

Obstruent alternations in sub-compounds*

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Kim, Gyung-Ran. 2001. Obstruent alternations in sub-compounds. *Studies in Phonetics, Phonology and Morphology* 7.2. 315-331. In this paper, three points are made with the data from obstruent alternations in a sub-compound noun such as tensing in Korean, voicing in Japanese, and gemination in Malayalam. First, each process occurs in a sub-compound, not in a co-compound, due to the difference in semantic dependency of the constituents. Second, normally the head of a sub-compound needs to be different from its counterpart in a co-compound or that in a free noun for the same reason. Third, a particular process, not others, in each language results from the obstruent inventory of each language. (Yeungnam University)

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1. Introduction

The phonological phenomena in compounds have been dealt with in many studies, either as segmental phenomena or as prosodic ones. As for the prosodic ones, English compound stress has been the most popular subject from the structuralists to the generative phonologists including those with the Optimality Theory. Other than English, several languages have provided the data relevant to assigning prosodic domains for stress, accent, or tone such as German stress (Cinque 1993), Malayalam stress and word melody (Mohan 1982), Japanese accent (Haraguchi 1977), and Chinese tone (Duanmu 1997) to name a few.

As for the segmental ones, Japanese Rendaku and so-called Korean "sai-sios" in a sub-compound have enjoyed much exploration (Itô & Mester 1986, Fukuzawa & Kitahara 2001, Cook 1987, Sohn 1987, J. H. Kim 1992). And Malayalam gemination in a sub-compound has been treated as supporting evidence for the theory of Lexical Phonology (Mohan 1982). However, these studies are mainly confined to how and why each process in each language happens. There has never been an attempt to explore what these processes have in common.

The present study tries to give answers to the questions such as 1) why there are certain phonological processes like obstruent tensing in Korean, voicing in Japanese, and gemination in Malayalam in the surface forms of sub-compounds, not in those of co-compounds, 2)

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why phonological alternations occur normally in the heads of sub-compounds, not in the non-heads, and 3) why that particular process in each language occurs, not other processes. Answering these questions will reveal the common properties of sub-compounds in three languages.

The organization of the paper is as follows. Sections 2, 3, and 4 explore obstruent tensing in Korean, voicing in Japanese, and gemination in Malayalam, respectively, providing the answers to the above three questions. It will be argued that 1) each process occurs in a sub-compound, not in a co-compound, due to the difference in semantic dependency of the constituents, 2) the head of a sub-compound needs to be different from its counterpart in a co-compound or that in a separate free noun for the same reason, 3) a particular process, not others, in each language results from the obstruent system of each language. In section 5, a brief account of each phonological process is provided in the framework of the Correspondence Theory. Finally, section 6 summarizes those three questions and corresponding answers.

In passing, whether a compound is a sub- or co-compound is decided by semantic relationships. If there is semantic dependency between the constituents, it is a sub-compound, and otherwise, it can be a co-compound. Compounds in this paper refer to root compounds, not synthetic compounds.

2. Korean Sub-Compounds

We will see in this section that phonological alternations have a morphological function in that they support an overt contrast between the surface forms (Alderete 2000). Compared with co-compound nouns, sub-compound nouns show obstruent tensing or consonant insertion. Let's compare the data in (1) and (2). (In the following data, the dot(.) marks the syllable boundary.)

- (1) sub-compounds
(Obstruent Tensing)
- | | | | |
|----|--|---|--------------------------------------|
| a. | [pom] _N + [ka.mum] _N | → | [pom.k'a.mum] _N |
| | spring drought | | spring drought |
| b. | [an] _N + [paŋ] _N | → | [am.p'aŋ] _N ¹² |
| | inside room | | master bedroom |

¹ Place Assimilation occurs so that alveolars have the same place of articulation with the following consonant. See (2b), also.

² Semantic information needs to be considered in the occurrence of tensing in a sub-compound. Compared with [[mul]_N [paŋ.ul]_N] 'water drop' whose surface form is [mul.p'aŋ.ul], [[in]_N [paŋ.ul]_N] 'silver bell' has [im.baŋ.ul] as its surface form. In the first case, [paŋ.ul] means 'something round' or 'liquid whose shape is round', while in the latter, it means 'something that rings.' For further detail in this regard, see J. H. Kim (1992).

- c. [coŋ]_N + [so.ri]_N → [coŋ.s'o.ri]_N³
 bell sound bell sound
 (Consonant Insertion)
- d. [a.ræ]_N + [ni]_N → [a.ræ.ni]_N⁴
 below tooth lower teeth
- e. [u]_N + [ə.rin]_N → [u.ðə.rin]_N
 upper elders seniors

(2) co-compounds

(no Obstruent Tensing)

- a. [pom]_N + [ka.ɨl]_N → [pom.ga.ɨl]_N, *[pom.k'a.ɨl]
 spring fall spring and fall
- b. [non]_N + [pat]_N → [nom.bat]_N, *[nom.p'at]
 rice paddy field a plot of field
- c. [toŋ]_N + [sə]_N → [toŋ.sə]_N, *[toŋ.s'ə]
 east west east and west
- (no Consonant Insertion)
- d. [wi]_N + [a.ræ]_N → [wi.a.ræ]_N, *[wi.da.ræ]
 above below above and below

We can see that in the almost same sequence of consonants between the two constituents, the first consonant of the second constituent in sub-compounds gets tensed when it is obstruent (1a, b, c), while it does not in the case of co-compounds (2a, b, c). In the latter, obstruents get voiced between voiced segments in (2a, b): /k, p/ → [g, b]. In (1d, e) there is a consonant inserted between the two constituents, while there is no such insertion in (2d).

Why is the same noun realized differently in the same phonological environment? The answer lies in the semantic relationship of the two constituents in each compound. The two constituents of a sub-compound are in a modifier+head relation and thus the first constituent changes its syntactic category from a noun to an adjective.⁵

A denominal adjective morpheme composed of one feature [+constricted glottis] is inserted between the two constituents (Sohn 1987: 263, J. H. Kim 1992: 154).

³ Korean /l/ becomes [r] between vowels.

⁴ According to Sohn (1987), the underlying form of the noun 'tooth' in Korean is /ni/ and its surface form as a separate word is [i], not [ni], due to the rule banning [n] word-initially. The discussion on whether the underlying form should be /ni/ or /i/ will take us too far afield.

⁵ The sub-compound of [[A] [N]]_N does not need a denominal adjective morpheme, since the non-head is already an adjective. No obstruent tensing occurs, either:

(ex) [pan]_A 'half' + [tal]_N 'moon' → [pan.dal], *[pan.t'al] 'half moon',
 [sæ]_A 'new' + [sæk.si]_N 'bride' → [sæ.sæk.s'i], *[sæ.s'æk.s'i] 'new bride'

(3) Denominal Adjective Morpheme in Korean

$$\begin{array}{c} [[[]_N \mathbf{x}]_A []_N]_N \\ | \\ [+CG] \end{array}$$

(x: a timing slot, [+CG]: [+constricted glottis])

The realization of the morpheme depends on the phonological environment. When the following constituent begins with an obstruent and the first constituent ends in a syllable with a coda, the inserted morpheme makes the following obstruent tensed. Here, for the time being, a serial derivation is adopted for the sake of exposition. In the following section 5, we are going to see an Optimality theoretical approach to this phenomenon.

$$\begin{array}{c} (4) [[[pom]_N \mathbf{x}]_A + [ka.mum]_N]_N \rightarrow [pom]_A [ka.mum]_N \rightarrow \\ | \qquad \qquad \qquad | \\ [+CG] \qquad \qquad \qquad [+CG] \\ [pom.k'a.mum]_N \text{ 'spring drought'} \end{array}$$

When the first constituent ends in a syllable with no coda and the second constituent begins with a sonorant consonant as in (1d), the inserted [+CG] is linked as the coda consonant to the preceding syllable and is neutralized as /t/, the least marked consonant in Korean, later undergoing Nasal Assimilation to become [n].

$$\begin{array}{c} (5) [[[a.ræ]_N \mathbf{x}]_A + [ni]_N]_N \rightarrow [a.ræt]_A [ni]_N \rightarrow [a.ræ.ni]_N \text{ 'lower teeth'} \\ | \\ [+CG] \end{array}$$

On the other hand, when the second constituent is onsetless and the first constituent ends in a syllable with no coda, the inserted [+CG] is realized as [d].

$$\begin{array}{c} (6) [[[u]_N \mathbf{x}]_A + [ə.rɪn]_N]_N \rightarrow [ut]_A [ə.rɪn]_N \rightarrow [u.də.rɪn]_N \text{ 'seniors'} \\ | \\ [+CG] \end{array}$$

⁶ The maximal type of the Korean syllable is CVC. The inserted timing slot \mathbf{x} has no place to go. After [+CG] tenses the following obstruent [k], the link between the timing slot \mathbf{x} and the feature [+CG] is delinked. For the derivational detail of how [+CG] is realized in the various environments, see Sohn (1987) and J. H. Kim (1992).

⁷ When the first constituent ends in a vowel and the second constituent begins with an obstruent, both consonant insertion and tensing occur:

$$\begin{array}{c} \text{(Ex) } [[[k^h o]_N + \mathbf{x}]_A + [tɪŋ]_N]_N \rightarrow [k^h ottɪŋ]_N \text{ 'the bridge of the nose'} \\ | \\ [+CG] \end{array}$$

The inserted [+CG] is linked to the preceding syllable as a coda. This in turn tenses the following obstruent [k], but is delinked via neutralization. The following segment [t] fills in the empty timing slot left by delinking.

The inserted morpheme [+CG] is linked to the coda position of the first constituent as the neutralized [t], later becoming voiced and the onset of the following syllable via resyllabification.⁷

Due to the semantic dependency in a sub-compound, the two constituents are very likely to blend into one and the first consonant of the second noun tends to become voiced between voiced segments. In a psychological effort to prevent this weakening, the denominal adjective morpheme [+CG] is inserted and tenses the following obstruent or is realized as an inserted consonant, leading to the preservation of the integrity of the second constituent (J. H. Kim 1992). In short, the difference in the surface forms of a noun reflects its status difference in a word: as a modified head noun of a sub-compound or as a separate noun in itself. For instance, the surface form of /kamum/_N 'drought' as a separate noun is [ka.mum], while as the head noun of a sub-compound [[pom]_N[ka.mum]_N 'spring drought', it surfaces as [k'a.mum]. To the ears of native speakers of Korean, the tensed obstruent [k'] marks the status of the word in which it occurs, that is, the head of a sub-compound.

In passing, why phonological alternations normally happen in the head, not in the non-head of a sub-compound? This is because the non-head is placed word-initially and the word-initial position is relatively strong, compared with the word-medial or word-final position (Beckman 1998, Lombardi 1999). Thus there is no possibility of the word-initial weakening and there is no need for the word-initial segment of the non-head to take any measures to keep its integrity phonetically.

On the other hand, in the case of co-compounds, the constituents are not in a modifier + head relation and thus there is no need of inserting a denominal adjective morpheme [+CG]. It is because the two constituents are of equal status in deciding the meaning of a whole compound as the examples in (2) show. Consequently, it is not necessary for the head to take any actions. This line of exposition applies to the cases of Japanese and Malayalam, too.

Now, let us reflect on why the feature [+CG] is chosen as a denominal adjective morpheme in a sub-compound. Why not the feature [+spread glottis], for instance, so that the following obstruent gets aspirated? The answer comes from the obstruent inventory of Korean.

(7) Korean Obstruent Inventory

plosives	p	t	k
	p'	t'	k'
	p ^h	t ^h	k ^h
affricates		c	
		c'	
		c ^h	

fricatives	s	h
	s'	

All obstruents except for fricatives are distinguished in three ways: plain, tensed, and aspirated. Voiceless bilabial plosives, for example, are voiceless plain /p/, tensed /p'/, and aspirated /p^h/. However, alveolar fricatives are distinguished only in two ways, plain /s/ and tensed /s'/. There is no aspirated counterpart /s^h/. While there is a gap in a series of aspirated obstruents such as * /s^h/, there is no gap in the case of tensed obstruents. Since tensed obstruents are more marked than plain ones, [+constricted glottis] is chosen as an effective way of denoting the denominal adjective morpheme, which is in turn realized as obstruent tensing or consonant insertion in a sub-compound.

3. Japanese Sub-Compounds

In Japanese sub-compounds, an initial obstruent of the second constituent becomes voiced and traditionally this phenomenon has been called Rendaku (Itô & Mester 1986, Vance 1987, etc.). Rendaku applies only when the second constituent of a sub-compound is native Japanese and it does not take place in a co-compound. The following data are mainly from Han (1994).

(8) sub-compounds (Rendaku)

- | | |
|--|------------------------------------|
| a. [iro] _N + [kami] _N | → [iro gami] _N |
| color paper | colored paper |
| b. [take] _N + [sao] _N | → [take zao] _N |
| bamboo pole | bamboo pole |
| c. [ike] _N + [hana] _N | → [ike hana] _N |
| arrange flower | flower arrangement |
| d. [yama] _N + [tera] _N | → [yama dera] _N |
| mountain temple | mountain temple |

(9) co-compounds (no Rendaku)

- | | |
|--|---|
| a. [yomi] _N + [kaki] _N | → [yomi kaki] _N , * [yomigaki] |
| reading writing | reading and writing |
| b. [oya] _N + [ko] _N | → [oya ko] _N , * [oyago] |
| parent child | parent and child |
| c. [me] _N + [hana] _N | → [me hana] _N , * [mebana] |
| eye nose | eye and nose |
| d. [iki] _N + [kaeri] _N | → [iki kaeri] _N , * [ikigaeri] |
| going returning | round trip |

The semantic relation of the constituents in a sub-compound is that of a modifier+head and thus a denominal adjective morpheme is inserted, consisting of one feature [voice] (Itô & Mester 1986, Fukuzawa & Kitahara 2001):

(10) Denominal Adjective Morpheme in Japanese(ρ)
$$\begin{array}{c} \rho \\ | \\ \text{[voice]} \end{array}$$

(ex) [[iro]_N + ρ]_A + [kami]_N → [irogami]_N 'colored paper'

$$\begin{array}{c} | \\ \text{[voice]} \end{array}$$

As seen in the Korean examples, there is no modifier + head relationship in a co-compound and there is no need of inserting the denominal adjective morpheme. Consequently, no Rendaku takes place in a co-compound. It is the denominal adjective morpheme [voice] of a sub-compound that induces Rendaku.

However, when there is a voiced obstruent in the second constituent of a sub-compound, Rendaku does not apply.

(11) sub-compounds (no Rendaku)

- a. [kami]_N + [kaze]_N → [kamikaze]_N, *[kamigaze]
 god wind divine wind
- b. [siro]_N + [tabi]_N → [sirotabi]_N, *[sirodabi]
 white socks white socks
- c. [onna]_N + [kotoba]_N → [onnakotoba]_N, *[onnagotoba]
 woman word feminine speech

This is one of the OCP phenomena, whereby adjacent identical elements are not allowed at the melodic level (McCarthy 1986) and Lyman's Law describes the blocking of Rendaku:

(12) Lyman's Law (Itô & Mester 1986: 60)

$$\begin{array}{c} \text{[+voi]} \rightarrow \emptyset / \text{---} \text{ [+voi]} \\ | \\ \rho \end{array}$$

Here again, we need to think about why voicing occurs to the obstruent of a sub-compound rather than other phonological processes such as aspiration or tensing, for example? The answer lies in the obstruent system of native Japanese, where the majority of obstruents are either voiceless or voiced. Only a series of labials /h/-/b/-/p^h/ have a three-way distinction as can be seen in the following Japanese syllabary including obstruents:

(13) Japanese Obstruents in Syllabary

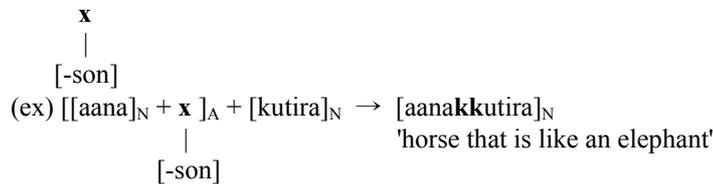
- | | | |
|----------------|---------------|-----------------|
| a. /k/ - /g/ | b. /s/ - /z/ | c. /t/ - /d/ |
| か /ka/ かゝ /ga/ | さ /sa/ ざ /za/ | た /ta/ だ /da/ |
| き /ki/ ぎ /gi/ | し /si/ じ /zi/ | ち /tsi/ ぢ /dzi/ |

- c. [[[pettj]_N + [pattaayam]_N]_N ka]_N → [pettjipattaayan̩a]ə]_N
 box grain-bin pl. boxes and grain-bins
 d. [[[aana]_N + [kutira]_N]_N ka]_N → [aanakkutiraka]ə]_N
 elephant horse pl. elephants and horses

When the first segment of the head is not an obstruent, the final segment of the non-head is geminated as in (14a). In the case of (14b), where the first segment of the head is an obstruent [k] and it can be geminated, the final segment of the non-head [r] is geminated to be [tt], instead. The [rkk] sequence which would be produced is ruled out because in Dravidian postvocalic clusters should be either geminates or sequences of nasal + stop (+ stop) (*International Encyclopedia of Linguistics*, 1992: 374). As seen in footnote 8, Malayalam geminates are all voiceless and /r/ becomes [tt] by gemination. This is indicative of the fact that when the head of a sub-compound cannot be distinguished from that of a co-compound due to the phonotactic constraint of Malayalam, the second choice is that the final segment of the non-head, the closest to the head, shows an alternation.

Since there is semantic dependency between the constituents of a sub-compound, a denominal adjective morpheme is inserted to make the non-head constituent a modifier as in Korean and Japanese. However, in Malayalam the morpheme under consideration can be posited as a timing slot with the [-son] feature attached.

(16) Denominal Adjective Morpheme in Malayalam



The inserted timing slot has no place node. The place node of the following obstruent [k] spreads to fill in the then unspecified place node of the inserted denominal adjective morpheme, resulting in a geminate [kk].

Then, why gemination, not aspiration or tensing, of obstruents? As in Korean and Japanese, the Malayalam obstruent system gives an answer to this question. The following chart is taken from Mohanan (1982: 149):

(17) Malayalam Obstruent Inventory

	bilabial	dental	alveolar	pal. alveolar	retroflex
stop	p b	t̪ d̪	t		ʈ ɖ
	ph bh	t̪h d̪h			ʈh ɖh
fricative			s	ʂ	ʂ̠

	palato- alveolar	palatal	velar	glottal	
stop	c j	k' g'	k g		
	ch jh	k'h g'h	kh gh		
fricative				h	

Except for the alveolar stop /t/, there is a four-way distinction in Malayalam stops: voiceless plain, voiced plain, voiceless aspirated, and voiced aspirated. As for /t/, it has neither aspirated nor voiced counterparts such as */th/, */d/, and */dh/. Fricatives are all voiceless, too; there are neither voiced nor aspirated ones. Since fricatives and the alveolar stop are voiceless only, neither aspiration nor voicing can be the optimal means of distinguishing obstruents in Malayalam. Therefore, the only way for all obstruents to be distinguished from their singleton counterpart is to get geminated. As contrasted with a single obstruent in its counterpart in a separate free word or a co-compound, a geminated obstruent appears in a constituent of a sub-compound. That is, gemination is an indicator of the status of a noun in a sub-compound.

In short, as a means of blocking the weakening of the constituents in a sub-compound, the process of gemination is adopted in Malayalam, since a geminate is stronger and more marked than its singleton counterpart. To the speaker of Malayalam, whether an obstruent is geminate or singleton tells the identity of the noun in question: a constituent in a sub-compound on the one hand and a free word or a constituent in a co-compound on the other hand.

5. An Optimality-theoretical Account

This section will give a brief Optimality-theoretical account of the phonological alternations in a sub-compound seen in the three languages. We are going to see in particular that the place in the constraint hierarchy of the constraints relevant to the realization of the denominal adjective morpheme determines the surface forms of the head constituent in a sub-compound. As always, the interaction of the markedness and faithfulness constraints leads to the optimal surface forms.

The followings are some constraints necessary to analyze the data:

- (18) a. Realize-Morpheme(RM): Morphemes must be realized in the output.
 b. *Lar: No voiced, tensed, or aspirated obstruents are allowed.
 c. Max[+CG]: The feature [+CG] in the input must have a correspondent in the output.
 d. Dep-IO: A segment of the output has a correspondent in the input.
 e. * [+voice][-voice][+voice]: Voiceless consonants are not allowed between voiced segments.
 f. *Lab, *Dor » *Cor: Labials or dorsals are more marked than coronals.
 g. *Geminate: No Geminates are allowed.
 h. *Sonority Reversal(SR): Sonority reversals are not allowed.
 *Sonority Plateau(SP): Sonority plateaus are not allowed.

(18a) requires that morphemes be realized phonetically. Otherwise, no morphemes can have surface forms. (18b), (18c), and (18h) are all markedness constraints, banning more marked segments. As for the constraints in (18h), these are from Syllable Contact Law, which says that a coda must not be lower in sonority than the following onset. The case of sonority reversal(SR) occurs when an onset is higher in sonority than the preceding coda, while that of sonority plateau(SP) occurs when the level of sonority is the same between a coda and the following onset (Morelli 1999, G. R. Kim 2001).

With these constraints in hand, let us take a look at the case of obstruent tensing in Korean first.

- (19) Korean Tensing:
 [pom] + [ka.mum] → [pom.k'a.mum] 'spring drought'

pom + x + ka.mum [+CG]	RM	Max[+CG]	* [+v][-v][+v]	*Lar
a. pom.ga.mum		*!		*
b. pom.ka.mum	*!	*	*	*
c. pom.k'a.mum			*	*
d. pom.k ^h a.mum		*!	*	*

The highest constraint RM rules out (19b), since the denominal adjective morpheme [+CG] is not realized. Other candidates have the morpheme realized as [-voiced], [+constricted glottis], and [+spread glottis] feature in the output, respectively. Among the rest of candidates, only (19c) survives since it retains the [+CG] feature of the input, despite the fact the lower constraints are violated.

Next is the case of consonant insertion in (1d,e).

(20) Korean Consonant Insertion:

[a.ræ] + [ni] → [a.ræ.ni] 'lower teeth'

a.ræ+ x + ni [+CG]	RM	Dep-IO	*[+v][-v][+v]	*SR	*SP	*Dor	*Cor	*Gem
a. a.ræ.ni	*!							
b. a.ræt.ni		*		*			*	
c. a.ræ.ni		*			*		*	*
d. a.ræŋ.ni		*			*	*!		

Although (20a) is the most faithful to the input, it violates the highest constraint RM. Other candidates have the denominal morpheme in the form of an inserted segment [t], [ŋ], and [ŋ], respectively. (20b) violates both the voicing constraint *[+v][-v][+v] and *SR to lose to (20c) and (20d). As for *SP, (20c) and (20d) fare the same. However, the constraint ranking *Dor » *Cor given in (18f) decides which one is the optimal. Since coronal segments are less marked than either labial or dorsal segments, the third candidate wins over the fourth one. Almost the same description can be given to the following tableau, where the least marked consonant /d/ is inserted as the realization of the denominal adjective morpheme in Korean.

(21) Korean Consonant Insertion:

[u] + [ə.rɪn] → [u.də.rɪn] 'seniors'

u + x + ə.rɪn [+CG]	RM	Dep-IO	*[+v][-v][+v]	*Dor	*Cor
a. u.tə.rɪn		*	*!		
b. u.ə.rɪn	*!				
c. u.də.rɪn		*			
d. u.gə.rɪn		*		*!	

As for Rendaku in Japanese, the relevant constraints are given in (22). For a detailed analysis see Fukuzawa & Kitahara (2001).

- (22) a. Ident[voice]: The value of the feature [voice] of the input and output segments must be identical.
 b. *[voice]&[voice]: Adjacent [voice] features are not allowed.
 c. Uniformity[voi]: The [voice] feature of the output cannot have two correspondents in the input.

(23) Japanese Voicing: [iro] + [kami] → [irogami] 'colored paper'

iro + ρ + kami [voice]	RM	Ident[voice]	*Lar
a. iro + kami [voice]	*!		
b. iro + gami [voice]		*	*

Even though (23b) violates two constraints, these two are lower than the highest constraint, RM. Thus (23b) wins over (23a).

For the OCP phenomenon in Rendaku, the constraints (22b) and (22c) are called for as in (24).⁹

(24) Japanese Voicing:

[kami] + [kaze] → [kamikaze], *[kamigaze] 'divine wind'

kami + ρ + kaze [voi] _i [voi] _j	*[voi]&[voi]	Uniformity	RM	Ident[voice]
a. kami + kaze [voi] _i [voi] _j			*	
b. kami + gaze / [voi] _i [voi] _j	*!			*
c. kami + gaze [voi] _{ij}		*!		*

Since [voi]_{ij} in (24c) has two input correspondents, the Uniformity constraint is violated. Even though (24a) violates RM, this constraint is lower than both *[voi]&[voi] and Uniformity. That is why (24a) is chosen as the optimal.

Now it is time for the Malayalam gemination case. As we have seen in the previous section, the denominal adjective morpheme of Malayalam consists of a timing slot attached with the [-son] feature

⁹ As in the case of shibu + ρ + kaki 'a tart persimmon,' where the first constituent has [voice], Fukuzawa & Kitahara (2001: 64) divides Uniformity[voice] of (22c) into two constraints: general Uniformity[voi] and specific Uniformity[voi]. The specific Uniformity[voi] bans the candidate where two [voice]'s are within a morpheme. For further detail Fukuzawa & Kitahara (2001) is referred to.

and the inserted timing slot is filled with the adjacent obstruent, becoming a geminate.

(25) Malayalam Gemination:

[aana] + [kutira] → [aanakkutira] 'a horse that is like an elephant'

aana + x + kutira [-son]	RM	*Gem
a. aana + kutira	*!	
b. aana + kkutira		*

For [kaat] + [maram] → [kaatʈəmaram] 'forest tree,' *SR in (18h) is recalled here.

(18h) *Sonority Reversal(SR): Sonority reversals are not allowed.

(27) Malayalam Gemination:

[kaat] + [maram] → [kaatʈəmaram] 'forest tree'

kaat + x + maram [-son]	RM	*Gem	*SR	Dep-IO
a. kaatmaram	*!			
b. kaatʈəmaram		*		**
c. kaatʈmaram		*	*!	*

The constraint ranking *SR » Dep-IO decides the winner between (27b) and (27c).

6. Conclusion

So far the analysis within the Optimality theory has been provided for the obstruent alternations in sub-compounds of Korean, Japanese, and Malayalam. Whether in a derivational approach or in a constraint-based approach, the analysis itself is not so important in this study.

Rather, the focus is first on why phonological processes such as obstruent tensing, voicing, and gemination happen in a sub-compound, not in a co-compound. The answer lies in the semantic dependency between the constituents in a sub-compound: a modifier + head relation. The non-head noun needs to change from a noun to an adjective, and a denominal adjective morpheme is inserted. In Korean it is a morpheme consisting of the [+constricted glottis] feature, while in Japanese the morpheme is [+voice] and it is [-son] in Malayalam. Thus, the presence or absence of this morpheme determines the

occurrence or non-occurrence of the obstruent alternations under consideration. In short, the obstruent alternations in a sub-compound reflect a morphological function of the constituents.

Second question is why those obstruent alternations take place normally in the head of a sub-compound? The answer lies again in the semantic relation of the constituents in a sub-compound. In a modifier + head relation, the constituents tend to become one and the adjacent segments are likely to assimilate to each other. As for the non-head noun, it normally takes the word initial position and that position is stronger than the word medial or final position. On the other hand, the head noun is not placed word-initially and it tends to undergo weakening processes, especially the first consonant of the head. In order to prevent weakening and retain its identity, the head needs to take some counteractions to be phonetically different from its counterpart in a free noun or from that in a co-compound. As a countermeasure against weakening, some phonologically functional process occurs to the head of a sub-compound and this leads to our third question.

Why obstruent tensing in Korean, voicing in Japanese, and gemination in Malayalam, not other processes? The answer comes from the obstruent inventory of each language. As seen in (7) Korean obstruents are distinguished in three ways except for fricatives: voiceless plain, tensed, and aspirated. For fricatives there is a gap in an aspirated alveolar fricative /s^h/ in Korean. Therefore, the only way to contrast optimally all the plain obstruents is to get it tensed. For the native speakers of Korean, obstruent tensing in a compound indicates the headship of a noun in question. Likewise, in Japanese voicing is the only way of phonemic contrast of all the obstruent series in native Japanese as seen in (13), while tensing difference brings about allophonic alternations and difference in aspiration is confined to the phonemic contrast in a series of labials. Since voiced segments are more marked than voiceless ones, Japanese takes voicing as a means of indicating the head noun of a sub-compound. On the other hand, the obstruent system of Malayalam in (17) reveals that neither tensing nor voicing nor aspiration can show a full contrast of obstruents and thus the only possibility is to make obstruents geminate. Geminates are stronger and more marked than their singleton counterparts, and compared with a singleton in a co-compound or a separate free noun, a geminate obstruent tells the native speakers of Malayalam that the noun under consideration is a constituent of a sub-compound.

This phenomenon is due to the fact that native speakers of a certain language cannot hear the allophonic differences of a given phoneme; only phonemic difference can be of any significance to the ears of native speakers of a language. We have seen here that as a counteraction against weakening processes likely to happen due to the semantic dependency between the constituents in a sub-compound, languages take strengthening processes to maintain the identity of the constituents. The semantic dependency leads to a morphological change, which in turn brings about obstruent alternations such as tensing,

voicing, and gemination in a sub-compound.

The present study has dealt with the data from three languages only: Korean, Japanese, and Malayalam and its result may be prone to jump to hasty conclusions. Nonetheless, we hope that this study can shed a little bit of light on the understanding of the obstruent alternations in a sub-compound.

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