An Aspect of Pali Assimilation*

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Chung, Chin-Wan. (2015). An Aspect of Pali Assimilation. *The Linguistic Association of Korea Journal, 23*(1), 1-21. This paper observes assimilation patterns in the Pali language and provides an alternative constraint-based analysis of them. The dominant pattern of assimilation in place and manner features is regressive but this pattern is sometimes overridden when an onset consonant is higher than a coda consonant in sonority. The other case is that the result of leftward assimilation creates a coda element that is not preferred in Pali. The leftward assimilation is triggered by a segment with a dorsal, labial, or coronal place of assimilation. This implies that assimilation follows from constraints based on the concepts of positional faithfulness but not based on the asymmetry between morphological constituents such as stems and affixes. It is revealed that the assimilation pattern in Pali provides support for an argument that the place markedness hierarchy is not fixed but is rather only a strong tendency.

Key Words: assimilation, onset-driven, markedness, constraints, ranking

1. Introduction

The purpose of this paper is to study assimilation patterns observed in Pali,[1] a middle Aryan language, and provide a theoretical analysis of the assimilation examples. The most dominant pattern of assimilation in Pali is regressive or onset-driven. The morphological category, such as stems and affixes of the

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* This paper was supported by research funds of Chonbuk National University in 2014. A part of this paper was presented at 2014 LAK Fall Conference, Jeonju University. I wish to thank anonymous reviewers for their insightful comments. Any remaining errors are my own responsibility.

1) It is reported that Pali is a dead language and it was indigenous to the Indian subcontinent.

segments (McCarthy and Prince 1995; cf. Lombardi 1999) involved in assimilation, does not seem to play an important role as the determining factor of assimilation direction. However, there are two cases where progressive assimilation occurs in Pali. The first case is that when anticipatory assimilation results in the production of a coda segment which is not preferred as a coda element of the language. The other case is that if a preceding consonant in a consonant sequence is lower in sonority than the following segment, progressive assimilation occurs instead of regressive assimilation (cf. Davis 1998).

The assimilation patterns occurring in Pali seem to overshadow the so-called place markedness hierarchy proposed by Prince and Smolensky (1993, 2004) in which coronal place is the least marked so that it is most likely to become a target place in assimilation (cf. Bailey 1970; Kiparsky 1985; Cho 1990, 1991; Paradis & Prunet 1991). This hierarchy is challenged by Hume & Tserdanelis (2002) who argue that labial and dorsal places of articulation seem to be the least marked in various phonological processes in Sri Lankan Portuguese Creole (SLPC). Kenstowicz (1980) and Odden (1987) argue that the dorsal place articulation of Chukchi undergoes place assimilation while coronal and labial places do not, which is potentially a problem for place markedness hierarchy. Similarly, Chung (2008) discusses that a coronal segment triggers assimilation while a dorsal segment undergoes the process in Mongolian. In spite of the fact that there have been some assimilation studies that argue against the efficacy of place markedness hierarchy, its concept and universal ranking are frequently cited and employed as one of the most powerful determining factors of assimilation direction.

Interestingly, the concept of place markedness hierarchy does not have any role in Pali assimilation because two consonants abutting over a syllable or morpheme boundary undergo assimilation triggered by a segment occurring in syllable onset regardless of its place of articulation. Thus, it is argued in this paper that the direction of place assimilation in Pali is leftward in general and occasional progressive assimilation is due to the coda condition of Pali and sonority issues (cf. Davis 1998).

The paper is structured as follows. Section 2 will introduce brief phonological facts of Pali and its assimilation examples. Section 3 will discuss a previous analysis of Pali assimilation. Section 4 will provide an alternative analysis, which is based on constraints and their ranking interaction. Section 5 will summarize the analysis and present its implications.

2. Data Presentation

In this section, we will briefly outline the phonological background of the Pali language along with examples of place assimilation. As presented in (1) and (2), Pali contains the following consonants and vowels. The places of articulation are modified to reflect commonly used terms in the IPA.

(1) Pali consonants (Duroiselle 1997; de Lacy 2008)

		lab	cor	pal	retro	dor	glott
stops	vl.	p	t	c	ʈ	k	
		ph	th	ch	ʈh	kh	
	vd.	b	d	j	ɖ	g	
		bh	dh	jh	ɖh	gh	
fricatives			s				h
nasals		m	m	ɲ	ɳ	ŋ	
liquids			l, r				
glides		v		y			

(2) Pali vowels

i i:		u u:
e		o
	a a:	

As shown in (1) each stop in Pali has a plain and an aspirated phoneme respectively. Fricatives and sonorants, however, do not have aspirated versions. Concerning the labial glide /v/, we follow Fahs (1989) who assumes it to be a glide because it behaves like a glide phonologically. Concerning vowels, only high and low vowels have short and long versions as illustrated in (2).

Pali generally requires an onset and may have an onset cluster if a sequence of consonants are phonotactically allowed such as in [bru:ti] ‘speak-3sg’ or [sne.he.ti] ‘he was hung up’. There is another case of an onset cluster which consists of a consonant and a following glide as in [ra.tyo] 'the nights (nominative)'. Even though an onset is generally required in Pali, an onsetless syllable can only occur word-initially as in [is] 'wish'. With respect to syllable coda, a syllable can end in a consonant but words always end in a vowel in Pali. Nasals can occur as a coda element when they are homorganic with the following stop and consonants can also be a coda constituent if they are the first half of a geminate consonant. However, /y, r, h/ are not preferred coda elements in Pali such that they are avoided as coda elements if possible (Zec 1995). Thus, the maximal syllable structure of Pali is CCVC.

Based on the consonants and vowels and its syllable structure briefly introduced above, we present the examples of place assimilation in Pali. We divide the data into several groups depending on the manner of articulation of two consonants. The first case is composed of a stop plus a stop sequence as presented in (3), where a morpheme boundary is indicated by '+'.

(3) Sequences containing a stop + a stop (Duroiselle 1997)

lip+ta	→	litta	'smeared'
sak+ta	→	satta	'attached to'
sak+thi	→	satthi	'thigh'
tad+karo	→	takkaro	'stealing'
ud+gacchati	→	uggacchati	'go up'
ud+cinati	→	uccinati	'choose'
ud+gaɳha:ti	→	uggaɳha:ti	'acquire'
tap+ta	→	tatta	'reality'
sat+purisa	→	sappurisa	'worthy man'

As presented in (3) when two consonants occur over a morpheme or syllable boundary, the second consonant or the consonant in syllable onset transmits its place feature onto the preceding consonant occurring in syllable coda. This completes the assimilation process. With respect to place feature in assimilation, all place features such as coronal, labial, and dorsal features can trigger the process. This pattern of place assimilation in (3) indicates leftward direction or onset-driven assimilation. This can also be construed as evidence that the place markedness hierarchy proposed by Prince and Smolensky (1993, 2004) does not play a significant role in Pali assimilation.

The second set of examples is composed of sequences of a stop plus a fricative as given in (4).

(4) Sequences containing a stop + a fricative[2)]

ud+sa:ha	→	ussa:ha	'strength, power'
ud+suka	→	ussuka	'anxious'
ud+harati	→	uddharati	'pull out'

An onset fricative triggers regressive assimilation concerning the manner feature in the first and the second examples in (4), which show an identical assimilation pattern to the one we observed in (3). However, when the second segment is /h/, it does not transfer its place feature onto the preceding coronal coda segment as shown in the final example. In this case, the onset coronal consonant induces progressive place assimilation producing a [d.dh] cluster. The rightward assimilation probably occurs in Pali if the resulting consonant cluster of assimilation creates a less favorable coda element like a segment with glottal feature or [+spread glottis].

The third group of data consists of a stop plus a nasal or a nasal plus a stop.

(5) A stop + a nasal or a nasal + a stop sequence

lag+na	→	lagga	'clung'
sak+no	→	sakko	'afford'
kam+ta	→	kanta	'beloved'
dam+ta	→	danta	'subdued'

When an obstruent stop is followed by a nasal as in the first and the second examples, regressive assimilation does not occur. In such a sequence of consonants, progressive assimilation occurs instead. On the other hand, in a sequence where a nasal is followed by an obstruent stop as presented in the

2) An anonymous reviewer pointed out that there should be a constraint which can discern an optimal output from a suboptimal form of the third input /ud+harati/. Concerning this, we employ CodaCon to rule out *[uhharati] but select [uddharati] as optimal form. The CodaCon constraint is introduced in section 4.

third and the fourth examples, regressive place assimilation occurs. The assimilation pattern illustrated by the first two examples in (5) does not follow the most dominant assimilation pattern in Pali even though the examples do not create an unacceptable coda element such as [n]. Based on this, we may assume that a segment with lower sonority of the two non-homogeneous manners generally triggers assimilation and such a consonant sequence can override onset-driven assimilation in Pali.[3)]

The final group of data is comprised of two sonorants as given in (6).

(6) Sequences containing a sonorant + a sonorant

dhar+ma	→	dhamma	'doctrine'
kam+ya	→	kamma	'deed'
kar+ya	→	kayya	'construct'

The first example follows the dominant assimilation pattern, the onset-driven. The second example shows progressive assimilation, which can be explained in two different ways. It undergoes progressive assimilation because the onset segment does not induce assimilation as it is higher in sonority than the coda element. On the other hand, onset-driven assimilation is presumed to be blocked in this case because it creates the less preferred coda element [y] if regressive assimilation occurs. The third example is interesting in that both /r/ and /y/ do not robustly occur as coda elements but regressive assimilation still occurs to satisfy a feature-sharing of two consecutive segments over a syllable or a morpheme boundary in Pali.

So far we have introduced a brief outline of Pali segments and its syllable structure and presented some examples of Pali assimilation. It can be assumed from the data that the dominant place/manner assimilation of Pali is leftward but rightward assimilation occasionally also occurs if regressive assimilation

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3) This progressive assimilation can be understood as the strategy that the Pali language adopts to solve rising sonority between two consonants over a syllable boundary. According to Davis (1998: 183), cross-linguistically languages use one of the following strategies to repair rising sonority between two consonants: coda weakening, onset strengthening, tauto-syllabification, gemination, epenthesis, regressive assimilation, progressive assimilation, contact anaptyxis, and contact metathesis.

creates a less preferred coda segment or if an onset segment is higher in sonority than a coda element. In the next section, we will review an earlier account of Pali assimilation and point out some problems in the analysis.

3. A Previous Analysis

The Pali language is not currently used by many people as it is employed only as a lingua franca for communication among Buddhist monks. Since this is the case, it is difficult to find a theoretical analysis of this language. With respect to Pali assimilation, we could find only one previous account by de Lacy (2008). Based on markedness theory, de Lacy argues that two consonants over a syllable or morpheme boundary are coalesced. The results of coalescence are summarized in (7).

(7) Summary of survived feature values in Pali coalescence
  a. If the input cluster includes a dorsal, the output is dorsal.
  b. If the input cluster consists of labials and coronals, the output is coronal.
  c. If the input cluster consists of coronals alone, and it contains an alveolar, the output is alveolar; otherwise, it is alveo-palatal.

De Lacy basically argues that coalescence follows from a universally fixed place markedness hierarchy and freely-rankable output place markedness constraints. Universally fixed ranking of place of articulation is presented in (8) where "≫≫" signals fixed ranking between two constraints.

(8) Ident{dorsal} ≫≫ Ident{labial} ≫≫ Ident{coronal}

The ranking given in (8) cannot be permuted because it is fixed. However, the conflated output constraints are freely rankable. The conflated constraints and their implementation are illustrated in (9).

(9) Constraint conflation and its evaluation

	*{dor}	*{dor, lab}	*{dor, lab, cor}	*{dor, lab, cor, gl}
k	*	*	*	*
p		*	*	*
t			*	*
ʔ				*

The evaluation of freely-ranked conflated place markedness constraints in (9) shows that we can still discern markedness among the given consonants with different places of articulation by the concept of harmonically bounding. This concept specifies that a candidate **A** is harmonically bound for **B** if **A** incurs a proper subset of **B**'s violations (Samek-Lodovivi 1992; Prince and Smolensky 1993, 2004). Thus, a segment with a velar feature is harmonically bound for a segment with a labial feature because the violations of a dorsal segment are included in a subset of a labial's violations.

Based on (9), de Lacy also comes up with faithfulness constraints which monitor input and output mapping. The evaluation of faithfulness constraints in (10) illustrates output mapping from different underlying places of articulation where [¬x] indicates some segment that differs from /x/ in place of articulation.

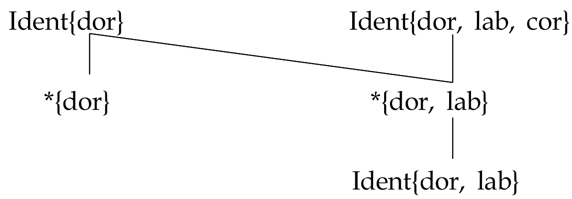
(10) Input to output mapping of different place of articulation

	Id-IO {dor}	Id-IO {dor, lab}	Id-IO {dor, lab, cor}	Id-IO {dor, lab, cor, gl}
/k/→[¬k]	*	*	*	*
/p/→[¬p]		*	*	*
/t/→[¬t]			*	*
/ʔ/→[¬ʔ]				*

We can argue from (10) that the mapping of dorsal input to a different output produces the least desirable result among the given mapping. This also indicates that a dorsal segment is the most marked in terms of place features, so if this input has a different place feature mapping in output, it results in the violations of all constraints in (10). Thus, in coalescence of consonants where a dorsal segment is in the input, the input dorsal segment should survive; otherwise, any coalesced output will incur all output constraints.

Based on the universally fixed place markedness hierarchy in (8), freely-rankable output conflated markedness in (9), and freely-rankable faithfulness constraints in (10), de Lacy proposes the following constraint ranking for Pali coalescence.

(11) Major place of articulation in Pali coalescence



The following constraint table shows how the constraint ranking given in (11) can select the optimal coalesced form in Pali.

(12) /labh$_1$-t$_2$ab:a/→ [ladh$_{1,2}$ ab:a] 'talking'

/labh$_1$-t$_2$ab:a/	Id{dor, lab, cor}	*{dor, lab}	Id{dor, lab}
ladh$_{1,2}$ ad:a	**!		**
labh$_{1,2}$ ab:a	*	**!	
☞ ladh$_{1,2}$ ab:a	*	*	*

The first candidate violates Id{dor, lab, cor} two times because two labial input consonants are unfaithfully mapping to two coronal output consonants in output. Because of these two violations, the first candidate is not selected as optimal. The second and third candidates fare equally on Id{dor, lab, cor} but they are different in *{dor, lab}. The second candidate incurs two violations of the markedness constraint due to two labial consonants in output. On the other hand, the third optimal candidate violates *{dor, lab} only once. Thus, the third candidate is selected as optimal.

The constraint ranking given in (11) and its implementation in (12) seem to explain some coalescent examples of Pali. However, if we consider some more examples of Pali, the given constraint ranking runs into problems. This is because the highest ranking, Id{dor}, requires that an input dorsal segment be realized in output and whenever there is an input dorsal, the result of coalescence is always dorsal. This also implies that a dorsal input segment takes precedence over segments with other place features such as labial and coronal. However, as illustrated by the examples of place assimilation in Pali in (3), some of the examples cannot be explained by the constraint ranking in (11). The following constraint table demonstrates the problem of the proposed constraint ranking.

(13) /sak-ta/→ [sat.ta] 'attached to'

/sak-ta/	Id{dor}	Id{dor, lab, cor}	*{dor}	*{dor, lab}	Id{dor, lab}
☜ sak.ta			*	*	
sak.ka		*!	**	**	
☞ sat.ta	*!	*!			*

The constraint ranking given in (11) selects the first candidate as optimal, which is not the actual winner in (13) marked by '☜'. The reason why the first candidate is chosen as optimal is that the actual optimal third candidate is edged out by the incorrect winner because of high-ranking Id{dor} and Id{dor, lab, cor}. These freely-rankable constraints call for the faithful realization of both dorsal and coronal input segments while the ranking eliminates the third candidate which undergoes regressive place assimilation. The result of regressive assimilation in the third form [t.t] violates Id{dor} and Id{dor, lab, cor} once each. Thus, the proposed constraint ranking is unable to select the correct output as optimal.

The identical problem also arises if we apply the constraint ranking in (11) to an input where a labial consonant is followed by a coronal consonant in the input. For example, input /tap-ta/ is realized as [tat.ta] in output but the given constraint ranking selects [tap.ta] as optimal due to the high-ranking Id-{dor, lab, cor}. This is illustrated by the following table in (14).

(14) /tap-ta/→ [tat.ta] 'reality'

/tap-ta/	Id{dor}	Id{dor, lab, cor}	*{dor}	*{dor, lab}	Id{dor, lab}
☜ tap.ta				*	
tap.pa		*!		**	
☞ tat.ta		*!			*

Since the analysis of Pali proposed by de Lacy (2008) can explain only limited examples, we need to come up with an alternative analysis to encompass extensive assimilation examples from Pali.[4] In order to analyze Pali examples, we do not opt for the theoretical proposal put forth by de Lacy in (8), (9), and (10). We employ constraints which reflect phonological facts of Pali and their ranking to account for the assimilation examples in the next section.

4. An Alternative Analysis

The theoretical background for the analysis is a constraint-based one which is rooted in Prince and Smolensky (1993, 2004) and McCarthy and Prince (1995). The constraints we use for the dominant assimilation pattern of Pali are introduced first.

(15) Constraints for regressive assimilation
- a. Agree: Two adjacent consonants over a syllable or morpheme boundary are identical in their place and manner features.
- b. Ident-Onset: An onset of output and its correspondent in input are identical in their place and manner features.
- c. Ident-Coda: A coda of output and its correspondent in input are identical in their place and manner features.

Agree calls for sharing of both place and manner features between two adjacent consonants occurring over a syllable or morpheme boundary. This constraint motivates assimilation but it does not require any specific direction (cf. Lombardi 1996, 1999; Wetzels & Mascaró 2001; Zigta 2011; Chung 2014). Since Agree is non-directional, the direction of assimilation is determined by

4) We regard the examples of Pali in this paper as assimilation rather than coalescence because the concept of assimilation can explain more examples of Pali than that of coalescence. If we consider examples such as /kam+ta/→[kan.ta] 'beloved' and /dam+ta/→[dan.ta] 'subdued', they are obviously not the results of coalescence but they are formed due to regressive partial place assimilation. Thus, we consider all the examples of Pali in this paper assimilation cases.

the ranking of two relevant constraints. Ident-Onset demands both place and manner features of an onset segment be identical with its input correspondent. This constraint dominates Ident-Coda which calls for identical features such as place and manner between an output coda and its correspondent in input. Ranking Ident-Onset over Ident-Coda ensures leftward assimilation in Pali. We rank Agree higher than Ident-Onset in the analysis. The following constraint tables show how the ranking interaction selects a harmonic candidate for regressive assimilation.5)

(16) /lip-ta/ → [lit.ta] 'smeared'

/lip-ta/	Agree	Id-Onset	Id-Coda
lip.ta	*!		
lip.pa		*!	
☞ lit.ta			*

(17) /sak-ta/ → [sat.ta] 'attached to'

/sak-ta/	Agree	Id-Onset	Id-Coda
sak.ta	*!		
sak.ka		*!	
☞ sat.ta			*

The constraint tables in (16) and (17) show that the direction of place assimilation is leftward and it is guaranteed by two positionally-specified faithfulness constraints (cf. Beckman 1998, 2004).6) This also reflects onset and

5) In this paper, we do not consider a candidate which uses a deletion strategy to avoid the violation the Agree constraint. For example, a candidate such as [li.ta] will be selected as optimal if it is included in (16) because the candidate satisfies all three constraints. This indicates that we assume an undominated Max-Seg in Pali even though we do not employ it in the analysis. The [li.ta] will be eliminated by Max-Seg.

6) If we adopt constraints based on morphological categories such as root/stem and affix status difference in faithfulness (McCarthy and Prince 1995) to determine the direction of assimilation, we will have inconsistent assimilation results. For example, ranking morphologically grounded Faith-Root/Stem over Faith-Affix will lead to regressive assimilation in a sequence with a prefix plus a root while it will call for progressive assimilation in a sequence with a root plus an affix. But as we have seen in section 2, the dominant direction of Pali assimilation is regressive, which means that examples comprised

coda asymmetry in assimilation in which an onset segment takes priority over a coda segment. The constraint ranking for regressive assimilation in Pali is presented in (18).

(18) Constraint ranking for leftward assimilation
Agree ≫ Ident-Onset ≫ Ident-Coda

There are, however, some other examples that cannot be explained by the constraint given in (18). Such examples are composed of an obstruent plus a sonorant, which are shown in the first two examples in (5). In such clusters, progressive assimilation occurs instead. Following Davis (1998:183), whose strategies to solve rising sonority are discussed in footnote 3, we argue that rising sonority over a sequence of consonants is resolved by progressive assimilation in Pali. But we do not employ Davis's Syllable Contact constraint (cf. Vennemann 1988: 40; Bat-El 1996: 303) in this analysis. We propose two identity constraints whose ranking leads to rightward assimilation. This implies that a segment with lower sonority between the two induces assimilation in Pali. Two new identity constraints we may use to solve the rising sonority issue are given in (19).

(19) Constraints for progressive assimilation
a. Ident-IO(obs): An input obstruent and its correspondent in output are identical in their place and manner features.
b. Ident-IO(son): An input sonorant and its correspondent in output are identical in their place and manner features.

Rightward assimilation is achieved by ranking Ident-IO(obs) over Ident-IO(son) and interaction with the constraints given in (15). A preceding obstruent transmits its features onto a following sonorant and this feature transmission achieves not only preservation of the obstruent features but also satisfying Agree at the cost of violating faithful realization of an input sonorant in output.

With respect to ranking of the newly introduced constraints and the

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of a root plus an affix cannot be explained by morphologically grounded constraints. Thus, we do not use morphologically grounded constraints, which are one of the major factors for determining the direction of assimilation.

constraints in (15), we rank Ident-IO(obs) equally with Ident-Onset. The Ident-IO(son) is ranked lower than Ident-Coda. This ranking leads to progressive assimilation in a sequence of an obstruent plus a sonorant as illustrated in (20).

(20) /lag-na/ → [lag.ga] 'clung'

/lag-na/	Agree	Id-Ons	Id-IO(obs)	Id-Coda	Id-IO(son)
lag.na	*!*				
laŋ.na	*!		*	*	
lan.na			**	*!*	
☞ lag.ga		**			**

(21) /sak-no/ → [sak.ko] 'afford'

/sak-no/	Agree	Id-Ons	Id-IO(obs)	Id-Coda	Id-IO(son)
sak.no	*!*				
saŋ.no	*!		*	*	
san.no			**	*!*	
☞ sak.ko		**			**

As shown in (20) and (21), a sequence of consonants with rising sonority is repaired by progressive assimilation, which is driven by the lower-sonority coda segment. The two constraint tables also show that a low-ranking constraint such as Ident-Coda plays a critical role when high-ranking constraints do not play an important role. The constraint ranking for progressive assimilation in (20) and (21) can also account for the examples of regressive assimilation. The constraint ranking is given in (22).

(22) Constraint ranking for progressive assimilation[7)]
Agree ≫ Ident-Onset, Ident-IO(obs) ≫ Ident-Coda ≫ Ident-IO(son)

7) An anonymous reviewer argued that the unranking between Ident-Onset and Ident-IO(obst) is problematic because the unviolable Ident-IO(obst) constraint should be ranked over the violable Ident-Onset constraint in OT. The point the reviewer brought up is correct in OT perspective. However, Ident-IO(obst) is not unviolable in the analysis because the constraint is always violated in the examples where two obstruents occurring over a morpheme boundary as we can observed in (3) and (4). Because of this reason, we rank Ident-Onset and Ident-IO(obst) equally in this analysis.

There are two more cases which cannot be explained by the ranking in (22). The first case is a sequence of a nasal plus an obstruent as presented in the third and the fourth examples of (5): /kam+ta/→[kan.ta] 'beloved' and /dam+ta/→[dan.ta] 'subdued'. The second case is a sequence of a nasal plus a glide, as given in the second example in (6): /kam-ya/→[kam.ma] 'deed'. In order to account for such examples, we propose two new constraints which are presented in (23).

(23) a. CodaCon: /r, y, h/ are not preferred coda elements.8)
b. Faith-NC: An input NC cluster order of a nasal plus an obstruent is faithfully realized in output.

CodaCon calls for the avoidance of [r, y, h] as coda elements if possible because they are not preferred coda segments in Pali. Thus, if one of them appears in onset, they generally do not trigger regressive assimilation; instead they undergo progressive assimilation when preceded by obstruents or nasals.

Faith-NC requires that a nasal plus an obstruent sequence in input be maintained in output. This constraint only monitors a NC segment sequence but not identical features of correspondents. This is because only NC sequences in Pali undergo a partial assimilation and such partial assimilation is not observed in other consonant sequences. Interestingly, the result of regressive assimilation in NC clusters is a homorganic NC in output. But maintaining the NC cluster leads to one violation of Agree. On the other hand, when an obstruent is followed by a nasal, the lower-sonority obstruent triggers progressive place and manner assimilation as in /lag-na/→[lag.ga] 'clung' as we illustrated in (20).

With respect to the ranking of two constraints in the analysis, we rank Faith-NC higher than Ident-Onset. If Ident-Onset dominates Faith-NC, the result of assimilation is [CC], which violates Faith-NC, but such a [CC] cluster does

8) This constraint can be construed as a hybrid constraint which reflects the idea proposed by Itô (1986) by which certain languages such as Japanese and Ponapean permits only placeless coda elements or the first half of a geminate in the coda. Thus, place feature of a consonant is licensed by a following onset segment. The CodaCon constraint we proposed in the analysis calls for another requirement that less preferred /r, y, h/ as coda elements not occur in the coda. Therefore, the geminate [y.y] satisfies the conventional coda condition put forth by Itô but it violates the current CodaCon constraint we employ in this paper.

not emerge as optimal from the input /NC/ in Pali. The Faith-NC constraint does not show any ranking with Agree in the analysis.

Concerning CodaCon, this is not an undominated constraint because the glide /y/ triggers regressive assimilation in onset position when preceded by another less preferred coda element [r] even though the [y] is not a good coda element either in Pali. This is because the glide [y] appears in syllable onset, which is a more prominent position than coda, and should maintain its identity with its input counterpart due to Ident-Onset. Thus, in really limited cases where the [r] is followed by [y], regressive assimilation creates a [y.y] cluster and in such cases, an unfavored coda element is tolerated in the language.9) So CodaCon is ranked lower than Agree and Faith-NC but is ranked higher than Ident-Onset. If Ident-Onset dominates CodaCon, an example where a consonant followed by the glide [y] such as /kam-ya/ 'clung' will take an incorrect form *[kay.ya] as its optimal output instead of [kam.ma]. The following constraint tables show the role of CodaCon and Faith-NC with other constraints in evaluation. In the following tables, irrelevant constraints which do not play a crucial role in selecting an optimal form are not included.

(24) /kam-ta/ → [kan.ta] 'beloved'

/kam-ta/	Agree	Faith-NC	Id-Ons	Id-IO(obs)	Id-Coda
kam.ta	**!				
kam.ma		*	*!*	*!*	
kat.ta		*			*!*
☞ kan.ta	*				*

(25) /kam-ya/ → [kam.ma] 'deed'

/kam-ya/	Agree	CodaCon	Id-Ons	Id-IO(obs)	Id-Coda
kam.ya	*!*				
kay.ya		*!			**
☞ kam.ma			**		

9) Another regressive assimilation example which contains two less preferred coda elements occurring over a morpheme boundary is /leh-ya/ → [leyya] 'to be licked'. This example can also be explained by prominence difference between onset and coda.

The constraint table in (24) illustrates that Faith-NC prohibits total assimilation of both progressive and regressive assimilation so the final candidate which undergoes partial regressive assimilation is selected as optimal. The CodaCon constraint in (25) rules out the second candidate whose medial consonant sequence [y.y] is the result of regressive assimilation triggered by the glide [y]. The only way to form a consonant cluster which satisfies Agree and avoids the violation of CodaCon is to apply progressive assimilation. Thus, the third candidate emerges as optimal in (25).

An interesting case to note in assimilation with respect to CodaCon is a consonant cluster where both consonants are not preferred coda elements. In such a cluster, CodaCon does not play a crucial role because both [r.r] and [y.y] clusters violate CodaCon. But the [y.y] cluster is still chosen as optimal, as determined by ranking onset-related constraints such as Ident-Onset over the coda-related constraints like Ident-Coda. This is illustrated in the following constraint table where we include only relevant constraints.

(26) /kar-ya/ → [kay.ya] 'construct'

/kar-ya/	Agree	CodaCon	Id-Ons	Id-Coda	Id-IO(son)
kar.ya	*!*	*			
kar.ra		*	*!*		**
☞ kay.ya		*		**	**

The third optimal candidate violates CodaCon but is tolerated because the optimal form fares better on Ident-Onset than its competitor, the second candidate. This type of optimal form is selected only when there is no way to avoid the violation of CodaCon. So far we have provided constraint tables to illustrate various cases of assimilation in Pali. The constraint rankings we have used so far can be unified as presented in (27).

(27) Unified constraint ranking for Pali assimilation[10)]

10) There are few examples that cannot be accounted for by the proposed constraint ranking: /nud-na/→ [nunna] 'removed' and /chid+na/→ [chinna] 'destroyed'. The expected output forms of the above inputs are [nudda] and [chidda] each but the actual output forms [nunna] and [chinna] do not follow the general regressive assimilation pattern. A possible

Agree, Faith-NC ≫ CodaCon ≫ Ident-Onset, Ident-IO(obst) ≫ Ident-Coda ≫ Ident-IO(son)

5. Conclusion

In this paper, we have observed types of assimilation occurring over a morpheme or syllable boundary in Pali and provided an alternative account of them. The dominant assimilation pattern of Pali is regressive assimilation, which is induced by a segment occurring in syllable onset while a coda segment undergoes assimilation. On the other hand, there are some restricted cases of examples where progressive assimilation overrides regressive assimilation. These limited cases of rightward assimilation occur when an onset segment is higher than a coda segment in its sonority. Progressive assimilation also occurs if a coda consonant to be formed by regressive assimilation is not a preferred one in Pali.

In order to explain both dominant and subordinate cases of assimilation, we proposed relevant constraints and their rankings. We repeat the constraint ranking in (27) which can explain both types of assimilation.

(28) The unified constraint ranking for Pali assimilation
Agree, Faith-NC ≫ CodaCon ≫ Ident-Onset, Ident-IO(obst) ≫ Ident-Coda ≫ Ident-IO(son)

There are several implications revealed by the analysis of Pali assimilation. First, the dominant type of assimilation in Pali follows from positionally-specified faithfulness constraints and their ranking whose concepts are well-summarized in Beckman (1998, 2004). The other major motivator of assimilation which is based on asymmetry of morphological constituents such as

assumption for such exceptional examples is that when two adjacent consonants share the same place of articulation, progressive assimilation strategy for solving rising sonority between the two consonants may be overridden. Thus, the dominant assimilation pattern occurs instead. However, further research is needed to support for a preliminary assumption for such minor examples in Pali.

stems and affixes is overshadowed by the concepts of positional faithfulness. Second, Pali regressive assimilation can be triggered by any place of articulation such as dorsal, labial, and coronal. This implies that the well-accepted place markedness hierarchy proposed by Prince and Smolensky (1993, 2004) does not have any influence on determining the direction of assimilation in Pali. And based on the place of articulation behavior in Pali assimilation and other languages such as SLPC, Chukchi, and Mongolian, we may argue that place markedness hierarchy (Prince and Smolensky 1993, 2004; Lombardi 1996, 1999; de Lacy 2008 among others) is not universally fixed but is rather a strong universal tendency. Third, the dominant assimilation can be blocked by phonologically motivated constraints such as Faith-NC and CodaCon, which lead to progressive assimilation. Fourth, even a segment which is not preferred in coda can be tolerated if there are no other options to avoid it. Finally, the two different directions of assimilation can be accounted for by the unified constraint ranking, which may be difficult for other theoretical frameworks.

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Received on January 28, 2015
Revised version received on February 28, 2015
Accepted on March 17, 2015