

# A Constraint-Based Account of Two Types of Korean /h/

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Lee, B., Kang, S.-K., & Lee, K.-J. 1999. A Constraint-Based Account of Two Types of Korean /h/. *Linguistics* 7-2, 207-223. This paper explores the phonological behavior of Korean /h/, which surfaces differently when it is preceded or followed by other segments. We start with exhaustive data and descriptive analyses. Two issues will receive special attention throughout this paper: the different behaviors between stem-final /h/ and onset /h/, and optional surface forms in speech. In this paper we provide a constraint-based analysis of these issues from the perspective of Optimality/Correspondence Theory laid out by Prince and Smolensky (1993) and developed by McCarthy and Prince (1993, 1995). (Wonkwang University and Hanyang University)

## 1. The Data: Two Types of /h/

Let us first take a look at the following data<sup>1</sup>:

(1) a. /noh-ca/	[noc <sup>h</sup> a]	'let's put (it) down'
b. /coh-ta/	[cot <sup>h</sup> a]	'to be good'
c. /nah-ko/	[nak <sup>h</sup> o]	'to give birth to and'

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<sup>4</sup>In Korean, lenis stops become voiced intervocally.

d. /manh-ta/	[mant <sup>h</sup> a]	'to be a lot'
(2) a. /kip-ha-ta/	[kip <sup>h</sup> ada]	'to be urgent'
b. /kak-ha/	[kak <sup>h</sup> a]	'Your excellency'
c. /mac-hi-ta/	[mac <sup>h</sup> ida]	'to hit'
d. /t <sup>h</sup> as-ha-ta/	[t <sup>h</sup> at <sup>h</sup> ada]	'to blame'

As shown above, obstruents are aspirated when either preceded or followed by /h/. It should also be noted that /kak-ha/ in (2b) can be realized optionally as either [kak<sup>h</sup>a] in a casual speech or [kakk<sup>h</sup>a] in an emphatic speech.

The stem-final /h/ in (1), however, behaves differently from the onset /h/ in (2) in crucial ways. First, the stem-final /h/ is obligatorily deleted before a vowel-initial suffix as shown in (3), whereas the onset /h/ is never deleted when it occurs intervocalically as shown in (4).

(3) a. /coh-a/	[coa]	*[coha]	'Good!'
b. /silh-a/	[sirə]	*[silhə]	'(I) hate (it)'
(4) a. /kiso-ha-ta/	[kisohada]	*[kisoada]	'to prosecute'
b. /ya-hap/	[yahap]	*[yaap]	'an illicit union'

Second, the stem-final /h/ is also deleted when followed by a suffix that begins with /n/ or /s/ as exemplified in (5). In the presence of /n/, the /h/ undergoes complete assimilation, resulting in a geminate [nn]. When followed by /s/, the /h/ deletes, and the following /s/ becomes tense.<sup>2</sup> In contrast, the onset /h/ in (6) is not deleted when adjacent to those consonants. Rather when it occurs after /s/, it triggers aspiration of the /s/, resulting in [t<sup>h</sup>].

(5) a. /coh-ne/	[conne]	*[cohne]	*[cone]	'I like (it)'
b. /coh-so/	[cos'o]	*[cohso]	*[coso]	'Good!'

<sup>2</sup>An obstruent becomes tensed when preceded by another obstruent (e.g., /kaksi/ → [kaks'i] 'bride', /ip-ta/ → [ipt'a] 'to wear'). For a detailed discussion, see Ahn (1985), J. Kim (1986), Sohn (1987) among others.

- (6) a. /non-ha-ta/ [nonhada] \*[nonnada] \*[nonada] 'to discuss'  
 b. /t<sup>h</sup>as-ha-ta/ [t<sup>h</sup>at<sup>h</sup>ada] \*[t<sup>h</sup>ashada] \*[t<sup>h</sup>asada] 'to blame'

Taking these differences into account, we propose that the stem-final /h/ be minimally distinguished from the syllable-initial /h/ as in (7a) and (7b).

- (7) a. C                    b. C  
           h                    |  
                                   h

Stem-final /h/ is a floating feature yet to be linked to the root node (henceforth, marked as C' to be distinguished from others), whereas underlyingly syllable-initial /h/ is represented as a spread glottis feature (*h* for convenience) linked to a root node (C for convenience). In order to support this argument, we can make use of speech errors as evidence, which are unintentional mispronunciations of words by native speakers of a language. Let us take a look at the following data, where # indicates an actual speech error.<sup>3</sup>

- (8) a. /noh-ta-ka/ [not<sup>h</sup>aga] #[not<sup>h</sup>ak<sup>h</sup>a] 'while putting (it) down'  
 b. /silh-ta-poni/ [silt<sup>h</sup>aboni]#[silt<sup>h</sup>ap<sup>h</sup>oni] 'as I hate (it)'  
 (9) a. /ha-ta-ka/ [hadaga] \*[hat<sup>h</sup>ak<sup>h</sup>a] 'while doing (it)'  
 b. /hokaŋ/ [hogaŋ] \*[hok<sup>h</sup>aŋ] 'wealthy life'

The data in (8) show that a stem-final /h/ can trigger a phenomenon which can be described as spreading [spread glottis] to the following stop consonants in speech errors. By contrast, an onset /h/ in (9) does not function as a trigger even in errors. We take this as a piece of evidence supporting our assumption that a stem-final /h/ should be represented differently from an underlying syllable-initial /h/ as illustrated in (7) above.

<sup>3</sup>Data comes from Ki-jeong Lee's own corpus of 5,000 errors of all types, collected over a period of two years.

## 2. Previous Analyses

There has been much discussion in the literature on Korean aspiration. C. Kim (1967), J. Kim (1986), K. Kim (1987) and H. Sohn (1987) try to account for both progressive and regressive aspiration processes by formulating a rule of mirror image. On the other hand, Kim-Renaud (1974) and S. Kim (1976) claim that progressive and regressive aspirations be not one but two independent phonological processes in that they should be ordered differently with respect to other phonological rules such as obstruent neutralization. Not only does their analysis need an extrinsic ordering of rules, but it inevitably derives the ill-formed intermediate structures. For example, derivations of [nat-t<sup>h</sup>a] 'to bear' from its underlying form /nah-ta/ would proceed like this: /nah-ta/ → /nah-t<sup>h</sup>a/ (aspiration) → /nat-t<sup>h</sup>a/ (obstruent neutralization), where an intermediate stage, /nah-t<sup>h</sup>a/, which is never surface-true, is produced.

Within the framework of the Feature Geometry proposed by Clements (1985), S. Kim (1989) provides an explanation why /h/ behaves differently from other segments. She tries to account for the diverse realization of /h/ in surface forms in terms of the structure preservation and spreading of the laryngeal node. She argues that aspiration involves a double spreading: spreading of the laryngeal node to the root node of the adjacent stop and spreading of the supralaryngeal node to the root node of /h/. Even though her analysis is basically correct, her account has not gone beyond the stipulation of the specific rule, a double spreading.

More recently, S. Lee (1996) attempted a constraint-based analysis of the stem-final /h/ within Optimality Theory. He claims that there is a constraint about onset requiring that it always have a place node except in a word-initial position. Then, he argues that since /h/ lacks a place node, it cannot occur in a word-medial onset position. However, his analysis makes wrong predictions in cases such as /ahop/ 'nine' and /ihæ-hata/ 'to understand': it would predict \*[aop] and \*[iæada] instead

of [ahop] and [ihæhada] respectively. In addition, all /h/'s in Sino-Korean do surface regardless of their positions.

### 3. A Constraint-based analysis

In this section, we will provide a constraint-based analysis of Korean /h/ within Optimality Theory using the concept of Correspondence, taking both native and Sino-Korean vocabulary into account. Main focus will be given on three phenomena addressed above: first, aspiration as coalescence; second, intervocalic /h/-deletion; and third, gemination of /n/ preceded by /h/, and /h/ in contact with /s/.

#### 3.1 Aspiration as coalescence

As shown in section 1, an /h/ coalesces with an adjacent obstruent at the expense of losing its individual identity as part of a separate morpheme. And yet, the result is more faithful than completely losing the feature (or segment) of the input. The data are repeated below for convenience.

(10)a. /noh-ca/	[noc <sup>h</sup> a]	'let's put (it) down'
b. /coh-ta/	[cot <sup>h</sup> a]	'to be good'
c. /nah-ko/	[nak <sup>h</sup> o]	'to give birth to and'
d. /manh-ta/	[mant <sup>h</sup> a]	'to be a lot'
(11)a. /kip-ha-ta/	[kip <sup>h</sup> ada]	'to be urgent'
b. /kak-ha/	[kak <sup>h</sup> a]	'Your excellency'
c. /mac-hi-ta/	[mac <sup>h</sup> ida]	'to hit'
d. /t <sup>h</sup> as-ha-ta/	[t <sup>h</sup> at <sup>h</sup> ada]	'to blame'

The motivation behind it is two-fold: a familiar Coda Condition<sup>4</sup> in

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<sup>4</sup>In Korean, the set of possible codas is restricted to [p, t, k, m, n, ŋ, l].

banning /h/ in the coda and a phonotactic constraint in (12) prohibiting a sequence of an obstruent either preceded or followed by an /h/. Since /h/ cannot stand in the coda, it coalesces with an adjacent obstruent. We capture this by an Alignment constraint in (13), which requires that every spread glottis feature (which may be generalized to laryngeal) be in a syllable onset.

(12) \*[-son] [h] % (mirror image)

(13) Align-Left(h, σ): Every spread glottis feature should be syllable initial.

As the result of the above two constraints which are undominated, concatenation of an obstruent with an /h/ leads to coalescence, which violates MorphDis and Uniformity introduced in McCarthy and Prince (1995: 62-66).

(14) MorphDis: Distinct instances of morphemes have distinct contents, tokenwise.

(15) Uniformity-IO : No mapping of multiple input elements to a single correspondent in the output.

The faithfulness constraint on /h/ as given in (16) then needs to be ranked between the undominated constraints and the constraints against coalescence as shown in (17).

(16) Max-IO (h): /h/ in the input should be present in the output.

(17) Align-L, \*[-son][h] > Max-IO(h) > MorphDis, Uniformity

Let us first illustrate how the ranked constraints proposed above

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Obstruents with laryngeal and/or continuant features are neutralized in the syllable-final position (e.g., /p, p', p<sup>h</sup>/ → [p], /t, t', t<sup>h</sup>, s, s', c, c', c<sup>h</sup>/ → [t], /k, k', k<sup>h</sup>/ → [k]). Kang (1995) defines it as CODA-COND: Coda licenses only Place, [nasal], [lateral].

work by considering a couple of representative coalescence cases in tableaux: one with an /h/ following an obstruent and the other with an /h/ preceding it. In obtaining the optimal outputs in these cases, the alignment constraint on /h/ and the phonotactic constraint on an obstruent and an /h/ play the most crucial roles.

(18) b. /coh-ta/ --> [cot<sup>h</sup>a] 'to be good' (10b)

CVC'CV      co h-t a	Align-L	*[-son][h] %	MAX-IO (h)	MorphDis	Uniform
a. CV . CV      co t <sup>h</sup> a				*	*
b. CV . CV      co t a			*!		
c. CVC'. CV        co h t a	*!	*			

(19) /kak-ha/ --> [kak<sup>h</sup>a] 'Your excellency' (11b)

CVC CV        kak -ha	Align-L	*[-son][h] %	MAX-IO (h)	MorphDis	Uniform
a. CV . CV      ka k <sup>h</sup> a				*	*
b. CVC.CV        kak ha		*!			
c. CV . CV      ka ka			*!		

The tableau in (18) shows a case of a stem ending in an /h/ followed by an obstruent-initial suffix. The most faithful candidate to the input in (18c) violates not only the phonotactic constraint but the Align-Left constraint because /h/ surfaces in the coda, which is fatal. The optimal

output in (18a) satisfies all the top ranked constraints at the expense of violating constraints against coalescence. The constraints work in the parallel manner in an input with an onset /h/. The most faithful candidate in (19b) makes a fatal violation with an undominated phonotactic constraint. If a candidate chooses to lose part of the input to get away from that constraint, it violates a faithfulness constraint which is ranked in the next level. Therefore, the optimal candidate turns out to be the one which violates the low ranked constraints militating against coalescence.

A careful reader may have noticed from the above tableaux that the optimal outputs are violating an additional Max-IO constraint -- on the root node (C or C'). This problem could be easily solved by ranking the constraint, namely Max-IO(C), very low. However, it is of great interest to note that the output form which keeps all the root nodes in the input results in an optional surface form which is heard in an emphatic speech. That is to say, [cot<sup>h</sup>a] in (18a) is optionally pronounced as [cotti<sup>h</sup>a], and [kak<sup>h</sup>a] in (19a) as [kakk<sup>h</sup>a].<sup>5</sup> We assume following Crosswhite (1996) that optionality can result when two constraints are free ranked. The constraints in conflict here are a faithfulness constraint on root node and a constraint against geminate consonants as follows:

- (20) Max-IO (C) : A root node in the input should be present in the output.
- (21) \*Geminate-C : There should be no geminate consonants in the output. (to be revised below)

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<sup>5</sup>In this paper, we assume that only [cokk<sup>h</sup>o] and [cok<sup>h</sup>o], but not [cotk<sup>h</sup>o], are generated from /coh-ko/ 'good and'. According to Iverson and Kim-Renaud (1994), [cotk<sup>h</sup>o] also emerges as an alternant in emphatic speech. However, Oh (1996) claims that a phonetic study conducted by her indicates that [cotk<sup>h</sup>o] is not possible even in emphatic reading. This is exactly what the present analysis predicts.



Then, a degeminated form would surface if \*Geminate-C dominates Max-IO(C) and a degeminated form if \*Geminate-C is subordinated to Max-IO(C) as illustrated in (22) and (23), respectively.

(22)

CVC CV        kak h a	*Gem-C	MAX-IO (C)
a. CV . CV      ka k <sup>h</sup> a		*
b. CVC.CV      ka kh a	*!	

(23)

CVC CV        kak h a	MAX-IO (C)	*Gem-C
a. CV . CV      ka k <sup>h</sup> a	*!	
b. CVC.CV      ka kh a		*

The above tableaux show that \*Geminate-C and Max-IO(C) interact to account for optionality. Below we will see a case where optionality is not allowed and only the geminated forms are considered optimal.

### 3.2 Intervocalic /h/-deletion

Let us now turn to a case where a stem-final /h/ disappears intervocalically.

- |                 |        |                    |
|-----------------|--------|--------------------|
| (24) a. /coh-a/ | [coa]  | 'Good!'            |
| b. /noh-a/      | [noa]  | 'Put (it) down'    |
| c. /silh-a/     | [sira] | '(I) hate (it).'   |
| d. /manh-a/     | [mana] | '(It's) too much.' |

When an /h/-final stem is followed by a vowel-initial suffix, the /h/ deletes completely rather than surfacing as a following onset or neutralized in the coda as [t]. This is puzzling because normally an /h/ can stay in the syllable onset in any position of a word in the native

vocabulary in (25) as well as the Sino-Korean vocabulary in (26).

- |                       |                            |
|-----------------------|----------------------------|
| (25) a. [hanɪl] 'sky' | (26) a. [hyoryək] 'effect' |
| b. [hada] 'do'        | b. [hanga] 'leisure'       |
| c. [hana] 'one'       | c. [pihæŋ] 'flight'        |
| d. [ahop] 'nine'      | d. [suhak] 'mathematics'   |
| e. [ahɪn] 'ninety'    |                            |

We therefore claim that deletion of a stem-final /h/ in (24) is due to the following alignment constraint requiring that the unlinked root node for the floating /h/ be always syllable-final, which is supposed to be an undominated constraint in Korean. The following tableau, then, shows how the alignment constraints rule out more faithful candidates to the given input.

(27) Align-Right(C',σ): An unlinked root node (C') should be syllable-final in the output.

(28) /coh-a/ --> [coa] 'Good!' (24a)

CVC' V       co h- a	Align-L	Align-R	MAX-IO (h)	MAX-IO (C)
a. CV . V       co a			*	*
b. CV . C'V         co h a		*!		
c. CVC' . V         co h a	*!			

On the other hand, the /h/'s linked to the root nodes in the input as in (25) and (26), i.e., syllable initial /h/'s in the input, do not undergo deletion, for the most faithful candidate keeping an /h/ in the original position satisfies all the constraints introduced so far.

## 3.3 Gemination

Let us now turn to another case of /h/-deletion: the stem-final /h/ is also deleted when followed by a suffix beginning with a nasal /n/. In this case, however, deletion of /h/ results in a geminate nasal /nn/, as shown in (29).<sup>6</sup> Unlike optionality of geminated and degeminated forms with obstruent gemination which was determined by style of speech (refer to (22) and (23) above), nasal gemination in this case is obligatory. On the other hand, an onset /h/ of the input stays the same as shown in (30).

- (29) a. /coh-ne/ [conne] \*[cohne] \*[con<sup>h</sup>ne] \*[cone] 'I like (it)'  
 b. /coh-ni/ [conni] \*[cohni] \*[con<sup>h</sup>ni] \*[coni] '(You) like (it)?'  
 (30)a. /non-ha-ta/ [nonhada] \*[nonnada] \*[nonada] 'to discuss'  
 b. /pan-ha-ta/ [panhada] \*[pannada] \*[panada] 'to be attracted'

/h/-deletion in (29) is a natural consequence: the only way a stem-final /h/ can survive is to be linked to the following onset segment, but Korean does not allow an aspirated nasal in its sound inventory. We will analyze this with a markedness constraint prohibiting an aspirated sonorant, i.e., \*[+son, h].

Obligatory gemination of nasals, on the other hand, is observed outside this phenomenon in Korean. Underlyingly geminated nasals (or sonorants) behave differently from obstruents in terms of optional degemination: sonorants do not degeminate whereas obstruents do,

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<sup>6</sup>Certain suffixes beginning with a nasal, e.g., /-myøn/ 'if' or /-ni/ 'associative', do not trigger gemination or assimilation, even when they are preceded by stems ending in /h/. Instead, they cause insertion of a vowel /i/ between the stem and the suffix: for example, /noh-myøn/ surfaces as [noimyøn] 'if (you) put (it) down.' However, it is a controversial matter to posit the underlying form of those suffixes without an underlying /i/. If we assume instead that the /i/ is already in the underlying form of the suffix, it becomes the totally different argument. Therefore, though interesting, we will not pursue this phenomenon further in this paper and leave it for further research.

optionally in casual speech.

- (31) a. /hannat<sup>h</sup>/                    [hannat] \*[hanat]            'merely'  
       b. /nammun/                    [nammun] \*[namun]        'south gate'  
       c. /nolla-ta/                   [nollada] \*[nolada]        'surprised'
- (32) a. /akki/                        [akk'i] [ak'i]                'musical instrument'  
       b. /tat-ta/                       [tatt'a] [tat'a]              'to close'  
       c. /kappu/                       [kapp'u] [kap'u]             'a millionaire'

Based on this observation, we revise the constraint against gemination which was introduced above in (21) so that it now penalizes only an obstruent geminate as in (33). Then, reranking MAX-IO(C) with this constraint against gemination would not make a difference in choosing an optimal output, since a geminate /nn/ will always win.

(33) \*Geminate-C[-son] : No obstruent geminates in the output.

(34) /coh-ne/ --> [conne] 'I like (it).' (29a)

CVC' CV      co h ne	Align-L	*[+son, h]	MAX-IO (h)	MAX-IO (C)	*Gem-C [-son]
a. CVC' CV      V   co n e			*		
b. CV . CV        co ne			*	*!	
c. CVC' . CV          co h n e	*!				
d. CV . CV        co n <sup>h</sup> e		*!			

The geminate candidate in (34a) satisfies the faithfulness constraint on root node in the first place. In addition, since the constraint against obstruent gemination does not apply to a nasal geminate, it vacuously

satisfies that constraint. The degeminated form in (34b), however, fares poorly by violating MAX-IO(C).

Likewise, invariability of an onset /h/ as in /non-hata/ in (30) is straightforward, since the most faithful candidate, [nonhada] satisfies all the constraints given in tableau (34), whereas another plausible candidate such as [nonnada] violates MAX-IO(h). Let us below move to the behavior of /h/ when adjacent to /s/.

### 3.3 /h/ in contact with /s/

When followed by an /s/-initial suffix, the stem-final /h/ deletes, and the following /s/ becomes tense as in (35a). In contrast, when preceded by an /s/, the /h/ in the onset triggers aspiration of the neutralized /s/, resulting in [t<sup>h</sup>] as in (35b).

- |                              |                                      |                          |                         |                       |            |
|------------------------------|--------------------------------------|--------------------------|-------------------------|-----------------------|------------|
| (35)a. /coh-so/              | [cos'o]                              | *[cohso]                 | *[cos <sup>h</sup> o]   | *[cot <sup>h</sup> o] | 'Good!'    |
| b. /t <sup>h</sup> as-ha-ta/ | [t <sup>h</sup> at <sup>h</sup> ada] | *[t <sup>h</sup> ashada] | *[t <sup>h</sup> asada] |                       | 'to blame' |

It should be first noted that while obstruents in Korean show a three-way distinction such as /p<sup>h</sup>/, /p'/, and /p/, /s/ is an exception in displaying only a two-way distinction, i.e., /s'/ vs. /s/, but *\*[s<sup>h</sup>]*. This requires a markedness constraint ruling out /s<sup>h</sup>/, which is undominated in Korean.

Comparison of (35a) and (35b), however, shows that clusters /h-s/ and /s-h/ end up with totally different outputs, i.e., [s'] and [t<sup>h</sup>] respectively. A closer examination of the data leads to a generalization that the features in the onset position do not change -- continuancy in (35a) and spread glottis in (35b). It is cross-linguistically well-attested that onset position is more stable than coda position in terms of phonological aspects. For example, many languages show obstruent neutralization in coda position or assimilation of coda consonants to the following onset consonants. Based on these observations, we propose the following constraints:

(36) \*s<sup>h</sup>: No aspirated /s/

(37) IDENT-IO(feet-onset): Features of an onset segment in the input must be identical in the output.

The following tableau shows how constraints \*s<sup>h</sup> and IDENT-IO(f-o) conspire with the other constraints discussed above.<sup>7</sup>

(38) /coh-so/ --> [cos'o] \*[cohso] \*[cos<sup>h</sup>o] \*[cot<sup>h</sup>o] 'Good!' (35a)

CVC' CV      co h so	Align-L	*s <sup>h</sup>	IDENT-IO (f-o)	MAX-IO (h)	MAX-IO (C)
a. CV . CV      co s <sup>h</sup> o		*!			*
b. CVC' . CV        co h s o	*!				
c. [-c][+c, cg]     CVC' . CV    \ /   co s o				*	
d. CV . CV      co t <sup>h</sup> o			*!		*
e. CV . CV      co so				*	*!

Note that constraints Align-L, \*s<sup>h</sup> and IDENT-IO(f-o) should be ranked over MAX-IO (h) and MAX-IO (C). Candidates (38a, b, d) incur a violation of one of the top-ranked constraints each. (38d) fails IDENT-IO(f-o) because it has changed its continuancy in the onset

<sup>7</sup>In (38), the first half of the geminate /ss/ in the winning candidate is neutralized to satisfy CODA-COND. On the other hand, the second half becomes tensed; hence [constricted glottis]. Also note that as discussed above, [cos'o] will be selected as optimal in casual speech with the ranking \*Geminate-C[-son] > MAX-IO(C).

segment. Both the remaining candidates satisfy the top-ranked constraints, and tie in violating MAX-IO(h). With the next constraint down the hierarchy, candidate (38c) fares better, hence the optimal output.

The process in /t<sup>h</sup>as-ha-ta/ → [t<sup>h</sup>at<sup>h</sup>ada] in (35b) is indeed strong evidence for identity of onset feature. The optimal output satisfies this constraint at the expense of changing identity of continuancy. Since /s/ is not compatible with /h/, it neutralizes to /t/ and then coalesces with the onset /h/ to surface as an aspirated stop, i.e., [t<sup>h</sup>].

#### 4. Conclusion

To sum up, we have discussed the different behaviors between a stem-final /h/ and an onset /h/, mainly focusing on aspiration as coalescence; intervocalic /h/-deletion; and gemination of /n/ preceded by /h/, and /h/ in contact with /s/ from the perspective of Correspondence Theory. The main result of our analysis was obtained by ranking the faithfulness constraints below the language specific markedness constraints: *Align-L(h, σ)*, *\*[-son][h]%* > *MAX-IO(h)*. Our analysis has also resolved the issue on optionality: [kak<sup>h</sup>a] and [kakk<sup>h</sup>a] are two optional surface forms of /kak-ha/. Given the free ranking between two crucial constraints, *MAX-IO(C)* and *\*Geminate-C*, the grammar selects either a degeminated form or a geminated one.

With regard to the intervocalic /h/-deletion, we have argued that the deletion is the result of ranking *Align-R(C', σ)*, which prevents the stem-final *h*'s from surfacing in the onset above faithfulness constraints on *h*. Finally, we dealt with the deletion of a stem-final /h/ when followed by the suffixes beginning with /n/ or /s/. In the presence of /n/, the /h/ undergoes complete assimilation, resulting in a geminate [nn]. When followed by /s/, the /h/ deletes, and the following /s/ becomes tense. These phenomena were accounted for by positing the language specific markedness constraints such as *\*[+son, h]* and *\*s<sup>h</sup>*.

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