Constraint interaction in Aranda stress[*]

TOYOMI TAKAHASHI

The concept of phonological weight has figured prominently in the literature on stress systems. It is generally assumed that the weight of a syllable is evaluated in terms of intra-rhyme structure: the decisive factor is the presence or absence of a (rhymal or nuclear) complement position. However, Aranda (Strehlow 1942) has a peculiar stress system that challenges this general assumption[1]. In this language, stress shows onset-sensitivity: that is, the ability of a syllable to bear stress is influenced by the presence or absence of an onset. This fact leads Davis (1988) to argue that the onset may have some contribution to make to phonological weight.

The present paper sets two goals. The first is to offer the possibility of improving the theory of phonological licensing by adopting the facets of Optimality Theory (Prince & Smolensky 1993; McCarthy & Prince 1993ab). The two frameworks are alike in some respects and complementary in others. The second goal is to present an alternative analysis of Aranda stress. I agree with Davis that Aranda stress shows onset-sensitivity, but I shall argue, within the theory to be developed here, that the presence of an onset is crucial not with respect to the notion of phonological weight but rather to more general well-formedness conditions of syllable structure.

The discussion proceeds as follows. In §1, I shall describe the Aranda stress system and refer to past analyses of it. §2 will introduce a version of the theory of phonological licensing, which will provide the basis of a subsequent discussion. In §3, I shall analyse Aranda stress, using the concept of constraint interaction taken from Optimality Theory.

1 Aranda

1.0 Aranda is spoken in Central Australia. For detailed descriptive work on this language, the reader is referred to Strehlow (1942, 1943-1944). In this section, I first present a brief summary of Aranda stress, and then review two analyses of this stress system.

1.1 Aranda stress

Consider the following data taken from Strehlow (1942; stress is indicated by ‘" placed before a relevant syllable; and, in a word containing two stressed syllables, the leftmost is always a primary

---

[*]I am grateful to Alan Prince for encouraging me to write this paper. My thanks are also due to John Harris and Phillip Backley for comments on an earlier draft. I am of course responsible for any shortcomings that remain here.

[1]In the present paper, ‘Aranda’ refers to Western Aranda.

one):

(1) Aranda Stress[2]

(a) C-initial words of three or more syllables

'balkala	‘in vain’	'bauuma	‘to push’
'jainama	‘to send’	'juntama	‘to search’
'ka:puta	‘head’	'ljupara	‘leg’
'ŋaiala	‘hungry’	'ŋalama	‘to move’
'pmaRala	‘in the camp’	'pmarama	‘to enquire’
'rinbinba	‘beak, lips’	'tarama	‘to laugh’
'tnjinama	‘to keep’	'wara'tara	*place name*
'kutu'ŋula	‘ceremonial assistant’	'ŋura'ŋura	‘evening’

(b) V-initial words of three or more syllables

al'kŋanta	‘temple’	an'ŋe:ra	‘face’
a'ratja	‘straight’	er'guma	‘to seize’
e'rena	‘him, her’	e'rilkŋa	‘dead’
il'tjanma	‘crayfish’	i'naŋa	‘arm’
in'ti:a	‘cave’	i'to:a	‘wild turkey’
u'litna	‘forehead’	ul'tunta	‘rain drops, spray’
uŋ'gwana	‘bone’	uŋ'gwaŋa	‘your’
alb'me:lama	‘to say’	a'ralkama	‘to yawn’
ar'tjanama	‘to run’	e'ŋka:nama	‘to set up’
i'lulama	‘to descend’	in'da:go:bma	‘mountain devil’

(c) Disyllabic words

'kala	‘already’	'kanta	‘frost, cold’
'katna	‘upstream’	'ltarba	‘sad’
'mbala	‘summer’s heat’	'nke:ra	‘bank of a river’
'ntjara	‘many’	'ŋkuRa	‘elder sister’
'pma:ra	‘large wooden vessel’	'ro:a	‘flood’
'tnata	‘stomach’	'a:roa	‘rock wallaby’
'a:twa	‘to man’	'anka	‘unripe, raw’
'anma	‘soon, later’	'apma	‘snake’
'era	‘he, she, it’	'ilba	‘ear’

(1a) lists words of more than two syllables with a (syllabic or non-syllabic) consonant word-initially.

[2]Transcription essentially follows the original in Strehlow, but with some minor modifications which do not affect the present discussion.

In such words, stress regularly falls on the initial syllable[3]. On the other hand, (1b) contains words of more than two syllables with a vowel in word-initial position. In this case, the second syllable attracts stress[4]. Such sensitivity to the melodic content of the initial position, however, cannot be observed in the disyllabic words in (1c); in these instances stress is, without exception, placed on the initial syllable. What is of interest in the present discussion is that, in words of more than two syllables, stress, which seems to scan the string for a landing site in a rightward direction, is sensitive to the presence or absence of an onset.

1.2 Previous analyses

1.2.1 Analysis I: Halle & Vergnaud (1987). Following Archangeli (1986), Halle & Vergnaud (1987: 48-50) account for Aranda stress by fully exploiting the notion of extrametricality. According to their analysis, both a domain-initial and domain-final melodic unit are marked as extrametrical. Such extrametricality allegedly 'percolates' upwards, and a constituent node immediately dominating such a melodic unit becomes extrametrical. (2) illustrates this (extrametrical units are enclosed in angled brackets):

(2) (a)

<O>	N	O	N	O	<N>
|	|	|	|	|	|
<t>	a	r	a	m	<a>

(b)

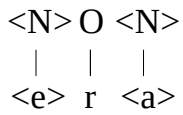
<N>	O	N	O	<N>
|	|	|	|	|
<e>	r	e	n	<a>

Marking extrametricality renders the domain-initial and domain-final melodic units and their parent nodes 'invisible' to stress assignment. Subsequently, Aranda stress is claimed, roughly speaking, to fall on the leftmost nucleus in the domain. In *tarama*, the word-initial nucleus receives stress; in *erena*, the word-initial nucleus is marked extrametrical, so the second nucleus from the left bears stress. As far as the words in (1a) and (1b) are concerned, this analysis makes the correct predictions. On the other hand, words such as those in (1c) need an additional condition, since the application of extrametricality to the melodic units at both edges of such words leaves no nucleus visible to stress:

[3]As for initial nasal + stop sequences such as *mb-* and *nk-*, Strehlow (1942: 270-271) states that the initial nasal 'has a slight syllabic value', and this is reflected in his transcription, eg. *m'bala*. However, it is not clear on what grounds Strehlow determines such a 'syllabic value', since Strehlow also reports that such a nasal, 'despite its syllabic value, is a rather faint and very short sound'. One possible reason is that initial nasal + stop sequences are often derived from the deletion of initial vowels; eg. *nbera* <**S** *anbera*. If the initial nasal is syllabic, the analysis by Halle & Vergnaud is undermined. However, allegedly syllabic nasals are observed only in initial position and, for the analysis I shall put forward in §3, whether the initial nasal is syllabic or not presents no significant problem, thus I ignore the allegedly syllabic nasals in the present paper.

[4]*'ara'gula* 'first' is the only exception found in Strehlow (1942).

(3)



In connection with cases such as that in (3), Halle & Vergnaud suggest the following condition:

> An element marked extrametrical is invisible to the rules constructing metrical constituents only if at the point in the derivation at which these rules apply (a) the element begins or ends the phonological string and (b) does not constitute the entire string.

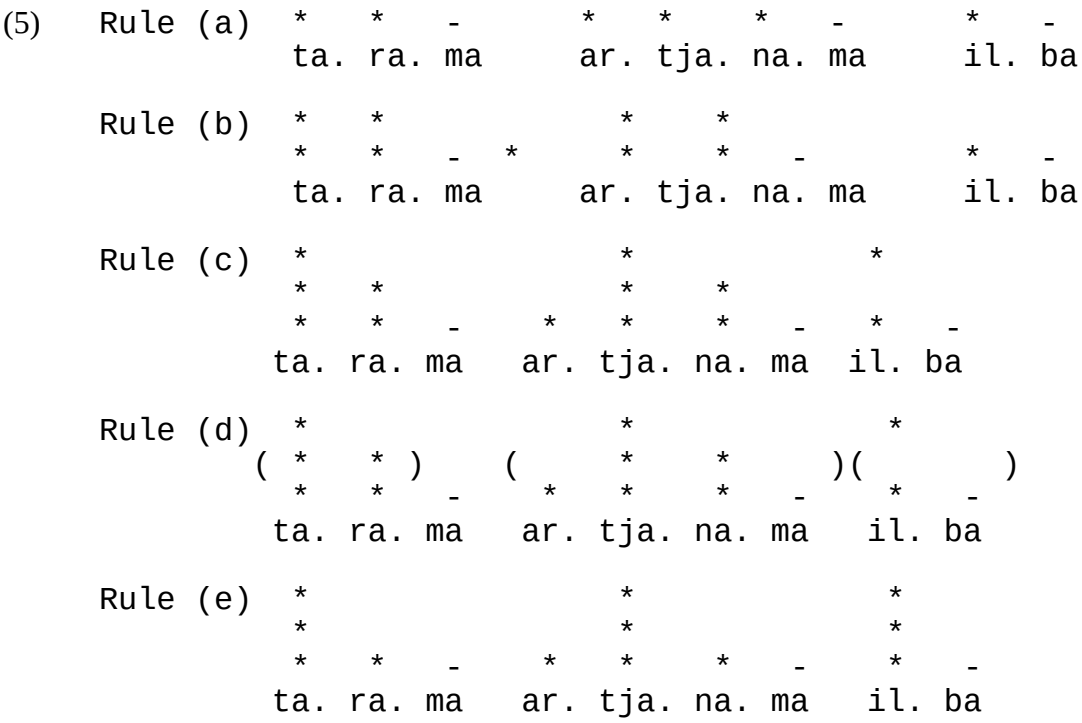
This expresses the fact that the occurrence of extrametricality is restricted to the **edges** of a domain and that the application of extrametricality must be **blocked** if it leaves no landing-site for stress.

1.2.1 Analysis II: Davis (1988). Although Halle & Vergnaud seem to be able to account for stress in Aranda, Davis (1988: 4) criticises their analysis by claiming that the application of extrametricality to both the edges of a domain 'is apparently otherwise unprecedented in stress systems'. It is true that stress phenomena in languages usually exhibit extrametricality domain-finally, but not domain-initially. The analysis by Halle & Vergnaud, in this regard, renders Aranda stress peculiar. Instead, Davis revises the procedure for stress assignment suggested by Halle & Vergnaud and proposes the following alternative:

(4) Aranda Primary Stress (Davis 1988: 14; my boldface)
- (a) Mark a domain-final vowel extrametrical.
- (b) Assign a line 1 grid mark to **syllables containing onsets**.
- (c) Line 1 constituents are left-headed.
- (d) Construct on line 1 an unbounded constituent.
- (e) Conflate. [i.e. remove grid marks (above line 0) from all syllables other than the syllable having the most grid marks.]

The above rules allow us to derive the correct stress patterns of the words in (1). For example, stress for '*tarama*, *ar*'*tjanama* and '*ilba* is assigned as follows (syllable boundaries are represented by dots):

(5)



(4) does not refer to any secondary stress present, for example, in '*kutu*'ŋ*ula* and '*wora*'*tara*, but its placement is accounted for by adding the binary-foot formation rule which creates bounded constituents (see Halle & Vergnaud 1987: 49).

1.2.2 Discussion of Analyses I and II. As mentioned, Davis rejects the analysis of Aranda stress by Halle & Vergnaud on the basis that alleged domain-initial extrametricality 'is apparently otherwise unprecedented in stress systems'. However, the same criticism, in fact, applies to his own proposal, since Davis' assumption that the onset may contribute to phonological weight is equally unprecedented; according to Davis (1988), Aranda is the only such reported language.

To make matters worse for Davis, the notion that a syllable with an onset is heavy does not appear to demonstrate any significant relevance to phonological phenomena other than those allegedly involving stress assignment, whereas the concept of extrametricality does. For instance, phonotactic constraints are often loosened at the **edges** of domains in many languages, and this state of affairs is dealt with by resorting to extrametricality in much of the literature. Prosodic Morphology (McCarthy & Prince 1990) accounts for morphological processes in languages by making use of an extended notion of extrametricality called prosodic circumscription. Charette (1991: 202-205) reports the fact that a vowel of a domain-initial CV-syllable never undergoes the process of syncope in languages such as Parisian French, Tangale, Mongolian, Tonkawa, Yawelmani and Turkish, although a vowel in a domain-internal CV-syllable is deleted when it is followed by another CV syllable in these languages. Yuko Yoshida (1992) discusses the inaccessibility of a domain-initial nucleus to tone-spreading in Tokyo Japanese. While we recurrently observe the failure of phonological

processes to apply to a domain-edge unit, the weight of a 'syllable' determined by the presence or absence of an onset does not seem to play any general role in processes.

Accordingly, we have reason to be sceptical of Davis' claim that phonological weight may involve the onset. Note, however, that this means neither that I argue for Halle & Vergnaud, nor that I approve of extrametricality.

In both the analyses, the notion of extrametricality plays a crucial role. Recourse to extrametricality may be useful in describing the stress phenomenon in Aranda, but it does not provide any explanation of it[5]. Besides, stipulating extrametricality seems to result in important generalisations being overlooked. For example, consider the following facts in Aranda:

(6) (a) Words are minimally disyllabic[6].
(b) Secondary stress falls one-syllable away from the primary stress.
(c) Stress never falls on a word-final syllable.

Attributing (6c) to word-final extrametricality entails that, at least, (6c) is independent of the others (6ab). As shown later (§3.3.1), however, these facts are derived from the interaction of constraints on the well-formedness of phonological structure **S** FOOT STRUCTURE and WORD MINIMALITY. As a result, we can dispense with extrametricality from phonological theory.

In addition to the facts stated in (6), (7) below is the observations taken from Strehlow (1942):

[5]See Harris (1992) and Prince & Smolensky (1993) for a discussion of extrametricality.

[6]According to Strehlow (1942: 299), monosyllabic words are restricted to interjections (eg. *`ou, `au* exclamations of surprise), or the imperative forms of disyllabic verbs, eg. *`lai!, `lau!* ('go' from *`lama*)

(7) (a) The phonemic inventory of Aranda[7]:

Vowels[8]:		i	e	a	o	u
		i:	e:	a:	o:	u:
		ai	ea	oa (word-medially only)		
Consonants:	p	t	k	b	d	g
		m	n	ŋ		
		w	j			
		l	r	R (pharyngeal initially; retroflex elsewhere)		

(b) Many consonant clusters do not show typical intra-onset or coda-onset sequential patterns[9]. (Eg. *'**pm**aRala, '**tn**auia, **n**'**k**e:ra, il'tja**nm**a, 'ka**tn**a, 'a**nk**a, 'a**nm**a*; see §2.1.2.)

2 The theory of phonological licensing

2.0 Although, in the previous section, I used terms such as the syllable, rhyme, onset, coda, vowel and consonant, the framework within which I shall reanalyse Aranda stress does not recognise the formal status of such units. Therefore, it may be prudent to outline the theory in this section before I set out a discussion of an alternative account of the phonological process in question.The framework to be introduced is a version of Government Phonology, and those readers who wish to know more about these theories are referred to Kaye, Lowenstamm & Vergnaud (1990); Brockhaus (1992); Charette (1989, 1991, 1992); Harris (1990, 1992, in press); Harris & Kaye (1990); Kaye (1990ac, 1992, 1993); Kaye & Gussmann (1993); Pagoni (1993); Takahashi (1993); Shohei Yoshida (1990); Yuko Yoshida (1992).

2.1 Phonological licensing

The present framework assumes two major categories of representational units: **phonological**

[7]See Strehlow (1942) for a detailed phonetic description of the inventory.

[8]Strehlow (1942) mentions only the three diphthongs shown in (7). As for *au*, which is found in many words (eg. *'bauuma*), it is not clear why this should not be included in the list of diphthongs.

[9]With respect to consonant clusters such as *-nm-* and *-nk-*, Strehlow (1942: 297) points out the noticeable lack of assimilation in Aranda.

elements and **phonological positions**[10]. The phonological elements are the primes of phonological representation in terms of which phonological oppositions are expressed. Since the intra-melodic structure of Aranda words is not of our concern in the present discussion, I shall leave untouched the syntax of melodic structure **S** Element Theory **S** and represent melodies with conventional alphabetic symbols[11]. The phonological positions consist of three types of unit: **nucleus, prehead**[12] and **persistent complement**[13] represented respectively as '**N**', '**X**', and '**x**'. Each type of unit belongs to its plane: nuclear plane, prehead plane and complement plane.

Positions and elements must all conform to the following universal principle (Kaye 1990a: 306; see also Harris 1992: 379):

(8) **Phonological Licensing Principle**
Within a domain, all phonological units must be licensed save one, the head of the domain.

Melodies must be licensed by positions in order to receive phonetic interpretation. This type of licensing established between positions and melodies is called **autosegmental licensing** (a-licensing, henceforth). In turn, positions themselves must enter into head-complement relations with other positions in the phonological hierarchy; such inter-position licensing is distinguished as **prosodic licensing**[14] (p-licensing, henceforth). Given the Phonological Licensing Principle, the well-formedness of any phonological structure is confirmed if all the units in the representation are connected via licensing paths to the ultimate head of a domain.

2.1.1 Prehead licensing. Among the three types of phonological positions, only nuclei may remain

---

[10]'Phonological positions' are variously called in the literature: 'timing units/slots/points', 'CVs', 'skeleta', etc. The choice of terminology does not reflect any theoretical assumption.

[11]Those readers who are interested in Element Theory are referred to Kaye, Lowenstamm and Vergnaud (1985); Backley (1993); Broadbent (1991); Coleman (1990ab); Harris & Lindsey (in press); Kaye (1990b); Lindsey & Harris (1990).

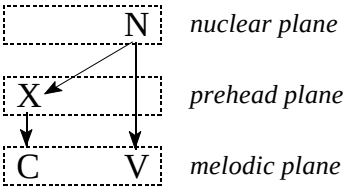
[12]I shall use the term 'prehead' for what is called 'onset' in the literature. The view that denies (explicitly or implicitly) the formal status of 'onset' as a constituent can be found in Hyman (1985), Kenstowicz & Rubach (1987), Levin (1985) and within the framework of Prosodic Morphology (McCarthy & Prince 1986). See Takahashi (1993) for a discussion of this issue.

[13]I borrow from Harris (in press) the descriptive term 'persistent'. Persistent complements may appear in Aranda words, but have no influence on Aranda stress system. Therefore, I shall choose only those example words that contain no persistent complement.

[14]'Prosodic licensing' is here used in a different sense from that in Itô (1986), in which 'prosodic licensing' amounts to what is called 'autosegmental licensing' in the present theory. My use of 'p-licensing' also differs from Kaye's (1992, 1993), for whom 'p-licensing' refers to licensing which allows an empty nucleus to receive no phonetic interpretation. My use of the terminology here follows Harris (1992).

unlicensed in a well-formed **minimal prosodic domain**. I assume that the well-formed minimal prosodic domain consists of a nucleus N and a prehead X, which enter into a licensing relation as follows (a solid and dotted arrow stand for a p-licensing and a-licensing relation respectively):

(9)



Let C and V informally represent melodic material. Within the domain, C and V are a-licensed by the positions X and N respectively, and X is p-licensed by N. The licensing relation between X and N is prescribed in the following universal principle (Harris 1992: 380, with modifications[15]):

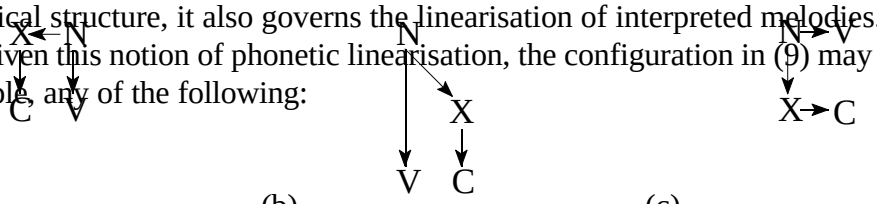
(10) **Prehead Licensing Principle**
The head of a minimal prosodic domain (i.e. a nucleus) must p-license a prehead.

Note that, although I stated above that the **well-formed** minimal prosodic domain comprises a prehead and nuclear head, the prehead may be absent. For example, many languages including Aranda allow words to begin with a nucleus. I shall discuss this in §3.2 and §3.3.

The prehead-licensing relation between X and N is reflected in the linear order of their phonetic interpretation: [CV]. The interpretation of the melodic content of X universally precedes that of N as a function of time. Thus, not only does p-licensing ensure the well-formedness of phonological structure, it also governs the linearisation of interpreted melodies.

Given this notion of phonetic linearisation, the configuration in (9) may be substituted with, for example, any of the following:

(11)



(a) (b) (c)

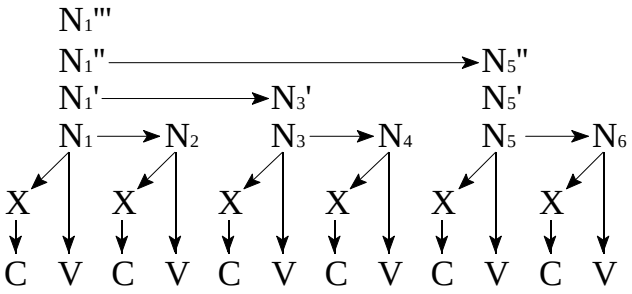
[15]The original version is 'A prehead position must be p-licensed by a nuclear position'. According to this, it is not necessary for a nucleus to license a prehead. My version of the Prehead Licensing Principle follows the definition of the constraint ONSET in Optimality Theory.

(11abc) are all equivalent to (9). No matter how many Xs and Ns are contained in a representation, as long as the head-complement relation between each X and N is identified, we are able to read off the information as to which C precedes which V in phonetic interpretation[16]. It is only for visual efficiency that I represent the well-formed minimal prosodic domain as in (9)[17].

2.1.2 Projection and p-licensing at higher levels. I have shown the structure of the minimal prosodic domain. Now let us turn our attention to larger prosodic domains.

The ultimate licenser of a minimal prosodic domain, the nucleus, is pushed up, or **projected**, onto higher levels in the phonological hierarchy and enters into p-licensing relations with other nuclei. Projection of nuclei stops when they are p-licensed by other nuclei at a level of projection. P-licensing at higher levels of projection is illustrated below:

(12)



In (12), inter-nuclear licensing is head-initial at higher levels of projection than the N-level: that is, in phonetic interpretation, head positions precede their complements. The head precedence of p-licensing at each higher level of projection is parametrically determined for individual languages, while it is universally fixed with respect to prehead and licensing of empty nuclei which will be introduced in the following subsection[18].

2.2 Empty nucleus

---

[16]This concept of phonetic linearisation by p-licensing enables us to eliminate the conditions Locality and Strict Directionality (Kaye, Lowenstamm & Vergnaud 1990: 198ff). In addition, some degree of freedom in the choice of representation is useful to account for affixation and/or reduplication. However, due to limitations of space, I shall leave a detailed discussion of these issues for the future.

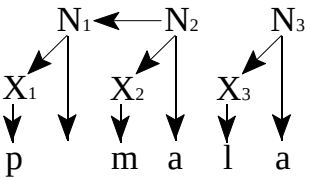
[17]As long as the phonetic precedence is mirrored in the phonological representation, then arrows that show licensing relations, in fact, bear redundant information and can be omitted. See Takahashi (1993) for a discussion of the formal representation in the light of Minimal Componentiality.

[18]The exploration of the possible parametric settings of head precedence should derive the foot and stress typology. In the present paper, I will leave this issue open.

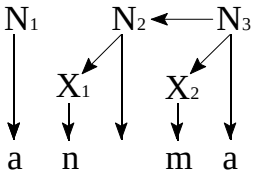
As mentioned in (7b), many consonant clusters in Aranda do not show typical intra-'onset' or 'coda-onset' sequential patterns. For example, neither of the consonant clusters in '***pm****arala*, '*a****nm****a* and '*ka****tn****a* can be well-formed as an 'onset' nor a 'coda-onset' sequence. The present theory assumes that there are **empty nuclei** breaking up such apparent clusters. Thus, the example words are assigned the following structures:

(13)

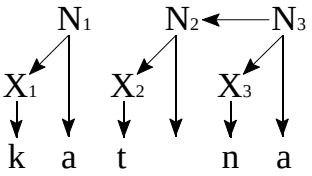
(a)



(b)



(c)



Each empty nucleus must be p-licensed at the N-level by the head of a following **well-formed** minimal prosodic domain, in order to receive no phonetic interpretation[19]. Positing these configurations explains why consonant clusters in Aranda often disobey cross-linguistically observed intra-'onset' or 'coda-onset' patterns. In such patterns, licensed positions (a complement of a prehead or a 'coda' complement) characteristically exhibit 'a seriously depleted set of distributional options' (Harris in press). However, Aranda allows empty nuclei to appear in phonological structure. X_2 in (13a, b) does not enter into a direct p-licensing relation with X_1, nor does X_3 in (13c) with X_2, and therefore no distributional depleting effect manifests itself.

3 An alternative analysis of Aranda stress

[19]The concept of empty nucleus accounts for vowel-zero alternation in many languages. In Aranda, the word-final *a* disappears when followed by a vowel-initial word, but, in this paper, I shall leave this process untouched. For conditioning of the interpretation of empty nuclei, the interested reader is referred to Charette (1991, 1992); Kaye (1990c, 1992); Kaye & Gussmann (1993); Kaye, Lowenstamm & Vergnaud (1990).

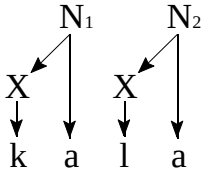
3.0 Now that I have introduced the framework that enables us to assign phonological structure to Aranda words, let us return to the stress phenomenon. The account of Aranda stress requires another theoretical assumption taken from Optimality Theory: **constraint ranking**. In this section, I show how this assumption plays an important role in stress assignment in Aranda.

3.1 C-initial words

In Aranda, primary stress is informally defined as the head of a disyllabic foot (ó́ó) designated at the left edge of a word; secondary stress is the head of another disyllabic foot, if any, that follows the leftmost foot. In terms of the theory introduced in the previous section, this disyllabic foot is captured as a domain of inter-nuclear licensing at the N'-level. That is, the head nucleus in the leftmost inter-nuclear licensing relation is interpreted with maximum prominence, and the head nucleus in another inter-nuclear licensing relation, if any, receives near-maximum prominence. Let me first illustrate this with an example word *kala*. (Note that, in the following discussion, I shall use the informal terms 'syllable' and 'foot' for 'minimal prosodic domain' and 'inter-nuclear licensing domain' respectively.)

Let us assume that lexical representation contains the information with regard to prehead licensing and empty-nucleus licensing. Accordingly, the lexical representation of the word in question is shown below[20]:

(14)



In (14), there are no empty nuclei (see §2.2), so all the nuclei are projected onto the N'-level.

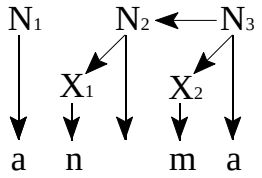
Now, in order to establish a desirable foot for stress assignment, the following constraint is necessary:

(15) **FTLICENSING (N', →)**

This constraint determines that licensing at the N'-level (i.e. a foot) is head-initial (i.e. the interpretation of the head position precedes that of its complement). Given this, the nuclei enter into a licensing relation at the N'-level, as shown below (the foot is indicated by brackets).

[20] As noted in §2.1, melodies are represented with conventional alphabetic symbols.

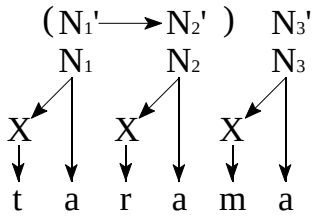
(16)



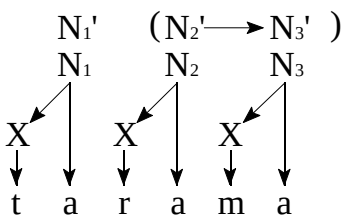
The head of inter-nuclear licensing, N_1', is interpreted with primary stress.

Now consider a word such as *tamara*. With (15) only, indeterminacy arises in foot assignment. Two competing candidates are shown below.

(17) (a)



(b)



(17a) is interpreted as '*tarama*, while (17b) as **ta*'*rama*. In order to obtain the appropriate structure (17a) to derive the correct stress pattern, I adopt the constraint **ALIGN** from McCarthy & Prince (1993ab) and propose that Aranda grammar has the following constraint[21]:

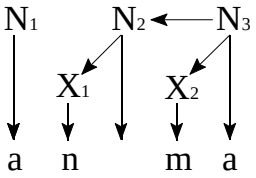
(18) **ALIGN (WD, L, FT, L)**

(18) means that the left edge of a word licenses the left edge of a foot[22] (i.e. the foot domain is interpreted word-initially in the signal). Here, the theory incorporates the **edge** as a formal unit into phonological representation. With word-edges and foot-edges indicated by '[ ]' and '( )' respectively, (17a, b) are represented as follows:

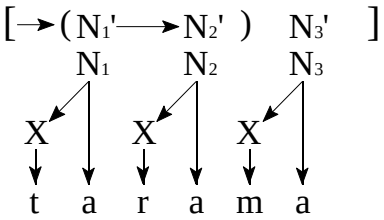
[21]Although this constraint is named 'ALIGN' following McCarthy & Prince, in the present work, this is captured as a type of head-complement relation between edges. Therefore, I could well call the constraint EDGELICENSING, in order to clarify that it belongs to a family of constraints LICENSING.

[22]Bear in mind that a 'foot' is an informal label for an inter-nuclear licensing domain at the N'-level.

(19) (a)



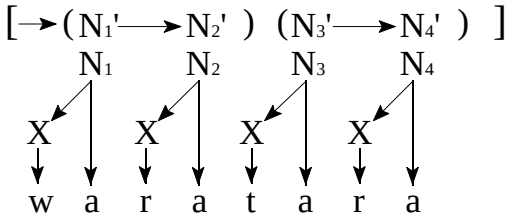
(b)



(19a) respects both the constraints FTLICENSING (15) and ALIGN (18). On the other hand, in (19b), the left word-edge does not **properly** license the left foot-edge because of the intervening N_1', and, in this case, ALIGN is assumed to be violated by one nucleus. Since (19a) does not violate ALIGN, this is the well-formed representation of *tarama*.

Applying (15) and (18) to *waratara*, the following configuration is obtained:

(20)

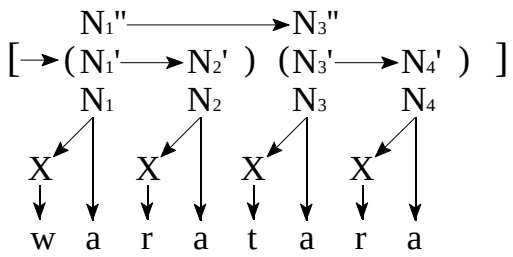


(20) contains two feet. The distinction between primary and secondary stress is made at the next level of projection. The directionality of inter-nuclear licensing at this level is determined as follows:

(21) **FTLICENSING (N'', →)**

As stated in §2.1.2, the head precedence of inter-nuclear licensing is parametrically decided at each level of projection above the N-level. (21) states that, in Aranda, inter-nuclear licensing at N"-level is also head-initial. This assigns the following structure to *waratara*:

(22)



In (22), N_1" is interpreted with primary stress while N_3 carries secondary stress.

3.2 V-initial words with more than two syllables

In the previous section, I have introduced two constraints, FTLICENSING and ALIGN. As far as C-initial words are concerned, these constraints are always well respected. However, this pattern is disrupted by V-initial words with more than two syllables such as those in (1b).

Let us take an example word, *erena*. Compare the following candidate structures for this word:

(23) (a) (b)

(23a) is the expected structure according to FTLICENSING and ALIGN; however, this incorrectly assigns stress as *'*erena*. The attested stress pattern *e'rena* is only derived from the structure (23b), but there is a problem as to why ALIGN is violated in the V-initial word in question.

I argue that the solution to the state of affairs requires the concept of constraint ranking taken from Optimality Theory (Prince & Smolensky 1993; McCarthy & Prince 1993ab). The principles of Optimality Theory relevant here are as follows:

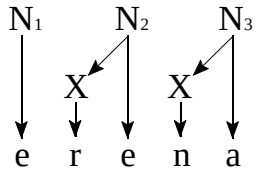
(24) (a) **Violability**
Constraints are violable; but violation is minimal.

(b) **Ranking**
Constraints are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking.

Let us assume, following Optimality Theory, that constraints are ranked in a language-specific constraint hierarchy; a lower-ranked constraint may be violated in order to achieve relative success with respect to a higher-ranked constraint. In (23b), therefore, the violation of ALIGN must be forced by some other constraint that outranks the former in the Aranda constraint hierarchy. It is the Prehead Licensing Principle (PREHEAD, henceforth), I argue, that interacts with ALIGN in the type of words in question.

PREHEAD ensures that a well-formed minimal prosodic domain (ie. a syllable) contains a nucleus that p-licenses a prehead (§2.1.1). Therefore, if a nucleus has no prehead to p-license, this leads to the violation of PREHEAD (10). Aranda words, in fact, frequently violate PREHEAD (as do most languages); the example word *erena* contains an ill-formed minimal prosodic domain initially. Let us assume that such violation is **registered** as follows:

(25)

Candidates	PREHEAD
	N_1

In Optimality Theory, identifying the violation of PREHEAD in this way can be shown to play an important role in accounts of phonological phenomena.

Concerning Aranda stress, I propose that the marking of PREHEAD-violation should not be restricted to the N-level. Once higher prosodic structure is established, the violation of PREHEAD may be incurred by the same nucleus at different projections. In order to formalise this concept, I revise (10) as follows:

(26) **PREHEAD (Δ)**
The head of a prosodic domain Δ must p-license a prehead.

In Aranda, the argument of the constraint in (26) is **PREHEAD (FT)**: the head nucleus of a foot must p-license a prehead.

Considering (23ab) in terms of PREHEAD and ALIGN, it should be understood that the two constraints are in conflict with respect to V-initial words with more than two syllables. (23a) satisfies ALIGN, but the head of the only foot N_1' violates PREHEAD; on the other hand, in (23b), the head of the only foot N_2' p-licenses a prehead, but this foot does not reside at the left word-edge. In order to arrive at the optimal structure (23b), a violation of ALIGN must be tolerated. Therefore, the Aranda constraint hierarchy has the following dominance relation:

(27) **PREHEAD ≫ ALIGN**

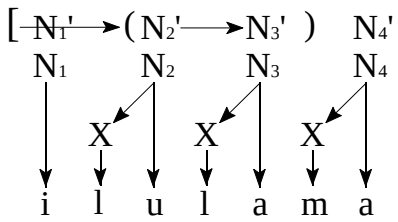
Given (27), the configurations (23ab) can be compared and evaluated as shown in the following tableau:

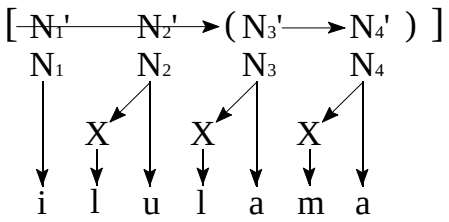
(28)

Candidates	PREHEAD	ALIGN
(a) [→(N$_1$'←N$_2$') N$_3$'] N$_1$ N$_2$ N$_3$ X X e r e n a	N$_1$' !	
☞ (b) [—N$_1$'→(N$_2$'→N$_3$')] N$_1$ N$_2$ N$_3$ X X e r e n a		N$_1$'

In the tableau, the order of constraints reflects the ranking in (27). Although (28a) is better than (28b) in terms of ALIGN, the former is dismissed for the violation of PREHEAD; this fatal PREHEAD-violation is indicated by '!'. (28b) violates ALIGN, but this violation is forced by the success of the higher-ranked constraint PREHEAD. The optimal structure **S** the most successful candidate **S** is thus (28b), shown by '☞'.

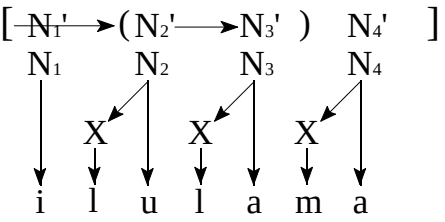
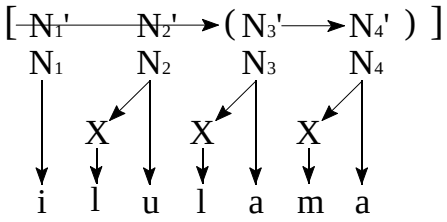
If ALIGN can be violated in order to satisfy PREHEAD, a word such as *ilulama* may be assigned the following structures:

(29) (a) 

(b) 

In both the configurations, the head nucleus of a foot p-licenses a prehead and ALIGN is violated. However only (29a) derives the correct stress pattern *i'lulama*. The factor that rules out (29b) is the concept of violability (24a), which prescribes that violation must be **minimal**. Consider the following tableau:

(30)

Candidates	PREHEAD	ALIGN
☞ (a) 		N_1'
(b) 		N_1' N_2' !

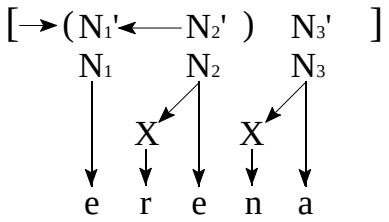
In (30b), ALIGN is violated by two N's, while only one N' intervenes between the ALIGN domain in (30a). In such a case, according to Prince & Smolensky (1993: Chapter 8), the optimal candidate is determined by the following technique:

(31) **Cancellation/Domination Lemma**
In order to show that one parse B is more harmonic (ie. well-formed) than a competitor A which does not incur an identical set of marks, it suffices to show that every mark incurred by B is either (i) cancelled by an identical mark incurred by A, or (ii) dominated by a higher-ranking mark incurred by A. That is, for every constraint violated by the more harmonic form B, the losing competitor A either (i) matches the violation exactly, or (ii) violates a constraint ranked higher.

Following this method of evaluating well-formedness, if we remove one mark of violation with respect to ALIGN from (30ab), no mark remains in the case of (30a), but (30b) retains one mark. Therefore, in the light of minimal violation, (30a) is more desirable than (30b).

Let me return to the example word *erena*. Given violability illustrated above, we might well posit an alternative representation as follows:

(32)



In (32), neither PREHEAD nor ALIGN is violated; the two left edges coincide, and the head nucleus of the foot N_2' p-licenses a prehead. Instead, this configuration shows a violation of FTLICENSING; the head precedence defined in (15) is reversed. Since this representation derives the correct stress pattern *e'rena*, we face a difficulty in judging which of the configurations (28b) and (32) is the more suitable. As shown, (28b) is the result of the ranking in (27): **PREHEAD » ALIGN**; on the other hand, if (32) is indeed the structure to be assigned to *erena*, PREHEAD and ALIGN are undominated in the constraint hierarchy of Aranda grammar, and FTLICENSING is a subordinate constraint, as follows:

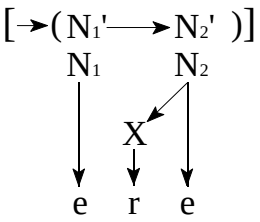
(33) **PREHEAD, ALIGN » FTLICENSING**

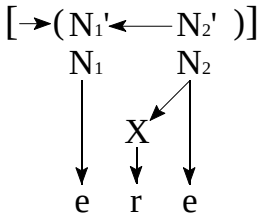
In the case of this sort, the dominance relation between PREHEAD and ALIGN is not relevant. As far as the example words in this section are concerned, the two sets of ranking give rise to identical results, so we cannot yet judge which should represent Aranda grammar. The conflict will be resolved in the following section.

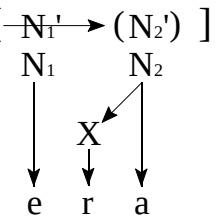
3.3 Disyllabic V-initial words

In the previous section, I have shown that onset-sensitivity arises from the requirement that the well-formedness of a head-syllable must be maintained. Such onset-sensitivity, however, ceases to apply when it comes to disyllabic words such as in (1c).

Let us consider the following candidate representations for an example word *era*:

(34) (a) 

(b) 

(c) 

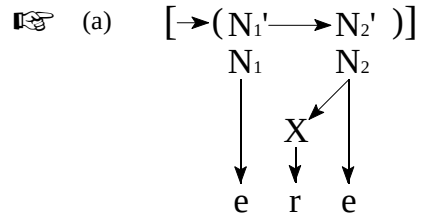
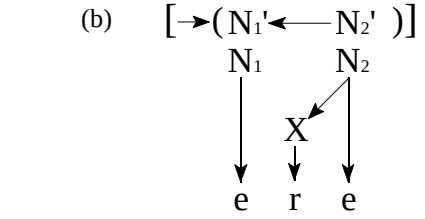
In (34), there is no configuration which simultaneously fulfils the requirements imposed by FTLICENSING, PREHEAD, ALIGN. FTLICENSING is violated in (34b), PREHEAD in (34a), ALIGN in (34c). (Note that (34c) is not assumed to violate FTLICENSING; see §3.3.1.)

Among the candidates, let us first compare (34a) and (34b). (I shall return to (34c) in the following subsection.) ALIGN is not violated in these configurations; they are in conflict solely with respect to PREHEAD and FTLICENSING: the former is violated in (34a) and the latter in (34b). Thus the dominance relation between these two constraints in the Aranda constraint hierarchy is crucial. The example word *era* confirms that they are ranked as in (35):

(35) **FTLICENSING » PREHEAD**

Given this ranking, the following tableau shows that (34b) is preferable to (34a):

(36)

Candidates	FT	PREHEAD
☞ (a) [→(N_1' ⟶ N_2')] 		N_1'
(b) [→(N_1' ⟵ N_2')] 	* !	

The violation of FTLICENSING is marked by '∗'. The violation of PREHEAD is forced to satisfy FTLICENSING.

At the end of §3.2, I mentioned the two competing constraint hierarchies, which are repeated below:

(37) (a) **PREHEAD » ALIGN**
(b) **PREHEAD, ALIGN » FTLICENSING**

I left unanswered the question as to which should be chosen for Aranda grammar. Now that I have shown that (35) is essential for stress in disyllabic V-initial words, (37b) is naturally excluded since the dominance relation between FTLICENSING and PREHEAD contradicts this. (37a) and (35) can be

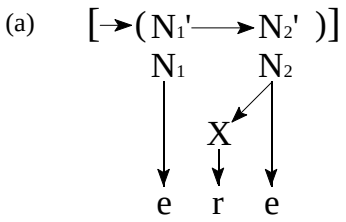
conflated into the following constraint hierarchy:

(38) **FTLICENSING » PREHEAD » ALIGN**

This ranking of the constraints, however, does not ensure that (34a) is the optimal structure of *era*. The following subsection will further refine the constraint hierarchy in (38).

3.3.1 Word minimality. As stated at the beginning of §3.1, stress prominence accompanies the phonetic interpretation of the head of a **disyllabic** foot. However, were the degenerate foot legitimate in Aranda, the competition between (34a) and (34c) would be offered in terms of the constraint ranking (38), as shown in the following tableau (39), and it must be concluded that the candidate with a degenerate foot (39c) would be the optimal structure, the violation of PREHEAD being fatal in (39a).

(39)

Candidates	FT	PREHEAD	ALIGN
(a) 		N_1' !	

☞ (c) [~~N_1'~~ → (N_2')] N_1 N_2 X e r a	*(vacuous)*		N_1'

The degenerate foot consists of a single N_2' in (39c), and FTLICENSING has nothing to say about its well-formedness. FTLICENSING evaluates the well-formedness of a p-licensing relation between two nuclei at the N'-/N''-level, but this constraint itself does not require a foot to be disyllabic. Thus, the degenerate foot never incurs the violation of FTLICENSING. In such a case, the theory assumes that the constraint in question is **vacuously** satisfied (Prince & Smolensky 1993).

Since the representation (39c) derives the false stress pattern **e'ra*, we must conclude that Aranda prohibits the degenerate foot. Because of this restriction, in Aranda, a syllable never bears stress word-finally, as mentioned in (6c). The word-final syllable is either the complement of a foot, or otherwise it is unfooted at the N'-level[23]: [(σσ)], [(σσ)**σ**], [(σσ)(σσ)], [(σσ)(σσ)**σ**]. By the same token, the ban on monosyllabic feet entails that secondary stress is located one syllable away from the primary one, as described in (6b). There is another constraint partly related to the restriction. In Aranda, monosyllabic words are excluded, as stated in (6a): that is, a word consisting of only one stressed syllable (ie. one degenerate foot **[(σ)]**) or of one unstressed syllable (ie. of no foot **[σ]**) is ill-formed.

To sum up, it is required in Aranda that a foot must be disyllabic, and that a word must minimally comprise one such foot. These two requirements are fulfilled by the following constraints[24] (Prince & Smolensky 1993: Chapter 4):

(40) (a) **FOOT STRUCTURE** (FTSTRUC)

[23]The word-final unfooted syllable is p-licensed by the head of a preceding foot at the next level of projection (see §3.1).

[24]FTSTRUC and WDMIN are referred to as FOOTBINARITY and LX PR in Optimality Theory. The latter constraints presuppose a constituent hierarchy, but, since the present theory does not formally assume any constituent (see Takahashi 1993), the names of the constraints make little sense. Although I modified their names to incorporate them into the theory, the fundamental concepts are more or less retained.

A foot is an inter-nuclear licensing domain[25].

(b) **WORD MINIMALITY** (WDMIN)
Words license at least one foot.

The fact described in (6a) is now provided for with a formal explanation. A corollary of these constraints is that a word in Aranda requires at least one inter-nuclear licensing domain: a disyllabic foot (σσ). The concepts of FTSTRUC and WDMIN play an important role in many phonological phenomena, as demonstrated within the framework of Prosodic Morphology (McCarthy & Prince 1986) as well as of Optimality Theory.

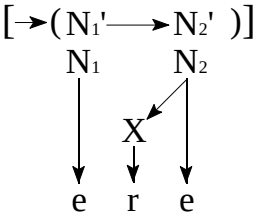
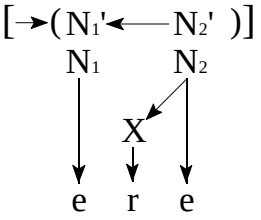
Since these constraints are never violated in Aranda (however, see Footnote 6), I assume that they occupy the highest position on the Aranda constraint hierarchy. Given the resulting complete ranking (for the present discussion), shown below,

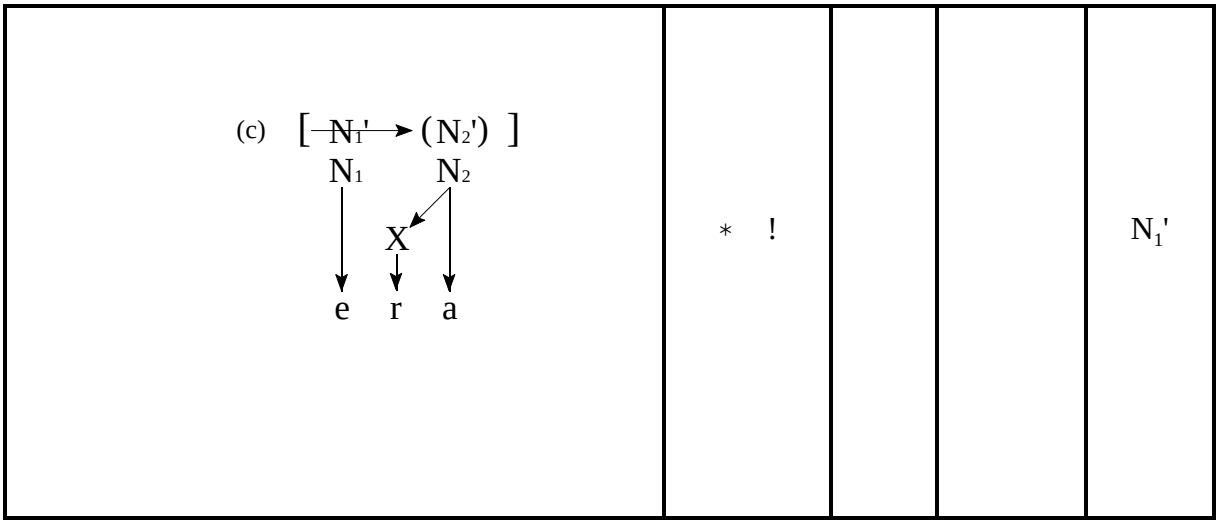
(41) **WDMIN, FTSTRUC » FTLICENSING » PREHEAD » ALIGN**

let us compare (34abc) again, in the following tableau:

[25]In many languages like English, a foot may be built either out of nucleus-complement licensing (eg. *I* /aI/, *day* /deI/) or of inter-nuclear licensing (eg. *utter* /^t{/, *city* /sItI/). The common factor in these two levels of licensing is that a nucleus p-licenses an optional position; within a minimal prosodic domain, a prehead is obligatory while a nuclear complement is optional, and also, at the N'-level, a nucleus may not p-license another nucleus (see the configuration (19a), for example). That is, in languages which follows the English pattern, a foot is a domain established when a nucleus exploits its p-licensing potential and p-licenses an optional position; and WORD MINIMALITY requires that a word must have such a nucleus. So a more generalised version of FTSTRUC is: a foot is a domain in which a nucleus fully exercises its p-licensing potential at the N-/N'-level.

(42)

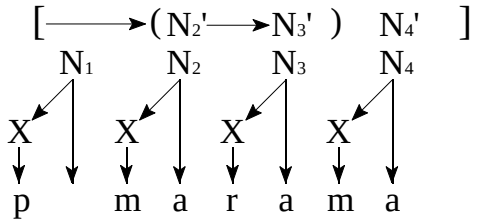
Candidates	WDMIN/ FTSTRUC	FT	PRE-HEAD	ALIGN
☞ (a) 			N_1'	
(b) 		* !		



The tableau shows that the structure (42c) is ruled out on the grounds that it violates the highest ranked constraints WDMIN/FTSTRUC, although it is preferable to the other candidates with respect to the other constraints. Among the other candidates that satisfy WDMIN/FTSTRUC, (42b) is inferior to (42a) because of the violation of FTLICENSING. As a result, (42a) wins this competition as the optimal structure.

Finally, let me note that the occurrence of an empty nucleus in a word does not affect stress assignment. As prescribed in §2.2, an empty nucleus is always licensed by a following nucleus at the **N-level**: that is, such a nucleus is not projected to the N'-level and thus does not participate in establishing inter-nuclear licensing paths at this level. For example, *pmarama* is assigned the following structure:

(43)



The empty nucleus N_1 is not projected to the N'-level because it is licensed by N_2. (Nuclei, recall, are projected to successively higher levels until they are p-licensed.) Foot assignment, therefore, proceeds with respect to the other nuclei projected onto the N'-level. In (43), no constraint in (41) is violated, so the configuration is well-formed.

4 Conclusion

I have shown in the present paper that the theory of phonological licensing can enhance its explanatory power by introducing Optimality Theoretic principles. The developed framework provides a reasonable account of onset-sensitivity conditioned by the size of words, as well as the basic stress assignment patterns in Aranda, which are derived from the interaction of five constraints ranked in a single hierarchy: WDMIN, FTSTRUC » FTLICENSING » PREHEAD » ALIGN. From the viewpoint of Optimality Theory, the present paper has offered some useful concepts. For example, a constraint such as ONSET in Optimality Theory seems to be highly informal, since the theory does not recognise such a constituent as the onset. As shown in the discussion, ONSET can be formally defined as prehead licensing. Besides, I have proposed that the violation of PREHEAD (ie. ONSET) may be considered at the foot level. Within Optimality Theory, this can be interpreted in terms of the constraint ONSET having arguments such as ONSET (s), ONSET (Ft) and ONSET (Wd). There are many other facets that have not been discussed in this short paper, but I strongly believe that, if we elaborate the framework along the lines of the arguments presented here, the theory will be able to provide a deeper insight into phonological phenomena.

References

Archangeli, Diana 1986. Extrametricality and the percolation convention. Ms. Department of Linguistics, University of Arizona, Tuscon.

Backley, Phillip 1993. Coronal: the undesirable element. *UCL Working Papers in Linguistics 5*. 301-324.

Broadbent, Judith 1991. Linking and intrusive r in English. *UCL Working Papers in Linguistics 3*. 281-302.

Brockhaus, Wiebke G. 1992. *Final devoicing: principles and parameters*. Ph.D. dissertation. University College London.

Charette, Monik 1989. The minimality condition in phonology. *Journal of Linguistics 25*. 159-187.

Charette, Monik 1991. *Conditions on phonological government*. Cambridge: Cambridge University Press.

Charette, Monik 1992. Mongolian and Polish meet government licensing. *SOAS Working Papers in Linguistics and Phonetics 2*. 275-292.

Coleman, John 1990a. Charm theory defines strange vowel sets. *Journal of Linguistics 26*. 165-174.

Coleman, John 1990b. Vowel sets: a reply to Kaye. *Journal of Linguistics 26*. 183-187.

Davis, Stuart 1988. Syllable onsets as a factor in stress rules. *Phonology 5.1*. 1-20.

Durand, Jacques & Francis Katamba (eds.) In press. *New frontiers in phonology*. Harlow, Essex: Longman.

Halle, Morris & Jean-Roger Vergnaud 1987. *An essay on stress.* Cambridge, Massachusetts: The MIT Press.

Harris, John 1990. Segmental complexity and phonological government. *Phonology 7*. 255-300.
Harris, John 1992. Licensing inheritance. *UCL Working papers in Linguistics 4*. 359-406.
Harris, John In press. *English sound structure*. Oxford: Blackwell.
Harris, John & Jonathan Kaye 1990. A tale of two cities: London glottalling and New York city tapping. *The Linguistic Review 7*. 251-274.
Harris, John & Geoff Lindsey In press. The elements of phonological representation. In Durand, Jacques & Francis Katamba.
Hyman, Larry M. 1985. *A theory of phonological weight*. Dordrecht: Foris.
Itô, Junko 1986. *Syllable theory in Prosodic Phonology*. Ph.D. dissertation. University of Massachusetts, Amherst.
Kaye, Jonathan 1990a. 'Coda' licensing. *Phonology 7.2*. 301-330.
Kaye, Jonathan 1990b. The strange vowel sets of Charm theory: the question from top to bottom. *Journal of Linguistics 26*. 175-181.
Kaye, Jonathan 1990c. Government in Phonology: the case of Moroccan Arabic. *The Linguistic Review 6*. 131-159.
Kaye, Jonathan 1992. Do you believe in magc? The story of S + C sequences. *SOAS Working Papers in Linguistics and Phonetics 2*. 293-314.
Kaye, Jonathan 1993. Derivation and interfaces. *SOAS Working Papers in Linguistics and Phonetics 3*. 90-126.
Kaye, Jonathan & Edmund Gussmann 1993. Polish notes from a Dubrovnik Cafe. *SOAS Working Papers in Linguistics and Phonetics 3*. 427-462.
Kaye, Jonathan, Jean Lowenstamm & Jean-Roger Vergnaud 1985. The internal structure of phonological elements: a theory of charm and government. *Phonology Yearbook 2*. 305-328.
Kaye, Jonathan, Jean Lowenstamm & Jean-Roger Vergnaud 1990. Constituent structure and government in phonology. *Phonology 7.2*. 193-232.
Kenstowicz, Michael J. & Jerzy Rubach 1987. The phonology of syllabic nuclei in Slovak. *Language 63*. 461-497.
Levin, Juliette 1985. *A metrical theory of syllabicity*. Ph.D. dissertation. Massachusetts Institute of Technology.
Lindsey, Geoff & John Harris 1990. Phonetic interpretation in Generative Grammar. *UCL Working Papers in Linguistics 2*. 355-369.
McCarthy, John J. & Alan Prince 1986. *Prosodic morphology*. Ms. University of Massachusetts, Amherst & Brandeis University.
McCarthy, John J. & Alan Prince 1990. Foot and word in prosodic morphology: the Arabic broken plural. *Natural Language and Linguistic Theory 8*. 209-283.
McCarthy, John J. & Alan Prince 1993a. *Prosodic Morphology I: constraint interaction and satisfaction*. Ms. University of Massachusetts, Amherst & Rutgers University.
McCarthy, John J. & Alan Prince 1993b. Generalised alignment. Ms. University of Massachusetts, Amherst & Rutgers University.
Pagoni, Stamatia 1993. *Modern Greek phonological variation: a Government Phonology approach*. Ph.D. dissertation. University College London.
Prince, Alan, S. & Paul Smolensky 1993. *Optimal theory: constraint interaction in generative*

grammar. Ms. Rutgers University.
Strehlow, T. G. H. 1942. Aranda phonetics. *Oceania 12*. 255-302.
Strehlow, T. G. H. 1943-1944. Aranda grammar. *Oceania 13*. 71-103; 177-200; 310-361. *Oceania 14*. 68-89; 159-181; 250-256.
Takahashi, Toyomi 1993. A farewell to constituency. *UCL Working Papers in Linguistics 5*. 375-412.
Yoshida, Shohei 1990. *Some aspects of governing relations in Japanese phonology*. Ph.D. dissertation. London: School of Oriental and African Studies.
Yoshida, Yuko 1992. Pitch accent and tone harmony in Japanese. *SOAS Working Papers in Linguistics and Phonetics 2*. 339-364.