Minimal Word Structure and the Morphology-Phonology Mapping*

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1. Introduction

Malayalam, Vedic and Japanese are languages which have productive compound formation and phonological phenomena that apply to compounds. In each language, the prosodic structure of compounds varies depending on the internal structure of compounds and the semantic relation between the compound members. The identical prosodic structure arises in the two-word compounds in all the three languages; subordinate compounds form one prosodic constituent and coordinate compounds form two prosodic constituents. However, systematic differences emerge among the three languages with regard to the prosodic constituency of more complex compounds.

In this paper, I propose that the prosodic differences can be accounted for by employing two distinct sets of constraints – constraints on word structure and constraints on the morphology-phonology mapping – and ranking one set of constraints independently from the other set. I adopt Itô and Mester's (1998) economy-based, minimal word structure to deal with the word structure assignment. The analysis of the morphology-phonology mapping relies on the theory of Generalized Alignment as developed by McCarthy and Prince (1993).

The paper is organized as follows. Section 2 presents the data on the prosodic constituent formation in Malayalam, Vedic and Japanese compounds. In Section 3, I introduce Itô and Mester's (1998) economy-based approach to morphological structure. In Section 4, the similarities and differences in the prosodic structure of compounds in the three languages are analyzed within the theories of minimal word structure and Generalized Alignment. The paper ends with a brief conclusion in Section 5.

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2. Prosodic Domains in Compounds

2.1. Prosodic Domains in Malayalam Compounds

In this section, I show how the phonological phenomena of stress and word melody assignment apply in Malayalam compounds and thus discuss what kind of prosodic structure arises in Malayalam compounds. In Malayalam, non-compound words have a single primary stress and a single LH word melody (Mohanan 1986).[1] As illustrated in (1), subordinate compounds have a single primary stress and a single word melody as non-compound words.[2] This implies that both non-compound words and subordinate compounds constitute a single prosodic domain.[3]

(1)	máṯam	wiḏwéeṣam	máṯawiḏwèeṣam
	| |	| |	| \\\|
	L H	L H	L H
	'religion'	'hatred'	'hatred of religion'

Coordinate compounds behave differently in that every stem in a compound constitutes an independent domain for stress and word melody assignment as shown in (2).[4]

(2)	ácchan	ámma	ácchanámmamaarə
	| |	| |	| | | |
	L H	L H	L HL H
	'father'	'mother'	'parents'

Let us consider more complex compounds in which one compound is embedded within another compound. (3) and (4) are subordinate compounds

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[1] In what follows, a letter with _ underneath designates a dental sound, and a letter with . underneath a retroflex sound.

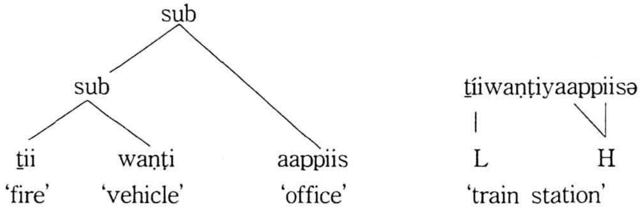
[2] Subordinate compounds refer to the compounds which have the semantic relation of modifier plus head.

[3] The deletion of the final *m* from the lefthand stem is due to Nasal Deletion, which applies between two compound members when the following stem is a polysyllabic noun.

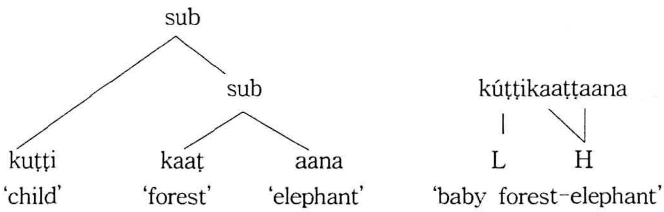
[4] Coordinate compounds refer to the compounds which are interpreted as coordinate constructions.

which contain another subordinate compound as one of their elements.[5]

(3)

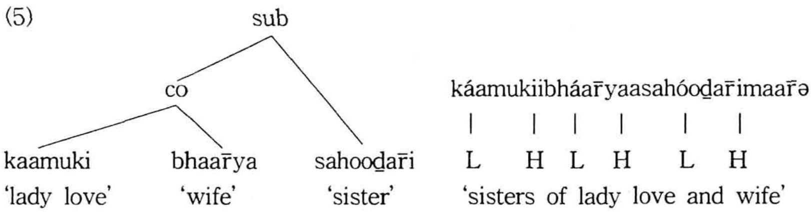


(4)



(3) and (4) demonstrate that a subordinate compound which consists of only subordinate compounds forms a single prosodic domain regardless of its internal structure. (5) is an example of the cases in which a subordinate compound contains a coordinate compound.

(5)



Three instances of the LH melody are realized in (5), indicating that compounds such as this form three separate prosodic domains.[6]

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[5] Henceforth, 'sub' and 'co' in the morphological structure stand for a subordinate and a coordinate compound, respectively.

[6] In this paper, I will not deal with the subordinate compounds whose righthand daughter is a coordinate compound since such compounds are relatively hard to find.

2.2. Prosodic Domains in Vedic Compounds

The pattern of prosodic domains formed in Vedic compounds provides a close parallel to that of Malayalam compounds except in one case. The analysis of prosodic domains in Vedic compounds presented in this section is based on compound accentuation discussed in numerous works (Macdonell 1910, Kiparsky and Halle 1977, Kiparsky 1983, 1987, Halle and Mohanan 1985). Every Vedic word is normally accented and has one primary accent only. It has been proposed that this normal accentuation pattern is governed by a general accentuation principle such as (6).

(6) Basic Accentuation Principle (Kiparsky 1987)
  a. Erase all but the first accent in a word.
  b. If there is no accent, put one on the first syllable.

The accentuation of Vedic compounds generally depends on two factors: the inherent accentuation of the elements of the compound and the morphological structure of the compound (Kiparsky 1983). The basic rule is that the first member is accented on its inherently accented syllable.[7]

(7) a.	[[sahásra][pád]]	sahásrapad
	'thousand''foot'	'thousand-footed'
b.	[[áśva][pṛṣṭhá]]	áśvapṛṣṭha
	'horse' 'back'	'horse-back riding'

The accentuation pattern in (7) is accounted for by the Basic Accentuation Principle. That is, the compounds in (7) form a single accentual domain.

Contrary to the general principle that a word has a single accent, a special class of compounds are doubly accented. A group of dvandva compounds and a certain number of tatpuruṣa compounds with genitive case endings behave this way.

(8) Dvandva compounds with double accents
  a. índrā-váruṇā 'Indra and Varuna'

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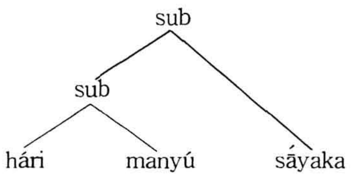
[7] Diacritics used for Vedic sounds are as follows. ṛ is syllabic *r* and ṃ is Anusvāra, which appears after vowels only and not before stops but before sibilants. A macron designates a long vowel and a dot under a consonant other than *m* stands for a retroflex consonant. Finally, *ś* is the palatal sibilant. Accents are designated by the acute accent over a vowel.

b. dyā́vā-kṣā́mā 'heaven and earth'

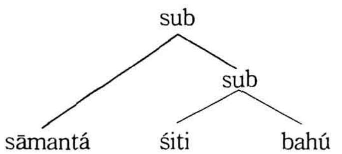
(9) Tatpuruṣa compounds with double accents
a. bṛ́has-páti 'lord of prayer (Bṛhaspáti)'
b. nárā-śáṃsa 'praise of men'

This shows that each element in the compounds in (8) and (9) thus constitutes an independent accentual domain. Hereafter, I will refer to the compounds with double accents such as in (8) and (9) as coordinate compounds and compounds with a single accent as subordinate compounds.

Let us examine more complex compounds in which one compound is nested within another compound. (10) and (11) are subordinate compounds which contain another subordinate compound. Both (10) and (11) have only one accent on the entire compound.

(10)


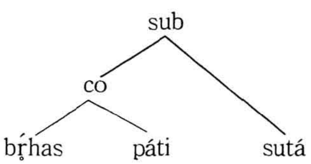
hárimanyusāyaka
'stimulating the mettle of the bay horses'

(11)


sāmantáśitibahu
'having a white front paw on either side'

Thus, subordinate compounds containing another subordinate compound create a single accentual domain whether the nested subordinate compound is a lefthand element or a righthand element.

The next type to consider is a subordinate compound one of whose elements is a coordinate compound.

(12)


bṛ́haspátisuta
'pressed out by Bṛhaspati'

In (12), the first two accents are retained whereas the third one is eliminated. This indicates that the leftmost stem forms one accentual domain and the following two stems form another domain. The second accentual domain [pátisuta] does not correspond to any morphological constituent.

2.3. Prosodic Domains in Japanese Compounds

Let us turn to another language, Japanese, in which prosodic domains in compounds exhibit a pattern different from those of Malayalam and Vedic. The analysis of prosodic structure in Japanese compounds is based on two phonological properties, compound accentuation and Rendaku (Sequential Voicing).

2.3.1. Compound Accentuation

As discussed in many works (McCawley 1968, 1977, Poser 1984, 1990, Kubozono 1987), the accent of noun-noun compounds in Japanese is determined by properties of the second member, most importantly, its length. When a second member is one or two moras long, it is considered 'short.' Otherwise, it is considered 'long.'

In this paper, I deal with only compounds with a long second member since as Kubozono (1987) mentions, this class of compounds shows a more regular accent pattern than compounds with a short second member.

(13) Accentuation of compounds with long second member (Poser 1990: 99)
  a. Mark the final foot of the second member as invisible.
  b. If the visible portion of the second member is unaccented, assign an accent to its initial syllable.
  c. Otherwise, leave the existing accent in place.

As shown in (14a), in compounds with a long second member, normally the accent of the first member is deleted and the accent of the second member, if any, surfaces. (13b), which is exemplified by (14b), describes a special case in which the existing accent is disregarded and a new accent is placed on the initial syllable of the second member.[8]

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[8] Accents are designated by ' after a vowel.

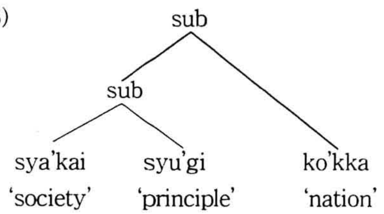
(14) a. [[sya'kai][se'edo]] syakaise'edo
'society' 'system' 'social system'
b. [[inaka][musume']] inakamu'sume
'country' 'girl' 'country girl'

According to Kubozono (1987), there are a number of compounds which are morphologically like regular compounds but take a phrasal accent pattern. These compounds are generally composed of two elements forming a coordinate structure. As in Malayalam and Vedic, I refer to compounds such as in (14) as subordinate compounds and to compounds such as in (15) as coordinate compounds.

(15) a. [[i'ppu][tasai]] i'pputasai
'one husband''many wives' 'polygamy'
b. [[i'ssiN][ittai]] i'ssiNittai
'one advance''one retreat' 'advance and retreat'

The accent pattern in the compounds in (15) is not in accord with the generalization in (13). Following Kubozono's analysis, I assume that these compounds form two domains for compound accent, rather than postulating a special accent rule that will delete the accent of the second member.

Let us now examine how accentual domains are formed in compounds with more than two elements. (16) is a subordinate compound with a left-branching structure.

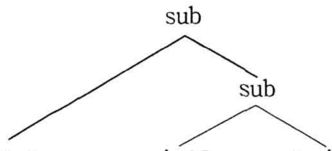
(16)


syakaisyugiko'kka
'socialist state'

Note that in (16), the accent of the rightmost element predominates over the accents of the preceding elements. This indicates that this compound constitutes a single accentual domain.

The compound in (17) is a subordinate compound containing a right-branching structure.

(17)

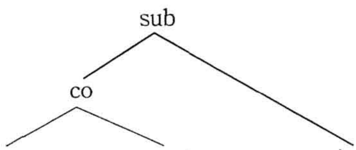


ze'Nkoku yo'roN tyo'osa ze'Nkoku yoroNtyo'osa
'whole nation' 'public opinion' 'survey' 'nation-wide opinion poll'

In (17), the accent of the rightmost element predominates over only the immediately preceding element and does not affect the accent of the leftmost element. This implies that the nested compound forms an independent accentual domain excluding the leftmost element. Thus a branching right member constitutes a separate accentual domain on its own although it is a part of another subordinate compound.

The next compound to consider is a subordinate compound with an embedded coordinate compound.

(18)



i'ppu tasai se'edo i'ppu tasaise'edo
'one husband' 'many wives' 'system' 'polygamy'

In (18), the accent of the leftmost element and the accent of the rightmost element survive on surface. This means that the lefthand element of the embedded coordinate compound forms one accentual domain and the rest of the entire compound forms the other accentual domain. This pattern of accentual phrasing is exactly the same as in Vedic.

2.3.2. Rendaku

The second phonological property relevant to the prosodic structure of Japanese compounds is Rendaku. As exemplified in (19), Rendaku voices an initial obstruent of the second element of compounds (McCawley 1968, Otsu 1980, Itô and Mester 1986, Vance 1987).[9]

[9] Rendaku applies only when the second member of a compound is native Japanese.

(19)	a. [[iro][kami]]	iro**g**ami
	‘color“paper’	‘colored paper’
	b. [[take][sao]]	take**z**ao
	‘bamboo“pole’	‘bamboo pole’

However, coordinate compounds do not undergo Rendaku, as shown in (20).

(20)	a. [[yomi][kaki]]	yomi**k**aki (*yomigaki)
	‘reading“writing’	‘reading and writing’
	b. [[oya][ko]]	oya**k**o (*oyago)
	‘parent“child’	‘parent and child’

There is another factor observed by Otsu (1980) which conditions the application of Rendaku. The condition is that Rendaku applies only when a potential Rendaku element is in a right branch constituent.

(21) Right Branch Condition (Otsu 1980: 219)
Rendaku applies only when a potential rendaku segment is in a right branch constituent.

(22) is a minimal pair that shows the effect of a right-branching node on the application of Rendaku.

(22)	a. [[[nuri][kasa]] [ire]]	nuri**g**asaire
	‘lacquered“umbrella“case’	‘a case for lacquered umbrellas’
	b. [[nuri] [[kasa][ire]]]	nuri**k**asaire
	‘lacquered“umbrella“case’	‘an umbrella case that is lacquered’

kasa in (22b) does not undergo Rendaku since it is on a left branch at the lowest level of compound structure.

Let us turn to subordinate compounds containing a coordinate compound. As shown in (20), Rendaku does not apply across two members of a coordinate compounds. However, when this coordinate compound is embedded in a subordinate compound as its left member, the initial obstruent of the rightmost element still undergoes Rendaku. This is demonstrated in (23).

(23)	a. [[[oya][ko]] keNka]	oya**k**o**g**eNka
	‘parent“child“quarrel’	‘quarrel between parent and child’
	b. [[[kusa][ki]] some]	kusa**k**i**z**ome
	‘grass“tree“dyeing’	‘dyeing with plants’

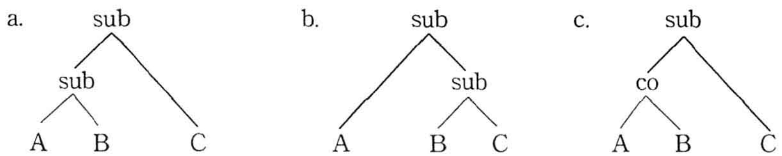
Having examined compound types and compound structures that the application of Rendaku is sensitive to, we find a striking parallelism between the prosodic conditions which govern the application of compound accentuation and those which govern the application of Rendaku. To treat this parallelism, I have argued in Han (1994) that these conditions must be specified concerning phonological phrasing rather than constraining directly the application of individual rules. In other words, the compound accentuation and Rendaku are phonological phenomena bounded by the same prosodic domain.

2.4. Summary

In this section, I have examined how prosodic domains are formed in Malayalam, Vedic and Japanese compounds. The examination has been based on stress and word melody assignment in Malayalam, compound accentuation in Vedic, and compound accentuation and Rendaku in Japanese. The three languages pattern together with respect to two-word compounds in that subordinate compounds form one prosodic domain and coordinate compounds form two prosodic domains.

However, they exhibit systematic differences with regard to more complex compounds. The differences in the characteristic cases can be schematically represented as follows:

(24) Morphological structure



Prosodic domains

	a	b	c
Malayalam	[ABC]	[ABC]	[A][B][C]
Vedic	[ABC]	[ABC]	[A][BC]
Japanese	[ABC]	[A][BC]	[A][BC]

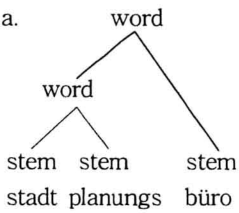
While compounds with the structure (24a) behave uniformly regarding prosodic constituent formation in all three languages, compounds with the structure (24b) distinguish Japanese from Malayalam and Vedic. In contrast, compounds with the structure (24c) group Vedic and Japanese, isolating Malayalam.

In the following sections, I propose that the systematic differences among the three languages in the pattern of prosodic structure of compounds can be accounted for by splitting constraints into two separate classes – constraints on morphological structure and constraints on the morphology-phonology mapping – and ranking those two classes of constraints independently. The next section briefly summarizes Itô and Mester's (1998) economy-based approach to morphological structure assignment, which the proposed analysis of compound structure crucially relies on.

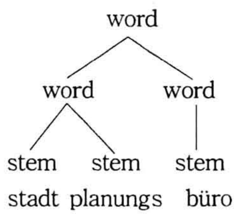
3. Economy-based Approach to Morphological Structure

Postulating two elementary lexical objects, stems (terminal elements) and words (nonterminal elements), Itô and Mester (1998) show that the three-member German compound *Stadt-planungs-büro* 'office for city planning' can be represented by the following two structures.

(25) a.



b.



The word structure (25a) violates a widely-held assumption that all constituents involved in compounds are of the same level (Selkirk 1982), which is stated as a principle by Itô and Mester (1998) as in (26).

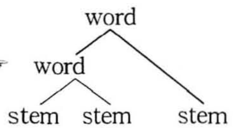
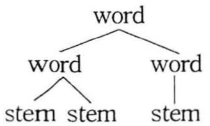
(26) Uniformity (Itô and Mester 1998: 37)
Sister constituents in compounds are of the same structural level.

On the other hand, the structure (25b) conforms to Uniformity. However, it has an extra intermediate non-branching word node which is not motivated by its semantic relation. Thus, (25b) incurs one more violation of *Struc, a structural economy principle which has the effect of minimizing structure (Prince and Smolensky 1993, Zoll 1993ab, Itô and Mester 1998).

(27) *Struc: All structure is disallowed. (Itô and Mester 1998: 37)

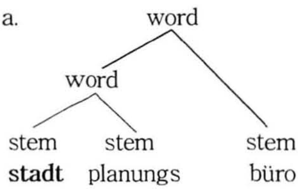
As illustrated in (28), if *Struc dominates Uniformity, the non-uniform structure in (25a) would arise.[10]

(28) *Struc ≫ *Uniformity*

[[Stadt-planungs]-büro]	*Struc	Uniformity
a. ☞ 		*
b. 	*!	

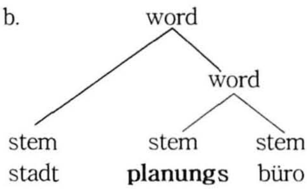
The uniform structure (25b) would result from the opposite ranking Uniformity≫*Struc.[11] Itô and Mester (1998) argue that *Struc≫Uniformity must be the correct ranking for regular compounding in German since a simple and explanatory account of compound stress presupposes economy-based compound structures. The location of primary stress in German compounds depends on the branchingness of compound structure; i.e. the right node is strong if and only if it branches, as illustrated in (29).[12]

(29) a.



'office for city planning'

b.



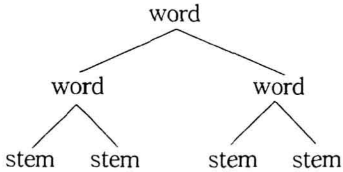
'planning office of the city'

[10] In (28) and the tableaux to follow, *Struc violations shared by all the candidates will be left out and only extra violations will be marked.

[11] Itô and Mester (1998) state that there is no intrinsic reason that *Struc must be ranked over Uniformity and the opposite ranking Uniformity≫*Struc may be called for in other languages.

[12] In (29), the most prominent stem in each compound is boldfaced.

c.



stadt planungs **haupt** büro
'main office for city planning'

According to Itô and Mester (1998), the economy-observing structures in (29) make it possible to state the generalization on compound stress in edge-based terms, as in (30), which can be analyzed in terms of Alignment Theory within the framework of Optimality Theory.

(30) German compound stress falls on the *rightmost* word-*initial* stem.
(Itô and Mester 1998: 39)

Thus, the structures in (29) eliminate the need to make direct reference to branchingness in morphological structure – an undesirable option in a restrictive theory of syntax-phonology interface. It will be shown in the next section that this sort of minimal word structure plays a key role in analyzing the data presented in section 2.

4. Minimal Word Structure and its Consequences in the Morphology-Phonology Mapping

In this section, I put forward an analysis of prosodic structure in Malayalam, Vedic and Japanese compounds. One of the main proposals is that constraints on morphological structure are ranked independently from constraints on the morphology-phonology mapping. In 4.1, the issue of morphological structure assignment for compounds is taken up and in 4.2, the prosodification of the morphological structure is discussed.

4.1. Word Structure

It has been shown in section 2 that each member of coordinate compounds forms a separate prosodic domain in all three languages. In order to deal with this word-like behavior of each compound element, I propose the following morphological constraint.

(31) Coordinate compounding (Co-com)
Each constituent of a coordinate compound is a *word*.

Co-com is undominated in all of the three languages.

In addition to Co-com, I suggest that *Struc be split into two sub-constraints, a constraint that disallows word nodes and one that disallows stem nodes, and that the two constraints be ranked separately.

(32) *Struc(Word) : Word nodes are disallowed.

(33) *Struc(Stem) : Stem nodes are disallowed.

To distinguish *Struc(Word) from *Struc(Stem) means that the extent to which one type of structure is disfavored is independent from the extent to which another type of structure is disfavored.

In the next subsections, I discuss how the newly introduced constraints assign the morphological structure to Malayalam, Vedic and Japanese compounds.

4.1.1. Malayalam and Vedic

I propose that Malayalam and Vedic share the same ranking in assigning word structure to compounds. The relevant constraints and their ranking are as in (34).

(34) Co-com≫*Struc(Word)≫*Struc(Stem), Uniformity

First, let us examine how a left-branching subordinate compound is given a word structure.

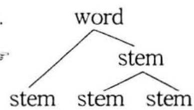
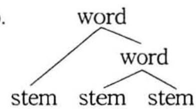
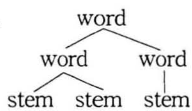
(35) left-branching subordinate compound

[[A B] C]	*Struc(Word)	*Struc(Stem)	Uniformity
a. ☞ word stem stem stem stem		*	
b. word word stem stem stem	*!		*
c. word word word stem stem stem	*!*		

Among the three candidates in (35), (35a) comes out as the winner since it contains the smallest number of word nodes – that is only one – while other candidates contain more than one. As *Struc(Word) is the highest-ranked constraint, *Struc(Stem) and Uniformity do not contribute to deciding the optimal candidate.

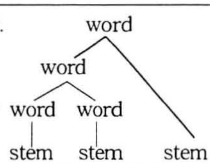
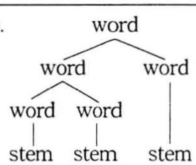
Right-branching subordinate compounds are assigned the morphological structure in a parallel fashion, as illustrated in (36). That is, the candidate that involves the smallest number of word node is selected as the winner.

(36) right-branching subordinate compound

[A [B C]]	*Struc(Word)	*Struc(Stem)	Uniformity
a. ☞ 		*	
b. 	*!		*
c. 	*!*		

The next type is a subordinatez compound containing a coordinate compound.

(37) subordinate compound containing a coordinate compound

[[A B] C]	Co-com	*Struc(Word)	*Struc(Stem)	Uniformity
a. ☞ 		***		*
b. 		****!		

[[A B] C]	Co-com	*Struc(Word)	*Struc(Stem)	Uniformity
c. word word stem stem stem	*!	*		*
d. word stem stem stem stem	*!		*	

(37c) and (37d) are out because they violate Co-com which is undominated. (37b) loses out to (36a) since it incurs one extra violation of *Struc(Word) due to the non-branching non-terminal word node. Hence, (37a) is selected as the optimal candidate although it violates Uniformity.

4.1.2. Japanese

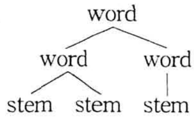
In this subsection, I show that Japanese differs from Malayalam and Vedic *concerning the ranking between* *Struc(Word) *and* *Struc(Stem). In other words, building stem nodes is more disfavored than building word nodes in Japanese. (38) is the overall ranking among the constraints on the word structure assignment in Japanese.

(38) Co-com≫*Struc(Stem)≫*Struc(Word)≫Uniformity

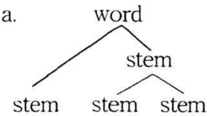
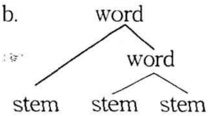
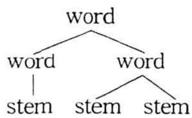
In the case of left-branching and right-branching subordinate compounds, the candidate in which two terminal stems form a word node wins over the structure in which the recursion of stems takes place. As in Malayalam and Vedic, the word structure containing non-branching non-terminal word nodes is less optimal because it incurs extra violations of *Struc(Word).

(39) left-branching subordinate compound

[[A B] C]	*Struc(Stem)	*Struc(Word)	Uniformity
a. word stem stem stem stem	*!		
b. word ☞ word stem stem stem		*	*

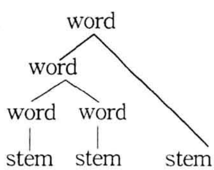
[[A B] C]	*Struc(Stem)	*Struc(Word)	Uniformity
c. 		**!	

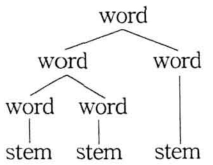
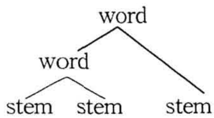
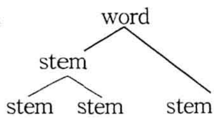
(40) right-branching subordinate compound

[A [B C]]	*Struc(Stem)	*Struc(Word)	Uniformity
a. 	*!		
b. ☞ 		*	*
c. 		**!	

(41) shows that the word structure of a subordinate compound containing a coordinate compound in Japanese is not different from that in Malayalam and Vedic. As in Malayalam and Vedic, the structure in which each member of a coordinate compound constitutes a word node is selected as the winner since Co-com is ranked highest. Further, between (41a) and (41b), the Uniformity-violating structure (41a) is taken as optimal because Uniformity is ranked below *Struc(Word).

(41) subordinate compound containing a coordinate compound

[[A B] C]	Co-com	*Struc(Stem)	*Struc(Word)	Uniformity
a. ☞ 			***	*

[[A B] C]	Co-com	*Struc(Stem)	*Struc(Word)	Uniformity
b. 			****!	
c. 	*!		*	*
d. 	*!	*		

In this section, it has been discussed how to assign morphological structure to compounds with various sorts of internal structure. In dealing with compounds of Malayalam, Vedic and Japanese, I have argued that four constraints – Co-com, *Struc(Word), *Struc(Stem) and Uniformity – play significant roles in the three languages, and that Malayalam and Vedic share the same ranking and Japanese diverges from the other two languages on the ranking between *Struc(Word) and *Struc(Stem). In the following section, I examine how the word structure discussed in this section is assigned an appropriate prosodic structure.

4.2. The Morphology-Phonology Mapping

The analysis of the morphology-phonology mapping is couched within the Alignment Theory developed since McCarthy and Prince (1993). Specifically, assuming that the prosodic domain referred to in the phonological phenomena in Malayalam, Vedic and Japanese is the prosodic word, the alignment constraints between the edges of the morphological word and those of the prosodic word as in (42) and (43) are crucially employed.

(42) Align-L/R(Wd, PWd) : Align the left/right edge of each morphological word with the left/right edge of a prosodic word.

(43) Align-L/R(PWd, Wd) : Align the left/right edge of each prosodic word with the left/right edge of a morphological word.

Selkirk (1995) decomposes the Strict Layer Hypothesis (Selkirk 1984, Nespor and Vogel 1986) into the following four constraints on prosodic structure and call them constraints on prosodic domination.

(44) Constraints on Prosodic Domination
(Selkirk 1995, Truckenbrodt 1995)
(i) Layeredness: No C^i dominates a C^j, $j>i$.
(ii) Headedness: Any C^i must dominate a C^{i-1} (except if $C^i=\sigma$).
(iii) Exhaustivity: No C^i immediately dominates a constituent C^j, $j<i-1$.
(iv) Nonrecursivity: No C^i dominates C^j, $j=i$.

In the analysis of the prosodification of compounds, Nonrecursivity(NonRec) significantly interacts with the alignment constraints in (42) and (43). What is of particular concern in the present case is the recursivity of the prosodic word.

(45) NonRec(PWd): No prosodic word dominates a prosodic word.

The next section will show what kind of prosodic constituency is selected as optimal by the alignment constraints and the constraint of Nonrecursivity.

4.2.1. Malayalam

In Malayalam, the alignment constraints, Align-R(Wd, PWd) and Align-L (PWd, Wd), are engaged in the prosodification of compounds and their ranking with each other and with NonRec(PWd) is as in (46).[13]

(46) Align-R(Wd, PWd), NonRec(PWd)≫Align-L(PWd, Wd)

(47) demonstrates that the optimal prosodic structure for a uniformly left-branching subordinate compound is a single prosodic word without any

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[13] Following Itô and Mester (1998), I assume that ranking of the morphological constraints introduced in 4.1 takes precedence (either serially or by ranking) over ranking of the constraints on the morphology-phonology mapping.

embedded prosodic word.[14]

(47) left-branching subordinate compound[15]

M: word [[stem stem] stem]	Align-R (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. (( )$_{pw}$)$_{pw}$		*!	
☞ b. ( )			
c. (( )( ))		*!	*
d. ( )( )			*!

The constraints and their ranking in (46) maps a right-branching subordinate compound to the same prosodic structure as a left-branching subordinate compound, i.e. a single prosodic word without any recursive structure.

(48) right-branching subordinate compound

M: word [stem [stem stem]]	Align-R (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. (( ))		*!	*
☞ b. ( )			
c. (( )( ))		*!	*
d. ( )( )			*!

It has been argued in the preceding section that a subordinate compound containing a coordinate compound is given a word structure in which two words form a word and the superordinate word forms another word together with a stem, exhibiting a non-uniform compound structure. (49) illustrates

[14] In (47) and the following tableaux, M represents morphological structure and P prosodic structure. The domain designated by parentheses is the prosodic word.

[15] In this paper, I apply alignment constraints categorically but applying them gradiently does not make any difference in the result of the evaluation.

how this type of compound is optimally prosodified.

(49) subordinate compound containing a coordinate compound

M: [word [word [word stem] [word stem]] stem]	Align-R (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. ((( )( )))		*!	
b. ( )	*!		
c. (( )( ))	*!	*!	*
☞ d. ( )( )( )			*
e. ( )( )	*!		
f. ( )( )	*!		*

Given the constraint ranking in (46), the optimal prosodic structure of the input morphological structure is (49d), in which each stem of the compound constitutes a separate prosodic word.

4.2.2. Vedic

Vedic crucially employs the alignment constraint, Align-L(Wd, PWd), but not Align-R(Wd, PWd), which is ranked high in Malayalam. Thus, in Vedic, Align-L(Wd, PWd) interacts with NonRec(PWd) and Align-L(PWd, Wd). However, as there is no evidence for ranking among the three constraints, I assume they are unranked.

(50) Align-L(Wd, PWd), NonRec(PWd), Align-L(PWd, Wd)

The constraints given in (50) map the input word structure of a left-branching subordinate compound in (51) into a prosodic structure (51b). The optimal prosodic structure of a left-branching subordinate compound is a single prosodic word without any recursion in the prosodic word level.

(51) left-branching subordinate compound

M: word stem stem stem stem	Align-L (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. (($)_{pw}$ $)_{pw}$		*!	
☞ b. ( )			
c. (( )( ))		*!	*!
d. ( )( )			*!

The prosodic structure of a right-branching subordinate compound is determined in the same way as that of a left-branching subordinate compound.

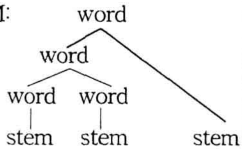
(52) right-branching subordinate compound

M: word stem stem stem stem	Align-L (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. (( ))		*!	*!
☞ b. ( )			
c. (( )( ))		*!	*!
d. ( )( )			*!

As illustrated in (51) and (52), there is no difference between Malayalam and Vedic regarding the prosodic structure of subordinate compounds whether the compounds are left-branching or right-branching; those compounds are assigned the prosodic structure in which the entire compound forms a unitary prosodic word without any recursive structure underneath.

The following tableau deals with a subordinate compound containing a coordinate compound. This is the case where Malayalam and Vedic diverge.

(53) subordinate compound containing a coordinate compound

M: 	Align-L (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. ((( )( )))		*!	
b. ( )	*!		
c. ( )( )	*!		*!
d. ( )( )( )			*!
☞ e. ( )( )			

We have seen that in Malayalam, three prosodic words are formed in this type of compounds. In contrast, the prosodic structure with two prosodic words – in which one prosodic word encompasses the first stem and the other prosodic word encompasses the following two stems – arises in Vedic. Thus, the difference in prosodic structure is attributed to the difference in the edge crucially referred to in the word alignment.

4.2.3. Japanese

Finally, this section deals with the prosodification of various sorts of Japanese compounds based on the morphological structure discussed in 4.1.2. The constraints relevant for the morphology-phonology mapping in Japanese are exactly the same ones as in Vedic. Like in Vedic, two alignment constraints and one nonrecursivity constraint interact.

(54) Align-L(Wd, PWd), NonRec(PWd), Align-L(PWd, Wd)

It has been proposed in 4.1.2 that the morphological structure of a subordinate compound in Japanese is different from that in Malayalam and Vedic as a result of ranking *Struc(Stem) above *Struc(Word). Hence, the morphological structure of a subordinate compound in Japanese, which is the input to the morphology-phonology mapping, involves word recursion, not stem recursion. As illustrated in (55), a different input, however, does not make any difference in the prosodification of a left-branching subordinate compound. Given the constraint interaction in (54), the entire left-branching subordinate compound constitutes a unitary prosodic word in Japanese, like in Malayalam and Vedic.

(55) left-branching subordinate compound

M: word word stem stem stem	Align-L (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. (($)_{pw}$ $)_{pw}$		*!	
☞ b. ( )			
c. (( )( ))		*!	*!
d. ( )( )			*!

The morphological structure with the word-level recursion, however, results in a unique prosodic structure in the prosodification of right-branching compounds in Japanese.

(56) right-branching subordinate compound

M: word word stem stem stem	Align-L (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. (( ))		*!	
b. ( )	*!		
c. (( )( ))		*!	
☞ d. ( )( )			

In this case, (56b) cannot be selected as the optimal candidate because it fatally violates Align-L(Wd, PWd). Instead, (56d), which consists of two, non-recursive prosodic words, provides the optimal prosodic structure to a right-branching subordinate compound. Thus, the right-branching part in a Japanese subordinate compound behaves like an island in the prosodification.

Assigning a prosodic structure to a subordinate compound containing a coordinate compound in Japanese does not need additional explanation. The morphological structure of this type of compounds is identical in the three languages. Further, Japanese and Vedic share the same constraints concerning the morphology-phonology mapping.

(57) subordinate compound containing a coordinate compound

M: [[[word: stem] [word: stem]]word stem]word	Align-L (Wd, PWd)	NonRec (PWd)	Align-L (PWd, Wd)
P: a. ((( )( )))		*!	
b. ( )	*!		
c. ( )( )	*!		*!
d. ( )( )( )			*!
☞ e. ( )( )			

As expected, (57e), the prosodic structure in which the first stem forms a prosodic word and the following two stems form another prosodic word, is selected as the winner since it violates none of the three constraints.

5. Conclusion

In this paper, I have examined how prosodic domains are formed in Malayalam, Vedic, and Japanese compounds. The prosodification is determined on the basis of stress and word melody assignment in Malayalam, compound accentuation in Vedic, and compound accentuation and Rendaku in Japanese. The three languages pattern together with regard to two-word compounds in that subordinate compounds form one prosodic domain and coordinate compounds form two prosodic domains. However, they exhibit systematic differences with regard to compounds containing more than two elements.

I have suggested that the prosodic differences can be accounted for by splitting the relevant constraints into constraints on word structure and constraints on prosodification and ranking the two classes separately. Itô and Mester's (1998) concept of economy-based, minimal word structure has been adopted to deal with word structure assignment. It has also been shown that the theory of Generalized Alignment (McCarthy and Prince 1993) and Selkirk's (1995) constraints on prosodic domination provide the right set of constraints for the morphology-phonology mapping.

Regarding the word structure assignment, I have proposed that *Struc be divided into two subconstraints *Struc(Stem) and *Struc(Word). Malayalam and Vedic differ from Japanese in the ranking between *Struc(Word) and *Struc(Stem); *Struc(Word) is ranked higher in Malayalam and Vedic whereas *Struc(Stem) is ranked higher in Japanese. In contrast, in the morphology-phonology mapping, Vedic and Japanese are grouped together, isolating Malayalam. The difference results from the edge referred to in the alignment of the morphological word with the prosodic word; the left alignment plays a prominent role in Vedic and Japanese while the right alignment plays a comparable role in Malayalam.

One of the advantage of the analysis proposed in this paper is that it accounts not only for the prosodic structure assignment in each language but also for the prosodic differences among the three languages with the limited number of constraints, most of which have already been independently motivated in other work.

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ABSTRACT

Minimal Word Structure and the Morphology-Phonology Mapping

Eunjoo Han

This paper examines how prosodic domains are formed in Malayalam, Vedic and Japanese compounds. The three languages have the same pattern with regard to two-word compounds. However, they exhibit systematic differences with regard to compounds containing more than two elements. I propose that the prosodic differences can be accounted for by splitting the relevant constraints into constraints on word structure and constraints on prosodification, and ranking the two classes of constraints independently. Itô and Mester's (1998) economy-based, minimal word structure is adopted for word structure assignment, and McCarthy and Prince's (1993) theory of Generalized Alignment for the morphology-phonology mapping.

Malayalam and Vedic differ from Japanese in assigning word structure, specifically in the ranking between *Struc(Word) and *Struc(Stem); *Struc (Word) is ranked higher in Malayalam and Vedic, whereas *Struc(Stem) is ranked higher in Japanese. In contrast, in the morphology-phonology mapping, Vedic and Japanese are grouped together, isolating Malayalam. The difference results from the edge referred to in aligning the morphological word with the prosodic word. The left-edge alignment plays a prominent role in Vedic and Japanese, while the right-edge alignment plays a comparable role in Malayalam.

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