Ternary rhythm in Sentani

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0. Introduction

The stress system of Sentani, a Papuan language spoken in Northern Irian Jaya, combines the properties of rhythmic binarity and ternarity.[1] In this paper we will have a look at these patterns, and I will propose a constraint based analysis within the framework of Optimality Theory. I will argue that two constraints which has been proposed for other so called ternary stress patterns like those found in Estonian and Chugach Alutiiq result in ungrammatical forms as the optimal candidate in Sentani. These constraints are PARSE-2 (Kager 1994) and LAPSE (Green & Kenstowicz 1995). Both refer to metrical constituent structure. I will propose a different constraint, *LAPSE, which is defined as a rhythmic constraint and refers to the grid only. This constraint allows us to analyse the data of Sentani correctly.

1. Observations

Before we can address the main issue of this paper, we have to look into the stress patterns in general. This discussion will result in a preliminary list of constraints that appear to be active in Sentani.

1.1 Stress patterns. In Sentani main stress falls on the penultimate syllable, when the final syllable is light and on the final syllable when this syllable is heavy. Closed syllables and diphthongs are heavy, open syllables are light.[2] In the examples /j/ represents the palatal-alveolar fricative and /y/ the palatal glide.

(1) a ijàxawáte 'they always explain/clarify'
b omòxoyéi 'not do'

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[1] The analysis of Sentani stress is based partly on data given in Cowan (1965) and M. Hartzler (1976), but mostly it is based on data collected by the author during fieldwork in Irian Jaya in the fall of 1994. I am grateful to the Netherlands Foundation for Advancement of Tropical Research (WOTRO) and the Research Institute for Language and Speech (OTS) for their financial support, which made this fieldwork possible. I would like to thank René Kager and Jan Don and an anonymous reviewer for useful comments on an earlier version of this paper.

[2] In monosyllabic content words there is a vowel length contrast.

/a/	'voice, word'	/ɾo/	'egg'	/ya /	'rain'
/a: /	'down'	/ɾo:/	'man'	/ya:/	'day'

This points in the direction of subminimal words and Degenerate Feet. I will not address this issue in this paper.

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Secondary stress falls two or three syllables to the left of main stress or to the left of another secondary stress.

(2) a molòkoxàwalɛ́ne 'because I wrote to you'
b molòkoxáwále 'I wrote to you'

Heavy syllables receive stress.

(3) a ràisixáte 'they all put down'
b bèukóxe 'it floated'

Clashes of two adjacent stresses are avoided. In (4) heavy syllables do not receive stress in order to avoid a clash. But sometimes clashes do occur as in (3b), (5) and (6).

(4) a xəlɛ̀waimíle 'they taught him'
b hilɛ̀mbondɛ́re 'for he will calm down'

(5) a molònasəhàndéra 'after they will bury me'
b əxàikɛləwàimíle 'they went and taught them'

(6) a ikòwáte 'they always play'
b fomàlɛ́re 'for we will go across'

Although schwa can receive both secondary and primary stress, there is a preference to avoid stress on an open syllables ending in schwa, wherever this is possible.[3]

(7) a àxəláne 'in the forest'
b xànəmikóxe 'he called them'

Although sequences of two adjacent syllables occur, there are no sequences of three or more syllables left unstressed.

(8) a nàləkoxále 'I felt something sharp'
b molòkoxawále 'I wrote to you (sg.)'

1.2 Constraints. Based on the observations just mentioned I consider at least the following constraints to be active in the stress system of Sentani. Below we will see whether these constraints are sufficient to deal with the data of Sentani.

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[3] According to Cowan (1965) there might be allophonic variation between /ə/ and /ø/, but in his work he gives only /ə/, and not /ø/, in his examples. M. Hartzler (1976) does not refer to such allophonic variation and uses only /ə/ in the relevant cases. Based on the notation of Cowan and Hartzler and the transcription of my own data I will also use /ə/ in the relevant examples.

ALIGN-L: ALIGN-L (PrWd, L, Ft, L). The left edge of a PrWd must coincide with the left edge of a foot (McCarthy & Prince 1993b).

ALIGN-R: ALIGN-R (PrWd, R, Ft, R). The right edge of a PrWd must coincide with the right edge of a Ft (McCarthy & Prince 1993b).

*Cə́: avoid stressing Cə (Cohn & McCarthy 1994).[4]

*CLASH: avoid a clash (Liberman & Prince 1977).

FtBin: feet are binary at some level of the analysis (Hayes 1995, Kager 1989).

FTFORM: the metrical foot is the iamb (Hayes 1995) (RhType=I/T (Prince & Smolensky 1993)).

NONFIN: the prosodic head of the word may not be word final[5] (Hayes 1982 (extrametricality), Prince & Smolensky 1993, Hung 1994).

PARSE-σ: a syllable must be parsed in a foot (Halle & Vergnaud 1987 (Exhaustivity Condition), Prince & Smolensky 1993).

2. *Constraint ranking*

In this section I will give arguments for the ranking of these constraints in Sentani. In words with light syllables, and no syllables ending in schwa, the stress pattern is as in (9).

(9)	a	σ́σ	bóhi	'next'
	b	σσ́σ	moxóle	'he does'
	c	σσ̀σ́σ	fomàlɛ́re	'for we will go across'
	d	σσ̀σσ́σ	ikàwalɛ́re	'for that I give it to you'
	e	σσ̀σσσ́σ	molòkoxawále	'I wrote to you'
	f	σσ̀σσ̀σσ́σ	molòkoxàwalɛ́ne	'because I wrote to you'

2.1 FTFORM = Iamb. When we look at the stress pattern of Sentani we see that one of the prominent characteristics is that main stress falls on the penultimate syllabe of the word, and that secondary stress falls on the second syllable, even when introducing a clash (9c), or a sequence of two unstressed syllables (9e). The question then arises whether feet are iambic or trochaic. I will assume the former foot type as basic, and account for the trochaic feet at the right word edge by constraint interaction.

Avoidance of clash and final stress is a phenomenon well known in the literature (Hayes 1981, Prince & Smolensky 1993, Hung 1994). Moreover it appears that iambic systems avoid final stress, even in words with an even number of light

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[4] This constraint looks like what Cohn and McCarthy 1994 propose for Indonesian, ie. NONHEAD ə. The reason that I use a slightly different constraint is due to the fact that in Sentani closed syllables of which the vowel is a schwa behave like other heavy syllables.

[5] In Elenbaas (forthcoming) I argue at what level this constraint is active in Sentani, the syllable or the mora. Since I will concentrate on light syllables, in this paper the syllabic and moraic view will coincide.

syllables. In Optimality Theory this is expressed by the constraint NONFIN (Prince & Smolensky 1993) or RHYTHM (Hung 1994).[6] I assume this constraint to be ranked high in Sentani. Furthermore I assume that FTFORM = Iamb. When iambic feet would would result in stressing a final light syllable FTFORM will be violated and a trochee will be used instead.

(10) a (haxò)mi(bóxe) 'he obeyed/followed them'
b (axò)(yóle) 'it always goes down'

As noted before and as we can see in (9), there is a strong tendency to place secondary stress on the second syllable from the left. I therefore assume that ALIGN-L will be ranked high in the hierarchy. Since main stress never falls further to the left than the penultimate syllable, ALIGN-R will be assumed to be ranked at least as high as ALIGN-L.

2.2 Two syllables. When we assume that the basic foot form is the iamb, then in words with an even number of light syllables, main stress is expected to fall on the final syllable. But in (10b) we see that this is not the case in Sentani. I argue that this is due to the constraint ranking NONFIN » FTFORM. We now have:

ALIGN-R, ALIGN-L, NONFIN » FTFORM

(11)

/bohi/ 'next'	ALIGN-R	ALIGN-L	NONFIN	FTFORM
→ a (bóhi)				*
b (bohí)			*!	
c bo(hí)		σ!	*	
d (bó)hi	σ!			

2.3 Three Syllables. The footing of three syllable words is ambiguous: *(moxó)le* versus *mo(xóle)* 'he does'. The optimal candidate cannot be determined until we have arguments for the optimal candidate of six syllable words and therefore the explanation of their stress pattern and constituency will be postponed until section 2.8.

[6] RHYTHM (Hung 1994) is a more general constraint that rules out both adjacent stresses and final stress, by demanding that every stressed element must be followed by a stressless element. Therefore this constraint rules out both final stress and clashes. Since we will see shortly that NONFIN and *CLASH occupy different positions in the hierarchy in Sentani I prefer to use both NONFIN and *CLASH instead of this more general constraint RHYTHM (see Elenbaas, to forthcoming).

2.4 Four Syllables. In words with four light syllables it is now correctly predicted that FTFORM of the final foot is violated in order to satisfy NONFIN (12c). However, (12c) shows a clash appear. This clash could be avoided by violating FTFORM of the initial foot as well (12b). But the actual output of the four syllable word show that it is better to have a clash than to violate FTFORM twice, hence we add the partial ranking FTFORM » *CLASH to the hierarchy, giving:

ALIGN-R, ALIGN-L, NONFIN » FTFORM » *CLASH

(12)

/fomalɛre/ 'for we will go across'	ALIGN-L	ALIGN-R	NONFIN	FTFORM	*CLASH
→ a (fomà)(lɛ́re)				*	*
b (fòma)(lɛ́re)				**!	
c (fomà)(lɛré)			*!		
d (fomá)lɛre		σ!σ			
e fo(málɛ)re	σ!	σ		*	
f foma(lɛ́re)	σ!σ			*	
g fo(malɛ́)re	σ!	σ			

Candidates (12d-g) arize by not stressing any of the two final syllables, satisfying NONFIN, FTFORM and *CLASH, but violating ALIGN-R in (12d) or ALIGN-L in (12f) and both in (12e,g).

2.5 Five Syllables. When we use stricly binary feet (due to undominated FTBIN), at least one syllable will remain unparsed in five syllable words. There are three logically possible ways to parse these words (see also (9)), while maximally satisfying PARSE-σ

(13) a (σσ̀)(σσ̀)σ
b σ(σ̀σ)(σ́σ)
c (σσ̀)σ(σ́σ)

Since we have assumed that ALIGN-R and ALIGN-L are ranked very high in the hierarchy, five syllables words in Sentani will be parsed as in (13c), see tableau 14.

(14)

/ikawalɛre/ 'for that I give it to you'	ALIGN-L	ALIGN-R	FTFORM
→ a. (ikà)wa(lɛ́re)			*
b. (ikà)(walɛ́)re		σ!	
c. i(kàwa)(lɛ́re)	σ!	σ	**

2.6 Six Syllables. A pattern that requires special attention is that of six syllable words:

(15) σσ̀σσσ́σ molòkoxawále'I wrote to you'

In these words two adjacent syllables systematically remain unstressed word internally, resulting in a ternary pattern. How come these six syllable words have a ternary pattern? Parsing the word with an even number of syllables using binary feet will result in a completely parsed prosodic word, maximally satisfying PARSE-σ. Apparently PARSE-σ is dominated by some constraint(s). Let us consider on what grounds the exhaustively parsed candidates are excluded.

(16) a (σσ̀)(σσ̀)(σσ́)
b (σ̀σ)(σ̀σ)(σ́σ)
c (σσ̀)(σσ̀)(σ́σ)
d (σσ̀)(σ̀σ)(σ́σ)

In (16a) we see a violation of NONFIN. In (16b) NONFIN is satisfied but FTFORM is violated in every foot. When we try to do better with respect to FTFORM, we get a clash, as in (16c, d). It seems that the only way to satisfy FTFORM, NONFIN and *CLASH is by leaving two syllables unparsed. Therefore we can now conclude to the following partial constraint rankings: NONFIN » PARSE-σ, and FTFORM » PARSE-σ and *CLASH » PARSE-σ. With the ranking we already determinde this gives us the following constraint hierarchy.

ALIGN-R, ALIGN-L, NONFIN » FTFORM » *CLASH » PARSE-σ

This ternary pattern is still ambiguous between various parsings.

(17) a (σσ̀)σσ(σ́σ)
b σ(σ̀σ)σ(σ́σ)
c σ(σ̀σ)(σσ́)σ
d (σσ̀)σ(σσ́)σ

The high ranked status of ALIGN-L and ALIGN-R, which we assumed earlier, singles out (17a) as the optimal candidate. In all examples except for (17a) one or both

alignment constraints will be violated. Hence, after having established the ranking *CLASH » PARSE-σ, the high ranking of the alignment constraints will enforce the ternary pattern found.

2.7 Cə-syllables. So far ALIGN-L has not been violated and therefore it was assumed to be undominated. Without any counter-evidence I have ranked ALIGN-R at the same position as ALIGN-L. This was motivated by the fact that candidates often violate FTFORM in order to satisfy ALIGN-R. But the undominated status of ALIGN-R has not been demonstrated conclusively. In order to do so, we have to look at three syllable words and words with Cə-syllables, that is, open syllables containing schwa. In Sentani Cə-syllables can receive both main and secondary stress (18). But there is a tendency to avoid stress on these syllables (19).

(18) a hoyə́le 'he always kills'
b həbə̀ləmə́xe 'he runs down he went'
c əyə̀ləwóle 'he always talks'

(19) a i moxànále 'I do it for him'
a ii àxəláne 'to the forest'
b i haxòmibóxe 'he obeyed/followed them'
b ii xànəmikóxe 'he called them'

Stress seems to have shifted to the left in (19aii, bii) violating FTFORM. What other possibilities could there be to avoid stressing this Cə-syllable? One option is to shift stress to the right. In the four syllable example this is not possible, because main stress is immediately to the right of the Cə-syllable. An alternative is to leave the first two syllables unparsed, satisfying *CLASH, but violating ALIGN-L. In the five syllable example shifting stress to the right would have resulted in a clash (**xanəmìkóxe*) and, even worse, a violation of Align-L.

These effects follow if the constraint *Cə́ is ranked high in Sentani. This constraint dominates FTFORM, because stress shifts to the left, causing the initial foot to be a trochee.

(20)

/axəlane/ 'to the forest'	*Cə́	FTFORM	*CLASH
→ a (àxə)(láne)		**	
b (axə́)(láne)	*!	*	*

When we look at words with a sequence of Cə-syllables we see the "regular" stress pattern re-appear. Apparently it is more important to have secondary stress at the left edge of the word, than it is to satisfy *Cə and therefore we can also conclude that ALIGN-L » *Cə.

(21)

/ənətɛre/ 'they 2 will go'	ALIGN-L	*Cə́	FTFORM	*CLASH
→ a (ənə̀)(tɛ́re)		*	*	*
b (ə̀nə)(tɛ́re)		*	**!	
c ənə(tɛ́re)	σ!			

We are now in a position to determine the ranking between ALIGN-L and ALIGN-R.

2.8 Three Syllables. As we saw in (18) the actual output of the three syllable example is [hoyəle] ("he always kills"). This produces an argument for a ranking of ALIGN-R and ALIGN-L. If these constraints are freely ranked, then due to the ranking *Cə́ » FTFORM the form **(hóyə)le* (22d) will be evaluated as optimal. This incorrect prediction arises as follows.

When ALIGN-R and ALIGN-L are ranked at the same position in the hierarchy, a single violation of ALIGN-R (22c,d) or a violation Align-L (22a) is not decisive. We have to look further down the hierarchy in order to see which candidates violate the lower ranked contraint. We see that (12a,c) violate *Cə́, but that (12d) satisfies this contraint. This makes (12d) optimal candidate. We can get the actual output as the optimal candidate by ranking ALIGN-R higher than ALIGN-L (22a).

(22)

/hoyəle/ 'he always kills'	FTBIN	NONFIN	ALIGN-R	ALIGN-L	*Cə́	FTFORM
→ a ho(yə́le)				σ	*	*
b ho(yəlé)		*!		σ		
c (hoyə́)le			σ!		*	
(→)d (hóyə)le			σ!			*
e (hò)(yə́le)	*!				*	*

We can also derive from this that Sentani does not allow degenerate feet, because the initial syllable remains unstressed, satisfying FTBIN. Since there is no need for Degenerate Feet in the analysis of Sentani, we will assign FTBIN an undominated status. The following constraint ranking now arises.

FTBIN, NONFIN, ALIGN-R » ALIGN-L » *Cə́ » FTFORM » *CLASH » PARSE-σ

We are now able to evaluate the six syllable words and find the optimal candidate.

(23)

/molokoxawale/ 'I wrote to you'	NONFIN	ALIGN-R	ALIGN-L	FTFORM	*CLASH	PARSE-σ
→a (molò)koxa(wále)				*		**
b (molò)(koxà)(wále)				*	*!	
c (molò)(kòxa)(wále)				**!	*	
d (mòlo)(kòxa)(wále)				**!*		
e mo(lokò)xa(wále)			σ!	*		**
f (molò) ko(xawá)le		σ!				**
g mo(lokò)(xawá)le		σ!	σ			**
h (molò)(koxá)wale		σ!σ				**
i (molò)(koxà)(walé)	*!					

2.9 Seven Syllables. With the constraint ranking just given we can correctly predict the pattern of the following two examples with seven syllables. Evaluation of the example (24) is demonstrated in (25).

(24) a σσσσσσσ molòkoxàwalɛne 'because I wrote to you'
b σəəσσσσ xànərəmìyəndɛre 'for I can go call them'

(25)

/molokoxawalɛne/ 'because I wrote to you'	ALIGN-R	ALIGN-L	FTFORM	*CLASH	PARSE-σ
→a (molò)(koxà)wa(lɛ́ne)			*		*
b (molò)ko(xawà)(lɛ́ne)			*	*!	*
c mo(lòko)(xàwa)(lɛ́ne)		σ!	***		*
d (molò)(koxà)(walɛ́)ne	σ!				*
e (molò)koxawawa(lɛ́né)			*		**!*

However we fail to predict the optimal candidate (26b) of the next example.

(26)

/molonasəhandera/ 'after they will bury me'	*Cə́	FTFORM	*CLASH	PARSE-σ
→ a *(molò)nasəhan(déra)		*		***
b (molò)na(səhàn)(déra)		*	*!	*
c (molò)(nasə̀)han(déra)	*!	*		*

Since *CLASH » PARSE-σ, as we saw for six syllable words, we get (26a) as the optimal candidate, whereas (26b) is the actual output. Apparently a constraint that is ranked above *CLASH is needed in order to get the actual output. The crucial dif-

ference between (26a) and (26b,c) is the sequence of three unstressed syllables in (26a).

In the literature on bound stress systems an interval of *more than two* unstressed syllables between two stressed syllables, or between a stressed syllable and the edge of the domain, is known as a *lapse* (Selkirk 1984).[7] Such a sequence of unstressed syllables is considered to be universally disfavoured in bound stress systems. Within the literature on Optimality Theory two different constraints have been proposed to rule out lapses, both of which are based on parsing, rather than sequences of unstressed syllables. Those constraints are PARSE-2 (Kager 1994) and LAPSE (Green & Kenstowicz 1995). Since the effects of these two constraints are almost identical I chose to demonstrate PARSE-2 only.

PARSE-2
One of two adjacent stress units must be parsed by a foot (Kager 1994).

We will see that avoidance of lapse outranks avoidance of clash. In (26a) PARSE-2 is violated. In (26b,c) we satisfy this constraint. Since in fact every word in Sentani (as well as in almost every other bound stress system) seems to satisfy this constraint I will rank it topmost, together with FTBIN, ALIGN-R and NONFIN.

(27)

/molonasəhandera/ 'after they will bury me'	PARSE-2[8]	*Cə́	FTFORM	*CLASH	PARSE-σ
→a (molò)na(səhàn)(déra)[9]			*	*	*
b (molò)(nasə̀)han(déra)		*!	*		*
c (molò)nasəhan(déra)	*!*		*		***
d (molò)(nàsə)han(déra)			*!*	*	*

However, when we reconsider the tableau of the six syllables word in (23) we see that the optimal candidate violates PARSE-2. This shows that PARSE-2 fails to make the correct distintion. Observe that (23a) does not have a rhythmic lapse in the sense of Selkirk. All it has is a sequence of two unstressed syllables word internally.

In demonstrating how to build grid structures Selkirk (1984) formulates the Principle of Rhythmic Alternation. This principle consists of an anti-clash provision

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[7] This is the definition of lapse given by Selkirk (1984) whith reference to building a grid structure in general (Selkirk 1984 p. 49-52). When referring to English in particular the notion of lapse is slightly different (Selkirk 1984 p.109). My arguments about lapses are based on the former definition of lapse.

[8] According to Kager (1994) an unstressed heavy syllable also violates PARSE-2 on the moraic level. The level on which this constraint might evaluate in Sentani will be discussed in Elenbaas (forthcoming). For now we consider this to be the syllabic level, since this will not influence the discussion about ternary rhythm in Sentani here.

[9] This is not due to WSP because in Sentani *CLASH >> WSP (cf. (4)).

and an anti-lapse provision. These refer to the grid only, without reference to constituent structure. I will give the anti-lapse provision below.

Anti-Lapse Provision (PRA)
Any weak position on a metrical level *n* may be preceded by at most one weak position on that level (Selkirk 1984).

Based on this provision I propose the following constraint:

*LAPSE:
A metrically weak element must be adjacent to a metrically strong element.

When we rank this constraint topmost we get the following constraint ranking.

FTBIN, ALIGN-R, *LAPSE, NONFIN » ALIGN-L » *Cə́ » FTFORM » *CLASH » PARSE-σ

The new constraint will replace PARSE-2 in tableau (27), repeated here as (28).

(28)

/molonasəhandera/ 'after they will bury me'	*LAPSE	*Cə́	FTFORM	*CLASH	PARSE-σ
→a (molò)na(səhàn)(déra)			*	*!	*
b (molò)(nasə̀)han(déra)		*!	*		*
c (molò)nasəhan(déra)	*!*		*		***

3. Conclusion

Although Sentani stress combines both binary and ternary rhythmic patterns we cannot conclude that the language has a ternary system for which we should expand the foot typology. Sentani can be succesfully analysed as a bound stress system with binary iambic feet.

The ternary patterns are the result of clash avoidance, nonfinality of stress and avoidance of stressing Cə́-syllables. However, satisfaction of the constraints that account for these requirements will not result in a sequence of three or more unstressed syllables, because of the higher ranked constraint *LAPSE.

Perhaps constraints such as these are also responsible for the ternary patterns in other languages for which these patterns have been reported. Based on the conclusion just given for Sentani, an interesting hypothesis is that ternarity is nothing more than a side effect of some high ranked rythmic constraints in binary systems.

In binary stress systems the distance between two stressed syllables or a stressed syllable and the edge of the word is never more than two syllables. When a sequence of more unstressed syllables appears we have a lapse (Selkirk 1984). The candidate

that was evaluated as optimal in (26) did in fact have a lapse, so we had to add a constraint to the ranking that prevents lapses from occurring in bound stress systems.

Scanning the constraints available in the Optimality Theory literature, we found two constraints with that intention, PARSE-2 (Kager 1994) and LAPSE (Green & Kenstowicz 1995). These constraints demand that of every two stress units one must be parsed in a constituent. This essentially is an attempt to state a rhythmic aspect as a parsing constraint. I hope to have shown here that this attempt fails, since it fails to distinguish six syllable words (23) from seven syllable words (27).

A reconsideration of six syllable words showed that the optimal candidate did not have a rhythmic lapse, but that PARSE-2 was violated. Therefore I proposed a rhythmic constraint *LAPSE, which does not make reference to constituency. It does not harm the evaluation of the seven syllable words and it prevents the actual output in (23) from being ruled out as the optimal candidate.

This concludes the analysis of ternary patterns in Sentani within the constraint based framework of Optimality Theory. This analysis reconfirmed the use of binary feet and of constraints proposed earlier for the analysis of stress patterns in other languages. Moreover it was not necessary to expand the foot typology in order to account for ternary patterns. However, it was necessary to redefine PARSE-2. We saw that this constraint referred to constituency, leading to wrong predictions. *LAPSE refers to the grid structure only, leading to the correct predictions.

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