in (1) illustrates the behavior of representative Tarahumara verbs in unaffixed and affixed forms. Bare roots are shown with their surface stress, which is assigned lexically, except in the lexically stressless boldfaced forms, which receive default stress according to the description above. This list comprises all possible stress patterns in Tarahumara verbs, with the exception of compound forms, which will be discussed later in this paper.

(1) Stress Patterns in Rarámuri

Bare Root	Conditional (Stress shifting)	Perfective (Stress neutral)	Gloss
sú	sú-sa	sú-ri	'to sow'
rú	ru-sá	rú-ri	'to speak'
táni	táni-sa	táni-ri	'to ask for'
katʃí	katʃí-sa	katʃí-ri	'to spit'
awí	awi-sá	awí-ri	'to dance'
húmisi	húmisi-sa	húmisi-ri	'to take off'
natéti	natéti-sa	natéti-ri	'to pay'
binihí	binihí-sa	binihí-ri	'to accuse'
anátʃa	anatʃá-sa	anátʃa-ri	'to endure'

(adapted from Caballero 2005, 15, Table 4)

The conditional ending is a stress shifting suffix, while the perfective suffix is stress neutral. Stress shifting suffixes only have an effect on stress if they are immediately adjacent to an underlyingly stressless verbal root; if there is an intervening stress neutral suffix, stress will remain on the second syllable. For illustration, see (2) below.

(2) awí-ti-sa
dance-CAUS-COND[1]
'would make dance' (Caballero 2005, 14, ex. 24)

In (2), the causative suffix, *-ti*, is stress neutral and prevents the stress shifting suffix *-sa* from affecting surface stress.

The Tarahumara stress system becomes more complex when compound verbs are considered. Compound verbs consisting of a nominal root plus a verbal root, both of which could appear in isolation, carry stress on the first syllable of the second element (the head), regardless of any lexical stress of either root (Caballero 2005, 7-9). Some examples appear in (3).

(3) a. busi-kási
eye-break
'to become blind' (Caballero 2005, 8, ex. 10a)

b. kawi-bóta
egg-come.out
'to lay eggs' (Caballero 2005, 8, ex. 10d)

c. la-bíwa
blood-clean
'to clean blood' (Caballero 2005, 9, ex. 11)

When the first element in a compound comes from a trisyllabic root, it is truncated to allow stress to fall on the first syllable of the head of the compound without violating the initial trisyllabic stress window. Consider the forms in (4). The elided syllable is given in parentheses.

[1] Abbreviations: CAUS=causative, COND=conditional

(4) a. ʧame(ka)-répu
tongue-cut
‘to cut the tongue’

b. ʧere(wa)-bíwa
sweat-clean
‘to clean sweat’ (Caballero 2008, 193, ex. 25)

2 Caballero’s (2005, 2008) cophonology account

Caballero (2005) shows that a traditional OT analysis is not able to account for the Tarahumara stress pattern in affixed verbs and compounds and proposes a cophonology analysis. Bulding on the account in Caballero (2005), Caballero (2008) posits a master phonology that applies to all forms in the language, along with three more limited cophonologies that apply in specific morphological contexts. The master phonology includes six constraints in three tiers, as follows:

Tier 1: ALLFT-LEFT: All feet must align with the left edge of the word
Tier 2: STEMSTRESS: Every stem (root or root + stem shifting suffix) must carry stress in the output
Tier 3: STRICT: All feet are maximally two syllables
PROS-FAITH: Lexical stress must be preserved in the output
IAMB: Feet are iambic
PARSE- σ: All syllables must be parsed into a foot
(adapted from Caballero 2005, 18 and Caballero 2008, 197)

Caballero (2008) posits three cophonologies, *Cophonology Weak* for stress-neutral suffixation, *Cophonology Strong* for stress-shifting suffixation, and *Cophonology Incorporation* for compounds. Cophonology Weak is identical to the master phonology, but ranks STRICT above IAMB and PARSE-SYLL to give second-syllable stress. Tableau I illustrates the effect of Cophonology A in *anáʧa-ri*.

Tableau I: Cophonology Weak (adapted from Caballero 2005, 21, Table 14)

/ anaʧa+ri/	ALLFT-L	STEMSTRESS	PROS-FAITH	STRICT	IAMB	PARSE-σ
☞a. (aná)ʧari						**
b. (ána)ʧari					*!	**
c. (<a>naʧá)ri				*!		*
d. a(náʧa)ri	*!				*	**
e. a(naʧá)ri	*!					**

Cophonology Strong differs from Cophonology Weak in that STRICT is ranked below IAMB and PARSE-SYLL, deriving third-syllable stress. The results of this cophonology can be seen in Tableau II, for *anaʧá-sa*.

Tableau II: Cophonology Strong (adapted from Caballero 2005, 19, Table 10)

/anaʧa+sa/	ALLFT-L	STEMSTRESS	PROS-FAITH	IAMB	PARSE-σ	STRICT
☞a. (<a>naʧá)sa					*	*
b. (aná)ʧasa					**!	
c. (ána)ʧasa				*!	**	
d. a(náʧa)sa	*!			*	**	
e. a(náʧa)sa	*!				**	

Finally, Cophonology Incorporation, applicable to compounds, includes two additional constraints. The first additional constraint, ACCENT-TO-HEAD(σ_1), is ranked below ALLFT-L and above STEMSTRESS and requires stress to fall on the first syllable of the head of a compound form. The second additional constraint is the faithfulness constraint MAX-IO, which is added to the second tier and requires input segments to have output correspondents (Caballero 2005, 20-21). The effect of Cophonology Incorporation is illustrated in Tableau III, for *ʧame-répu*.

Tableau III: Cophonology Incorporation (adapted from Caballero 2005, 21, Table 14)

/ʧaméka+repú/	ALLFT-L	ACCENT-TO-HEAD(σ_1)	STEMSTRESS	PROS-FAITH	IAMB	MAX-IO	PARSE-σ	STRICT
☞a. (<ʧa>meré)pu				**		*	*	*
b. (ʧamé)karepu		*!		*			***	
c. (<ʧa>meká)repu		*!		**			**	*
d. (ʧamé)(karé)pu	*!			*			*	
e. ʧame(karé)pu	*!			**			***	

3 Issues with a cophonology account and an alternative analysis

While Caballero's (2005, 2008) cophonology account deals with the Tarahumara data well, the multiple phonologies required do not preserve the traditional OT tenet of direct mapping and present a learnability problem. Cophonologies represent a theoretical problem in that they allow for extremely different phonologies within a single language, an unattested situation (Kager 1999). In addition, not all of Caballero's claims are well motivated. For example, there is no clear reason to posit three separate cophonologies, when Cophonology Incorporation could handle single-root verbs with stress shifting suffixes equally as well as Cophonology Strong; in fact, it differs from Cophonology Strong only in that it includes two additional constraints that would have no effect on stress shifting suffixed forms.

Cophonologies are plausible for languages with portions of the lexicon from disparate historical sources, such as in the case of extensive borrowing. Since all the Rarámuri data is native, a single level account is preferable and more plausible.

*MAP constraints (Zuraw 2007) provide a possible solution for the Rarámuri data within a single level phonology. *MAP constraints prohibit input sequences specified in the constraint from being mapped to specified output sequences. This account relies on stress shifting suffixes being treated as underlyingly stressed. Since the Cophonology Incorporation of Caballero (2008) already accounts for both compounds and stress shifting suffixes, I take it as a starting point, adding the following constraint, hereafter referred to as *MAP, to the third tier:

*MAP($\#\sigma\sigma\sigma\begin{Bmatrix}\#\\ \sigma\end{Bmatrix} \sim \#\sigma\sigma\acute{\sigma}\begin{Bmatrix}\#\\ \sigma\end{Bmatrix}$): Do not map an underlying sequence of three stressless syllables at the beginning of a word, followed by another stressless syllable or a word boundary, to an output sequence with third syllable stress.

*MAP serves to eliminate unattested candidates like *(<a>natʃá)ri*, while allowing PARSE-SYLL to dominate STRICT and therefore predicting the correct surface forms for verbs with stress shifting suffixes and for compound forms. *MAP is crucially dominated by ACCENT-TO-HEAD(σ_1) because of forms like *busi-kási*, 'to become blind', which carry no underlying stress and yet have surface stress on the third syllable. In addition, it crucially dominates PARSE-σ, allowing verbs with stress neutral suffixes to have fewer parsed syllables as long as they satisfy *MAP.

Caballero's (2005, 2008) account also fails to prohibit the first or second syllable of the incorporated root in compounds from being truncated instead of the attested third syllable truncation. I further modify Caballero's (2008) Cophonology Incorporation by adding two positional faithfulness constraints (Beckman 1998) to constrain the position of the underlying syllable that does not surface in compound forms. I add two positional faithfulness constraints, formalized below, to the first tier:

MAXσ_1(root): The initial syllable of a root must have a correspondent in the output
MAXσ_2(root): The second syllable of a root must have a correspondent in the output

Tableaux IV-VII illustrate the performance of this modified, single-level constraint ranking for *anátʃa*, 'to endure'; *anátʃari*, 'to endure-PERF'; a*natʃása*, 'to endure-COND'; and *busi-kási*, 'to become blind'.

Tableau IV: Default second syllable stress

/anatʃa/	ALLFT-L	MAXσ1(root):	MAXσ2(root):	ACCENT-TO-HEAD(σ_1)	STEMSTRESS	PROS-FAITH	IAMB	MAX-IO	*MAP	PARSE-σ	STRICT
☞a. (aná)tʃa										*	
b. (ána)tʃa							*!			**	
c. (<a>natʃá)									*!	*	*
d. a(nátʃa)	*!						*			**	
e. a(natʃá)	*!									**	

In Tableaux IV and V, candidate (a) is the winner because it satisfies *MAP, despite that fact that it performs worse than candidate (c) on PARSE-SYLL. Tableau V is exactly the same as Tableau IV except for the presence of the stress neutral suffix *-ri*. This supports Caballero’s (2005) claim that stress neutral suffixes are not part of the stem or prosodic word for purposes of stress assignment, as they have no effect on the surface stress of the affixed verb.

Tableau V: Stress neutral suffixation

/anaʧa+ri/	ALLFT-L	MAXσ1(root):	MAXσ2(root):	ACCENT-TO-HEAD(σ_1)	STEMSTRESS	MAX-PROM	IAMB	MAX-IO	*MAP	PARSE-σ	STRICT
☞a. (aná)ʧari										*	
b. (ána)ʧari							*!			**	
c. (<a>naʧá)ri									*!	*	*
d. a(náʧa)ri	*!						*			**	
e. a(naʧá)ri	*!									**	

Tableau VI is identical to Tableau II except for the additional constraints, which have no effect on the choice of the winning candidate. Tableau III for *ʧame-répu* would also be unaffected by the *MAP constraint. Therefore, the proposed analysis preserves the strengths of the cophonology analysis in Caballero (2005, 2008).

Tableau VI: Stress shifting suffixation

/anaʧa+sá/	ALLFT-L	MAXσ1(root):	MAXσ2(root):	ACCENT-TO-HEAD(σ_1)	STEMSTRESS	PROS-FAITH	IAMB	MAX-IO	*MAP	PARSE-σ	STRICT
☞a. (<a>naʧá)sa						*				*	*
b. (ána)ʧasa						*				**!	
c. (aná)ʧasa						*	*!			**	*
d. a(náʧa)sa	*!					*	*			**	
e. (aná)(ʧasá)	*!										
f. a(naʧá)sa	*!					*				**	

Tableau VII illustrates that the posited ranking predicts the correct output form for *ʧame-répu*, as the prosodic faithfulness constraints rule out candidates like (b) and (c) in which the first or second syllable of the root is omitted instead of the third.

Tableau VII: Compound incorporation

/ʧaméka+repú/	ALLFT-L	MAXσ1(root):	MAXσ2(root):	ACCENT-TO-HEAD(σ_1)	STEMSTRESS	PROS-FAITH	IAMB	MAX-IO	*MAP	PARSE-σ	STRICT
☞a. (<ʧa>meré)pu						**		*		*	*
b. (meká)repu		*!		*		**				**	
c. (ʧaká)repu			*!	*		**				**	
d. (ʧamé)karepu				*!		*				***	
e. (<ʧa>meká)repu				*!		**				**	*
f. (ʧamé)(karé)pu	*!					*				*	
g. ʧame(karé)pu	*!					**				***	

The proposed *MAP constraint affects the choice of a winning candidate only for underlyingly stressless trisyllabic verbs with no affix or with a stress neutral suffix, the same set of data that Caballero (2005) posits Cophonology Weak to deal with; as noted above, Cophonologies Strong and Incorporation can easily be considered a single ranking. The analysis presented in this paper allows for a unified account of the Tarahumara data with a single constraint ranking, and the *MAP and prosodic faithfulness constraints are sufficiently simple that it is plausible that they could be learned. Cophonologies are not necessary to account for the stress pattern of Rarámuri. Rarámuri stress is likely difficult to deal with in OT because the differences in stress are due to historical processes; for example, stress shifting suffixes may be derived from verbal roots, explaining their lexical stress and their ability to join with the verb they affix to form a single stem (Caballero 2005, 14). The additional constraints I propose are also psycholinguistically motivated; for example, earlier syllables in a root are more prominent psychologically and crosslinguistically (Beckman 1998).

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