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Target Asymmetries in Consonant Harmony

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Abstract

Target Asymmetries in Consonant Harmony

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Consonant harmony refers to non-local assimilation between consonants: for instance, in Kera, /**k**ə-dà:rə̀/ 'friend' becomes [**g**ə-dà:rə̀], in which a nominalizing prefix /k-/ takes on the voicing of the following stem-initial voiced stop /d/. As seen in Kera, there are triggers that cause other sounds to change, and the targets that undergo the change, under the influence of triggers. The present study investigates restrictions on the type of target and trigger consonants. Suppose that A and B are potential target consonants. If A undergoes consonant harmony (**A**…B → **B**…B) whereas B doesn't (**B**... A → **B**…A, not * A … A), A would be considered a preferred target (or B would be a preferred trigger). This kind of target asymmetry is observed in consonant

harmony whereby only certain types of consonants are preferred as targets. This study concerns a question of whether and why target asymmetries exist in consonant harmony typology.

In order to address this question, I conducted a cross-linguistic survey. From the survey results, I found target asymmetries in the following three types of consonant harmony: sibilant, retroflex, and nasal consonant harmony. In sibilant consonant harmony whereby place assimilation occurs between alveolar sibilants ([s, z, ts, tz]) and palatal sibilants ([ʃ, ʒ, tʃ, dʒ]), it is observed that alveolar sibilants are more likely to be targets, whereas palatal ones are more likely to be triggers. Of 25 languages in my survey, 15 languages reveal the target asymmetry in which only alveolar sibilants are targets, to the exclusion of palatal sibilants (e.g. Sarcee, /**s**ì-**tʃ**ógò/ → [**ʃ**ì**tʃ**ógò] 'my flank', but /sí**-tʃ**í**z-**àʔ/ → [ʃí**t**ʃí**dz**àʔ], *[sí**tz**í**dz**àʔ] 'my duck' (Hansson 2001)). On the other hand, the rest 10 languages show symmetric harmony in which both alveolar and palatal sibilants are equally targeted (e.g. Navajo, /**s**i**-dʒ**é:ʔ/ → [**ʃ**i**dʒ**é:ʔ] 'they lie (slender stiff objects)', and /j**-**i**ʃ-**ma**s**/→ [ji**s**ma**s**] 'I'm rolling along' (Hansson 2001)). Significantly, however, the opposite case of asymmetric situation whereby only palatal sibilants are targeted is not attested in any language in the survey. Similar kind of target asymmetry is also observed in retroflex and nasal consonant harmony. In retroflex consonant harmony, non-retroflex consonants such as dental or alveolar stops and nasals (/d, t, n/ and /d̪, t̪, n̪/) are more likely to be targets, whereas their retroflex counterparts (/ɖ, ʈ, ɳ/) are more likely to be triggers. In nasal consonant harmony, non-nasal consonants such as plain stops (/b, d, g, p, t, k/) and liquid consonants (/l, r/) are more likely to be targets, while nasal consonants (/m, n, ŋ/) are more likely to be triggers. Based on these survey results, I conclude that the observed target asymmetries should be expressed as the following implicational statements: i) If palatal sibilants are targets of consonant harmony, so are alveolar sibilants. ii) If retroflex consonants are targets of consonant harmony, so are non-retroflex consonants. iii) If nasal consonants are targets of consonant harmony, so are non-nasal consonants.

Inspired by phonetically-based Optimality Theory (Hayes, Kirchner and Steriade 2004), I investigate perceptibility variation in contexts where consonant harmony typically occurs. Based on this investigation, I argue that the target asymmetries are perceptually motivated and can be well understood under P-map hypothesis (Steriade 2001, 2009). The upshot of P-map is that perceptually prominent phonological change is avoided. In Optimality-Theoretic terms, faithfulness constraints preventing more prominent perceptual change invariably outrank those prohibiting less perceptual change. In line with P-map, I claim that consonant harmony is a process preferring less perceptual modification. Various phonetic research show that some phonological features have prolonged phonetic cue spanning over multi-segmental domains, among which the features relevant to palatal, retroflex, and nasal consonants are included. I assert that consonants with prolonged phonetic cue (i.e. more likely triggers of consonant harmony) may weaken perceptibility of the relevant features in nearby consonants and make them less perceptible. This means that phonetic cue of relevant phonological features is weaker before the consonants with long cue (i.e. palatal sibilants, retroflex consonants, and nasal consonants) than before the consonants without long cue.

Reflecting this contextual perceptibility variation, constraints for the corresponding contexts are projected and universally ranked by P-map. The faithfulness constraints prohibiting phonological change before alveolar sibilants, non-retroflex consonants, and non-nasal consonants universally outrank those prohibiting change before palatal sibilants, retroflex consonants, and nasal consonants, respectively. To take an example of sibilant consonant harmony, ID-IO (anterior/__s) is universally ranked above ID-IO (anterior/__ʃ), explaining a cross-linguistic tendency that faithfulness for anteriority is weaker before palatal sibilants than before alveolar sibilants. Moreover, language-specific consonant harmony patterns are also explained by interaction of these constraints with IDENT-CC, which induces consonant harmony. When IDENT-CC dominates the two ID-IO faithfulness constraints, consonant harmony occurs all the time, regardless of the type of triggers and targets. When it is ranked between the two ID-IO faithfulness constraints, only the alveolar sibilants are targeted, revealing target asymmetry patterns. Finally, when IDENT-CC is dominated by the two ID-IO faithfulness constraints, consonant harmony do not occur at all. The target asymmetries in retroflex and nasal consonant harmony are similarly analyzed: ID-IO (anterior/_d) ≫ ID-IO (anterior/_ɖ), and their interaction with IDENT-CC in retroflex consonant harmony, and ID-IO (nasal/_d) ≫ ID-IO (nasal/_n), and their interaction with IDENT-CC in nasal consonant harmony. Note that this analysis predicts the absence of the pattern in which palatal sibilants, retroflex consonants, and nasal

consonants are exclusively targeted in consonant harmony.

The analysis accounts for all and only the attested patterns of consonant harmony typology. Both universal and language-specific patterns are explained in terms of proposed constraint interaction.

Keywords: Consonant harmony, Typology, Asymmetry, P-map, Optimality Theory

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1. Introduction

Consonant harmony refers to non-local assimilation between consonants as can be seen in the following examples from Kera where a nominalizing prefix /k-/ takes on the voicing of the following stem-initial voiced stop /d/.

(1) Consonant harmony in Kera (from Hansson 2001 citing Ebert 1979)

/**k**ə-dà:rə̀/	[**g**ə-dà:rə̀]	‘friend’
/**k**ə-dàjgá-w/	[**g**ə-dàjgá-w]	‘jug (plur.)’

Several characteristic properties of consonant harmony have been found in the literature. They include predominance of morphological influence (i.e. stem control) and phonological similarity between target and trigger consonants. Notice, in the above examples, that the target /k/ in the affix assimilates in voicing to the trigger /d/ in the root. In addition, the target /k/ and the trigger /d/ can be considered phonologically similar to each other in the sense that they are both stops.

For the purpose of adding an additional characteristic of consonant harmony, the present study investigates restrictions on the type of target and trigger consonants. Suppose that A and B are potential target consonants in consonant harmony. If A undergoes consonant harmony (**A**…B → **B**…B) whereas B doesn’t (**B**... A → **B**…A, not * A … A), A would be considered a preferred target (or B would be a preferred trigger). This study concerns a question of whether and why such target asymmetries exist in consonant harmony typology. In order to address this question, I conducted a survey of consonant harmony patterns by investigating the data, mostly discussed by Hansson (2001) and Arsenault (2012). From the survey results, I found target asymmetries in the following three types of consonant harmony: sibilant consonant harmony, retroflex consonant harmony, and nasal consonant harmony. Furthermore, it is suggested that the observed target asymmetries should be expressed as the following implicational statements: (i) If palatal sibilants are targets of consonant harmony, so are alveolar sibilants. (ii) If retroflex consonants are targets of consonant harmony, so are non-retroflex consonants. (iii) If nasal consonants are targets of consonant harmony, so are non-nasal consonants.

Inspired by phonetically-based Optimality Theory (Hayes, Kirchner, and Steriade 2004) that explores the role of phonetics in shaping phonology, I investigated perceptibility variation in contexts where consonant harmony typically occurs. Based on this investigation, I argue that the observed target asymmetries are perceptually motivated and can be well understood under P-map hypothesis (Steriade 2001, 2009). The upshot of P-map is that perceptually prominent phonological change is avoided. In Optimality Theoretic terms, faithfulness constraints preventing more prominent perceptual change invariably outrank those prohibiting less perceptual change. Under this idea, I claim that consonant harmony is a process preferring less perceptual modification. To be specific, various phonetic research show that some phonological features have prolonged phonetic cue spanning over multi-segmental domains, among which the features relevant to palatal, retroflex, and nasal consonants are included. I assert that consonants with prolonged phonetic cue may weaken the perceptibility of the relevant feature in nearby consonants and make them less perceptible. This contextual perceptibility variation gives rise to the observed target asymmetries where perceptually weaker consonants are likely to be targeted, whereas perceptually more salient consonants (i.e. the consonants with elongated phonetic cue) survive unchanged through harmonic process. Based on this relative perceptibility difference, the constraints are projected and universally ranked by P-map, which accounts for all and only the attested patterns of consonant harmony.

The organization of the thesis is as follows. Chapter 2 presents a typological survey results of target asymmetries. It will be shown that some types of consonant harmony reveal target asymmetry. In chapter 3, I will explore the reason why target asymmetries occur in consonant harmony. I will lay out phonetic and perceptual grounding for the phenomenon. To be specific, I suggest that consonants with prolonged phonetic cue weaken the perceptibility of other segments, and this causes perceptibility variation in different phonological contexts. In chapter 4, Optimality-Theoretic analysis is provided under P-map hypothesis. The analysis correctly predicts the attested patterns in consonant harmony, including both universal and language specific patterns, according to the ranking of the proposed constraints. Finally, chapter 5 concludes the thesis.

2. Typology

2.1. Overview of the survey

This section discusses the consonant harmony typology. For the purpose of finding target asymmetries in consonant harmony, I conducted a survey of consonant harmony patterns, by investigating the data discussed by Hansson (2001) and Arsenault (2012). Hansson surveyed 120 cases of consonant harmony from 15 different language families, distributed over at least 4 continents (North and South America, Africa, and Europe). Arsenault (2012) investigated 185 cases of retroflex consonant harmony in South Asian languages. (Examples in this paper are from Hansson (2001, 2010) unless otherwise indicated.)

2.2. Patterns with target asymmetries

The first step in the investigation of target asymmetry in consonant harmony is to determine which is the target and which is the trigger. In cases where synchronic alternation is involved as in /A … B/ → [B … B], the changed segment A is the target whereas the segment B, which has a harmonic feature but does not change, is the trigger. However, the target-trigger distinction is not always obvious in cases where static distributions with co-occurrence restrictions may suggest the occurrence of consonant harmony: for instance, /A…A/ and /B…B/ are attested whereas /A…B/ and /B…A/ are not. In such cases with no synchronic alternation, if the record of diachronic sound change as in /A…B/ → /B…B/, is available, I considered the changed segment A as the target and the unchanged one B as the trigger. Otherwise, the data in question were excluded from the investigation of the target asymmetry.

Before I present my survey results, it needs to be mentioned that consonant harmony is mostly regressive (i.e. right-to-left) rather than progressive (left-to-right). As stated above, consonant harmony is largely subject to morphological influence known as stem control. It is common that consonants in affixes (whether they are prefixes or suffixes) assimilate to those in stems, rather than vice versa. However, in cases without such morphological influence, consonant harmony is normally regressive, as pointed out by previous research on consonant harmony (Hansson 2001; Rose and Walker 2004; Arsenault 2012).

Consonant harmony types can be defined depending on harmonizing properties. Nine types of consonant harmony are reported in the literature: Sibilant consonant harmony, Non-sibilant coronal consonant harmony, Retroflex consonant harmony, Dorsal consonant harmony, Secondary articulation consonant harmony, Nasal consonant harmony, Liquid consonant harmony, Stricture consonant harmony, and Laryngeal consonant harmony. Among these, target asymmetries were observed in the following three types: sibilant, retroflex, and nasal consonant harmony. I will now illustrate in detail target asymmetries in each case.

2.2.1. Sibilant consonant harmony

Based on my survey results, I will first inspect the target asymmetry in sibilant consonant harmony. Sibilant consonant harmony refers to place assimilation between coronal sibilants. Specifically, alveolar sibilants ([s, z, ts, tz]) and their palatal counterparts ([ʃ, ʒ, tʃ, dʒ]) change their anteriority ([±anterior]) to agree in place of articulation. That is, alveolar or palatal sibilants assimilate to each other within words. In the situation that these two classes of consonants assimilate to each other, both alveolar and palatal sibilants are expected to be equally targeted. Indeed, this is the case in many languages including Navajo, Barbareno, Southern Paiute, and Nebaj Ixil. Of 25 languages in my survey, 10 languages show this kind of symmetric sibilant consonant harmony. Examples from Navajo are provided in (2) below. In (2a), alveolar sibilants /s, dz/ become palatal sibilants [ʃ, dʒ], taking on the anteriority of following palatal sibilants in the word. Since Navajo shows regressive harmony, the rightmost sibilant in a word becomes a trigger. Conversely, in (2b), palatal sibilants /ʃ/ are targeted and change their anteriority to that of alveolar sibilants /s, ts'/. (Relevant segments are boldfaced.)

(2) Symmetric sibilant consonant harmony in Navajo

a. Alveolar sibilants are targets.

i.	/**s**i-**dʒ**é:ʔ/	[**ʃ**i**dʒ**é:ʔ]	'they lie (slender stiff objects)'
ii.	/**dz**-i**ʃ**-l-ta:l/	[**dʒ**i**ʃ**ta:l]	'I kick him (below the belt)'

b. Palatal sibilants are targets.

i.	/j-i**ʃ**-ma**s**/	[ji**s**ma**s**]	'I'm rolling along'
ii.	/**ʃ**-i**s**-ná/	[**s**i**s**ná]	'he carried me'
iii.	/**dz**-i**ʃ**-l-**ts'**in/	[**dz**i**s**t**s**'in]	'I hit him (below the belt)'

However, some languages in the survey exhibit an asymmetric consonant harmony. That is, it happens that only a certain subset of potential target consonants undergo harmony, whereas the rest of them do not. Interestingly, in all such cases, only alveolar sibilants, not palatal sibilants, are targeted. In Sarcee in (3), alveolar sibilants take on the anteriority of the palatal ones (3a), but not vice versa (3b).

(3) Asymmetric sibilant consonant harmony in Sarcee

a. Alveolar sibilants are targets.

i.	/**s**ì-**tʃ**ógò/	[**ʃ**ì**tʃ**ógò]	'my flank'
ii.	/nā-**s**-ɣá**tʃ**/	[nā**ʃ**ɣá**tʃ**]	'I killed them again'

b. Palatal sibilants are *not* targets.

i.	/sí-**tʃ**í**z**-àʔ/	[**ʃ**í**tʃ**í**dz**àʔ]	'my duck'
		(*[sí**tz**í**dz**àʔ])	

This kind of asymmetric situation is attested in many other languages such as Slave, Moroccan Arabic, Aari, and Berber. 15 out of 25 languages in my survey revealed this sort of target asymmetry in which only alveolar sibilants are targets, to the exclusion of palatal sibilants. Significantly, however, the opposite case of asymmetric situation whereby only palatal sibilants are targeted is not attested in any language in the survey. The table in (4) below summarizes the relevant survey results. The fact that there is no language in which palatal sibilants are exclusively targeted but alveolar sibilants are not, indicates the apparent target asymmetry in sibilant consonant harmony that is biased towards alveolar sibilant targets.

(4) Survey results: cross-linguistic patterns of target asymmetries in sibilant consonant harmony.

Consonant harmony targets			Languages
	Alveolar	Palatal	
a.	O	X	**15 languages**: Sarcee (Athapaskan), Slave (Athapaskan), Wiyot (Algic), Tzeltal (Mayan), Aari (Omotic), Koyra (Omotic), Benchnon Gimira (Omotic), Zayse (Omotic), Moroccan Arabic (Semitic), Berber (various dialects;Afroasiatic), Coptic (various dialects;Afroasiatic), Nkore-Kiga (Bantu), Rundi (Bantu), Shambaa (Bantu), Izere (Bantu).
b.	O	O	**10 languages**: Navajo (Athapaskan), Chiricahua Apache (Athapaskan), Kiowa-Apache (Athapaskan), Tanaha (Athapaskan), Barbareno (Chumashan), Ineseno (Chumashan), Ventureno (Chumashan), Southern Paiute (Uto-Aztecan), Nebaj Ixil (Mayan), Misantla Totonac (Totonacan).
c.	X	O	**None**

Moreover, note again that no language is detected in which palatal sibilants are exclusively targets (4c). That is to say, it is not the case that (4a) simply outnumbers (4c), but (4c) is not detected at all in any language in the survey.

From this fact, I conclude that target asymmetry in sibilant consonant harmony is not a mere tendency but should be expressed as an implicational relationship whereby the existence of palatal targets implies the existence of alveolar targets. Therefore, I propose the following implicational relationship for sibilant consonant harmony:

(5) Implicational relationship in sibilant consonant harmony

If palatal sibilants are targets of consonant harmony, so are alveolar sibilants.

2.2.2. Retroflex consonant harmony

I proceed to confirm the presence of target asymmetry in retroflex consonant harmony. In retroflex consonant harmony, place assimilation arises between non-retroflex coronal consonants and their retroflex counterparts. Specifically, dental or alveolar stops and nasals such as /d, t, n/ and /d̪, t̪, n̪/ agree in [±anterior] feature with retroflex consonants, namely /ɖ, ʈ, ɳ/. Only 2 languages out of 187 languages in my survey display symmetric consonant harmony whereby retroflex and non-retroflex consonants are both targeted: Gooniyandi and Gaagudju. An example of Gooniyandi, an Australian language, is given in (6). In Gooniyandi, retroflex consonants /ɖ, ʈ, ɳ, ɭ, ɽ/ are optionally neutralized word-initially as alveolar consonants /d, t, n, l, r/ (6a). When these word-initial coronal consonants are followed by non-adjacent coronal consonants, they obligatorily take on the anteriority of the following segments (6b).

(6) Symmetric retroflex consonant harmony in Gooniyandi

a.	Word-initial neutralization of retroflex consonants (optional)			
i.	/**ʈ**u:wu/	[**t**u:wu] ~ [**ʈ**u:wu]	‘cave’	
ii.	/**ɳ**a:gʌ/	[**n**a:gʌ] ~ [**ɳ**a:gʌ]	‘dress’	
b.	Harmony between alveolars and retroflexes			
i.	/**ʈ**i**l**i/	[**t**i**l**i]	‘light’	(*[ʈili])
ii.	/**ʈ**ɨ**ɽ**ɨppɪndi/	[**ʈ**ɨ**ɽ**ɨppɪndi]	‘he entered’	(~ [tɨɽɨppɪndi] only rarely)

On the other hand, the languages other than Gooniyandi and Gaagudju show asymmetric consonant harmony whereby only non-retroflex consonants are targeted to the exclusion of retroflex consonants. Notably, all these languages are consistently biased toward non-retroflex consonant targets. I show examples from Gondi in (7). In Gondi, alveolar stops /d, t/ may assimilate to the following retroflex stops /ɖ, ʈ/ within a word. In (7i), /**t**a:**ɖ**va:/, for instance, non-retroflex stop /t/ optionally becomes a retroflex stop [ʈ], under the influence of /ɖ/. Thus this word may surface as [ʈa:ɖva:]. Note that the word does not become *[ta:dva:], which means it is not the case that retroflexes assimilate to non-retroflexes. That is, non-retroflex consonants are exclusively targeted. (The symbol ‘~’ means optional realization.)

(7) Retroflex consonant harmony (variable) in Gondi (from Arsenault 2012)

i.	/**t**a:**ɖ**va:/	[**t**a:**ɖ**va:] ~ [**ʈ**a:**ɖ**va:]	‘chin’
ii.	/**toɖ**ɖi/	[**toɖɖ**i] ~ [**ʈ**o**ɖɖ**i]	‘beak, mouth’
iii.	/**teɳɖ-**/	[**teɳɖ-**] ~ [**ʈ**e**ɳɖ-**]	‘to take out, remove, draw (water)’
iv.	/**d**a:**ʈ/**	[**d**a:**ʈ**] ~ [**ɖ**a:**ʈ**]	‘much, many’
v.	/**d**a**ɳɖ**a:ri/	[**d**a**ɳɖ**a:ri] ~ [**ɖ**a**ɳɖ**a:ri]	‘Gond ritual song and dance’

To the contrary, no language is detected in which only retroflex consonants are targeted by harmony. Survey results for retroflex consonant harmony are demonstrated in the table (8). There is no language in which retroflex consonants are exclusively targeted by consonant harmony (8c). However, the opposite asymmetrical patterns in which non-retroflex consonants are targeted as in (8a), are robustly attested in many languages. From the survey results, I confirm the existence of target asymmetry in which non-retroflex consonants are more likely to be targets, while retroflex consonants are more likely to trigger the harmony.

(8) Survey results: cross-linguistic patterns of target asymmetries in retroflex consonant harmony

Consonant harmony Targets			Languages
	Non-retroflex	Retroflex	
a.	O	X	**185 languages**: Malto, Pengo, Gondi, Parji, Kuvi, Konda, Panjabi, Indus Kohistani, Kalasha, Yasin (dialect of Burushaski), Nagar (Burushaski dialect), Sherpa, Santali (Munda), Mundari (Munda), and many others.
b.	O	O	**2 languages**: Gooniyandi, Gaagudju.
c.	X	O	**None**

Note again the fact that no language of type (8c) is observed at all. That is, no language reveals consonant harmony that only retroflex consonants are targeted but their non-retroflex counterparts are not. The presence of retroflex targets in a certain language implies non-retroflex targets. This leads me to propose an implicational relationship for retroflex consonant harmony as follows:

(9) Implicational relationship in retroflex consonant harmony

If retroflex consonants are targets of consonant harmony, so are non-retroflex consonants.

2.2.3. Nasal consonant harmony

Finally, I investigate the target asymmetry in nasal consonant harmony. In nasal consonant harmony, nasality (or orality) of nasal consonants and non-nasal consonants is agreed. Nasal consonants with different places of articulation, /m, n, ŋ/, interact with their non-nasal counterparts, namely plain stops such as /b, d, g, p, t, k/ and liquid consonants /l, r/. When assimilation takes place between these segments types, either nasal or non-nasal consonant is expected to be equally targeted. However, survey results show that typology is clearly biased toward non-nasal targets. To be exact, of 21 languages surveyed, only 2 languages show symmetric consonant harmony whereby non-nasal and nasal consonants are both targeted. The rest of the languages, on the other hand, show asymmetric harmony in which only non-nasal consonants, excluding nasal consonants, are targeted by harmony. I will examine the symmetric harmony first, and then go through the asymmetric harmony that exhibits target asymmetry, which is the case in point.

Tiene, a Bantu language, reveals symmetric nasal consonant harmony in which either nasalization or denasalization occurs, depending on the circumstances. Nasalization occurs in (10) where plain stops and liquid consonants assimilate to nasals in the stems. In (10a), /l/ in the applicative infix becomes nasal under the influence of the nasals in the stem. The underlying form of the infix is /l/, as seen in (10a)-(i) and (ii), but it surfaces as [n] in (10a)-(iii) and (iv), following the [m] and [ŋ], respectively. Likewise, in (10b), /k/ in the stative suffix becomes [ŋ] in (10b)-(iii) and (iv), assimilating to the nasal consonants in the stem. ('-' indicates a morpheme boundary.)

(10) Symmetric nasal consonant harmony in Tiene: Nasalization

a. Applicative infix /-l-/ (< Proto-Bantu *-ed-)

	Stems		Infixed forms		
i.	[bák-a]	'reach'	/bá-**l**-ka/	[bá-**l**a-ka]	'reach for'
ii.	[jók-a]	'hear'	/jó-**l**-ka/	[jó-**l**e-kɛ]	'listen to'
iii.	[dum-a]	'run fast'	/du-**l**-**m**a/	[du-**ne**-**m**ɛ]	'run fast for'
iv.	[lɔŋ-ɔ]	'load'	/lɔ-**l**-**ŋ**ɔ/	[lɔ-**n**ɔ-**ŋ**ɔ]	'load for'

b. Stative suffix /-k-/ (< Proto-Bantu *-ek-)

	Stems		Suffixed forms		
i.	[jaat-a]	'split'	/jaat-**k**-a/	[jat-a**k**-a]	'be split'
ii.	[ból-a]	'break'	/ból-**k**-a/	[ból-e**k**-ɛ]	'be broken'
iii.	[vwuɲ-a]	'mix'	/vwu**ɲ**-**k**-a/	[vwu**ɲ**-e**ŋ**-ɛ]	'be mixed'
iv.	[sɔn-ɔ]	'write'	/sɔ**n**-**k**-ɔ/	[sɔ**n**-ɔ**ŋ**-ɔ]	'be written'

Next, I present the case of de-nasalization in Tiene. In fact, de-nasalization is distinguished from nasalization in that it only happens when oral consonants cannot be nasalized. When the causative infix /-s-/ is infixed into the nasal-final roots as in (11), /s/ is expected to be nasalized to undergo nasal consonant harmony. But /s/ lacks its nasal counterpart in the consonant inventory of Tiene, and thus cannot be nasalized. In this situation, the root-final nasal instead yields to harmony, becoming de-nasalized as [b].

(11) Symmetric nasal consonant harmony in Tiene: De-nasalization

- De-nasalization of causative infix /-s-/ (< Proto-Bantu *-es-)

	Stems		Infixed forms		
i.	[tó**m**-a]	'send'	/tó-**s**-**m**-a/	[tó-se-**b**-ɛ]	'cause to send'
ii.	[dí**m**-a]	'get extinguished'	/dí-**s**-**m**-a/	[dí-se-**b**-ɛ]	'extinguish'
iii.	[suɔ**m**-ɔ]	'borrow'	/sɔ-**s**-**m**-ɔ/	[sɔ-sɔ-**b**-ɔ]	'lend'

Now I go on to present an asymmetric nasal consonant harmony. As previously mentioned, target asymmetry in nasal consonant harmony reveals the pattern that non-nasal consonants are more likely to be targeted than their nasal counterparts. Examples from Yaka, a Bantu language, are provided in (12). The voiced stop /d/ and liquid /l/ in the perfective suffixes are nasalized after the nasal consonants in the roots. In contrast, it is not the case in Tiene that nasal consonants in an affix become denasalized to harmonize with the oral consonants in a root.

(12) Asymmetric nasal consonant harmony in Yaka

- Alternations in perfective suffixes [-idi] / [-ele]

i.	/són-e**l**e/	[só**n**-e**n**e]	'color'
ii.	/kém-e**l**e/	[ké**m**-e**n**e]	'moan'
iii.	/mák-i**d**i/	[**m**ák-i**n**i]	'climb'
iv.	/hámúk-i**d**i/	[há**m**úk-i**n**i]	'break (into)'

Thus I observed the target asymmetry in nasal consonant harmony that is biased toward non-nasal consonant targets. This kind of asymmetry is attested in 19 languages out of 21 in the survey, including a number of Bantu languages such as Kongo, Lamba, and KiMbundu, and also languages other than Bantu such as Hausa (Chadic), Ngbaka (Niger-Kongo), and Yabem (Oceanic). Survey results are summarized in (13).

(13) Survey results: cross-linguistic patterns of target asymmetries in nasal consonant harmony

Consonant harmony targets			Languages
	Non-nasal	Nasal	
a.	O	X	**19 languages**: Baasa (Bantu), Bemba (Bantu), Fang (Bantu), Ganda (Bantu), Hausa (Chadic), Herero (Bantu), Ila (Bantu), Kongo (Bantu), Kwanyama (Bantu), Lamba (Bantu), Luba (Bantu), (Ki)Mbundu, Ndonga (Bantu), Ngbaka (Niger-Congo), Pangwa (Bantu), Suku (Bantu), Teke (dialect cluster;Bantu), Tonga (Bantu), Yabem (Oceanic).
b.	O	O	**2 languages**: Tiene (Bantu), Sawai (Austronesian).
c.	X	O	**None**

Note that asymmetric nasal target cases in (13c) are not observed at all throughout survey. From this, I draw a conclusion that the presence of nasal consonant target implies that of non-nasal consonant target. Therefore, I suggest the following implicational relationship for nasal consonant harmony:

(14) Implicational relationship in nasal consonant harmony

If nasal consonants are targets of consonant harmony, so are non-nasal consonants.

2.2.4. Summary

In this section, I have explored the universal patterns of consonant harmony. Results of my cross-linguistic survey show that some harmony types reveal target asymmetries in which particular types of consonants are more likely to be targets: sibilant, retroflex, and nasal consonant harmony. The implicational relationships found are as follows.

(15) Implicational relationships in consonant harmony typology

a. If palatal sibilants are targets of consonant harmony, so are alveolar sibilants.

b. If retroflex consonants are targets of consonant harmony, so are non-retroflex consonants.

c. If nasal consonants are targets of consonant harmony, so are non-nasal consonants.

2.3. Patterns with no target asymmetries

In the previous section, I found target asymmetries in consonant harmony typology and proposed implicational relationships. In this section, I will deal with the other types of consonant harmony. It will be shown that some of them do not show target asymmetries: liquid consonant harmony and stricture consonant harmony. In these types of harmony, no cross-linguistic preference for targets is detected, and therefore no implicational relationship is established. In the other consonant harmony types, on the other hand, target asymmetry is observed, but the data is insufficient to make typological generalizations: non-sibilant coronal consonant harmony, dorsal consonant harmony, secondary articulation consonant harmony and laryngeal consonant harmony. To verify the existence of target asymmetry in these harmony types, more data should be available to me. In the upcoming subsections, I illustrate in detail each type of consonant harmony.

2.3.1. Non-sibilant coronal consonant harmony

Non-sibilant coronal consonant harmony refers to place assimilation between coronal consonants that are not sibilants. Dental stops, both oral and nasal ([d̪, t̪, n̪]), and their alveolar counterparts ([d, t, n]), are typically engaged in harmony. Survey results show that target asymmetry might exist in non-sibilant coronal consonant harmony that is biased toward dental targets. However, my database has only four languages which are insufficient for any typological generalizations. To be specific, this category contains the following four languages: Päri, Anywa, Shilluk and Mayak. Among these languages, Päri and Anywa reveal symmetric consonant harmony where dental and alveolar consonants are both targets. I provide an example of Päri in (16). In Päri, a root-final consonant alternation frequently occurs in its inflectional and derivational morphology whereby the root-final consonant is replaced with alveolar stops or nasals. Those underlyingly alveolar consonants in the root final position then agree with the preceding dental stops within the root, as shown in (16iv) and (16vi).

(16) Non-sibilant coronal consonant harmony in Päri

	Unpossessed	Possessed (1Sg)	
i.	/bò:l-ì/	[bò:**t**-â]	‘handles’ vs. ‘my handles’
ii.	/àbí-í ̀/	[àbí:**n**̀ - á]	‘cloth’ vs. ‘my cloth’
iii.	/**d**è:l/	[**d**è:**nd**-á]	‘skin’ vs. ‘my skin’
iv.	/**t̪**ùol/	[**t̪**úo**n̪d̪**-à]	‘snake’ vs. ‘my snake’
v.	/**t**à-à/	[**t**à:**n**:-á]	‘pancreas’ vs. ‘my pancreas’
vi.	/ù**t̪**ô-ó/	[ùt̪ó:**n̪**-á]	‘fox’ vs. ‘my fox’

Shilluk and Mayak, on the other hand, show an asymmetric consonant harmony in which only dental consonants are targets. An example of Mayak is illustrated in (17). In Mayak, a contrast of dental vs. alveolar exists among stops ([t̪ , d̪] vs. [t, d]). Out of these stops, /d̪/ is realized as [ð] and /d/ as [ɗ] in some predictable contexts, thus rendering surface contrast among stops [t̪ , d̪, ð] vs. [t, d, ɗ], which are the consonants taking part in harmony. When various suffixes such as singulative affixes /-ɛt̪ /, /-ʌt̪ /, /-it̪ / are attached to roots containing alveolars ([t, d, ɗ]), the dental consonants ([t̪ , d̪, ð]) optionally become alveolars (17iv) and (17v).

(17) Non-sibilant coronal consonant harmony in Mayak

i.	[leɣ-it̪]	‘tooth’
ii.	[gim-it̪]	‘cheek’
iii.	[wʌð-it̪]	‘buttock’
iv.	/tiɗ-ʌt̪/ ~ [ti**ɗ**-ʌ**t**]	‘doctor’
v.	/tuɣ-it̪/ ~ [**t**uɣ-i**t**]	‘back of head’

Note that if there is no language revealing the opposite case of asymmetric consonant harmony in which only alveolar consonants are targets of consonant harmony, we might establish target asymmetry in which dental consonants are preferred targets. Due to small data, however, that is not substantiated in the present survey.

2.3.2. Dorsal consonant harmony

In dorsal consonant harmony, place assimilation arises between velar stops ([k]) and uvular stops ([q]). Just like the case in non-sibilant coronal consonant harmony, even though survey results point towards the target asymmetry in which velar consonants are preferred targets, insufficient amount of data (only four languages) in the survey does not lead me to propose any typological generalization. To be precise, four languages in the data include Misantla Totonac, Tlachichilco Tepehua, Bolivian Aymara, and Malto. Among these languages, Misantla Totonac and Tlachichilco Tepehua show an asymmetric consonant harmony in which only velar consonants are targets. An example of Tlachichilco Tepehua is provided in (18). In Tlachichilco Tepehua, synchronic alternation occurs where velar stops /k/ in prefixes and clitics become uvular stops /q/ or /q'/, following the uvular stops in the stem. In the first word in (18a)-(i), for example, /k/ in the derivational prefix /ʔuks-/ becomes [q], following /q/ in the stem /-laqts'in/. In the second word in (18a), /k/ in /ʔuks-/ appears intact, since it already agrees in place with the following velar stop /k'/.

(18) Dorsal consonant harmony in Tlachichilco Tepehua

a.	Harmony alternations in derivational prefixes		
i.	/ʔu**k**s-la**q**ts’in/	[ʔo**q**sla**q**ts’in]	‘look at Y across surface’
cf.	/ʔu**k**s-**k’**atsa:/	[ʔu**k**s**k’**atsa:]	‘feel, experience sensation’
ii.	/la**k**-tʃi**q’**i-ɬ/	[la**q**tʃe**ʔ**eɬ]	‘X broke them’
cf.	/la**k**-huni:-ɬ/	[la**k**huni:ɬ]	‘X told them’
b.	Harmony in locative proclitic /laka:-/		
iii.	/laka:-tʃaqa:/	[la**q**a:-tʃa**q**a:]	‘house’
cf.	/laka:-k’iw/	[la**k**a:-**k’**iw]	‘tree’

But in the remaining two languages, Bolivian Aymara and Malto, I could not identify the targets, due to lack of evidence, whether synchronic or diachronic. In these languages without synchronic alternations, I could see the trace of consonant harmony only in static co-occurrence restrictions. Examples from Bolivian Aymara are shown in (19) below. MacEachern (1997[1999]) describes that velar and uvular consonants are not allowed to co-occur within roots, even though these consonants freely occur with consonants with other places of articulation. The words containing only uvular stops such as [qelqa] in (19a) and the words containing only velar stops like [kiki] in (19a) are allowed, but combinations such as *[k…q] or *[q…k] in (19b) are disallowed as proper roots in Bolivian Aymara.

(19) Dorsal consonant harmony in Bolivian Aymara

a. Well-formed roots

i.	[**q**el**q**a]	'document'
ii.	[**q^h**atʃ**q^h**a]	'rough to the touch'
iii.	[**q'**en**q'**o]	'rough (ground); crooked'
iv.	[**q^h**apa**q**a]	'wealthy, rich person'
v.	[**k**i**k**i]	'similar, identical'
vi.	[**k^h**us**k^h**a]	'common'
vii.	[**k'**as**k'**a]	'acid to the taste'
viii.	[**k'**i**k**u]	'wise' (obsolete)

b. Unattested combinations in roots

*k^h...q^h	*k'…q'	*k…q	*k'… q^h	*k'…q	(etc.)
*q^h…k^h	*q'…k'	*q…k	*q^h… k'	*q'…k	(etc.)

In these languages, no record of sound change that I could take as a criterion for trigger-target distinction was available to me. Therefore, it is difficult to reach well-founded generalizations on target asymmetry in dorsal consonant harmony.

2.3.3. Secondary articulation consonant harmony

Secondary articulation consonant harmony refers to agreement between the consonants with respect to the features known as secondary articulation such as palatalization, labialization, velarization, and pharyngealization. Secondary articulation consonant harmony is distinguished from the other types of consonant harmony in that it involves superimposition of vocalic features onto consonants. Survey database contains only two languages belonging to this type of consonant harmony: Tsilhqot'in and Pohnpeian. Just as in the previous mentioned harmony types, more data are required for a valid cross-linguistic generalizations. For now, I provide a brief discussion of each case of secondary articulation consonant harmony.

First, Tsilhqot'in (a.k.a. Chilcotin) exhibits pharyngealization consonant harmony that occurs between pharyngealized alveolar sibilants ([sˤ, zˤ, tsˤ, ts'ˤ, dzˤ]) and their non-pharyngealized counterparts ([s, z, ts, ts', dz]). Alveolar sibilants within a word agree with regard to [±RTR] feature. Note that palatal sibilants do not participate in this consonant harmony since pharyngealization contrast only exists among alveolar sibilants in Tsilhqot'in. Harmony is symmetric in that both pharyngealized and non-pharyngealized (i.e. plain) sibilants are targets of consonant harmony.

Tsilhqot'in examples are provided in (20) below. Tsilhqot'in is anticipatory in that the rightmost segment among all the alveolar sibilants within a word determine the [±RTR] feature of all the preceding alveolar sibilants. In (20a), alveolar sibilants /s/ become pharyngealized, following the pharyngealized alveolar sibilants /sˤ/. In (20b), on the other hand, pharyngealized sibilants /sˤ/ are de-pharyngealized under the influence of the plain alveolar sibilants /s, z/.

(20) Pharyngealization consonant harmony in Tsilhqot’in

a. Pharyngealization

i.	/næ -sɛ-næ -ʁɛ-nɛ-l-tsˤɛnsˤ/	[nɑ**sˤ**ʌnɑʁʌ̃ĩlt**sʰˤ**ʌ̃**sˤ**]	‘you’re hitting me’
ii.	/næ -nɛ-dɛ-ʁɛ-s-ɬ-bæsˤ/	[nɑnʌd̥ɑ**sˤ**b̥ɑ**sˤ**]	‘I’m turning you around’
	(cf. /næ -nɛ-dɛ-ʁɛ-**s**-ɬ-g̊æɬ/	[næ nɛd̥æ**s**g̊æɬ]	‘I’m spinning you’)

b. Depharyngealization

i.	/næ -tɛ-**sˤ**ɛ-**s**-d-bin/	[næ tɛ**z**ɛ**s**b̥in]	‘I’m swimming away’
	(cf. /næ -tɛ-**sˤ**ɛ-id-d-bin/	[nɑtʌ**zˤ**ʌib̥in]	‘we’re swimming away’)
ii.	/**sˤ**ɛ-i-ɬ-tʃæ **z**/	[**s**iɬtʃʰæ **z**]	‘I barbequed it’
	(cf. /jæ -**sˤ**ɛ-id-ɬ-tɪg/	[jɑ**zˤ**ʌiltʰig̊]	‘we’re not talking’)

Velarization consonant harmony is witnessed in Pohnpeian, as in (21). Velarized labial consonants /pˠ, mˠ/ and their non-velarized labial counterparts /p, m/ agree with regard to velarization. Harmony reveals itself in form of static co-occurrence restrictions on roots. Velarized and non-velarized labial consonants are not allowed to co-occur in roots. As we can see in (21a), the roots containing only non-velarized labial consonants such as [**p**ira**p**] and the roots with velarized labial consonants only, such as [**pˠ**u**pˠ**], are both well-formed, but the roots containing velarized and non-velarized consonants at the same time within the word, as in (21b), are unattested throughout the root inventory of Pohnpeian.

(21) Velarization consonant harmony in Pohnpeian

a. Well-formed roots

i.	[**p**ira**p**]	‘steal; be stolen’
ii.	[**m**e**m**]	‘sweet’
iii.	[**p**are**m**]	‘nipa palm’
iv.	[**m**ate**p**]	‘species of sea cucumber’
v.	[**p**$^{\gamma}$u**p**$^{\gamma}$]	‘fall down’
vi.	[**m**$^{\gamma}$aa**m**$^{\gamma}$]	‘fish’
vii.	[**m**$^{\gamma}$o**p**$^{\gamma}$]	‘out of breath’

b. Unattested roots

p…p$^{\gamma}$	*m…m$^{\gamma}$	*p…m$^{\gamma}$	*m…p$^{\gamma}$
p$^{\gamma}$…p	*m$^{\gamma}$…m	*p$^{\gamma}$…m	*m$^{\gamma}$…p

2.3.4. Liquid consonant harmony

In liquid consonant harmony, assimilation takes place either between liquid consonants or between liquid ([l, r]) and non-liquid consonants such as glides ([j]). Thus, liquid consonant harmony can be classified into two subtypes, according to whether non-liquid consonants take part in harmony or not. In case where only liquid consonants are involved, they agree with regard to [±lateral] feature. Four languages belong to this type of consonant harmony: Bukusu, Sundanese, Pohnpeian and Hausa. In the other type of consonant harmony where non-liquid consonants take part in harmony, liquids ([l, r]) and glides ([j]) assimilate to each other. In featural terms, it can be represented as agreement between [±consonantal] feature. Two languages belong to this type of consonant harmony: Bassa and Pare.

In liquid consonant harmony, no cross-linguistic asymmetrical pattern is found in which a particular type of consonant is more likely to be a target. Instead, liquid and glide consonants are all equally likely to be targets. Recall that in target asymmetries, cross-linguistic implicational relationship was established that a particular type of target consonant implies the existence of the other target consonant. For example, in sibilant consonant harmony, we observed that if palatal sibilants are targets of consonant harmony in a language, so are alveolar sibilants. We cannot say this kind of implicational statement holds in liquid consonant harmony. To elaborate the situation in detail, in the first type of liquid consonant harmony where only liquid consonants (/l, r/) participate in harmony, for example, there is both a language in which only the lateral /l/ is a target of consonant harmony (e.g. Bukusu) and a language in which only the rhotic /r/ is a target of harmony (e.g. Sundanese), to the contrary. These languages exhibit alternation between laterals /l/ and rhotics /r/. First, in Bukusu presented in (22), /l/ in the applicative suffix /-il/ becomes /r/ when there is /r/ in the stem. Thus in (22b), /-il/ is realized as /-ir/, under the influence of preceding /r/.

(22) Liquid consonant harmony in Bukusu

a.	i.	[xam-i**l**-a]		‘milk for’
	ii.	[but-i**l**-a]		‘pick / gather for’
	iii.	[te:x-e**l**-a]		‘cook for’
	iv.	[i:l-i**l**-a]		‘send thing’
b.	i.	/bi**r**-i**l**-a/	[bi**r**-i**r**-a]	‘pass for’
	ii.	/i**r**-i**l**-a/	[i**r**-i**r**-a]	‘die for’
	iii.	/ka**r**-i**l**-a/	[ka**r**-i**r**-a]	‘twist’
	iv.	/**r**e:b-e**l**-a/	[**r**e:b-e**r**-a]	‘ask for’
	v.	/**r**esj-e**l**-a/	[**r**esj-e**r**-a]	‘retrieve for’

Bukusu exhibits consonant harmony in the form of co-occurrence restriction on roots as well, as illustrated in (23) below. An important thing to note here is that /l/ assimilates to /r/, but /r/ does not assimilate to /l/. To give full details, /l/ and /r/ in Bukusu are reflexes of Proto-Bantu *d and *t, respectively. When /l/ and /r/ appear in roots, it is /l/ that yields to harmony. The root /-le:r-a/ (> Proto-Bantu *deet-a), for instance, is optionally realized as /-re:r-a/ in which /l/ assimilates to /r/ or realized intact as /-le:r-a/, but is never realized as */-le:l-a/, which shows /r/ does not assimilate to /l/. Therefore, we can conclude that /l/, but not /r/, is a target in Bukusu liquid consonant harmony.

(23) Root-internal liquid consonant harmony in Bukusu

i.	[-**r**a**r**e]	'iron/copper ore'	<	Proto-Bantu *tade
ii.	[-**r**e:**r**-a] ~ [-le:r-a]	'bring'	<	Proto-Bantu *deet-a
iii.	[-**r**o:**r**-a] ~ [-lo:r-a]	'dream (verb)'	<	Proto-Bantu *doot-a

The opposite case in which /r/ is a target of consonant harmony is observed in Sundanese, a Malayo-Polynesian language. In Sundanese presented in (24), the plural (or distributive) marker /-ar-/ is infixed after a root-initial onset consonant as in (24a) and (24b). When the root-initial onset consonant is /l/, the /r/ in the infix becomes /l/. This is shown in (24c), where [l-al-ɨtik] is observed, instead of *[l-ar-ɨtik].

(24) Liquid consonant harmony in Sundanese plural marker /-ar-/

		Singular	Plural (/-ar-/)		
a.	i.	[kusut]	[k-a**r**-usut]		'messy'
	ii.	[poho]	[p-a**r**-oho]		'forget'
	iii.	[di-visualisasi-kɨn]	[di-v-a**r**-isualisasi-kɨn]		'visualized'
b.	i.	[rɨwat]	[**r**-a**r**-ɨwat]		'startled'
	ii.	[rahɨt]	[**r**-a**r**-ahɨt]		'wounded'
c.	i.	[lɨtik]	/**l**-a**r**-ɨtik/	[**l**-a**l**-ɨtik]	'little'
	ii.	[ləga]	/**l**-a**r**-əga/	[**l**-a**l**-əga]	'wide'

Therefore, we cannot establish an implicational relationship such as a lateral target /l/ implies a rhotic target /r/, or vice versa. The same goes for the second type of liquid consonant harmony where liquid and non-liquid glide consonants are involved in harmony. In this type of consonant harmony as well, both liquids and non-liquid consonants are targets, and no generalized typological patterns with regard to targets are detected. In Basaa described in (25), liquid consonant /l/ in the applicative suffix /-Vl/ become glides /j/ when they follow the root-final /j/ as in (25b).

(25) Liquid consonant harmony in Basaa applicative /-Vl/

a.	i.	/tèŋ-Vl/	[tìŋ-ì**l**]	'tie for/with'	(root: /tèŋ-/)
	ii.	/ɓám-Vl/	[ɓém-ê**l**]	'wait with/for'	(root: /ɓám-/)
	iii.	/ɓɔ̀l-Vl/	[ɓòl-ò**l**]	'go bad for/because of'	(root: /ɓɔ̀l-/)
b.	i.	/tɔ́j-Vl/	[tó**j**-ô**j**]	'drip for'	(root: /tɔ́j-/)
	ii.	/ɓàj-Vl/	[ɓè**j**-è**j**]	'shine on/for'	(root: /ɓàj-/)
	iii.	/ɲɔ́j-Vl/	[ɲó**j**-ô**j**]	'disappear for'	(root: /ɲɔ́j-/)

In Pare (26), on the other hand, palatal glide /j/ in the suffix optionally becomes the liquid /l/ or /r/, following the root-final liquid consonants. In the first example from (26b), the applicative suffix /-ij-/ surfaces as [-il-], assimilating to the root final /l/ in /-tal/. In the second example, /-ij-/ surfaces as [-ir-], following root final 'r' in the root /-zor/. The same situation occurs in (26d) as well.

(26) Liquid consonant harmony in Pare

Applicative suffix /-ij-/

a.	i.	[-tet-i**j**-a]		'say for'
	ii.	[-big-i**j**-a]		'beat for'
b.	i.	/-tal-ij-a/	[-ta**l**-i**l**-a] ~ [-tal-ij-a]	'count for'
	ii.	/zor-ij-a/	[-zo**r**-i**r**-a] ~ [zor-ij-a]	'buy for'

Perfective suffix /-ije-/

c.	i.	[-kund-i**j**e]		'like (perf.)'
	ii.	[-dik-i**j**e]		'cook (perf.)'
	iii.	[-von-i**j**e]		'see (perf.)'
d.	i.	/-tal-ije/	[-ta**l**-i**l**e] ~ [-tal-ije]	'wash (perf.)'
	ii.	/-zor-ije/	[-zo**r**-i**r**e] ~ [-zor-ije]	'heal (perf.)'

These facts distinguish liquid consonant harmony from the rest of consonant harmony patterns that we have discussed so far in 2.3. For the latter, more data were needed to make sure whether target asymmetry exists or not. However, in liquid consonant harmony, no matter how much more data become available to me, there is no possibility of target asymmetry.

2.3.5. Stricture consonant harmony

Stricture consonant harmony refers to harmony in which degree of stricture of consonants agree with each other. Usually, obstruents and glides participate in stricture consonant harmony. To be specific, the term degree of stricture refers to how much constriction is made when pronouncing consonants. In general, it is known that obstruents are most constricted, among which stops are most constricted, next affricates, and finally fricatives the least constricted. That is to say, in stricture consonant harmony, harmony occurs in the way that consonants' degree of stricture agrees on the scale of *stop-affricate-fricative-approximant*.

I failed to find any indication about target asymmetry in stricture consonant harmony. Five languages fall under stricture consonant harmony: Yabem, Shambaa, Pare, Mwiini and Pengo. Of these languages, Yabem, an Oceanic language, targets only fricatives while stops are triggers, as presented in (27). Yabem shows alternation in which alveolar fricative /s/[1] of the plural prefix (27a) optionally assimilates to homorganic stop /d/ and /t/, as seen in (27b). On the other hand, /t/ or /d/ does not assimilate to fricative /s/ (27c). Furthermore, Yabem stricture consonant harmony is also attested as static co-occurrence restriction within morphemes. Native Yabem morphemes do not contain the sequences /s…t/ or /s…d/.

[1] /s/ is the only fricative in Yabem segment inventory.

(27) Stricture consonant harmony in Yabem

<u>3rd plural prefix /se-/</u>

a.	i.	[**s**é-líʔ]		‘see (3pl realis/irrealis)’
	ii.	[**s**é-gàbʷàʔ]		‘untie (3pl realis)’
	iii.	[**s**é-kátóŋ]		‘make a heap (3plr realis/irrealis)’
b.	i.	/sé-táŋ/	[**t**é-**t**áŋ]	‘weep (3pl realis/irrealis)’
	ii.	/sɛ́-tɛ́ŋ/	[**t**ɛ́-**t**ɛ́ŋ]	‘ask, beg (3pl realis/irrealis)’
	iii.	/sè-dèŋ/	[**d**è-**d**èŋ]	‘move towards (3pl realis)’
	iv.	/sè-ⁿdèŋ/	[**d**è-**ⁿd**èŋ]	‘move towards (3pl irrealis)’

<u>1st plural inclusive prefix /ta-/, /da-/</u>

c.	i.	[**d**à-**s**ùŋ]	*[sà-sùŋ]	‘we push’
	ii.	[**t**á-**s**èlèŋ]	*[sá-sèlèŋ]	‘we wander’

On the other hand, in Pengo, a Dravidian language, stops are targeted and affricates trigger harmony, as shown in (28) below. Root-initial dental stops optionally become palatal affricates when followed by palatal affricates within the same morpheme.

(28) Stricture consonant harmony in Pengo

i.	/titʃ-/	[**tʃ**i**tʃ**-]	‘to eat (past stem)’	(derived form /tin-/ ‘eat’)
ii.	/to:tʃ-/	[**tʃ**o:**tʃ**-]	‘to show’	
iii.	/ta:ndʒ-/	[**tʃ**a:n**dʒ**-]	‘to weave (a garland)’	
iv.	/dʒo:tʃ-/	[**dʒ**o:**tʃ**-]	‘to carry on the head’	(cf. Gondi /to:tʃa:na:/)
v.	/tʃo:ndʒ-/	[**tʃ**o:n**dʒ**-]	‘to appear’	(cf. Kuvi /to:ndʒ-/)

In the remaining languages, glide /j/ (in Shambaa and Pare) and lateral tap /ɾ/ (in Mwiini) are targeted and become fricatives or stops. First, examples from Shambaa (or Shambala), a Bantu language, are shown in (29). In Shambaa, a palatal glide /j/ assimilates to coronal fricatives /s, z, ʃ/, as exhibited in (29b). The perfective suffix /-ije/ surfaces as [-ize] when it follows the stem ending in coronal fricatives.

(29) Stricture consonant harmony in Shambaa

Perfective suffix /-ije/

a.	i.	[-kant-i**j**e]	'wear (past)'
	ii.	[-ʃind-i**j**e]	'during the whole day (past)' [aspectual auxiliary verb]
	iii.	[-dik-i**j**e]	'cook (past)'
b.	i.	[go**ʃ**-i**z**e]	'sleep (past)'
	ii.	[gwi**ʃ**-i**z**e]	'drop (past)'
	iii.	[ka**s**-i**z**e]	'roast (past)'
	iv.	[-to**z**-i**z**e]	'hold (past)'

Another Bantu language Pare shows similar patterns of consonant harmony, as illustrated in (30). A palatal glide /j/ in a perfective suffix /-ije/ optionally becomes a palatal stop /ɟ/[2] when it follows the stem ending in palatal non-glide consonants, namely /ɟ, ʃ, ɲ/. Furthermore, an applicative suffix /-ij-/ also shows the same kind of alternation, as in (30d). To sum up, in Pare stricture

[2] Odden (1994) describes this segment as a 'palatal stop', but Hansson (2001) suggests that this segment might be a 'palatal affricate' /dʒ/. I follow Odden (1994) here.

consonant harmony, palatal approximant /j/ becomes obstruent when it follows homorganic stem-final stops and fricatives.

(30) Stricture consonant harmony in Pare

<u>Perfective suffix /-ije/</u>

a.	i.	[-tet-i**j**e]		‘say (perf.)’
	ii.	[-kund-i**j**e]		‘like (perf.)’
	iii.	[-dik-i**j**e]		‘cook (perf.)’
	iv.	[-von-i**j**e]		‘see (perf.)’
b.	i.	/-oɟ-ije/	[-o**ɟ**-i**ɟ**e]	‘wash (perf.)’
	ii.	/-banɟ-ije/	[-ban**ɟ**-i**ɟ**e]	‘heal (perf.)’
	iii.	/-vuʃ-ije/	[-vu**ʃ**-i**ɟ**e]	‘put up (perf.)’
	iv.	/-maɲ-ije/	[-ma**ɲ**-i**ɟ**e]	‘know (perf.)’

<u>Applicative suffix /-ij-/</u>

c.	i.	[-tet-i**j**-a]		‘say for’
	ii.	[-big-i**j**-a]		‘beat for’
	iii.	[-dik-i**j**-a]		‘cook for’
d.	i.	/oɟ-ij-a/	[-o**ɟ**-i**ɟ**-a]	‘wash for’
	ii.	/-miɲ-ij-a/	[-mi**ɲ**-i**ɟ**-a]	‘press for’

To recapitulate, I failed to find target asymmetry in stricture consonant harmony in the survey. I cannot say that one type of consonant is cross-linguistically more likely to be targets.

2.3.6. Laryngeal consonant harmony

The last type of consonant harmony that will be covered here is laryngeal consonant harmony in which obstruent consonants with different laryngeal features agree with each other with respect to laryngeal features. In fact, most of the languages exhibiting laryngeal consonant harmony show static co-occurrence restrictions without synchronic alternations, and historical evidence to identify the targets are absent as well. Therefore, it was impossible to identify the targets in most cases. I will only discuss the case in which targets are clearly identified: voicing consonant harmony.

There are two languages that show voicing consonant harmony: Kera and Ngizim. In both of them, only voiceless obstruents are targets of consonant harmony while voiced obstruents are triggers. Consonant harmony in Kera, a Chadic language, is illustrated in (31). Kera shows alternation in which voiceless stops and affricates in the affix assimilate in voicing to voiced counterparts in the root.[3] In (31a), the underlying form of nominal prefix is /k-/, as you can see from the word [**k**ə-màanə̀]. When this prefix occurs before roots containing voiced stops, however, it becomes [g], as in [**g**ə-**d**àarə̀]. Suffixes in (31b) and (31c) also show same kind of alternation. However, no words are attested in which voiced obstruents assimilate to voiceless ones. Therefore, I can confirm that only voiceless obstruents are targets of consonant harmony in Kera, while voiced obstruents are triggers.

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[3] Fricatives do not participate in consonant harmony, as seen in the words /fèrgé/ 'itch' and /dèfé/ 'make (a sauce)' (Ebert 1979).

(31) Voicing consonant harmony in Kera

a.	Nominal prefix /k-/		
i.	/kə-màanə̀/	[kə-màanə̀]	‘woman’
ii.	/kə-taatá-w/	[kə-taatá-w]	‘cooking pot (plur.)’
iii.	/kə-kámná-w/	[kə-kámná-w]	‘chief (plur.)
iv.	/**k**ə-**d**àarə̀/	[**g**ə-**d**àarə̀]	‘friend’
v.	/**k**ə-**d**àj**g**á-w/	[**g**ə-**d**àj**g**á-w]	‘jug (plur.)’
b.	Feminine suffix /-ká/		
i.	/sár-ká/	[sár-ká]	‘black (fem.)’
ii.	/**dʒ**àr-**k**á/	[**dʒ**àr-**g**á]	‘colorful (fem.)’
c.	Collective suffix /-káŋ/ and masculine suffix /-kí/		
i.	/**k**ə-**s**ár-**k**áŋ/	[**k**ə-**s**ár-**k**áŋ]	‘black (coll.)’
ii.	/**k**i-**s**ír-**k**í/	[**k**i-**s**ír-**k**í]	‘black (masc.)’
iii.	/**g**ə-**dʒ**àr-**k**áŋ/	[**g**ə-**dʒ**àr-**g**áŋ]	‘colorful (coll.)’
iv.	/**g**i-**dʒ**ír-**k**í/	[**g**i-**dʒ**ír-**g**í]	‘colorful (masc.)’

In Ngizim, another Chadic language, same kind of voicing consonant harmony is observed where only voiceless obstruents are targets of harmony. Ngizim underwent historical sound change in which voiceless obstruents became voiced following voiced obstruents within the same root. As you can see in (32), roots in Ngizim never contain voiceless and voiced obstruents simultaneously.

(32) Voicing consonant harmony in Ngizim

i. [**k**ù**t**ə́r] ‘tail’

ii. [**t**à**s**áu] ‘find’

iii. [**s**ə̀**t**ú] ‘sharpen to point’

iv. [**g**âa**z**á] ‘chicken’ (< *k…z, cf. Hausa /kàazáa/)

v. [**d**ə́**b**â] ‘woven tray’ (< *t…b, cf. Hausa /tàafíl/ ‘palm’)

vi. [**z**à**b**ìjú] ‘clear field’ (< *s…b, cf. Hausa /sássàbée/)

vii. [**z**ə̀**d**ù] ‘six’ (< *s…d, cf. Hausa /ʃídà/)

In voicing consonant harmony, typological generalization is impossible to make at this moment, due to insufficient data.

2.3.7. Summary

Survey results show that some types of consonant harmony do not show target asymmetries: liquid consonant harmony and stricture consonant harmony. Generalized asymmetrical patterns are not detected in these types of consonant harmony, and therefore, no implicational relationship with respect to targets is found. In the other types of consonant harmony, data is insufficient to make cross-linguistic generalizations, although asymmetrical patterns are in fact found: non-sibilant coronal consonant harmony, dorsal consonant harmony, secondary articulation consonant harmony and laryngeal consonant harmony. Therefore, more data are required to make sure whether target asymmetry exists or not in those cases.

3. Phonetic and perceptual basis

This section discusses phonetic and perceptual groundings for the typological patterns of consonant harmony. I explore the reason why particular types of consonants are cross-linguistically preferred targets in consonant harmony. In order to address this question, I investigate the perceptibility variation in different phonological contexts, inspired by numerous previous works based on phonetically based OT (Hayes, Kirchner, and Steriade 2004) that explore how phonetics affects phonology. It is plausible that different phonetic properties of the consonant types and their phonological contexts bring about perceptibility variation, which gives rise to target asymmetries in consonant harmony. As a particular phonetic property that creates perceptibility variation, I take 'elongated phonetic cue' of certain phonological features. It is known by various phonetic research that some phonological features have drawn out phonetic cue, so that they might span over multi-segmental domains. It turns out that those features include the ones relevant to palatal, retroflex, and nasal consonants, which are favored triggers in consonant harmony. The prolonged phonetic cue of certain segment types weakens perceptibility of the relevant features in nearby consonants. In other words, consonants containing long phonetic cue become perceptually more salient than others with regard to relevant features. This phonetic fact is essential for the analysis to come in the next chapter, which takes up P-map hypothesis. P-map states that in phonological changes, prominent perceptual modification tends to be avoided. This indicates that in consonant harmony, consonants with perceptually weaker cues are better opted as targets, since this means less perceptual modification than changing perceptually more noticeable consonants, i.e., consonants with elongated phonetic cue. This section serves as the basis for this line of analysis by providing relevant phonetic evidence from previous research.

3.1. Phonetic grounding: contextual perceptibility variation

In order to explain why only a particular subset of consonant types is more likely to be chosen as targets, I discuss how perceptibility is contextually influenced by phonological features with elongated phonetic cue. I will first show that the features relevant to preferred trigger consonants, i.e., sibilants, retroflexes, and nasals, have elongated phonetic cue. Then I will discuss how this phonetic cue causes positional asymmetry in perceptibility. It is important to note that a lesser degree of perceptual change is caused when perceptually less prominent consonants, i.e., consonants without extended phonetic cue, are targeted. This perceptibility fact is consistent with the observed typology of triggers and targets.

It has been pointed out in the literature (Ladefoged 1993; Ladefoged and Maddieson 1996; Ladefoged, Maddieson, and Jackson 1988; Blevins and Garrett 2004) that some phonological features have elongated phonetic cue, with their effects spanning over multi-segmental domains. I cite the table in (33) below from Blevins and Garrett (2004) who worked on metathesis from the point of evolutionary phonology. The table in (33) below provides a list of the phonological features that have long cues and relevant acoustic properties. It is important to note that phonological features related to palatalization, retroflexion, and nasalization are included in the list. The list also shows other features having no such prolonged phonetic effects.

(33) Features with long durations

Features with typically LONG DURATIONS		Features WITHOUT long durations
Feature	Acoustic property with long durations	
Palatalization	Raised F2 (LM: 364)	Major consonantal place of articulation (coronal, labial,dorsal), voicing, frication, continuancy, major class features.
Retroflexion	Lowered F3, F4; clustering of F2, F3, F4 (L: 204, LM: 28)	
Nasalization	Spectral zero/nasal anti-resonance (LM: 116)	
Rhoticity	Lowered F3 (LM: 244,313)	
Laterality	Lateral formants (LM: 193-7)	
Rounding	Lowering of all formants (LM: 356-8)	
Velarization	Lowered F2 (LM: 361-2)	
Pharyngealization	Lowered F3, raised F1 (LM: 307)	
Laryngealization	More energy in F1, F2 More jitter (LMJ)	
Aspiration	More energy in F0; More noise (LMJ)	

(L = Ladefoged 1993; LM = Ladefoged and Maddieson 1996; LMJ = Ladefoged, Maddieson, and Jackson 1988)

Now that we have phonetic grounding that some features may carry on their effects on nearby segments, let us explore how these features with drawn-out phonetic effects arouse perceptibility variation across different phonological contexts. Segments that have elongated phonetic cue affect nearby segments, leading to the relative weakening of the phonetic cue for the affected segments. That is, when a sequence of non-adjacent consonants are located in a phonological domain and one of these segments has prolonged phonetic effects, it brings the result that perceptibility of the other is weakened. With this in mind, I will inspect in detail how human listeners' perception is influenced by these contextual factors.

3.2. Asymmetry in perceptibility of phonological features

Suppose a situation where two non-adjacent sibilant consonants are located in a certain phonological domain. The preceding sibilant consonant has an alveolar place of articulation that can be represented with [+anterior] feature, whereas the latter sibilant consonant has a palatal place of articulation that can be represented with [-anterior] feature. [4] Now consider the relative

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[4] I assume here that the preceding segment is influenced by the following segment. This assumption is based on the prevalence of regressive harmony. In this research, I do not discuss the reason why consonant harmony is regressive believing that it is beyond the scope of this study. However, there are some possible reasons I can think of. Firstly, it is possible that the later segment have greater phonetic influence on the preceding segment, rather than vice versa. Another possibility is that anticipatory perception is more common than progressive perception even though the preceding and the following segments equally affect each other.

perceptibility of the two segments, with respect to [±anterior] feature. The prolonged phonetic cue of the palatal sibilant affects the preceding alveolar sibilant, thus masking the cue to the anteriority feature of the alveolar sibilant. In other words, perceptibility of the alveolar sibilant's anteriority is weakened, due to the influence of the elongated phonetic cue of palatal sibilants.

To illustrate this, consider a sequence /s…ʃ/. Palatal sibilant /ʃ/ has a palatal feature and thus have a prolonged phonetic cue. In this situation, /s/ might be confused with /ʃ/, under the influence of the elongated cue of the following /ʃ/. On the other hand, consider the opposite consonant sequence /ʃ…s/. /ʃ/ is not perceptually influenced by /s/, since /s/ does not have elongated phonetic cue that spans through a number of syllables. Therefore, /ʃ/ in /ʃ…s/ would not be as much confused with /s/ as /s/ in /s…ʃ/.

From these considerations, it may be derived that [±anterior] feature of sibilants is better perceived before alveolar sibilants rather than before palatal sibilants. In other words, the distinction of alveolar and palatal sibilants is better perceived before alveolar sibilants than before palatal sibilants, since palatal sibilants may affect alveolar sibilants with their drawn-out cue. This fact can be represented as a hierarchy of perceptibility scale, as follows ('>' means better perceptibility).

(34) Perceptibility scale for [±anterior] feature in case of sibilants

$$\begin{bmatrix}\alpha\text{anterior}\\ +\text{sibilant}\end{bmatrix} / \underline{\quad}\ldots\begin{bmatrix}+\text{anterior}\\ +\text{sibilant}\end{bmatrix} > \begin{bmatrix}\alpha\text{anterior}\\ +\text{sibilant}\end{bmatrix} / \underline{\quad}\ldots\begin{bmatrix}-\text{anterior}\\ +\text{sibilant}\end{bmatrix}$$

Similarly, non-retroflex consonants are more likely to be confused with their retroflex counterparts. And therefore, we can say that [±anterior] feature is better perceived before non-retroflex consonants than before retroflex consonants. In other words, the distinction between retroflex and non-retroflex is clearer before non-retroflex consonants than before retroflex consonants. Again, we acquire the following perceptibility scale.

(35) Perceptibility scale for [±anterior] feature in case of retroflexes

$$\begin{bmatrix} \alpha\text{ anterior} \\ \text{+coronal} \\ \text{-distributed} \end{bmatrix} / \_\_\_ \ldots \begin{bmatrix} \text{+anterior} \\ \text{+coronal} \\ \text{-distributed} \end{bmatrix} > \begin{bmatrix} \alpha\text{ anterior} \\ \text{+coronal} \\ \text{-distributed} \end{bmatrix} / \_\_\_ \ldots \begin{bmatrix} \text{-anterior} \\ \text{+coronal} \\ \text{-distributed} \end{bmatrix}$$

Finally, we can apply the same line of reasoning to the comparison between nasal and non-nasal consonant sequence as well. Perception of non-nasal consonants is likely to be weakened in the presence of nearby nasal consonants. And therefore we can say that [±nasal] feature is better perceived before non-nasal consonants than before nasal consonants. Oral and nasal distinction is better perceived before non-nasal consonants than before nasal consonants. We obtain the following perceptibility scale.

(36) Perceptibility scale for [±nasal] feature in case of nasals

$$\begin{bmatrix} \alpha\text{ nasal} \\ \text{+consonantal} \end{bmatrix} / \_\_\_ \ldots \begin{bmatrix} \text{-nasal} \\ \text{+consonantal} \end{bmatrix} > \begin{bmatrix} \alpha\text{ nasal} \\ \text{+consonantal} \end{bmatrix} / \_\_\_ \ldots \begin{bmatrix} \text{+nasal} \\ \text{+consonantal} \end{bmatrix}$$

3.3. Summary

This section investigated how perceptibility variation arises across different phonological contexts. I suggested that features with long phonetic cues have influence on nearby segments and make them less perceptible. This arouses contextual perceptibility variation where perception cues for relevant phonological features are weaker before consonants with elongated phonetic cue. Specifically, the distinction between alveolar vs. palatal is better perceived before alveolar sibilants than before palatal sibilants. Next, the distinction between retroflex vs. non-retroflex is better perceived before non-retroflex consonants than before retroflex consonants. Finally, distinction between oral vs. nasal is better perceived before non-nasal consonants than before nasal consonants. Discussion of relevant acoustic and perceptibility facts lead me to the following perceptibility scales.

(37) Perceptibility scales for phonological features involved in consonant harmony target asymmetries

a. Sibilant palatality

$$\begin{bmatrix}\alpha\text{anterior}\\ +\text{sibilant}\end{bmatrix} / \_\_ \ldots \begin{bmatrix}+\text{anterior}\\ +\text{sibilant}\end{bmatrix} > \begin{bmatrix}\alpha\text{anterior}\\ +\text{sibilant}\end{bmatrix} / \_\_ \ldots \begin{bmatrix}-\text{anterior}\\ +\text{sibilant}\end{bmatrix}$$

b. Coronal retroflexion

$$\begin{bmatrix}\alpha\text{ anterior}\\ +\text{coronal}\\ -\text{distributed}\end{bmatrix} / \_\_ \ldots \begin{bmatrix}+\text{anterior}\\ +\text{coronal}\\ -\text{distributed}\end{bmatrix} > \begin{bmatrix}\alpha\text{ anterior}\\ +\text{coronal}\\ -\text{distributed}\end{bmatrix} / \_\_ \ldots \begin{bmatrix}-\text{anterior}\\ +\text{coronal}\\ -\text{distributed}\end{bmatrix}$$

c. Consonant nasality

$$\begin{bmatrix}\alpha\text{ nasal}\\ +\text{consonantal}\end{bmatrix} / \_\_ \ldots \begin{bmatrix}-\text{nasal}\\ +\text{consonantal}\end{bmatrix} > \begin{bmatrix}\alpha\text{ nasal}\\ +\text{consonantal}\end{bmatrix} / \_\_ \ldots \begin{bmatrix}+\text{nasal}\\ +\text{consonantal}\end{bmatrix}$$

4. Analysis

Based on phonetic and perceptual grounding outlined in the previous section, I will now provide an analysis of target asymmetry in consonant harmony typology within the framework of Optimality Theory (Prince and Smolensky 2004, McCarthy and Prince 1995). I adopt P-map hypothesis (Steriade 2001, 2009) to account for the universal patterns of consonant harmony. Contextual perceptibility variation discussed above will be directly incorporated into the universal ranking of phonetically-driven faithfulness constraints that are projected by P-map, which correctly produces the attested patterns of target asymmetry. Language-specific patterns are also explained by the interaction of those constraints with another faithfulness constraint preventing the consonant harmony process. Consequently, both universal and language-specific patterns of target asymmetry in consonant harmony are well explained in a unified way.

4.1. Preliminaries

This section provides some preliminaries to proceed with a new proposal for target asymmetries in consonant harmony. First of all, I adopt correspondence based approach that has widely been accepted to account for consonant harmony in recent theoretical phonology. The model will be extended to the analysis of asymmetrical patterns discussed above. Also, P-map hypothesis is briefly introduced which is a pivotal framework for my analysis.

4.1.1. Correspondence-based approach

Correspondence-based model, which is called 'Agreement by Correspondence (ABC approach)' has been adopted to account for characteristic properties of consonant harmony (Rose and Walker 2001, 2004; Hansson 2001, 2010; McCarthy 2010) for its advantages to explain consonant harmony. First of all, it captures the similarity of participating consonants. As mentioned in the introduction, the consonants that take part in harmony are phonologically similar segments. Since correspondence relationship is established depending on the degree of similarity between consonants, and the degree that allows correspondence relationship varies according to the language, correspondence model can explain both universal and language-specific aspects of consonant harmony. Secondly, consonant harmony is featured by the neutrality of intervening segments. Correspondence is held between similar consonants, leaving the intervening segments intact. Thus, the model automatically accounts for the fact that intervening segments are unaffected by harmony. For these reasons, I adopt ABC model for an analysis of consonant harmony.

I will now explain how ABC analysis works. In ABC, correspondence relationship is established between the consonants that share certain degree of similarity in a phonological property. Just like Input-to-Output correspondence is held between input and output segments, Output-to-Output correspondence holds between output segments. This is called CC (Consonant-to-Consonant) faithfulness here. The schematic consonantal correspondence model is demonstrated in (38).

(38) Consonantal correspondence model (from Rose and Walker 2004)

Input /b e p o/

IO Faithfulness

Output [b e p o]

CC Faithfulness

According to this model, consonant harmony is explained by three correspondence constraints and their interaction. First, correspondence between phonologically similar consonants is required by Corr-CC constraint. Next, identity is required between corresponding consonants. This is done by Ident-CC that demands corresponding consonants should be identical in a particular phonological feature. Finally, there is a constraint preventing consonant harmony. Ident-IO requires that the input segment should not change in the output. Definitions of these constraints are provided below.

(39) Main constraints in consonant harmony

a. Constraints that cause consonant harmony

Corr-CC: Phonologically similar output consonants should be in correspondence relation with each other.

Ident-CC: Corresponding consonants in the output should have the same feature value.

b. A constraint that prevents consonant harmony

Ident-IO: Input and output segments should have the same feature value.

These constraints interact to explain occurrence or absence of consonant harmony. If Corr-CC and ID-CC outrank ID-IO, as shown below, consonant harmony would arise.

(40) Ranking for the occurrence of consonant harmony

Corr-CC, Ident-CC ≫ Ident-IO

To illustrate this, I consider the case of voicing consonant harmony in Kera. Firstly, Corr-CC requires correspondence relationship between the stops. For example, in the word /kV-gər/ 'knee', correspondence is established between /k/ and /g/, for they share the same manner of articulation and thus regarded as phonologically similar segments. The correspondence relationship is indicated by subscript indexes *x* and *y*, as in [$\mathbf{k}_x$ə$\mathbf{g}_x$ər]. Same indexes between segments indicate that they are in correspondence. Next, corresponding consonants should have the same value for voicing feature. This is done by Ident-CC (voice). Lastly, these two constraints must be ranked higher than Ident-IO (voice) that prohibits the change of voicing feature value of input consonant. The following tableau illustrates how voicing consonant harmony occurs.

(41) An OT analysis of voicing consonant harmony in Kera

	/**k**V-**g**ər/ 'knee'	Corr-CC	Ident-CC (voice)	Ident-IO (voice)
i.	$\mathbf{k}_x$ə$\mathbf{g}_y$ər	*!		
ii.	$\mathbf{k}_x$ə$\mathbf{g}_x$ər		*!	
iii.	☞ $\mathbf{g}_x$ə$\mathbf{g}_x$ər			*

This analysis can explain symmetric consonant harmony in which any type of consonants are equally targeted by harmony. Also, it can account for the case in which consonant harmony does not occur. However, target asymmetry patterns cannot be explained under current analysis. Consider a schematic example of sibilant consonant harmony in which /s/ and /ʃ/ are involved. A crucial case is that /s/ is a target, but /ʃ/ is not a target. Current constraints can produce symmetric harmony patterns whereby /s/ and /ʃ/ are both targets. However, the analysis fails to explain the languages showing target asymmetries, that is, languages in which only alveolar sibilants /s/ are targeted, to the exclusion of palatal sibilants /ʃ/. Tableaux in (42) illustrate this point. In (42a), we get iii. [ʃ…ʃ] as the result of harmony. This is fine because it shows the case in which /s/ is a target, which is consistent with target asymmetry patterns in sibilant consonant harmony. The problematic result occurs in (42b). In languages showing target asymmetry, /ʃ/ is not targeted by harmony but survives intact. But the current analysis is unable to produce such results and incorrectly selects iii. *[s_x…s_x] as an optimal candidate in (42b). However, to correctly account for the target asymmetry, the ii. [**$ʃ_x$…s_x**] should be selected as an optimal candidate. Even if we change the ranking of these constraints, it still fails to produce target asymmetry patterns. Therefore, a revised analysis is obviously needed that can explain the target asymmetries.

(42) Inadequacy of current analysis to account for target asymmetry

a. /s/ is a target.

	/s…ʃ/	Corr-CC	ID-CC (anterior)	**ID-IO (anterior)**
i.	s_x…$ʃ_y$	*!		
ii.	s_x…$ʃ_x$		*!	
iii.	☞ $ʃ_x$…$ʃ_x$			*

b. /ʃ/ is NOT a target.

	/ʃ…s/	Corr-CC	ID-CC (anterior)	**ID-IO (anterior)**
i.	$ʃ_x$…s_y	*!		
ii.	☞ **$ʃ_x$…s_x**		*!	
iii.	*☞ s_x…s_x			*

4.1.2. P-map

P-map is a mental representation of the degree of distinctiveness of contrasts in various positions (Steriade 2001, 2009). It deals with relative and absolute perceptibility of different 'contrasts' across different contexts. Speakers have the knowledge of similarity judgment of phonological contrasts, and this judgment directly projects correspondence constraints and universally or language-specifically rank them. As constraints are ranked to preserve perceptually more distinctive contrasts, phonological change occurs in the direction of minimal modification, avoiding drastic perceptual change.

As mentioned above, P-map hypothesizes that speakers possess judgments of relative similarity of contrasts. Speakers have the knowledge that a certain contrast is more perceptible than another contrast. This notion is represented as follows. (The representations in this section, (43)-(45), are from Steriade (2001, 2009).)

(43) Judgments of relative similarity

The pair of strings x-y is less similar than the pair w-z.

(abbreviated as Δ(x-y) > Δ(w-z), where Δ = difference).

Once we have judgments that a certain contrast is more similar than the other, this is directly projected into correspondence constraints. That is, "when P-map encodes a similarity ranking between two contrasts, each of the contrasts map onto a distinct correspondence constraint, CORRESP (x-y) and CORRESP (w-z)." (Steriade 2009) This is formalized in (44).

(44) P-map projects correspondence constraints

- Let $\Delta(x\text{-}y)/\_K_i$ stand for the perceptual difference between members of sound classes x and y in context K_i.
- If $\Delta(x\text{-}y)/\_K_i > \Delta(w\text{-}z)/\_K_j$, then there exist distinct sets of correspondence conditions, CORRESP ($x\text{-}y/\_K_i$) and CORRESP ($w\text{-}z/\_K_j$).

Ranking of these constraints is also derived from P-map. As more distinctive contrasts are primarily protected, thecorrespondence constraint that preserves more distinct contrast outranks the faithfulness constraint preserving less distinct contrast. This is formalized as follows.

(45) Ranking correspondence constraints by relative distinctiveness

If $\Delta(x\text{-}y)/\_K_i > \Delta(w\text{-}z)/\_K_j$, then any correspondence constraint referring to $\Delta(x\text{-}y)/\_K_i$ outranks any parallel constraint referring to $\Delta(w\text{-}z)/\_K_j$.

As a result, distinctive phonological contrast always receives a prior protection when a phonological change occurs. Therefore, less prominent perceptual change is chosen among possible phonological resolutions. In the next section, I will demonstrate how the P-map hypothesis can be a key to the patterns of target asymmetries.

4.2. Proposal

My proposal is formalized in Optimality Theory (Prince and Smolensky 2004; McCarthy and Prince 1995), with an assumption that invariable ranking of correspondence constraints is projected by P-map (Steriade 2001, 2009). The core idea is that perceptual distinctiveness of the harmonic feature plays a role in determining triggers and targets of consonant harmony. I argue that consonant harmony may occur in the direction of making less perceptual change. I will show that the proposal properly accounts for all and only the attested patterns in consonant harmony.

To take target asymmetry in sibilant consonant harmony as an example, harmony is more likely to occur before palatals than before alveolars. This means that faithfulness for anteriority is weaker before palatals than before alveolars. Recall from section 3 that perception cues for anteriority are weaker before palatals than before alveolars. This perception-faithfulness parallel can be understood and further formalized under the P-Map theory. According to P-map hypothesis, speakers possess the knowledge of relative similarity of the forms with multiple sibilants. That is, the contrast /s…ʃ/ is more akin to /ʃ…ʃ/ than /ʃ…s/ is to /s…s/. This is because elongated phonetic cue of palatal sibilant /ʃ/ may span its effects to previous /s/ sound. In a nutshell, perceptual distinctiveness between /s/ and /ʃ/ is larger before /s/ (i.e. alveolar sibilants) than before /ʃ/ (i.e. palatal sibilants). This relative similarity judgment can be represented as in (46).

(46) A hierarchy of distinctiveness in contrasts

Δ (s-ʃ/_s) > Δ (s-ʃ/_ʃ)

From this similarity judgment, faithfulness constraints are derived by P-map. The phonological feature that distinguishes /s/ and /ʃ/ is their place of articulation, for which I will use the feature ‘anteriority’. IO-faithfulness constraints that preserve anteriority before /s/ and /ʃ/ are needed to reflect the distinctiveness of contrasts between /s…ʃ/, /ʃ…ʃ/, and /s…s/.

(47) Correspondence constraints

ID-IO (anterior/_s), ID-IO (anterior/_ʃ)

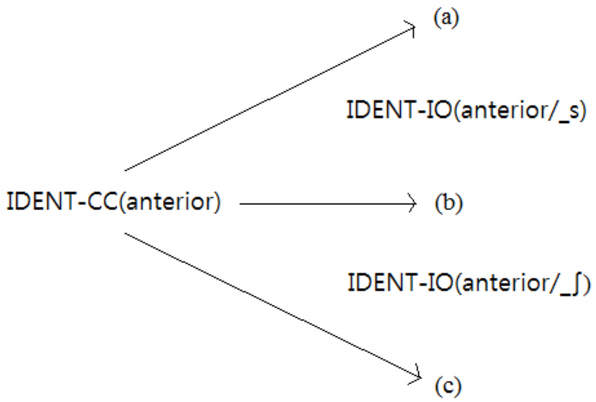
Their ranking is also derived by the distinctiveness scale in (46). Since anteriority feature is better perceived before an alveolar sibilant than before a palatal sibilant, the faithfulness constraint preserving the anteriority before alveolar sibilants outranks the faithfulness constraint preserving the anteriority before palatal sibilants. We acquire the following ranking.

(48) Ranking of correspondence constraints

ID-IO (anterior/_s) ≫ ID-IO (anterior/_ʃ)

This fixed ranking of faithfulness constraints and their interaction with IDENT-CC constraint predicts the attested patterns of target asymmetry in consonant harmony. Since the ranking between the two correspondence constraints, ID-IO (anterior/_s) and ID-IO (anterior/_ʃ), is invariable, their ranking relative to IDENT-CC produces the patterns in consonant harmony. Depending on the position of IDENT-CC relative to the other two constraints, the following patterns are predicted.

(49) Possible constraint rankings and predicted patterns



(a) Symmetrical consonant harmony (s↔ʃ) occurs.

(b) Asymmetrical consonant harmony (s→ʃ only) occurs.

(c) No harmony occurs.

If IDENT-CC dominates both ID-IO (anterior/_s) and ID-IO (anterior/_ʃ) as in (49a), symmetrical consonant harmony occurs. In other words, consonant harmony occurs all the time, regardless of whatever the target may be. This is illustrated in the following tableaux.

(50) Analysis of symmetrical consonant harmony (s↔ʃ)

	/s…ʃ/	Corr-CC	ID-CC	ID-IO (anterior/_s)	ID-IO (anterior/_ʃ)
i.	s_x…$ʃ_y$	*!			
ii.	s_x…$ʃ_x$		*!		
iii.	☞ $ʃ_x$…$ʃ_x$				*

	/ʃ…s/	Corr-CC	ID-CC	ID-IO (anterior/_s)	ID-IO (anterior/_ʃ)
i.	$ʃ_x$…s_y	*!			
ii.	$ʃ_x$…s_x		*!		
iii.	☞ s_x…s_x			*	

Now we are in a position to consider the case of target asymmetry. If IDENT-CC is located between the ID-IO (anterior/_s) and ID-IO (anterior/_ʃ) as in (49b), asymmetrical consonant harmony occurs. Consonant harmony occurs only when the target is /s/. The schematic figure and tableaux are provided below in (51) and (52). In the tableau (52a), the input /s…ʃ/ is exempted from ID-IO (anterior/_s) and therefore the ranking of ID-IO (anterior/_s) above ID-CC does not take effect. As a result, the third candidate

[$ʃ_x$…$ʃ_x$] that satisfies higher ranked ID-CC is selected. However, situation changes with the input /ʃ….s/, as in (52b). This time ID-IO (anterior/_s) takes effect and requires anteriority feature be preserved before /s/. This prevents harmony from occurring, and /ʃ…s/ comes out intact.

(51) Asymmetrical consonant harmony (s→ʃ only)

i)	/s…ʃ/	vs.	ii) /ʃ…s/
	↓		↓
	[ʃ…ʃ]	vs.	[ʃ…s]
	(harmony occurred)		(intact)

(52) Analysis of asymmetrical consonant harmony (s→ʃ only)

a. Consonant harmony occurs.

	/s…ʃ/	Corr-CC	ID-IO (anterior/_s)	ID-CC	ID-IO (anterior/_ʃ)
i.	s_x…$ʃ_y$	*!			
ii.	s_x…$ʃ_x$			*!	
iii.	☞ $ʃ_x$…$ʃ_x$				*

b. Intact (Consonant harmony does not occur).

	/ʃ…s/	Corr-CC	ID-IO (anterior/_s)	ID-CC	ID-IO (anterior/_ʃ)
i.	$ʃ_x$…s_y	*!			
ii.	☞ $ʃ_x$…s_x			*	
iii.	s_x…s_x		*!		

Lastly, if IDENT-CC is dominated by both ID-IO(anterior/_s) and ID-IO(anterior/_ʃ) as in (49c), no harmony occurs at all. Tableaux in (53) show this. Since the constraint that causes consonant harmony (IDENT-CC) is always dominated by the constraints prohibiting consonant harmony, harmony does not occur at all.

(53) Analysis of No consonant harmony

	/s…ʃ/	Corr-CC	ID-IO (anterior/_s)	ID-IO (anterior/_ʃ)	ID-CC
i.	s_x…$ʃ_y$	*!			
ii.	☞ s_x…$ʃ_x$				*
iii.	$ʃ_x$…$ʃ_x$			*!	

	/ʃ…s/	Corr-CC	ID-IO (anterior/_s)	ID-IO (anterior/_ʃ)	ID-CC
i.	$ʃ_x$…s_y	*!			
ii.	☞ $ʃ_x$…s_x				*
iii.	s_x…s_x		*!		

I will not provide detailed analysis of retroflex and nasal consonant harmony, since they can be analyzed in a similar way to the analysis of sibilant consonant harmony just presented. In case of retroflex consonant harmony, faithfulness constraint preserving anteriority before non-retroflex consonants should be ranked higher than the faithfulness constraint preserving anteriority before retroflex consonants: ID-IO (anterior/_d) ≫ ID-IO (anterior/_ɖ). These constraints and their interaction with IDENT-CC will produce all the attested patterns, just as in case of sibilant consonant harmony. In nasal consonant harmony as well, ranking of two faithfulness constraints are projected as follows: ID-IO (nasal/_d) ≫ ID-IO (nasal/_n). According to the relative ranking of IDENT-CC with those two faithfulness constraints, consonant harmony patterns can be properly explained.

4.3. Summary

I have claimed that all and only the attested patterns of consonant harmony are explained by the interaction of constraints that are proposed with phonetic and perceptual motivations. Universal ranking of the two faithfulness constraints ID-IO (anterior/_s) and ID-IO (anterior/_ʃ) and their interaction with IDENT-CC correctly predict all the patterns attested in consonant harmony, including target asymmetries which were not explained in previous research. Retroflex and nasal consonant harmony are also accounted for in a similar way. The analysis predicts the absence of the patterns in which palatal, retroflex, and nasal consonants (i.e. less likely targets) are exclusively targeted.

5. Conclusion

The aim of the thesis was to present a typological study of consonant harmony and provide a formal account for the observed patterns, focusing on target asymmetries. My survey results show that there are systematic asymmetrical patterns that can be characterized with implicational relationship. Those asymmetrical patterns do not occur arbitrarily, but have phonetic and perceptual motivations. I have claimed that those motivations can be well accounted for under the framework of P-map hypothesis whose core idea is that prominent perceptual change is avoided when a phonological change occurs. Adopting the P-map hypothesis, consonant harmony can be understood as a phonological phenomenon where less prominent perceptual change is preferred over more drastic phonological change. I provide OT analysis in which faithfulness constraints are projected and universally ranked by P-map. Interaction of these faithfulness constraints and another constraint instigating consonant harmony, namely IDENT-CC, correctly predicts all and only the attested patterns in consonant harmony typology. Both universal and language-specific patterns are explained in a unified way by the interaction of proposed constraints. The thesis first serves as an empirical contribution in that I found target asymmetries in consonant harmony typology. In addition, it provides theoretical explanation for all the attested patterns including target asymmetries, about which no previous studies provide an in-depth discussion.

REFERENCES

Arsenault, Paul. 2012. *Retroflex consonant harmony in South Asia*. Toronto: University of Toronto dissertation.

Blevins, Juliette. and Garrett, Andrew. 2004. The evolution of metathesis. In Hayes, B., Kirchner, R., and Steriade, D. (Eds.), *Phonetically-Based Phonology.* Cambridge: Cambridge University Press., pp.117-156.

Ebert, Karen. 1979. Sprache und Tradition der Kera (Tschad), Teil III: Grammatik. (Marburger Studien zur Afrika- und Asienkunde, Serie A: Afrika, 15.) Berlin: Reimer.

Hansson, Gunnar Ó lafur. 2001. *Theoretical and typological issues in consonant harmony*. Doctoral dissertation, University of California, Berkeley.

2010. *Consonant Harmony: long-distance interaction in phonology*. UC Publications in Linguistics.

Hayes, Bruce., Kirchner, Robert. and Steriade, Donca. (Eds.) 2004. *Phonetically-Based Phonology.* Cambridge: Cambridge University Press.

Ladefoged, Peter. 1993. *A course in phonetics*. Fort Worth, TX: Harcourt Brace Jovanovich.

Ladefoged, Peter. and Maddieson, Ian. 1996. *The sounds of the world's languages*. Oxford: Blackwell.

Ladefoged, Peter., Maddieson, Ian. and Jackson, Michel T.T. 1988. Investigating phonation types in different languages. In O. Fujimura (ed.), *Vocal physiology: Voice production, mechanisms and functions.* Raven: New York, pp. 297-317.

MacEachern, Margaret. 1997. Laryngeal co-occurrence restrictions. Doctoral dissertation, University of California, Los Angeles. [Published 1999, New York: Garland.]

McCarthy, John. and Prince, Alan. 1995. Faithfulness and reduplicative identity. In Jill Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk (eds.), *University of Massachusetts occasional papers in linguistics 18: Papers in Optimality Theory.* Amherst: GLSA, 249-384.

Odden, David. 1994. Adjacency parameters in phonology. Language 70: 289-330.

Prince, Alan. and Paul Smolensky. 2004. *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden, MA, and Oxford, UK: Blackwell. [Revision of 1993 technical report, Rutgers University Center for Cognitive Science. Available on Rutgers Optimality Archive, ROA-537.

Rose, Sharon. and Rachel Walker. 2001. A typology of consonant agreement as correspondence. Ms. University of California, San Diego and University of Southern California.

2004. A typology of consonant agreement as correspondence. Language, Volume 80, Number 3, September 2004, pp. 475-531.

Steriade, Donca. 2001. Directional asymmetries in place assimilation: A perceptual account. In Elizabeth Hume and Keith Johnson (eds.), *The role of speech perception in phonology*. New York: Academic Press, 219-50.

2009. The phonology of perceptibility effects: the P-map and its consequences for constraint organization. In K. Hanson & S. Inkelas (Eds.), *The Nature of the Word: Studies in Honor of Paul Kiparsky* (pp.151-179). Cambridge: MIT Press. (originally circulated in 2001)

국문 초록

자음조화에서 관찰되는 타겟 비대칭성

본 논문은 자음조화 현상에서 관찰되는 타겟 비대칭성의 양상을 상세히 밝히고, 청취적 사상에 입각하여 최적성 이론 분석을 제시하는 것을 목적으로 한다. 자음조화가 일어날 때에는 변화를 유발하는 소리와 변화를 겪는 소리(타겟)가 존재하게 되는데, 이 때에 특정 종류의 자음들이 더 타겟이 잘 되는 비대칭적 경향이 관찰된다. 본고에서는 광범위한 언어 조사를 통해 이러한 타겟 비대칭성이 유형론적 함의 관계로 존재함을 보인다.

자음조화에서 관찰되는 타겟 비대칭성은 임의로 나타나는 것이 아니라 음성적이고 인지적인 요인에 의해 발생하며, 이는 Steriade (2001, 2009) 의 청취적 사상 가설로 잘 설명된다. 청취적 사상에 의하면 음운 변화가 일어날 때에 큰 인지적 변화를 피하게 되는데, 큰 인지적 변화를 막는 충실성 제약이 작은 인지적 변화를 막는 충실성 제약보다 상위에 있게 된다. 이에 입각하여 본고에서는 자음조화가 큰 인지적 변화를 지양하는 방향으로 일어나며, 그 과정에서 타겟 비대칭성이 나타나게 된다고 주장한다. 더 강한 음성적인 단서를 가지는 소리들이 인접한 다른 소리들의 음성적인 단서를 상대적으로 약화시키며, 이 때에 약화된 소리들이 타겟이 됨으로써 인지적으로 변화가 적은 쪽으로 자음조화가 일어나게 된다. 이러한 상대적인 인지의 차이가 청취적 사상에 의하여 충실성

제약들로 투사되고, 이는 타겟 비대칭성을 포함하여 자음조화에서 관찰되는 모든 양상을 정확하게 예측하고 설명한다.

주요어 : 자음조화, 유형론, 비대칭성, 청취적 사상, 최적성 이론

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