

Aperture-related Rules and Syllable Structure

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Lee, Jong Kun(1995) **Aperture-related Rules and Syllable Structure**. *Linguistics vol. 3*. According to Itô (1986), syllabification consists of mapping the phonological string to the syllable template of the language, and syllabification is governed by syllable well-formedness conditions and a directional parameter. She assumes that every language has its own syllable template. However, I argue that a syllable template is not needed in many languages because either there are independently-motivated aperture-related phonological rules which obviate a syllable template, as in Korean, or there are aperture-related rules which might not be independently motivated, but they can simplify the grammar by eliminating both the syllable template and coda condition from the phonology of the language, as in Japanese. Instead of invoking a language-particular syllable template, I propose a very general syllabification principle saying "syllabify maximally" as long as the syllabification obeys other principles and rules.

1. Introduction

According to Itô (1986), syllabification consists of mapping the phonological string to the syllable template of the language, which is governed by syllable well-formedness conditions such as coda conditions and a directional parameter. She assumes that every language has a syllable template of some form. Thus, she writes that Japanese has the

syllable template [CVVC], Italian has the syllable template [CCVC], and Finnish has the syllable template [CVCC].

Itô claims that there is no redundancy in the grammar between a syllable template and syllable well-formedness conditions on the one hand, and other independently-motivated phonological rules on the other hand in a particular language. Contrary to Itô's claim, an analysis of Korean data suggests that no syllable template is needed in Korean. There are independently-motivated phonological rules which correctly block ill-formed syllabification in Korean. In fact, it will be shown that a syllable template is not needed in many other languages, either.

2. Aperture-related Rules in Korean and Syllabification

In English, the word *cat* can be pronounced either with the word-final stop *t* released or without the stop released. However, in Korean, the word-final *t* and all other word-final obstruents are always pronounced without release (oral airflow). In fact, an obstruent in Korean is released only if there is a following [-cons] sound. Examples are as follows:

- (1) a. *yak-i* 'medicine-NOMINATIVE'
ip^h-i 'leaf-NOM'
ip-i 'mouth-NOM'
kas-i 'hat-NOM'
k'oc^h-i 'flower-NOM'
- b. *kokyo* 'high school'
c^hwihata 'to be drunk'

However, Korean obstruents are not released word-finally, as we can see in (2) below¹.

- (2) /*yak*/ 'medicine' * [*yak^h*], [*yak*']
 /*ip*/ 'mouth' * [*ip^h*], [*ip*']
 /*kot*/ 'soon' * [*kot^h*], [*kot*']
 /*kas*/ 'kind of hat' * [*kas*], * [*kat^h*], [*kat*']
 /*puðk^h*/ 'kitchen' * [*puðk^h*], [*puðk*']
 /*coh*/ 'be fond of' * [*coh*], [*cot*']
 /*k'oc^h*/ 'flower' * [*k'oc^h*], * [*k'oc*], [*k'ot*']
 /*pyðk*/ 'wall' * [*pyðk^h*], [*pyðk*']

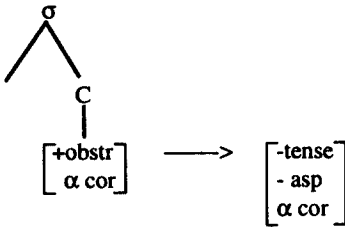
Note that even the fricative /s/ is not released word-finally. /s/ becomes [t'] in this environment.

A Korean obstruent is not released if it precedes a [+cons] sound, either. Let us look at the following examples:

(3) /yak-to/	'medicine, too'	*[yak ^h to], [yak't'o]
/ip-to/	'mouth, too'	*[ip ^h to], [ip't'o]
/kas-to/	'kind of hat, too'	*[kasto], *[kat ^h to], [kat't'o]
/puðk ^h -to/	'kitchen, too'	*[puðk ^h to], [puðk't'o]
/k'oc ^h -to/	'flower, too'	*[k'oc ^h to], *[k'octo], [k'ot't'o]
/pyðk-to/	'wall, too'	*[pyðk ^h to], [pyðk't'o]

Ahn (1985, p. 171) gives the following rule to account for the Korean data above:

(4) Coda-Obstruent Neutralization



e.g. $\left\{ \begin{array}{l} p, p', p^h \longrightarrow p \\ t, t', t^h, s, s', c, c', c^h \longrightarrow t \\ k, k', k^h \longrightarrow k \end{array} \right.$

However, it is not clear how /s/ or /s'/ becomes [t] by Rule (4). He seems to assume that [s] is [-asp], but this assumption is not entirely clear.

Steriade (1990, 1991) argues that closure and release are phonological objects. Steriade defines the terms closure and release in the following way:

- (5) a. Closure = A_0 , defined by total absence of oral airflow.
- b. Approximant Release = A_{max} , degree of aperture found in approximants.
- c. Fricative Release = A_f , degree of aperture found in fricatives.

Steriade (1990) gives the following examples of aperture phases:

- (6) a. plain, released stop = $A_0 A_{max}$
- b. unreleased stop = A_0
- c. affricate(d stop) = $A_0 A_f$
- d. approximant = A_{max}
- e. fricative = A_f

If we assume Steriade (1990, 1991), we can account for the coda-obstruent neutralization in Korean in a straightforward way.

(7) Korean Obstruent Neutralization

- a. [-son] is released before [-cons]
- b. otherwise, A_0

Let us call the rules in (7) aperture-related rules since the rules in (7) involve an aperture. It should be pointed out that the aperture-related rules in (7) are necessary in Korean phonology.

In Korean, phonological strings such as /haksa/, /kyoyuk/ are possible words, but phonological strings such as /klima/, /strok/ are impossible words. /k/ in /klima/ is not licensed in this position because the /k/ before [+cons] is A_0 , and the only way for preconsonantal unreleased /k/ to be realized phonetically is by giving some different formant shapes to the preceding vowel when it immediately follows a vowel as in /haksa/, but there is no preceding vowel in the case of /klima/. /s/ in /strok/ is not allowed because it violates the Sonority Sequencing Generalizations, and /t/ in /strok/ is not licensed basically the same way as /k/ in /klima/.

If we assume the aperture-related rules in (7), and other conditions and conventions assumed in syllabifying phonological strings, such as Universal Core Syllable Condition (Itô 1986), Structure Preservation, the Sonority Sequencing Generalizations, and Directionality, etc., we can syllabify Korean phonological strings without a syllable template.

Instead of having a language-particular syllable template, we propose, as a working hypothesis, the following very general syllabification principle for languages such as Korean:

- (8) "Syllabify maximally" (as long as the syllabification obeys other principles and rules)²

As an example, let us take the word /həkp^ha/ 'school.' If we syllabify this phonological string randomly, we have several different ways of syllabification as in (9) below.

- (9) a. həkp^ha (one syllable)
 b. h.əkp^ha
 c. hə.əkp^ha
 d. hək.p^ha
 e. həkp^h.a

Among these possibilities, (9a) and (9b) are ruled out because they violate the sonority profile. (9e) is also ruled out because it violates the Universal Core Syllable Condition (Itô 1986). (9c) is ruled out because sonority must decline from the nuclear vowel in this language, but the stops k and p^h have the same sonority. In addition, in slow speech, hə can be a syllable, but əkp^ha cannot be a possible syllable since k in həkp^ha is not followed by [-cons], so it cannot be released. The only way the stop k in həkp^ha can be phonetically realized in slow speech is to become the coda of the first syllable. It seems that in many cases, slow speech can tell where the syllable boundary is in a straightforward way. Syllabification (9d) is the only correct way of syllabification among the possibilities in (9). (9d) violates nothing. Let us look at another example.

- (10)a. kaps 'price' [kəp'], *[kəps]
 b. kaps-to 'price, too' [kəp't'o], *[kəpst'o]
 c. kaps-i 'price-NOM' [kəpsi]

According to Itô (1986, p. 113), the reason why the fricative s in /kəps/ is eliminated is that the fricative s is unsyllabified, and thus stray-erased, assuming that Korean has only one coda position in Korean Syllable Template. However, this way of eliminating the fricative s in /kəps/, which crucially makes use of a syllable template, is not necessary if we are given the aperture-related rules in (7), which we argue are independently needed in Korean phonology. Recall that an obstruent in Korean cannot be released word-finally. Thus, the fricative s in /kəps/ cannot be released in this

environment. If the fricative *s* in /kaps/ is not released, there is no way it can be phonetically implemented. This is why the fricative *s* in /kaps/ is eliminated. However, if a suffix which begins with a vowel follows /kaps/, the fricative *s* in /kaps/ is realized phonetically, as we can see in (10c) above.

The fricative *s* in /kaps-to/ cannot be realized phonetically because an obstruent cannot be released before a [+cons] segment, and there is no immediately preceding vowel in /kaps-to/. Thus, the fricative *s* in /kaps-to/ cannot be phonetically implemented in Korean. So far, we have seen that the aperture-related rules in (7) play a very important role in Korean syllabification, and these rules allow us to obviate a syllable template in Korean, when other principles and conditions are assumed.

One question that arises here is whether an appropriate syllable template and a well-written coda condition can obviate Korean aperture-related rules in (7). My answer is no. At first glance, a positive coda condition such as (11) below seems to obviate the aperture-related rules in (7).

(11) Korean Coda Condition

IF	C]σ
	[-son]
THEN	[-cont + C. G.]

Condition (11) is interpreted as follows: If there is a C-slot which is an obstruent and a single link, then only when the melody is [-cont, + C.G.] can it be syllabified as a coda. This means that the fricative *s* in /kas-k'ûn/ 'hat string' simply cannot be syllabified, and eliminated by Stray Erasure.³ The fact is that the fricative *s* becomes [t'], and it is syllabified as a coda. The surface form of /kas-k'ûn/ is [kat'k'ûn].

Thus, it is concluded that we need the aperture-related rules in (7) even if we posited a syllable template and a coda condition in Korean. If we are given the aperture-related rules in (7), we can syllabify phonological strings in Korean even without any syllable template and coda condition. If we have both the aperture-related rules and a syllable template/coda condition, there is redundancy in the grammar, contrary to Itô's (1986) claim.

An argument against syllable template comes from the following Korean

words⁴:

- (12)a. ilk-ta 'read-DECLARATIVE'
 b. palk-ta 'bright-DEC'

Itô (1986) does not give any specific syllable template for Korean, but she will probably give [CCVC] because syllables such as [pyðk] are possible. The second C-slot in Korean Syllable Template should be filled by a glide. Thus, the stop k in (12a) and (12b) cannot be syllabified, and stray-erased, according to the syllable template [CCVC]. In fact, the stop k is eliminated in (12a) and (12b) in pronunciations of many Korean speakers. However, some speakers of Korean articulate the stop k in (12a) and (12b), but without releasing this stop (there is no aspiration). This phenomenon cannot be accounted for by Itô's syllabification model. On the other hand, my syllabification model, which does not posit any syllable template, has an open possibility to account for this phenomenon, since the stop k cannot be released before a [+cons] sound, but it does not prohibit silent articulation.

3. Lexical Extraprosodicity and Syllabification

Itô (1986, p. 100) writes " ... Lexical Extraprosodicity is universal and defines edge segments as extraprosodic throughout the lexical derivation before the word level..." As an example, she gives the alternations between the unaffixed forms and affixed forms in Lardil. In Lardil, "... final consonants are extraprosodic during the lexical cycles, so that edge segments can be saved by affixation. The alternations found between the unaffixed and affixed forms (NGalu vs. NGaluk-in 'story nonfuture') are revealing in this respect.⁵ On the first cycle [NGaluk], the final consonant k cannot be syllabified because of Structure Preservation. But, Stray Erasure must not apply to k because it surfaces in the suffixed form [NGaluk] in [...]" (Itô 1986, p. 99). However, lexical extraprosodicity is not necessary in Korean and in other languages as well, if we syllabify phonological strings without a syllable template, assuming aperture-related rules such as (7) above. Let us look at the following Korean alternations between the unaffixed and affixed forms;

- (13)a. /kaps/ 'price' [kap']
 b. /kaps-i/ 'price-NOM' [kap'si]

The phonological strings above can be syllabified without making the stem-

final fricative *s* extraprosodic. The fricative *s* in (13a) can not be released by the aperture-related rules in (7), and there is no preceding vowel, so the fricative *s* cannot be phonetically implemented in (13a). On the other hand, the fricative *s* in (13b) can be released since there is a following vowel. Thus, if we assume the aperture-related rules in (7), which is necessary in Korean phonology, we do not have to invoke lexical Extraprosodicity.

So far, we have dealt with Korean data. From now on, we will discuss whether syllabification without any syllable template is possible in other languages as well.

4. Japanese Syllable Structure

Itô (1986, p. 144) gives the following syllable template and coda condition:

- (14)a. Japanese Syllable Template: [CVVC]
- b. Coda Condition: * C] σ
|
[-nasal]

What Japanese Coda Condition (14b) means is that if there is a C-slot and a single link, then only [+nasal] can be syllabified as a coda. If there is a double link, then the distinction between [-nasal] or [+nasal] is irrelevant, and syllabification applies freely by the Linking Constraint (Hayes 1986, p. 331), given in (15) below.

(15) Linking Constraint

Association lines in structural descriptions are interpreted as exhaustive

Some examples of Japanese words are as follows:

- (16)a. ka.mi.ka.ze 'devine wind'
i.ke.ba.na 'flower arrangement'
- b. sen.see 'teacher'
kam.pai 'cheers'
- c. gak.koo 'school'
kap.pa 'legendary being'

tos.sa 'impulsively'
toot.te 'passing'

d. hon 'book'

e. *kap.toot
*sek.pa
*kap.sek
*te.gak

However, it is possible to correctly syllabify Japanese words without using Japanese Syllable Template, if we have the following aperture-related rule:

(17) Japanese Aperture-related Rule

At the melodic level, every [+cons, -nasal] is released and a following vowel is necessary for that consonant to be released.

Furthermore, in Japanese, a coda condition is not necessary, either, if we assume the aperture-related rule in (17). The word *kamikaze* is syllabified as *ka.mi.ka.ze* because of the Universal Core Syllable Condition. The word *sensee* is syllabified as *sen.see* because *se.nsee* violates the sonority profile and *sens.ee* violates the UCSC. The string *kapta* is not a possible word because the stop *p* in *kapta*, being a [+cons, -nasal] sound, should be released, but there is no following vowel. Thus, the stop *p* in *kapta* cannot be syllabified. The phonological string *gakkoo* is syllabified as *gak.koo* because sonority must decline from the nuclear vowel, so *ga.kkoo* is impossible. *gakk.oo* is ruled out because it violates the UCSC, as well.

In Japanese, it is not entirely clear whether the aperture-related rule in (17) is independently motivated. However, if the aperture-related rule in (17) is assumed, syllabification can be done without any syllable template, and without any coda condition. In this sense, our syllabification model is simpler than Itô's syllabification model. Furthermore, our syllabification model, which is based on aperture-related rules, seems to explain why coda conditions such as (14b) are frequently found in the languages of the world. In Japanese, "... an obstruent can be the final element in a syllable only if the following syllable starts with an identical obstruent..." (Itô 1986, p.20). She writes that this phenomenon is frequently found in the languages of the world, and she argues that a coda condition such as (14b) can account for this phenomenon. Prince (1984) also observes that there are many unrelated languages which share a restriction on the possibilities of what consonants

can appear between vowels. Goldsmith dubs such languages 'Prince languages.'

(18) Prince languages

- a. a.ta
a.pa
- b. at.ta
ap.pa
- c. an.ta
am.pa

One possible reason why coda conditions such as (14b) are frequently found is as follows. In languages where an obstruent must be released, and a following vowel is necessary for that obstruent to be released, as in Japanese, only one obstruent or a geminate obstruent can appear intervocally because if C_i is different from C_j in VC_iC_jV (where both C_i and C_j are obstruents), C_i cannot be released before a consonant, thus C_i is not allowed in VC_iC_jV . If C_i is the same as C_j in VC_iC_jV , the obstruent C_i can be successfully released because at the melodic level C_i is eventually released. In this case, VC_iC_jV and VC_iV are identical except for the duration of stop closure.

One possible reason why only a sonorant consonant can be a coda without a double link, in many languages, is that as Blevins (p.c.) suggests, sonorant consonants are more likely to be recognized without release than obstruents; sonorants are more sonorous than obstruents as the name 'sonorant' indicates.

Finally, Itô's coda conditions are problematic since they make wrong predictions in some cases. For example, Itô gives the following coda condition for Diola.

(19) Diola Coda Condition

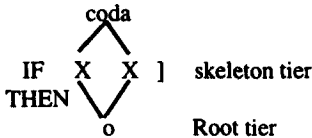
$$\begin{array}{c} *C] \sigma \\ | \\ [+cons] \end{array}$$

The stop k in /ujukja/ 'if you see' is not syllabified, and stray-erased because the stop k is a [+cons] consonant, and singly linked. However, as Steriade (p.c.) pointed out to me, Itô's Diola Coda Condition above wrongly predicts

that geminate stops are possible intervocally. Itδ's coda condition predicts that words such as /ujukka/ are possible in Diola, but such words are in fact not possible.

Chung (1990, p. 24) also points out that the Coda Condition of Tamazight Berber (hereafter, TB) below reveals a restriction which cannot be expressed by a negative condition.⁶

(20)TB Coda Condition



This positive Coda Condition allows TB words such as /xddm/ 'to work' (intensive form) to be syllabified correctly as [xed.dem]. Chung argues that a negative coda condition such as (21) below

(21) *C C]σ
 | |
 R R

yields the ill-formed * [exdedm]. Chung correctly points out that (21) does not rule out the illicit partial syllable structure (22) below.

(22) C C]σ
 ∨ |
 R R

Chung concludes that there is no way to express the Coda Condition in (20) as a negative coda condition which involves the Linking Constraint, thus the use of negative coda conditions which crucially depend on the Linking Constraint should be reconsidered.

Considering the simplicity of our syllabification model over Itδ's (1986) syllabification model, the problems of Itδ's coda conditions, and the explanatory adequacy our model has, we argue that our syllabification model which makes use of aperture-related rules is superior to Itδ's model which makes use of a syllable template and a coda condition. Our syllabification

principle “Syllabify maximally” can correctly syllabify Japanese words as well, if the aperture-related rule is assumed.

Thus far, we have dealt with two oriental languages. In the next section, we turn to Italian Syllable Structure, and we will argue that syllabification is possible without any syllable template in Italian as well.

5. Italian Syllable Structure

Itô (1986) gives the following syllable template and coda condition for Italian:

(23) Italian syllable structure

- a. Syllable Template: [CCVC]
- b. Italian Coda Condition: * C] σ
 |
 [- cont]
 [- son]

The following data are given by Itô (1986):

- (24)i) in.flessibile 'inflexible'
 al.tro 'other'
 bur.gravio 'castle lord'
 em.blema 'emblem'
 es.presso 'express'
- ii) *it.flessibile
 *ap.tro
 *bud.gravio
 *eg.blema
 *es.presso
- iii) lab.bro 'lip'
 grap.pa 'brandy'
 ap.plaudire 'clap, applaud'
 tut.to 'all'
 elet.trico 'electric'
 rad.drizzare 'make straight, straighten'
 ag.creditabile [kk] 'credible'
 ag.glomerare 'agglomerate'

If we have the following rules in Italian, we need neither the Syllable Template [CCVC] nor the Coda Condition:

- (25)a. /s/ is released everywhere.
 b. At the melodic level, [-son] is released, and a following sonorant is necessary for that [-son] to be released.

As Itô (1986) already pointed out, there is one problem for the formulation of the Italian Coda Condition in (23b). The Coda Condition in (23b) wrongly predicts that not only s but also f and ʃ should occur ungeminated in coda position. If we eliminate the feature [-cont] from the Coda Condition, then the word *es.presso* is ruled out incorrectly. However, the aperture-related rules in (25) do not give rise to such a problem.

6. Kutenai Syllable Structure

The syllable structure of Kutenai is very interesting in terms of our syllabification model. Initial clusters of up to four consonants occur in Kutenai. The materials presented here are based on Garvin (1948)⁷.

- (26) ksl'q
 ksl'ʔ
 ksl's
 kl'cʔ
 kl'ci'
 kl'cx
 kl'cm
 kc/k
 ckcx
 sqʔm

Some Kutenai words are as follows:

- (27) huslqʔumneeʔnee 'I am sleeping'
 hunʔupxnee 'I know'
 tuqʔcqaklun 'tell me the news'

The aperture-related rule in Kutenai can be formulated as follows:

- (28) A consonant is released in every position

If we have the aperture-related rule in (28), it is possible to syllabify Kutenai words, without a syllable template. In order to maximize the onset, it is necessary to syllabify from right to left. Directionality is what Itô assumes, so this is not a problem. Kutenai is a language where release is extremely unconstrained while Japanese is a language where release is severely constrained.

7. Conclusion

According to Itô (1986), syllabification consists of mapping the phonological string to the syllable template of the language, and syllabification is governed by syllable well-formedness conditions and a directional parameter. She assumes that every language has its own syllable template.

However, we have argued that a syllable template is not needed in many languages because either there are independently-motivated aperture-related rules which obviate a syllable template, as in Korean, or there are aperture-related rules which might not be independently motivated, but they can simplify the grammar by eliminating both the syllable template and coda condition from the phonology of the language, as in Japanese. Instead of having a language-particular syllable template, we have proposed a very general syllabification principle saying "syllabify maximally" (as long as the syllabification obeys other principles and rules). Furthermore, we have discussed the problems of Itô's coda conditions which crucially make use of the Linking Constraint. We have argued that lexical Extraprosodicity is not needed, and coda conditions are not necessary in many languages, either, when aperture-related rules are assumed.

Finally, we point out that the syllabification principle above is the unmarked case, and yet some languages might require language-specific syllable templates as marked cases.

Notes

1. The symbol C' in the Korean data here stands for a glottalized consonant.
2. Even the word "maximally" is redundant if we assume the Maximality Condition (Itô 1986).
3. The symbol \hat{i} in the Korean data here stands for a high central vowel, which is usually represented by an upside down m or a barred i .
4. I am grateful to J. S. Kim for pointing out this to me.
5. The symbol NG in this data stands for a velar nasal.

6. Chung's TB Syllable Template Mapping Rules are as follows:

Map skeletal slots to the syllable template [ONC1C2] from right to left.

Scan the two segments in syllable window at the same time.

Rule 1. Map /a/ to N obligatorily

Rule 2. Map /l.U/ to N if there is no /a/ in syllable window. (N represents the nucleus in the syllable template)

Chung (1990, p. 19)

7. The symbol l' in this data stands for a voiceless lateral fricative.

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