# Asymmetric occurrence of glide formation and compensatory lengthening in Korean: an OT-CC analysis*

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**Park, Chang-beom. 2009. Asymmetric occurrence of glide formation and compensatory lengthening in Korean: an OT-CC analysis.** *Studies in Phonetics, Phonology and Morphology* 15.3. 441-464. The main purpose of this paper is to provide a new look on the nature of compensatory lengthening (henceforth CL) found in Korean glide-formation (henceforth GF). Korean has two types of GF: obligatory and optional one. The occurrence of CL is, interestingly, limited only in optional GF. Such asymmetric distribution of CL in Korean is accounted for in this study by employing OT-CC and partial free ranking. The basic concept is like this: (i) difference between obligatory and optional GF is based on the Korean grammar: if Korean allows either form (GF or non-GF), optional GF occurs, resulting in stylistic variation, and otherwise, only single form surfaces (obligatory GF), (ii) asymmetric occurrence of CL results from the chain construction which depends on the constraint hierarchy, thus, each first chain member of obligatory and optional GF has different syllable structure with each other, resulting in non-occurrence or occurrence of CL. **(Seowon University)**

Keywords: compensatory lengthening, glide formation, mora, variation, derivation, hiatus resolution, OT-CC, chain condition, partial free ranking

## 1. Introduction

A well-known phenomenon called as Compensatory Lengthening (henceforth CL) is usually defined as lengthening of a segment (vowel), resulting from loss of another segment, to compensate it. The most widely accepted approach for CL is moraic theory (Hayes 1989).

However, the nature of CL in Korean shows somewhat different aspects to be accounted for by moraic theory alone, since CL occurs in glide formation (henceforth GF) as well as segmental deletion. Moreover, the occurrence of CL is limited to its environment: CL does not occur in every GF.

The primary goal of the present study is to provide an explicit account of the nature of CL found in Korean GF. For this, this paper is structured as follows. Section 2 introduces asymmetric occurrence of both GF and CL in Korean, and reviews some previous approaches before OT. In section 3, I overview two theoretical backgrounds adopted in this study: OT-CC and partial free ranking. In section 4, I provide an analysis on CL and GF in Korean. Section 5 contains a discussion comparing alternatives in OT. Section 6 concludes this paper.

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## 2. Compensatory lengthening in Korean

### 2.1 Glide-formation and compensatory lengthening

Hiatus, a vowel sequence across a syllable boundary, is a dispreferred structure cross-linguistically. In Korean, several strategies are used in order to avoid hiatus such as vowel deletion, epenthesis, glide formation, coalescence, and others (see J. Kim 2000 for details). Among them, I shall focus on GF in this study. Let us look at the following examples:[1]

(1) Glide-formation in Korean[2]

| | | | |
|---|---|---|---|
| /s’au-ə/ | [s’a.u̯ə] | *[s’a.u.ə] | ‘to fight’ |
| /pei-ə/ | [pe.i̯ə] | *[pe.i.ə] | ‘to be cut’ |
| /moi-ə/ | [mo.i̯ə] | *[mo.i.ə] | ‘to gather’ |
| /o-a/ | [u̯a] | *[o.a] | ‘to come’ |

As shown in (1), when hiatus is created as a result of suffixation, high vowels /i/ and /u/ in a vowel sequence are parsed into the onset, to avoid hiatus.[3]

However, such avoidance of hiatus does not always happen in Korean. Take a look at the examples below:

(2) Optional glide-formation

| | | | |
|---|---|---|---|
| /ki-ə/ | [ki.ə] | [ki̯ə:] | ‘to crawl’ |
| /pi-ə/ | [pi.ə] | [pi̯ə] | ‘to empty’ |
| /tu-ə/ | [tu.ə] | [tu̯ə:] | ‘to put’ |
| /po-a/ | [po.a] | [pu̯a:] | ‘to see’ |

The examples in (2) represent that either form is possible: tolerance or avoidance for hiatus. The choice relies on speaker’s speech rate: stylistic variation. Thus, the former forms surface in formal or slow speech tolerating hiatus, while the latter in casual or fast speech resulting in GF.

There is a challenging aspect concerning vowel length in the data. Thus, optional GF as in (2) involves compensatory lengthening, whilst obligatory one as in (1) does not. For example, in casual speech of /po-a/ ‘to see’, CL

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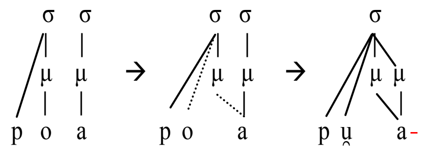
[1] The Korean data in this paper are mostly from O. Kang (1999a,b), J. Kim (2000), and M. Lee (2001), unless any specific reference is given.

[2] In this paper, I shall use the symbol “ ̯ ” to stand for non-syllabic vowels, so called “glides”.

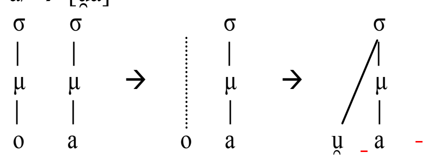
[3] In this paper, I assume that glides are high vowels parsed in the onset, namely non- nucleus position, following B. Lee (1982), S. Ahn (1985, 1988), J. Lee (1992), Y. Lee (1993, 1994), S. Cheon (2002), C. Park (2008), among others.

occurs as [pu̯a:] during the course of GF.[4] By contrast, CL never occurs as in [u̯a] from /o-a/ 'to come', which shows obligatory GF. In moraic theory (Hayes 1989), this situation can be illustrated as follows:

(3) a. /po-a/ → [pu̯a:]




b. /o-a/ → [u̯a]




As seen in (3a), GF occurs without mora deletion, resulting in CL. However, in (3b), GF accompanies deletion of mora: CL does not occur.

To sum up, obligatory GF in Korean does not involve CL. In other words, a prosodic structure like mora should be deleted during the course of GF, in terms of moraic theory. On the other hand, optional process involves CL. When casual forms are derived from inputs, mora should be preserved during the course of the process.

### 2.2 Problems of pre-OT approaches

One may raise a question with regard to CL in Korean: why does CL occur only in optional GF, especially casual forms, while it does not occur in obligatory GF? In other words, a successful analysis should capture the asymmetric occurrence of CL in optional and obligatory GF. In this sub-section, I will briefly review some pre-OT analyses to CL in Korean. The OT alternatives will be examined in the next sub-section.

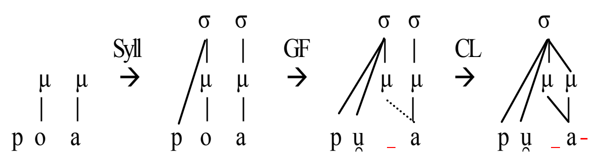
In pre-OT analysis, distinction between CL in optional forms and non-CL in obligatory ones mostly depends on somehow stipulative assumption. E. Han (1990) suggests that moras do not exist in the underlying representation (following McCarthy and Prince 1986) and words are classified into two groups: early syllabification and late one. For example, /po-a/ 'to see' belongs to early syllabification class, which is syllabified before affixation: e.g. $po_{\mu}$ + a. As a result, after glide formation, mora is still preserved, inducing CL: e.g. $po_{\mu}$ + a (early syllabification) →

[4] Although vowel length contrast in Korean is lost in the younger generation, CL in GF has still been widely accepted phenomenon in Korean phonology in many works, especially Y. Lee(1993), O. Kang (1999a,b), N. Kim & H. Sohn(1999), J. Kim (2000), and M. Lee (2001).

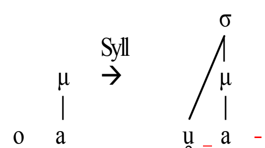
po$_{\mu}$a$_{\mu}$ (syllabification) → pu̯a$_{\mu\mu}$ (GF and CL). On the other hand, /o-a/ 'to come' is supposed to be late syllabification class, which is syllabified after affixation. Consequently, CL dose not happen: e.g. o + a → u̯a$_{\mu}$ (syllabification and GF). However, the problem of this approach is that the division of syllabification into early and late level seems too arbitrary. It is unpredictable which word is early syllabified and which one is late.

Y. Lee (1993) proposes different analysis on this matter. In his approach, moras are assumed to exist in the underlying representation, following Hayes (1989), and vowels are divided into two classes: moraic and non-moraic vowels. For example, the vowel /o/ in /po-a/ is regarded as moraic, while /o/ in /o-a/ is non-moraic. The following figures show how this assumption makes the different result:

(4) a. moraic vowel




b. non-moraic vowel




As illustrated in (4), CL occurs, after moraic vowels undergo glide -formation. In this situation, stylistic variation (optionality) is possible: a form before GF and after syllabification is formal speech, and final form is casual speech. By contrast, non-moraic vowels cannot induce CL, since they have no mora to be preserved, as shown in (4b). In addition, they do not cause optional forms, since hiatus are always avoided owing to their non-syllabicity.

Although this analysis explains why CL occurs only in optional GF (casual forms), the solution still depends on the arbitrary distinction between optional and obligatory GF, similar to Han's (1990). Thus, the distinction is rooted in diacritic lexical information: moraic and non-moraic vowels. This approach would be undesirable if it is possible to predict the distinction phonologically.

## 2.3 Problems of OT approaches

CL has been troublesome in classical OT which prohibits intermediate levels beyond direct input-output mapping, since CL usually occurs during the series of process, derivation. For this reason, CL has been accounted for by various mechanisms in OT, demanding more than two levels of representation.

The most seemingly successful approaches on CL in Korean GF would be O. Kang (1999a,b) and N. Kim & H. Sohn (1999), which employ OO-correspondence (Benua 1995). Basic idea is like this:

(5) Basic idea employing OO-correspondence for /po-a/ 'to see'
(adapted from O. Kang 1999a: 3)

/$po_{\mu}$-$a_{\mu}$/ → [$po_{\mu}$.$a_{\mu}$] ~ [pu̯$a_{\mu\mu}$]

/$po_{\mu}$-$a_{\mu}$/

I-O (*CG >> ONS)

[$po_{\mu}$.$a_{\mu}$] ⋯⋯→ [pu̯$a_{\mu\mu}$]

Slow sp. O-O Fast sp.

(ONS >> *CG)

In this mechanism, two optimal outputs are available, since there are two separate correspondent relations: IO and OO correspondence. According to O. Kang (1999a,b), IO ranking produces formal (slow-speech) forms and OO ranking casual (fast-speech) forms. For example, let us look at the following tableau:[5]

(6) Slow speech: /po-a/ → [po.a] (adapted from O. Kang 1999a: 7)

| /$po_{\mu}$-$a_{\mu}$/ | *CG | ONS | ID-IO(μ) | MAX-IO(μ) |
|---|---|---|---|---|
| a. ☞ $po_{\mu}$.$a_{\mu}$ | | * | | |
| b. pu̯$a_{\mu}$ | *! | | * | * |
| c. pu̯$a_{\mu\mu}$ | *! | | ** | |

According to the ranking in (6) representing slow speech, the candidate (6a) is the winner, since (6b, c) crucially violate *CG. On the other hand, the ranking and constraints for fast speech is as follows:

[5] *CG means that no consonant-glide complex in onset. In addition, ID-IO(μ) demands that mora specification of input and output segments should be identical. Therefore, the candidate (6c) for example violates ID-IO(μ) twice.

(7) Fast speech: /po-a/ → [pu̯a:] (adapted from O. Kang 1999a: 8)

| /po$_\mu$-a$_\mu$/ Base: po$_\mu$a$_\mu$ | ONS | MAX-OO(μ) | *CG | ID-OO(μ) |
|---|---|---|---|---|
| a. po$_\mu$.a$_\mu$ | *! | | | |
| b. pu̯a$_\mu$ | | *! | | * |
| c. ☞ pu̯a$_{\mu\mu}$ | | | | ** |

In this OO correspondence for fast speech, the ranking is quite different from that of IO correspondence as in (6). As a result, the winner is (7c).

However, this approach has a problem with the case of /o-a/ 'to come'. Let us consider the following tableau:

(8) /o-a/ → [u̯a] (☹ = actual output, 💣 = wrong output)

| /o$_\mu$-a$_\mu$/ | *CG | ONS | ID-IO(μ) | MAX-IO(μ) |
|---|---|---|---|---|
| a. 💣 o$_\mu$.a$_\mu$ | | ** | | |
| b. ☹ u̯a$_\mu$ | *! | | * | * |
| c. u̯a$_{\mu\mu}$ | *! | | ** | |

Under the ranking for IO correspondence, the candidate (8a) is the winner. However, this is the wrong result, since the actual output is (8b): /o-a/ is only pronounced as obligatory GF [u̯a] in Korean. To solve this problem, O. Kang (1999a) proposes another ranking like this:

(9) /o-a/ → [u̯a] (adapted from O. Kang 1999a: 17)

| /o$_\mu$-a$_\mu$/ | ONS | ID-IO(μ) | *CG | MAX-IO(μ) |
|---|---|---|---|---|
| a. o$_\mu$.a$_\mu$ | **! | | | |
| b. ☞ u̯a$_\mu$ | | * | * | * |
| c. u̯a$_{\mu\mu}$ | | **! | * | |

Obviously, this is an ad-hoc solution, resulting in ranking paradox. In fact, however, this problem may simply be solved by employing self local conjunction of ONSET as I propose in the section 4.2 below: [ONSET & ONSET] (=ONS$^2$). Thus, a candidate that violates ONSET twice will always be ruled out if [ONSET & ONSET] is high ranked in a given language.

Another problem is the fact that the status of obligatory GF like [u̯a$_\mu$] is ambiguous: formal or casual form? This form seems to be fast speech by its appearance as GF, but it also could be slow speech, since it is directly from the input (IO correspondence).

More fundamental problem of this approach is that the formalization of stylistic variation by adopting OO-correspondence may proliferate redundant inputs, constraints and rankings as a whole. Under this approach, both slow and fast speech are the result of the separate mapping: IO mapping for slow speech and OO for fast. This implies that two forms in the relation of variation are derived from the different dimension with each other. For example, starting point of the fast form [pu̯a$_{\mu\mu}$] is the slow form [po$_{\mu}$.a$_{\mu}$] as a base which is the output form of the input /po-a/. Moreover, the slow form [po$_{\mu}$.a$_{\mu}$] is selected by constraints and ranking for IO correspondence, while the fast form [pu̯a$_{\mu\mu}$] is selected by those for OO correspondence. Every dimension essentially requires different inputs, constraints and rankings with each other. This mechanism faces more serious problem when it comes to additional variation forms. For example, if faster form than [pu̯a$_{\mu\mu}$] is found in Korean, another OO correspondent relation would be added to account for the new form. Supposing new correspondent relationship inevitably multiplies additional inputs and constraints as well as rankings. Obviously, such strategy is undesirable from both viewpoints of economy and simplicity. Rather, it would be more appealing to formalize such variations simply by changing ranking (grammar) with common input and constraints, as Anttila (2006) claimed: "variation arises when one input yields multiple outputs."

In section 4 below, I will provide a novel approach to CL in Korean GF which does not face the problems as seen so far.

## 3. Theoretical backgrounds

Before analyzing CL in Korean, I shall give a brief overview of two theoretical backgrounds that I shall adopt for my analysis.

### 3.1 OT-CC

OT-CC (Optimality Theory with Candidate Chains) is proposed in McCarthy (2007) to solve opacity problems in classic OT. The term of 'opacity' originated in Kiparsky (1973: 79):

(10) A phonological rule *P* of the form A → B / C__D is opaque if there are surface structures with either of the following characteristics:
a. instances of A in the environment C__D.
b. instances of B derived by *P* that occur in environments other than C__D.

(10a) describes a situation where a surface structure like CAD is not affected by a phonological rule like A → B/C__D, even if the structure meets the environment of the rule, as CAD does. (10b) refers to the case where a surface structure like CBE is affected by a phonological rule like A → B/C__D, even if the structure does not meet the environment of the rule, as in CAE.6 Both situations can simply be supposed by derivational rule ordering like this:

[6] In the terms of McCarthy (1999: 332), the effect of (11a) is non surface-true, and that of (11b) non surface-apparent.

(11) a. /CED/
N/A (A→B/C__D)
CAD (E→A/__D)
[CAD]

b. /CADF/
CBDF (A→B/C__D)
CBEF (D→E/__F)
[CBEF]

In (11a), the underlying form is /CED/ which is not affected by the rule *P* in (10), and another rule, E → A/__D, is applied after the rule, resulting in CAD. That is why the surface form [CAD] looks not applied by the rule *P*. In (11b), *P* is applied to the underlying form /CADF/, which changed into CBDF. And then, another rule, D → E/__F, is applied, resulting in CBEF. For this reason, the surface [CBEF] looks over-applied by *P*. The crucial point here is that the rules should be applied in a strict order.

There has been much debate on such phonological opacity since the introduction of parallel-based OT. The specific problem is that OT does not allow intermediate levels between the input and the output as well as derivational rule ordering. Various mechanisms have been proposed in order to overcome the opacity problem in OT, even though they have been all proven to be fallen short, owing to some unexpected results, wrong typological predictions, giving up parallelism, and others.[7]

McCarthy (2007) proposes OT-CC to overcome the problems that previous approaches have for phonological opacity. The basic concept of OT-CC is similar to classic OT, in that grammar consists of five core components (input, candidates, CON, GEN, and EVAL), and the output is selected by competition of the candidates (potential output forms), and the competition depends on constraint ranking in a parallel way. However, the fundamental difference between classic OT and OT-CC is that OT-CC allows derivation. This means that EVAL considers derivational process as well as the input and output. Allowing derivation in OT is possible by slight modification of the candidates: a candidate includes a series of intermediate forms like chains, instead of a single form. In the candidate chain, the first member is the most faithful one to the input, and the last one is the output as in classic OT. The candidate chain should satisfy the following requirements:

(12) Conditions of candidate chain (abstracted from McCarthy (2007: 61)

a. Faithful first member: The first member of every candidate chain based on the input /in/ is a fully faithful parse of /in/. A fully faithful parse of /in/ is any analysis of /in/ that violates no faithfulness constraints. The fully faithful parse can therefore differ from /in/ in any phonological property that is not protected by faithfulness constraints. There can be more than one fully faithful parse of /in/; the one that actually initiates a chain is determined by the principle of

7 See Kager (1999) and McCarthy (2002) for brief introductions and comparisons of the various mechanisms, especially McCarthy (2007) for criticism of them, and Roca (1997) for a review of various opacity problems in OT.

local optimality in (12c) below.

b. Gradualness: A single violation of a basic faithfulness constraint in a specific location in a form is a localized unfaithful mapping, or LUM. Gradualness embodies two related requirements: the successive forms in a candidate chain are required to accumulate all of their predecessors' LUMs; and a form adds exactly one LUM to those of its immediate predecessor.

c. Local optimality: In OT-CC, unlike classic OT, the candidates derived from a particular input can differ from language to language. The source of this difference is the local optimality requirement, which has two aspects:

(a) The initial form of a chain is the fully faithful parse of the input that is most harmonic according to the constraint hierarchy of the language in question. In other words, it is locally optimal among all faithful parses.

(b) Every noninitial form in a chain is more harmonic than its predecessor (=harmonic improvement). It is also more harmonic than every other form that can be derived by violating the same basic faithfulness constraint (=best violation).

Once valid candidate chains are supplied by GEN following the conditions in (12), they are evaluated by EVAL. However, a question arises in this connection. In OT-CC, like classic OT as well, markedness constraints only evaluate the output forms (the last member of a chain), and faithfulness constraints examine the input-output correspondence. Then, how can intermediate members in a chain be considered? If not, there would be no way to allow derivation in OT. For this purpose, MaCarthy (2007) propose a novel constraint, PREC(edence), which determines the preferred order of faithfulness violations in a chain. The constraint is defined as follows:

(13) PREC constraints (McCarthy 2006: 25)

PREC (A, B)

Let A' and B' stand for forms that add violations of the faithfulness constraints A and B, respectively.

To any chain of the form <X, B', Y>, if X does not contain A', assign a violation mark, and

to any chain of the form <X, B', Y>, if Y contains A', assign a violation mark.

Informally, PREC(A,B) states that violation of B must be preceded and not followed by violation of A, in local mapping. For example, if a candidate chain include violation order like B and then A, it violates PREC(A,B) twice. If only B is violated in any member of a chain, the candidate chain violates the constraint once. Otherwise, no violation is incurred. More specific examples are given in section 4.

### 3.2 Partial free ranking

In order to analyze CL in Korean, I will briefly explore the treatment of variation in OT. Forms involving two or more optimal outputs in free variation raise a challenge to OT, because an OT grammar selects a single output as the most harmonic candidate. Of course, two candidates may be optimal outputs if they incur even violations of the given constraint hierarchy. Take a ranking like (14):

(14) Anttila (1997: 45)

| | A | B | C |
|---|---|---|---|
| a. ☞ $cand_1$ | * | | |
| b. ☞ $cand_2$ | * | | |

If the constraint hierarchy in a given grammar is A >> B >> C, and two candidates equally violate constraint A, without any further violation of the other constraints, both of them will be optimal outputs and will exhibit free variation.

Unfortunately, this is not a real life situation, simply because, if two candidates are different, they must incur different violation marks for any constraint, from the perspective of OT. Thus, ‘if two output candidates O and O’ are different in grammatical terms, then this difference must be relevant to some constraint(s) in the hierarchy. This implies that O and O’ do not share violations marks, hence one is more harmonic than the other with respect to the hierarchy.’ (Kager 1999: 404, similarly in Anttila 1997: 45). How, then, can free variation be formalised in OT?

There have been a number of proposals concerning this matter.[8] Morris (1998) classifies the proposals in two groups. One is the ‘floating constraint’ approach of Reynolds (1994), Nagy & Reynolds (1997), Morris (1998), and others. The alternative is the ‘partial free ranking’ approach of Kiparsky (1993, 1994), Anttila (1997, 2002, 2006), Itô & Mester (1997), and many others. In addition, ‘tied ranking’ (Broihier 1995), ‘negative constraints’ (Hammond 1994), ‘relative unordered ranking’ (Sells et. al. 1996), and ‘reversible ranking’ (M. Lee 2001) are also proposed for variation or optionality. Inevitably, most of them involve constraint re-ranking, since different outputs require different rankings in an OT grammar. In this paper, I adopt the ‘partial free ranking’ model, simply because of its straightforward formalization. The basic concept is like this. Under free ranking, two conflicting constraints A and B are freely ranked with each other, resulting in variable outputs. Let us look at the example:

8 For detailed discussion of them, see the references therein.

(15) Partial free ranking

| | C | A | B |
|---|---|---|---|
| a. ☞ $cand_1$ | | * | |
| b. ☞ $cand_2$ | | | * |
| c. $cand_3$ | *! | | |

Strictly speaking, Anttila(1997) only allows pairs of constraints to be free ranked, and uses at least two tableaux: e.g. [A >> B] and [B >> A]. However, I will not limit the number of constraints to be free ranked, following 'floating constraints' of Reynolds (1994), which allows a radical ranking permutation within a specified range of the hierarchy. In addition, I will use a single tableau as in (15), following the way of 'relative unordered ranking' (Sells et. al. 1996) and 'reversible ranking' (M. Lee 2001).

## 4. Application to CL in Korean GF

In this section, I shall provide an explicit analysis of CL in Korean GF, within the framework of OT-CC and partial free ranking.

### 4.1 Generalization of CL in Korean GF

At first, we need to generalize CL in Korean GF as follows:

(16) Generalization of CL in Korean GF
  a. Once hiatus is tolerable in surface, its hiatus resolution form is also possible, resulting in stylistic variation; CL occurs during the course of the hiatus resolution process.
  b. Once hiatus is intolerable, only hiatus resolution form surfaces; CL does not occur.

My analysis is based on this generalization. However, more specific details are required, mainly with regard to two questions: (i) what makes distinction between tolerable and intolerable hiatus resolution? (ii) why does CL occur only in optional GF? The answers will clearly be provided in the following sections.

### 4.2 Basic constraints and ranking

If we carefully compare the data in (1) with (2) above, we can observe that the environment of obligatory GF is different from that of optional one. I reintroduce the data as follows, for convenience:

(17) Glide formation

a. Obligatory glide-formation

| | | | |
|---|---|---|---|
| /s’au-ə/ | [s’a.u̯ə] | *[s’a.u.ə] | ‘to fight’ |
| /pei-ə/ | [pe.i̯ə] | *[pe.i.ə] | ‘to be cut’ |
| /moi-ə/ | [mo.i̯ə] | *[mo.i.ə] | ‘to gather’ |
| /o-a/ | [u̯a] | *[o.a] | ‘to come’ |

b. Optional glide-formation

| | | | |
|---|---|---|---|
| /ki-ə/ | [ki.ə] | [ki̯əː] | ‘to crawl’ |
| /pi-ə/ | [pi.ə] | [pi̯ə] | ‘to empty’ |
| /tu-ə/ | [tu.ə] | [tu̯əː] | ‘to put’ |
| /po-a/ | [po.a] | [pu̯aː] | ‘to see’ |

As shown in (17a), intolerable hiatus forms like *[s’a.u.ə] and *[o.a] seem to be blocked by high ranked well-formedness constraints, compared with tolerable forms in (17b). In other words, Korean grammar never allows two adjacent onsetless syllables (.V.V sequences) (as noticed in Y. Lee 1994). Problem is that the constraint ONSET cannot rule out such sequences consistently, regardless of its ranking. For example, although *[s’a.u.ə] violates ONSET twice, it still could defeat [s’a.u̯ə] when a constraint like *u̯ dominates ONSET, as already seen the similar situation in §2.3 above. I suggest self local conjunction of ONSET which is undominated in Korean, to handle the problem: [ONSET & ONSET] (=$ONS^2$). Local constraint conjunction (Smolensky 1993, 1995, Crowhurst and Hewitt 1997, and many others) implies ‘banning the worst of the worst’ (Prince and Smolensky 1993: 180). I assume that the violation of the constraint twice (ONSET) at the same time during suffixation is crucial so that the wrong examples like *[s’a.u.ə] and *[o.a] can be ruled out. This constraint conjunction plays a crucial role to differentiate optional and obligatory GF automatically.

I also introduce the following constraints to account for the phenomenon:

(18) a. $*M/V_{[-high]}$: no non-high vowels in the margin[9]
(henceforth *o̯ in the interest of simplicity)
b. $*M/V_{[+high]}$: no high vowels in the margin (*u̯/*i̯)
c. *o: no vowel [o] / *u: no vowel [u]
d. MAX(μ): no deletion of mora
e. UNIFORMITY(μ): no segment has multiple correspondents for mora
(no coalescence of mora)

The markedness constraints $*M/V_{[-high]}$ and $*M/V_{[+high]}$ in (18a,b) seem to have originated in the *M/V (no vowels in the margin) of Prince and

9 Here, the margin represents non-syllabic position.

Smolensky (1993).[10] The reason why I separate high and non-high vowels is to distinguish the candidates like [o̯a] and [u̯a]. More detailed examples are provided in the following sub-sections.

Other markedness constraints *o and *u in (18c) are introduced for Korean vowel inventory.[11] In addition, I will assume that *o outranks *u, based on the historical change of the vowels in Korean. For example, vowel [o] in non-initial syllables tends to neutralize into [u] historically. Korean words like **k'aŋc*$^h$*oŋ* 'hopping' have already changed into *k'aŋc*$^h$*uŋ*, and many others like *patoŋ* 'struggling' have variation forms as *patuŋ*. Moreover, suffixes like *–ko* 'and' are pronounced as *–ku* in younger generation: e.g. *p*$^h$*alko ~ p*$^h$*alku* 'to sell and'.

The faithfulness constraints MAX(μ) and Uniformity(μ) in (18d,e) are to prohibit deletion of mora and to coalescence of mora, respectively.

Finally, I propose basic ranking as follows:

(19) ONS$^2$ >> *o̯ >> ONS >> *u̯/i̯ >> ID(hi) >> *o >> MAX(μ) >>
UNIFORMITY(μ) >> *u

In this ranking, three constraints in a box represent partial free ranking, which implies they are ranked freely, causing stylistic variation.

### 4.3 The choice of the first chain member

In this paper, I assume that any prosodic units like mora as well as syllable structure are absent in the input (underlying representations), unless they are required for lexical vowel length, syllabicity of high vowels (c.f. C. Park 2008), or so. This assumption follows recent works like Sprouse (1997), McCarthy (1999), Shaw (2007) and among others, from the viewpoint of Richness of the Base and other reasons (related discussion is given in 4.5 below.).

Since every member of a chain should be pronounceable output, according to the architecture of OT-CC, syllabification including moraic structure is determined from the first members. Following Shaw (2007), I assume that moraic specification is rooted in the principle of Weight-by-Position (Hayes 1989), which is undominated in the ranking. Interestingly, there could be one more possible first members of a chain. For example, both forms [tab.la] and [ta.bla] are fully faithful candidates for the input /tabla/, since no syllabic specification is in the input. In this situation, the choice is based on the chain condition in (12): if one more

[10] An anonymous reviewer suggests that more universal constraint like *Complex-Onset would be desirable for this purpose. However, the main reason why I introduce *M/V is to distinguish the quality of onset vowels regardless of occurrence of non-occurrence of preceding consonants.

[11] I simply regard that the constraints like *o and *u are universal to determine segmental inventory of a language.

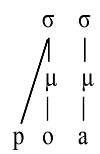
candidates are possible as the first member, they depend on the constraint hierarchy of a language in question. Thus, the first candidate will be [tab.la], instead of [ta.bla], if *Complex-Onset outranks NoCoda in the language (McCarthy 2007: 72).

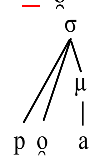
Returning to the Korean case, two forms are possible as the first chain member for the input /po-a/ 'to see': [po$_{\mu}$.a$_{\mu}$] and [po̯a$_{\mu}$].[12] Similarly, [o$_{\mu}$.a$_{\mu}$] and [o̯a$_{\mu}$] are possible for the input /o-a/ 'to come'.[13] However, they result in different first members. Compare the following examples:

(20) Different first members of the chain for /po-a/ and /o-a/

a. /po-a/ <po$_{\mu}$.a$_{\mu}$> **<po̯a$_{\mu}$ >[14]

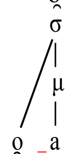
violation: ONS *o̯

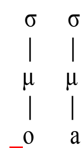



b. /o-a/ <o̯a$_{\mu}$> **<o$_{\mu}$.a$_{\mu}$>

violation: *o̯ ONS$^2$




In the situation of (20a), even though two candidates are fully faithfulness (no violation of any faithfulness constraints), the first candidate chain is selected as <po$_{\mu}$.a$_{\mu}$>, instead of **<po̯a$_{\mu}$>, because of the constraint hierarchy as in (19). Thus, <po$_{\mu}$.a$_{\mu}$> is the most harmonic candidate than the others, since it violates ONSET which is lower ranked than *o̯. By contrast, in (20b), the first chain is <o̯a$_{\mu}$>, instead of **<o$_{\mu}$.a$_{\mu}$>. Since ONS$^2$ is higher ranked than *o̯, the violation of *o̯ is more harmonic than that of the other. Consequently, different environment causes the different first members of a chain. Note here that the choice is not arbitrary but natural and automatic by the chain condition of OT-CC which determines

---

[12] Recall that the difference between [po$_{\mu}$.a$_{\mu}$] or [po̯a$_{\mu}$] depends on the syllabic position of /o/: it is parsed in nucleus position in the former, while it non-nucleus (onset) in the latter.

[13] In fact, other candidates like [oa$_{\mu}$] (diphthong) and [oa̯$_{\mu}$] (falling diphthong) can also be fully faithful member. With regard to them, NoSharedMora (Moras may not be shared; Broselow et al. 1997) and NoFallDiph would be introduced. However, I will ignore them here, since no diphthongs are allowed in Korean, except [ii̯] which is still controversial for the nature. I assume that the constraints are undominated in Korean phonology.

[14] Double asterisk represents an invalid candidate chain.

the first chain member depending on the constraint hierarchy (grammar) of a given language.

### 4.4 Analysis: valid chains and evaluation

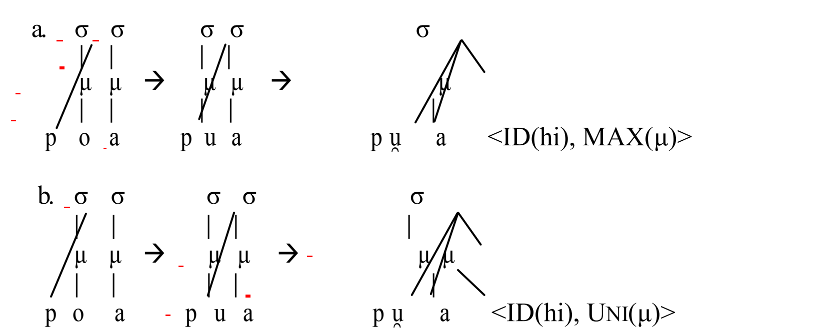
Now, let us look at how such different first chains affect the result. First, consider the following valid candidate chains for /po-a/ and their LUM (Localized Unfaithful Mapping) sequences:

(21) Valid candidate chains for /po-a/ and their LUM sequences

a. <po$_{\mu}$.a$_{\mu}$> < >
b. <po$_{\mu}$.a$_{\mu}$, pu$_{\mu}$.a$_{\mu}$> <ID(hi)>
c. <po$_{\mu}$.a$_{\mu}$, pu$_{\mu}$.a$_{\mu}$, pu̯a$_{\mu}$> <ID(hi), MAX(μ)>
d. <po$_{\mu}$.a$_{\mu}$, pu$_{\mu}$.a$_{\mu}$, pu̯a$_{\mu\mu}$> <ID(hi), UNI(μ)>

(21a) is the first chain member for /po-a/ as seen in the previous sub-section. (21b) is more harmonically improved chain by violating fathfulness constraint ID(high) to satisfy *o. (21c,d) are more harmonic ones than (21b), but they show different unfaithful mapping to satisfy ONSET: (21c) violates MAX(μ) while (21d) violates UNIFORMITY(μ). The situation is illustrated like this:

(22) Candidates in each chain for /po-a/




As seen in (22), the difference between two chains is only faithfulness constraints for mora they violate. In (22a), mora of [u] is deleted during the course of GF to avoid hiatus (or to satisfy ONSET), whereas it is parsed in the following vowel [a] for the same purpose, resulting in CL, in (22b). I propose the choice of the two chains depend on MinimalWord (McCarthy and Prince 1986, 1990, 1991, Y. Lee 1993, M. Lee 2001), stating that a prosodic word should be minimally bimoraic. Detailed discussion about the ranking of MinimalWord will be given below.

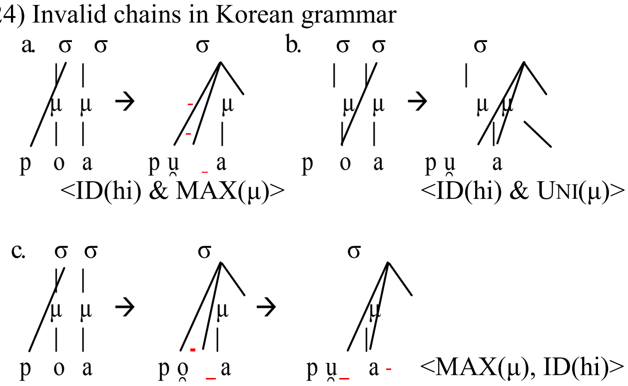
Before examining how it works, I will confirm why the chains of /po-a/ can only be limited to four types as in (21). Compared with such valid chains, invalid chains for /po-a/ are listed as follows:

(23) Invalid chains for /po-a/:

| | | |
|---|---|---|
| a. **<po̯a$_{\mu}$> | < > | —Wrong first chain |
| b. **<po$_{\mu}$.a$_{\mu}$, pu̯a$_{\mu}$ > | <ID(hi)&MAX(μ) > | No gradualness |
| c. **<po$_{\mu}$.a$_{\mu}$, pu̯a$_{\mu\mu}$ > | <ID(hi)&UNI(μ) > | No gradualness |
| d. **<po$_{\mu}$.a$_{\mu}$, po̯a$_{\mu}$, pu̯a$_{\mu}$> | _<MAX(μ),ID(hi)> | No harmonic improvement |

The reason why (23a) cannot be the first chain member is already shown in the previous sub-section. Chains like (23b,c) are invalid, since they are not gradual LUM, as illustrated below:

(24) Invalid chains in Korean grammar




As seen in (24a,b), each second candidate incurs two faithfulness violations at a time: ID(hi) and MAX(μ), ID(hi) and UNI(μ), respectively. Obviously, such radical unfaithful mapping is prohibited in OT-CC grammar as in (12b): gradualness. The reason why the mapping in (23d/24c) is invalid is based on the requirement of OT-CC stating "every noninitial form in a chain is more harmonic than its predecessor (=harmonic improvement)." (McCarthy 2007: 61) Thus, the problem of the second candidate [po̯a$_{\mu}$] in (24c) which violates faithfulness constraint MAX(μ) to satisfy ONSET, is that such change costs violating higher ranked *M/V$_{[\text{-high}]}$(=*o̯), which means the mapping is not harmonic improvement, according to the ranking as in (19).

Now, take a look at how valid candidate chains in (21) are evaluated in the tableau:[15]

[15] McCarthy (2007) and much following literature use the "comparative tableau format" proposed in Prince (1998, 2002). However, I will use classic format of OT in this paper, just to avoid confusion with regard to partial free ranking. In addition, recall that the constraints

(25) /po-a/ → [po.a] ~ [pu̯a:] ‘to see’

| /po-a/ | [ONS]$^2$ | *o̯ | MINWD | ONS | *u̯/i̯ | ID(hi) | *o |
|---|---|---|---|---|---|---|---|
| a. ☞ <po$_{\mu}$.a$_{\mu}$><br>< > | | | | * | | | * |
| b. <pu$_{\mu}$.a$_{\mu}$><br><ID(hi)> | | | | * | | *! | |
| c. < pu̯a$_{\mu}$><br><ID(hi), MAX(μ)> | | | *! | | * | * | |
| d. ☞ <pu̯a$_{\mu\mu}$><br><ID(hi), Uni(μ)> | | | | | * | * | |

In this tableau, each leftmost cell from the second low includes the final member of a chain and its LUM sequences, following McCarthy (2007). The optimal output is determined by free ranking permutation of the three constraints, resulting in free-variation. Although the number of constraints in free ranking and candidates is three and four, respectively, the possible number of optimal output is only two. Thus, if ONSET is higher ranked than the others, (25d) will be a winner. In this situation, the keenest competitor (25c) never defeats (25d), since it violates one more constraint MinimalWord.[16] If either *u̯/i̯ or ID(hi) dominates the others, (25a) will be a winner, since its competitor (25b) always loses because of violating one more constraint ID(hi). As a result, (25a) is tolerant in hiatus, while (25d) shows hiatus resolution and CL.

On the other hand, consider the valid candidate chains for /o-a/ ‘to come’ and their LUM sequences:

(26) Valid candidate chains for /o-a/ and their LUM sequences
a. <o̯a$_{\mu}$> < >
b. <o̯a$_{\mu}$, u̯a$_{\mu}$> <ID(hi)>

This case requires only two possible valid chains, according the constraint hierarchy in Korean. The first chain member as in (26a) which is already confirmed above violates *o̯. In order to satisfy the constraint, (26b) changes into [u̯a$_{\mu}$] violating ID(hi): harmonic improvement. The evaluation of them is illustrated in the following tableau:

like MAX(μ) and ID(μ) cannot be evaluated in the tableau, since mora specification is absent in the input. For this reason, I omit the constraints in the tableau.

16 Here, the ranking of MinimalWord is temporary, since it is not crucial at this point.

(27) /o-a/ → [u̯a] ‘to come’

| /o-a/ | [ONS]$^2$ | *o̯ | MINWD | ONS | *u̯/i̯ | ID(hi) | *o |
|---|---|---|---|---|---|---|---|
| a. <o̯a$_\mu$><br>< > | | *! | | | | | * |
| b. ☞ <u̯a$_\mu$><br><ID(hi)> | | | * | | * | * | |

As seen in the tableau (27), the candidate (27a) is crucially ruled out by *o̯ regardless of partial free ranking. Accordingly, only one form (27b) is possible in such cases, resulting in obligatory GF (intolerance of hiatus) and no CL.

I propose that MinimalWord is outranked by ONS$^2$ and WBP which is undominated in Korean, since if it outranks ONS$^2$, the first chain of /o-a/ would be **[o̯a$_{\mu\mu}$], misleading the wrong output as *[u̯a$_{\mu\mu}$], instead of [u̯a$_\mu$]. In addition, the reason why MinimalWord dominates the three constraints in free ranking is cleared by the examples like /ki-ə/ ‘to crawl’. Thus, if it is ranked below ONSET, the first member of /ki-ə/ will be **[ki̯ə$_\mu$], instead of [ki$_\mu$.ə$_\mu$]. Obviously, such wrong start misleads the result: *[ki̯ə$_\mu$], neither causing variation nor CL. Let us consider how this works to select the first candidate of /ki-ə/:

(28) First chain member selection for /ki-ə/

| /ki-ə/ | [ONS]$^2$ | WBP | *o̯ | MINWD | ONS | *u̯/i̯ |
|---|---|---|---|---|---|---|
| a. ☞ ki$_\mu$.ə$_\mu$ | | | | | * | |
| b. ki̯ə$_\mu$ | | | | *! | | * |
| c. ki̯ə$_{\mu\mu}$ | | *! | | | | * |

As seen above, (28a) is selected as the first chain member. (28b) is ruled out by Minimal Word, since it involves only one mora. (28c) violates Weight-by-Position, since its vowel [ə] lengthens unnecessarily.[17] Since the first member is selected as [ki$_\mu$.ə$_\mu$], it leads right outputs: either [ki$_\mu$.ə$_\mu$] or [ki̯ə$_{\mu\mu}$] with stylistic variation. The following tableau illustrates:

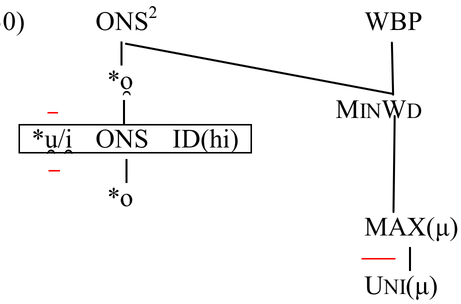
(29) /ki-ə/ → [ki.ə] ~ [ki̯əː]

| /ki-ə/ | [ONS]$^2$ | WBP | *o̯ | MINWD | ONS | *u̯/i̯ |
|---|---|---|---|---|---|---|
| a. ☞ <ki$_\mu$.ə$_\mu$><br>< > | | | | | * | |
| b. <ki̯ə$_\mu$><br><MAX(μ)> | | | | *! | | * |
| c. ☞ <ki̯ə$_{\mu\mu}$><br><Uni(μ)> | | | | | | * |

17 I simply assume here that WBP includes the constraint which bans non-derived segmental lengthening.

Finally, I sum up with a constraint tree of the overall ranking like this:

(30)




## 4.5 An alternative: moras in the input

The purpose of this sub-section is to corroborate the assumption in this paper that syllable structure including mora should be absent in the input. I now discuss one crucial reason for this view.

Suppose the situation of underlying mora specification for the examples like /$po_{\mu}$-$a_{\mu}$/ and /$o_{\mu}$-$a_{\mu}$/. Under my analysis, the first chain member for /$po_{\mu}$-$a_{\mu}$/ is <$po_{\mu}.a_{\mu}$>, and its valid chains are also same with (20a) above. However, the problem is /$o_{\mu}$-$a_{\mu}$/ which misleads the first chain member as <$o_{\mu}.a_{\mu}$>, instead of <o̯$a_{\mu}$> in (20b), since the most faithful parsing should preserve mora if exists. Needleless to say, this wrong beginning causes wrong result. Let us consider the following valid chains:

(31) Valid candidate chains for /$o_{\mu}$-$a_{\mu}$/ and their LUM sequences

a. <$o_{\mu}.a_{\mu}$> < >
b. <$o_{\mu}.a_{\mu}$, $u_{\mu}.a_{\mu}$ > <ID(hi)>
c. <$o_{\mu}.a_{\mu}$, $u_{\mu}.a_{\mu}$, u̯$a_{\mu}$ > <ID(hi), MAX(μ)>
d. <$o_{\mu}.a_{\mu}$, $u_{\mu}.a_{\mu}$, u̯$a_{\mu\mu}$ ><ID(hi), UNI(μ)>

With the chains in (31), the evaluation will be like the following tableau:

(32) /o-a/ → [u̯a] 'to come' (☹ = actual output, 💣 = wrong output)

| /$o_{\mu}.a_{\mu}$/ | [ONS]² | *o̯ | MINWD | ONS | *u̯/i̯ | ID(hi) |
|---|---|---|---|---|---|---|
| a. <$o_{\mu}.a_{\mu}$><br>< > | *! | | | ** | | |
| b. <$u_{\mu}.a_{\mu}$><br><ID(hi)> | *! | | | ** | | * |
| c. ☹ <u̯$a_{\mu}$><br><ID(hi), MAX(μ)> | | | *! | | * | * |
| d. 💣 <u̯$a_{\mu\mu}$><br><ID(hi), Uni(μ)> | | | | | * | * |

Actual output (32c) never defeats the candidate like (32d), since deletion of mora incurs the violation of MINWD. Since both candidates violate the same constraints except MINWD, it is inevitable to propose additional ranking permutation, in order to avoid the wrong result like (32d). Obviously, this strategy causes ranking paradox.

## 5. Conclusion

It is time to answer the two questions raised in section 2.3, to sum up my analysis of CL in Korean GF: (i) what makes distinction between tolerable and intolerable hiatus resolution? (ii) why does CL occur only in optional GF? A brief answer is like this: (i) difference between obligatory and optional GF is based on the Korean grammar: if Korean allows either forms (GF or non-GF), optional GF occurs, resulting in stylistic variation, and otherwise, only single form surfaces (obligatory GF), (ii) asymmetric occurrence of CL results from the chain construction which depends on the constraint hierarchy, thus, each first chain member of obligatory and optional GF has different syllable structure with each other, causing non-occurrence or occurrence of CL.

I briefly illustrate the main process of my approach as follows:

(33) Derivation and variation

a. /o -a/ → [o̯a$_{\mu}$] → [u̯a$_{\mu}$] —— Obligatory GF (no CL)

b. /po-a/ ⇉ [po$_{\mu}$.a$_{\mu}$] —— No GF (slow speech)

[po$_{\mu}$.a$_{\mu}$] → [pu$_{\mu}$.a$_{\mu}$] → [pu̯a$_{\mu\mu}$] —— GF (fast speech) with CL

As seen (33b), the different two outputs in variation, [po$_{\mu}$.a$_{\mu}$] and [pu̯a$_{\mu\mu}$], are derived from the input /po-a/. The difference is the result of speaker's speech rate represented by partial free ranking: stylistic variation. However, the only output like [u̯a$_{\mu}$] in (33) is available regardless of speaker's choice (by partial free ranking), since undominated constraint in Korean always prohibits the other form like *[o$_{\mu}$.a$_{\mu}$].

There are several important implications in my analysis. First, mora should not be specified in the input. Mora can be fully predictable by WBP, except in the case of lexical lengthening. Second, optional and obligatory distinction is unnecessary in partial free ranking, since only one (obligatory) form is available where the grammar in a given language prohibits certain forms consistently; otherwise, multiple outputs are possible. We don't need to cling to such an arbitrary distinction. Third, the choice of the first member of a candidate chain causes the occurrence and non-occurrence of CL. Note that, however, the choice should not be arbitrary but natural and automatic by the chain condition of OT-CC which determines the first chain member depending on the constraint hierarchy (grammar) of a given language.

In this study, I only aim at CL of GF in Korean. Of course, CL also occurs in many other processes in Korean, such as vowel deletion, coalescence, insertion, mostly for hiatus resolution. Therefore, more successful analysis should provide a unified account of CL in all kinds of forms found in Korean. I will leave this for further study.

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