http://dx.doi.org/10.17959/sppm.2018.24.3.347

C-to-C correspondence and agreement-at-a-distance*

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Lee, Minkyung. 2018. C-to-C correspondence and agreement-at-a-distance. *Studies in Phonetics, Phonology and Morphology* 24.3. 347-369. Assimilation as feature agreement is attributed to two distinct modes: local, by autosegmental spreading; and long-distance, by correspondence. As evidenced in Kinyarwanda, a Bantu language in which feature agreement from a palatal trigger to the preceding targets involves long-distance action, assimilation can occur without autosegmental spreading. In Optimality Theory (OT) (Prince and Smolensky 1993/2004, McCarthy and Prince 1995), pro-spreading markedness constraints like Align are responsible for such long-distance harmony, but they are caught in a serious pathology (McCarthy 2003, 2009). In addition, identity-referring Correspondence (Corr) constraints (Walker 1999, 2000a, 2000b) are criticized due to their redundant characteristic, i.e. there is no need for Corr constraints. As an alternative, Max-CC via consonant-consonant or CC correspondence (McCarthy 2010) replace Corr constraints without regard to featural identity. In essence, feature agreement at a distance results from the co-work of Ident-CC(F) checking featural identity between Cs in correspondence and Max-CC demanding co-indexation between Cs in the output under OT. **(Daegu University, Professor)**

Keywords: CC correspondence, Corr constraints, Max-CC, Kinyarwanda palatal harmony, co-indexation, Align, OT

1. Introduction

Previous literature (Walker 1999, 2000a, 2000b, Hansson 2001, Rose and Walker 2004, McCarthy 2007a, 2010) has offered an appealing idea for the phonology of consonant harmony at a distance via a correspondence relation (McCarthy and Prince 1995, 1999) that is well-couched into Optimality Theory (henceforth OT) (Prince and Smolensky 1993/2004, McCarthy and Prince 1995). Given the correspondence

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* This research was supported by the Daegu University, 2018. I would like to thank three anonymous reviewers for their insightful comments and suggestions. Any and all errors are solely my own responsibility.

approach to long-distance consonant harmony, it is viewed that feature agreement is attributed to Consonant-Consonant or CC correspondence (the terminology from McCarthy 2010) enforcing C-to-C or intersegmental correspondence in the output rather than input-output reference.

In Autosegmental Phonology (hereafter AP) (Goldsmith 1976a, 1976b), feature agreement is a byproduct of feature spreading between a trigger and a target. Under OT, however, a pro-spreading markedness constraint such as long-distance Align is equivalent to feature spreading rules in AP[1]. As argued at length in McCarthy (2003, 2009) (originally identified by Wilson 2003, 2004, 2006) and as will be discussed in detail later, a pro-spreading Align constraint reveals some pathological problems in the phonology of harmony. Contrary to this, a correspondence relation between a pair of the agreeing consonants in the output might be a right answer to get rid of a widely implausible prediction by Align.

Unlike feature spreading via Align under OT, the mechanism of correspondence enables a specific feature agreement with no links gapping over the intervening segments. Another characteristic is that it does not limit feature agreement to the root-adjacent segments, i.e. non-local. Feature agreement by correspondence results from the joint-work of two types of constraints, i.e. consonantal correspondence (henceforth Corr) constraints (Walker 1999, 2000a, 2000b) requiring C-to-C or CC correspondence between output consonants agreeing in certain features and Ident-CC(F) constraints demanding that output consonants (hereafter Cs) have the same featural value when they are in a correspondence relation.

In the meantime, McCarthy (2010) asks a challenging question about the necessity of Corr constraints (Walker 1999, 2000a, 2000b) in the sense that Corr constraints and Ident-CC(F) constraints both refer to featural identity. Provided that the latter can replace the role of the former, Corr constraints and their role are entirely redundant, i.e. no need of Corr constraints. Rather, he proposes a more general correspondence constraint like Max-CC requiring CC correspondence coupled with Ident-CC(F) demanding featural identity.

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[1] As argued at length in McCarthy (2009), local Agree is also responsible for assimilation as feature spreading under OT, especially when the agreeing segments are, this time, locally adjacent with one another. Since this paper mainly focuses on the issue of consonant harmony at a distance, with respect to the surface-unattested predictions of local Agree, refer to McCarthy (2009: 2-4).

To examine and analyze how feature agreement takes place between Cs in the output via employing McCarthy's (2010) Max-CC replacing Corr constraints along with Ident-CC(F) under OT, this paper targets the data of consonant harmony found in Kinyarwanda (Kimenyi 1979), an eastern Bantu language. Kinyarwanda involves long-distance palatal harmony within or across a morpheme boundary. A target, an alveolar fricative, namely *s* and *z*, precedes a palatal fricative trigger, *š/ž*, i.e. anticipatory or regressive.

Section 2 observes and discusses the target data of long-distance palatal harmony found in Kinyarwanda. An alveolar fricative, *s/z*, is affected by its palatal fricative trigger, thus the palatal place of articulation assimilation emerges. Section 3 starts with introducing two major approaches to the phonology of harmony; pro-spreading markedness account via Align (McCarthy 2003, 2009) vs CC correspondence approach with Corr constraints (Walker 1999, 2000a, 2000b) under OT. It will be also spotlighted that, compared to these, McCarthy's (2010) CC correspondence approach via Max-CC is superior in that Align is faced with pathology and Corr constraints suffer from their redundancy. Section 4 provides a CC correspondence approach to the target data via Max-CC. It will be shown that Corr constraints are not supportive and further long-distance harmony results from the co-work of Ident-CC(F) ranked over Max-CC in the domain of correspondence. Section 5 summarizes and concludes the present paper.

2. Examining the data

As observed and described in Kimenyi (1979), long-distance palatal harmony in Kinyarwanda is a place assimilation process in which only alveolar fricatives, *s/z*, become palatalized when they are followed by the palatal fricatives, *š/ž*, as illustrated in (1) below[2].

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[2] Here I will clarify that this paper does not touch upon the case of palatalization found in the target language where the agreeing consonants are locally adjoined together as the rule below formalizes.

$$\begin{matrix} [\text{C}] \\ +\text{velar} \\ +\text{stop} \end{matrix} \rightarrow [+\text{palatal}] \;/\; \_\_\_ \begin{matrix} [\text{V}] \\ +\text{front} \end{matrix}$$

Velar stops /k, g/ tend to be palatalized right before the front vowels /i, e/ as observed in [areǩe](←/a-rek-e/) 'he should stop'. See Kimenyi (1979: 40) for more details.

(1) Palatalization rule (Kimenyi 1979: 43)

[C]		[+palatal] / ____V [C]	
+ fricative	→		+ fricative
+ alveolar			+ palatal

The rule formalization in (1) tells us that a palatal trigger and an alveolar target are not directly adjoined each other since there appears an intervening vowel between them, i.e. non-local. Also note that the agreeing consonants are exactly the same in manner, thus the content of sound change in (1) is the place of articulation assimilation, that is, the place change of an alveolar to a palatal. In addition, with respect to the direction of assimilation, an alveolar target precedes its palatal trigger, thus the assimilatory effect goes leftward, i.e. anticipatory or regressive.

Prior to examining and discussing the data of long-distance palatal harmony found in the target language, let us take a brief look at the structure of Kinyarwanda morphology. As well described in Kimenyi (1979: 8), likewise other Bantu languages, nouns, adjectives, and verbs are all bound, thus they never stand as a word by themselves, which implies that they should be attached to other morphemes to become a full word. For Kinyarwanda nouns, stems necessitate prefixes denoting the class marker of its head noun as shown in /umu-gabo/ ‘man’ in which the former morpheme is the marker of Class 1 and the latter is the noun stem meaning ‘man’. On the other hand, for verbs, they must have both prefixes and suffixes as in /gu-kor-a/ ‘to work’ where the prefix shows the infinitive marker, the suffix is the aspect marker and in the middle is the verb stem meaning ‘work’.

Now let us move on to the target data of Kinyarwanda palatal harmony where a palatal trigger affects its preceding alveolar targets skipping over the intervening segments. Given the presence or absence of palatal harmony, the data are split off into two; one set is arrayed in (2) with no harmony due to the lack of the trigger and the other set is laid out in (3) with harmony. Note that the latter data are separately arranged since the trigger is underlyingly present sometimes or derived some other times. The data introduced here are all excerpted from Kimenyi (1979: 43-44)[3.]

[3] Vowel length in Kinyarwanda is phonemic and thus contrastive as specified in *gusega* ‘to climb a tree’ vs *guseega* ‘to beg’. Following Kimenyi (1979: 3), a long vowel is represented as a sequence of two identical vowels to distinguish a short vowel in length. Therefore, /aa, uu, ee/ are long and /a, u, e/ are short.

(2) Absence of palatal harmony

With no palatal fricative

/ku-sas-a/	[gusasa][4]	'to make bed'
/ku-uzuz-a/	[kuuzuza]	'to fill'
/ku-saaz-a/	[gusaaza]	'to get old'
/ku-sooz-a/	[gusooza]	'to finish'
/ku-soonz-a/	[gusoonza]	'to get hungry'

(3) Presence of palatal harmony

a. With a palatal fricative underlyingly

/ku-sas-iiš-a/	[gušašiiša]	'to cause to make the bed'
/ku-uzuz-iiš-a/	[kuužužiiša]	'to cause to fill'
/ku-saaz-iiš-a/	[gušaažiiša]	'to cause to get old'
/ku-sooz-iiš-a/	[gušoožeeša]	'to cause to finish'

b. With a palatal fricative derived[5]

/a-sas-ye/	[ašaše]	'he just made bed'
/a-sokoz-ye/	[ašokože]	'he just combed'
/ba-ra-saaz-ye/	[barašaaže]	'they are old'
/a-samaaz-ye/	[ašamaažiže]	'I just caused to make the bed'

Compared to the data in (3), the data in (2) tell us that alveolar targets /s, z/ remain intact with no palatal trigger, thus no change of the place of articulation is observed. However, the data in (3) involve long-distance palatal harmony from right to left over a morpheme boundary. A palatal fricative as a trigger lets its preceding alveolar fricatives all palatalized. Note here that palatal harmony is non-local, i.e. skipping

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[4] The change of /k/ to [g] is attributed to Dahl's law, so-called a voice dissimilation rule, whereby voiceless consonants are voiced before other voiceless consonants. As Kimenyi (1979: 65) points out, the voice dissimilation is quite frequent in Kinyarwanda and some other eastern Bantu languages such as Kikuyu and Nyankusa.

[5] Even though this paper does not provide a comprehensive picture of Kinyarwanda morphophonology here, there are two things to be noticed; as argued in Kimenyi (1979: 45, 55), when a stem ending in an alveolar fricative is followed by an aspect marker *-ye*, the stem-final C gets mutated, thus becoming palatal. Also, for the case of [ašamaažiže] in (3b) where *-iz-* is inserted before the suffix *-ye*, the alveolar C of *-iz-* undergoes mutation, which leads to the leftward palatal harmony. However, these processes go beyond our major concern, thus not dealt with here. Also see footnote 11.

over all the intervening segments and thus palatalization is viewed as action-at-a-distance.

With a closer look at the data in (3), for instance, in [gušašiiša] from (3a) in which the palatal trigger is underlyingly present, the palatal trigger *š* makes its preceding alveolar targets all palatalized, jumping over a long vowel /ii/ and a short vowel /a/. However, unlike the data in (3a), in (3b), as witnessed in the examples of [ašaše] and [barašaaže], the palatal trigger is not underlyingly present but derived. In fact, the stem-final alveolar consonant is first palatalized before the perfective marker *-ye*, which gives rise to further palatalization to the preceding alveolar targets. Here recall that palatalization stems from a palatal or palatalized fricative.

One step further, as observed in [ašokože] in (3b), even when a CV syllable not containing a fricative intervenes between a palatal trigger and an alveolar target, long-distance harmony still occurs. Here the target is far distant from the palatal trigger due to the intervening syllable and further, interestingly enough, the C of the CV syllable, not a fricative, is entirely neutral or insensitive to palatal harmony. Therefore, to take these into a unified account, the rule given in (1) is modified as illustrated in (4).

(4) Palatalization rule revised (Kimenyi 1979: 44)

$$\begin{bmatrix} C \\ +\text{fricative} \\ +\text{alveolar} \end{bmatrix} \rightarrow [+\text{palatal}] \;/\; \_\_\_\; V(CV)\begin{bmatrix} C \\ +\text{alveolar} \\ +\text{palatal} \end{bmatrix}$$

Likewise the data in (3) where the palatal trigger comes from the causative marker *-iiš* as in (3a) or it is derived before the aspect marker *-ye* as in (3b), the data in (5) also contain a sequence of palatal fricatives, but, this time, inside a morpheme. Still palatalization is non-local, i.e. not root-adjacent, jumping over all the intervening segments[6].

[6] Here note that Kimenyi (1979) does not provide the underlying form of each word in (5) and further he distinguishes the data in (3) from those in (5) in that, unlike the data in (3), in (5), it is hard to tell the first fricative of words is underlyingly a palatal fricative or an alveolar fricative. However, Kimenyi (1979) strongly claims that the words in (5) get involved in long-distance feature agreement. Also see footnote 14.

(5) Palatal harmony inside a morpheme

[gušišimura]	'to tear up'
[gušiišikara]	'to get excited'
[gušigiša]	'to prepare alcoholic beverages'
[gušušaaňa]	'to draw'

Some might ask whether the first palatal fricatives in (5) are underlyingly palatal or alveolar. In fact, alveolar fricatives and palatal fricatives are both present in the phonemic inventory of this language. Therefore, the underlying consonants and the phonetic consonants are not distinguishable. But, as argued in Kimenyi (1979: 44), the word 'prayer' is uttered as [išeengešo] in one dialect but [iseengešo] in the standard dialect, which means that palatalization arises inside a morpheme as well.

Given this amount of data observations and discussions thus far, palatal harmony in Kinyarwanda is not locally achieved but occurs as an instance of action-at-a-distance skipping over all the intervening segments from right to left. One more to be spotlighted is that alveolar targets are highly exposed to palatal harmony no matter whether their trigger is a palatal or palatalized.

3. Current approaches to feature agreement

This section starts with introducing and comparing two major approaches to harmony under OT along with their theoretic limitation and weakness; feature spreading via Alignment theory (McCarthy and Prince 1993, Prince and Smolensky 1993/2004) and CC correspondence via Corr constraints (Walker 1999, 2000a, 2000b). The latter approach is two-fold; identity-referring Corr constraints (Walker 1999, 2000a, 2000b) vs a more general Max-CC constraint (McCarthy 2010).

3.1 Feature spreading via Align

Assimilation as feature spreading originates from AP (Goldsmith 1976a, 1976b). Feature spreading in AP tends to be iterative until there exist no segments left or there appears a blocker with incompatible feature specification. However, OT grammar (Prince and Smolensky 1993/2004, McCarthy and Prince 1995), with no direct equivalent to feature spreading rules, necessitates a markedness constraint like Align that triggers feature spreading under OT.

As argued and criticized in McCarthy (2003, 2009), an alignment-based pro-spreading markedness constraint like Align makes some implausible predictions when it is applied to the harmony process, i.e. surface-unattested languages emerge, and thus it is not a sound basis for the phonology of harmony. As exemplified in McCarthy (2009), in Johore Malay, a [nasal] autosegment propagates rightward until there appears a blocker, a fricative *s*, as observed in [mãw̃ãsa](←/mawasa/). Regarding this characteristic, let us look at the hypothetical word where a vowel is epenthesized as witnessed in (6).

(6) An implausible prediction of Align

a. Vowel epenthesis with no blocker *s*

/maw/ → [mãw̃ĩ]

/maw/	*NasFric	Align-R([Nas], word)	No-Coda	Dep
☞i. mãw̃ĩ				1
ii. mãw̃			1 W	L

b. Align preventing vowel epenthesis

/mas/ → [mãs]

/mas/	*NasFric	Align-R([Nas], word)	No-Coda	Dep
☞i. mãs		1	1	
ii. mãsi		2 W	L	1 W
iii. mãs̃ĩ	1 W	L	L	1 W

c. Vowel epenthesis with no nasal trigger

/pas/ → [pasi] (but [pas] in (ii) is attested.)

/pas/	*NasFric	Align-R([Nas], word)	No-Coda	Dep
☞i. pasi				1
ii. pas			1 W	L

Given the tableaux in (6), the presence or absence of vowel epenthesis relies on the fact that the added vowel can be accessible to [nasal] spreading. Vowel epenthesis always takes place if the added vowel can be nasalized or there is no nasal trigger involved in a word. For more details, vowel epenthesis is totally allowed when a word contains a nasal trigger but no blocker *s* is involved as in (6a). This enables total spreading up to the added vowel. However, if there is a blocker *s* in a word as in (6b), vowel epenthesis is entirely obstructed. Or as in (6c), even when a word has no nasal trigger, vowel epenthesis is still legitimate, but this is a widely implausible prediction, i.e. a true pathology (McCarthy 2009: 5).

As such, regardless of the presence of a blocker *s* (as in (6b)) or the absence of a nasal trigger in a word (as in (6c)), no vowel is epenthesized equally, i.e. like (6b), in (6c), [pas] (not *[pasi]) should surface. Therefore, vowel epenthesis is permitted only in (6a)[7]. What comes next is to introduce and discuss a CC correspondence approach with or without Corr constraints, i.e. Walker (1999, 2000a, 2000b) vs McCarthy (2010).

3.2 CC correspondence with Corr constraints

As discussed earlier, feature agreement is realized via two major mechanisms; one is feature spreading and the other is C-to-C or intersegmental correspondence. Given the cross-linguistic studies (Flemming 1995, Gafos 1996, Ní Chiosáin and Padgett 1997), it has been shown that feature spreading occurs only between the segments locally adjacent at the level of the root node. Furthermore, the survey of nasal harmony at a distance (Walker 1998, 1999) or the reduplication studies (Gafos 1996, 1998, Walker 1998, 1999) supports that segmental interaction at a distance may occur via correspondence between Cs in the output. As exemplified in (7), let us briefly look at the case of Ngbaka, a Niger-Congo language, in which homorganic oral stops in the same morpheme agree in voicing.

(7) Segmental correspondence

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   /tida/ → [tita]
    ti  i    ti  a
    |        |
  [-voi]   [-voi]
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[7] This paper does not delve into the comparison of feature spreading via Align to feature sharing via Share[F] newly proposed by McCarthy (2009). The latter approach correctly fixes the surface-unattested result found in (6c). Provided that Share[Nas] is put at the position of Align in the tableaux in (6), the pathology is entirely resolved. Regarding the crucial role of Share[F] in the phonology of harmony, refer to Lee (2015, 2016).

As specified in (7), the intersegmental correspondence relation is established between the similar Cs in the output. Note that two corresponding Cs are co-indexed and feature agreement is achieved via checking identity for [voice] specification between the related oral stops. To deal with consonant harmony at a distance, Walker (2000a: 537) proposes a correspondence constraint between Cs in the output as introduced in (8).

(8) Consonantal correspondence constraint: Corr-$C_1 \leftrightarrow C_2$

Given an output string of segments S, and consonants $C_1 \in S$ and $C_2 \in S$, then C_1 is in a relation with C_2, that is, C_1 and C_2 are correspondents of one another.

As stated in Walker (2000a), Corr-$C_1 \leftrightarrow C_2$ in (8) is similarity-based and also applicable to all Cs in an output candidate. The degree of similarity between Cs operates as a key factor to trigger a correspondence relation between them. Therefore, the more similar the Cs in the output, the higher ranked the constraint requiring that they be in correspondence. Given the definition of Corr constraints above, oral stops, for instance, hold the CC correspondence hierarchy as arrayed in (9).

(9) Similarity-based correspondence hierarchy for stops (Walker 2000a: 537)

Corr-$T_1 \leftrightarrow T_2$ $\gg$ Corr-$T_1 \leftrightarrow D_2$ $\gg$ Corr-$K_1 \leftrightarrow D_2$

← more similar less similar →

Any pair of oral stops sharing both place and voice ([t...t], [b...b], etc.) should be in correspondence under the demand of Corr-$T_1 \leftrightarrow T_2$ and then the pair matching only place via Corr-$T_1 \leftrightarrow D_2$, which is followed by the pair of any oral stops via Corr-$K_1 \leftrightarrow D_2$ that is at the bottom in hierarchy. Therefore, Corr constraints in (8) demand correspondence if certain identity conditions are met.

Another set of constraints relevant to CC correspondence is one of the Faith-CC constraints as adopted in (10) based upon the intersegmental correspondence model as illustrated in (11). Note that Ident-CC(F) in (10) requires identity when there is correspondence.

(10) Ident-CC(F) (a bit modified from Walker 2000a: 538)

Let C_1 be a consonant in the output and C_2 be any correspondent of C_1 in the output. If C_1 is [αF], then C_2 is [αF].

(11) Intersegmental correspondence model (Walker 2000a: 538)

Input /tadu/

↕ Faith-IO

Output [$\underline{t}a\underline{d}u$]

↔ Faith-CC

In order to obtain featural identity between Cs in the output as underlined in (11), Ident-CC(F) must be top-ranked, which is followed by Corr constraints as indicated in (12). Now going back to the case of Ngbaka in (7) above, let us consider how voicing assimilation in Ngbaka is achieved by an intersegmental correspondence relation in the output.

(12) Voicing assimilation in oral stops (Walker 1999: 80)

/t i d a/	Ident-CC(Voi)	Corr-T_1↔T_2	Corr-T_1↔D_2	Ident-IO(Voi)
a. t_i i d_j a			1 W	L
☞b. t_i i t_i a				l
c. t_i i d_i a	1 W			L

Ident-CC(Voi), top-ranked, bans any corresponding segments that do not share the same [voice] value. In Corr constraints, Corr-T_1↔T_2 demands that any pair of oral stops matching in both place and voice be in a correspondence relation. Among three candidates, only (12b) satisfies Corr-T_1↔T_2 while the rest satisfies it vacuously. In (12a) and (12c), two Cs share the same place feature only, thus there is no obligation to fulfill the requirement of Corr-T_1↔T_2. Rather, they must satisfy Corr-T_1↔D_2. But (12a) violates Corr-T_1↔D_2 since two agreeing Cs are not co-indexed with one another while (12c) satisfies it with co-indexation, which additionally incurs the fatal violation of Ident-CC(Voi). Note here that two correspondents in (12c) do not hold the same [voice] value.

As such, it is highlighted that a CC correspondence approach via Corr constraints is quite appropriate for the consonant harmony of long-distance interaction based upon similarity effect and that feature agreement is realized by identity-referring CC correspondence. In the meantime, McCarthy (2010) sheds new light on the necessity of Corr constraints and their redundant role, which comes next.

3.3 CC correspondence without Corr constraints

As argued and criticized in McCarthy (2010: 3), Walker's (1999, 2000a, 2000b) Corr constraints hinged upon intersegmental similarity effect can be replaced by a more general faithfulness constraint influencing the output segments, so-called Max-CC as manifested in (13).

(13) Max-CC (McCarthy 2010: 3)
Assign a violation mark for every consonant that is not in the domain of the CC correspondence relation.

Max-CC in (13), unlike Corr constraints (Walker 1999, 2000a, 2000b), is not sensitive to feature composition between Cs in the output and further Max-CC is defined on the analogy with the familiar Max constraints. As mentioned earlier, Corr constraints in (8) enforce CC correspondence if featural identity conditions are met while Ident-CC(F) constraints in (10) demand featural identity under the precondition that there is CC correspondence. In fact, both are redundantly referring to featural identity, thus either of the two, i.e. Ident-CC(F), suffices to check featural identity. Therefore, McCarthy (2010: 2) suggests that identity-referring Corr constraints can be dispensed with since Ident-CC(F) can replace their role and further it is needed independently in other dimensions of correspondence, i.e. IO, BR, OO. Ident-CC(F) states which features must match between two correspondents in the output while Max-CC in (13) favors CC correspondence without mentioning featural identity. Here note again that Max-CC requires that every consonant correspond with one another, i.e. co-indexed, whether or not two Cs are identical in a certain feature. This is the major difference of Mac-CC from Corr constraints.

Prior to inspecting the pivotal role of Max-CC replacing Corr constraints, let us briefly consider how Max-CC violation is calculated referring to McCarthy (2010) in which Chaha consonant harmony is reanalyzed via adding Max-CC but omitting Corr constraints in his tableau. Note that Max-CC violation is gradiently evaluated as indicated in (14) below. For the sake of simplicity, all the constraints but Max-CC are not full-fledged here. Also note that CC correspondence is entirely failed when Cs are in non-indexation as well as in different indexation.

The output in (14a) violates Max-CC three times since neither consonant is in correspondence with one another. Here all Cs are not indexed, thus Max-CC is violated as the number of Cs non-indexed. The outputs in (14b), (14e), and (14g) violate Max-CC once since the final *s* is outside the domain of correspondence, i.e. not indexed but other Cs are all co-indexed. In (14f), all the consonants are not in correspondence at all. In fact, all Cs must be co-indexed with either C_i or C_j. However, the first C is not co-indexed to the following C, the second C is not co-indexed to its preceding C and further the last one is outside the domain of correspondence. Both (14c) and (14d) fully satisfy Max-CC with all Cs co-indexed with respect to each other.

(14) Max-CC violation (modified from McCarthy 2010: 3)

/t ɨ g ɨ s/	Max-CC
a. t…g…s	3
b. d_i…g_i…s	1
c. d_i…g_i…z_i	0
d. d_i…g_i…d_i	0
e. t_i…g_i…s	1
f. t_i…g_j…s	3
g. g_i…g_i…s	1

With this amount of argumentation on the violation of Max-CC constraint as in (14), the tableau in (12) is reanalyzed as in (15) via adding Max-CC instead of Corr constraints.

(15) With Max-CC replacing Corr constraints

/t i d a/	Ident-CC(Voi)	Max-CC	Ident-IO(Voi)
a. t_i i d_j a		2 W	L
☞b. t_i i t_i a			1
c. t_i i d_i a	1 W		L

The tableau in (15) supports the fact that there is no need of Corr constraints fully substituted by Max-CC. Unlike the tableau in (12) above, in (15), Max-CC replaces the role of Corr constraints. Compared to (15b) and (15c), (15a) violates Max-CC twice since two Cs are not co-indexed in the domain of correspondence. Note again that Max-CC requires every consonant to correspond with one another whether or not two Cs are identical in a certain feature. (15c) is the worst due to the fatal violation of Ident-CC(Voi). Here note that two correspondents, co-indexed though, do not share the same [voice] value. Therefore, the candidate in (15b) becomes the winner with all CC correspondence constraints satisfied.

So far, it has been shown that CC correspondence via Max-CC (McCarthy 2010) instead of Corr constraints (Walker 1999, 2000a, 2000b) is suitable for the phonology of harmony at a distance. Max-CC, unlike Corr constraints, does not require any featural identity between Cs in the output. The following section, to verify the superiority of Max-CC approach to long-distance harmony, analyzes the target data of Kinyarwanda via employing Max-CC requiring every consonant be in a correspondence relation and Ident-CC(F) demanding featural identity between Cs in the output under OT[8].

4. A Max-CC approach to Kinyarwanda palatal harmony

Returning to the target data discussed above, here repeated in (16), let us consider how long-distance palatal harmony found in Kinyarwanda takes place between Cs in the output via CC correspondence under OT.

(16) With palatal harmony

a. A palatal fricative underlyingly

/ku-sas-iiš-a/	[gušašiiša]	‘to cause to make the bed’
/ku-uzuz-iiš-a/	[kuužužiiša]	‘to cause to fill’
/ku-saaz-iiš-a/	[gušaažiiša]	‘to cause to get old’
/ku-sooz-iiš-a/	[gušoožeeša]	‘to cause to finish’

b. A palatal fricative derived

/a-sas-ye/	[ašaše]	‘he just made bed’
/a-sokoz-ye/	[ašokože]	‘he just combed’
/ba-ra-saaz-ye/	[barašaaže]	‘they are old’

[8] As evidenced in Chumash where [anterior] harmony at a distance occurs with no autosegmental spreading, McCarthy (2007a) supports the claim of previous literature (Hansson 2001, Rose and Walker 2004, Walker 1999, 2000a, 2000b) in which consonant harmony needs to be dealt with via two-way approach; local, by feature spreading and long-distance, by correspondence. Therefore, autosegmental spreading fares better for local harmony but CC correspondence is more favored for long-distance agreement.

/a-samaaz-ye/ [ašamaažiže] ‘I just caused to make the bed’

As observed and discussed earlier, the target of palatal harmony is an alveolar fricative, *s/z*, and its trigger is a palatal fricative that is underlyingly present sometimes (as in (16a)) or derived some other times (as in (16b)). Especially for the latter, an alveolar fricative is not originally a palatal but palatalized before its CC correspondence process. Interestingly enough, no matter whether a fricative trigger is originally a palatal or gets palatalized, under the influence of CC correspondence, the same place of articulation is favored between Cs in the output and thus the preceding targets are all palatalized.

Given the mechanism of CC correspondence, Ident-CC(Pal) in (17) ranked over Max-CC incurs feature agreement between Cs in the output as exemplified in (18).

(17) Ident-CC(Palatal) (=Ident-CC(Pal))

Let C_1 be a consonant in the output and C_2 be any correspondent of C_1 in the output. If C_1 is [αPal], then C_2 is [αPal].

Ident-CC(Pal) as defined in (17) requires that, if two Cs are in correspondence, i.e. co-indexed, they must have the same value in the feature [Pal] as evidenced in (18) below. Note again that Ident-CC[Pal] crucially outranks Max-CC demanding CC correspondence in every segment in the output, not limited to the segments that are similar to one another unlike Corr constraints.

(18) Place assimilation via CC correspondence

/ku-sas-iiš-a/	Ident-CC(Pal)	Max-CC	Ident-IO(Pal)
a. -$š_{i}$...s_{i}...$š_{i}$-	2 W		1 L
☞b. -$š_{i}$...$š_{i}$...$š_{i}$-			2
c. -s_{i}...s_{j}...š-		3 W	
d. -$š_{i}$...s_{j}...$š_{i}$-		2 W	1 L

For easy configuration, each candidate includes only Cs in a correspondence relation[9]. The output in (18a) is the worst since it fatally violates Ident-CC(Pal) twice

[9] Due to space limit, any harmonically bounded candidates are not fully displayed in the tableaux here since, for instance, if the constraint violation of candidate A is the proper

since the corresponding Cs do not share the same place of articulation though they are correspondents. Note that the first C and the second C do not have the same palatal place though they are co-indexed. One step further, the second C and the last C do not have the same place, either, which also adds the Ident-CC(Pal) violation. However, Max-CC is fully satisfied since all Cs are in the domain of correspondence, i.e. co-indexed. The output in (18c) is worse as well due to the violation of Max-CC three times since three consonants are not co-indexed with respect to each other as defined in (14) above. In (18d), the second C is not co-indexed to the preceding C as well as to the following C, which renders the Max-CC violation twice. Therefore, the winner falls on (18b) since all the alveolar targets get assimilated to the place of the palatal trigger in a complete CC correspondence relation[10]. As McCarthy (2010: 1-2) points out, CC correspondence between Cs is an abstract relation while similarity effect is realized by the crucial role of Ident-CC(F).

Now let us move on to the data where a palatal trigger is not underlyingly present but derived as observed in [ašokože](←/a-sokoz-ye/) in (16b). As Kimenyi (1979: 44-45) describes, a consonant that ends in a verb stem gets mutated before the aspect marker *-ye*, thus becoming palatal. This makes the stem-final alveolar fricative palatalized and further it plays a key role as a trigger for further palatalization as elaborated in (19). Here note that the current OT analysis does not include these two morphophonological processes that both occur before the aspect marker *-ye*; consonant mutation where the stem-final alveolar fricative becomes palatal and *-iz-* insertion. As briefly stated earlier, these processes are not directly relevant to CC correspondence. However, it is quite apparent that the application of these two processes must precede the CC correspondence process. Since long-distance palatal harmony to the preceding alveolar targets originates from the palatal trigger, strictly speaking, palatalized, the input starts with /a-sokož-e/ as shown in (19).

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subset of the ill-formed candidate B, the latter is harmonically bounded by the former (Kager 1999).

10 Regarding the directionality of palatal harmony in Kinyarwanda, a potential candidate like *[-s_i…s_i…s_i-] involves the left-to-right feature agreement, i.e. progressive, and it violates less in Ident-IO(Pal) than the real winner in (18b) with all else being equal. However, following Max[F] (McCarthy and Prince 1995), the ranking of Max(Pal) ≫ Ident-CC(Pal) completely banns the surface-unattested assimilatory direction. Note that Max(Pal) protects the palatal feature of a trigger on the surface. Also refer to Hansson (2001) for the relevant argument on the dilemma of directionality in consonant harmony under Corr constraints.

(19) Long-distance palatal harmony[11]

/a-sokož-e/	Ident-CC(Pal)	Max-CC	Ident-IO(Pal)
a. -s_{i}...k...$ž_{i}$-	1 W	1	L
☞b. -$š_{i}$...k...$ž_{i}$-		1	1
c. -s_{i}...k...$ž_{j}$-		3 W	L
d. -$š_{i}$...k...$ž_{j}$-		3 W	1

Regarding the violation of Ident-CC(Pal), (19a) is fatally screened out since two agreeing Cs, co-indexed, do not share the same palatal place. However, both (19c) and (19d) satisfy Ident-CC(Pal) vacuously since two Cs are not correspondents, thus there is no obligation to fulfill the requirement of Ident-CC(Pal). Given the violation of Max-CC, also well described in (14) above, (19a) and (19b) violate Max-CC once since only *k* is outside the domain of correspondence but others are co-indexed. Also both (19c) and (19d) are disfavored with the Max-CC violation three times.

Here is the question to be addressed; is there any possibility that the intervening consonant *k* also undergoes palatalization? As strongly argued in Kimenyi (1979: 43), only alveolar fricatives get involved in this assimilatory process in Kinyarwanda. This means that any C belonging to a plosive, irrespective of its place, never stands as the target of palatal harmony. With reference to McCarty (2010: 9), Ident-IO(Pal)/Stop, top-ranked, disallows any plosive Cs wrongly palatalized as postulated in (20).

(20) Ident-IO(Pal)/Stop (cf. McCarthy 2010)
Correspondent stops are identical in their specification for palatal.

Unlike Ident-IO(Pal), the constraint in (20) affects only plosives to ban their palatalization on the surface, i.e. no change of their original place feature. Given the

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[11] Unlike [ašokože] in (19) where consonant mutation creates a palatalized trigger, for the case of [ašamaažiže](←/a-samaaz-ye/) in (16b), two steps of *-iz-* insertion and consonant mutation necessitate before the process of CC correspondence. To obtain a derived palatal trigger, *-iz-* insertion comes first before the suffix *-ye*, which leads to consonant mutation whereby the *z* becomes palatal. For the long-distance harmony via CC correspondence, as in (19), /a-samaaz-iž-e/ is taken as an input. Also see footnote 5. Regarding how CC correspondence approach is integrated into the serialism-based OT grammar (McCarthy 2007b, 2009), it will be put for further research.

fact that a dorsal *k* palatalized is surface-unattested in this language, it is preferred that a velar *k* is not in a correspondence relation with its surrounding segments as approved in (21) expanded from the tableau in (19).

(21) With an intervening neutral /k/[12]

/a-sokož-e/	Ident-IO (Pal)/Stop	Ident-CC (Pal)	Max-CC	Ident-IO (Pal)
a. -š$_i$...ǩ$_i$...ž$_i$-	1 W		L	2 W
☞b. -š$_i$...k...ž$_i$-			1	1
c. -š$_i$...k$_i$...ž$_i$-		2 W	L	1
d. -š$_i$...k$_j$...ž$_i$-			2 W	1

Let us first compare the optimal form in (21b) (also in (19b)) to the strong competitor in (21a) where the velar *k* is wrongly palatalized. As witnessed in (21a), also in comparison with (21c), if the velar *k* is co-indexed with its surrounding Cs, its palatalization is the best way to satisfy Ident-CC(Pal) on one hand. However, it is the worst way to disobey Ident-IO(Pal)/Stop on the other hand. This requires that Ident-IO(Pal)/Stop be crucially ranked over Ident-CC(Pal) as specified in (21). In addition, in (21c), though the velar *k* is co-indexed, it has no change in its original place, which leads to the violation of Ident-CC(Pal) twice. The output in (21d) fares worse as well since Max-CC is violated twice since the velar *k* is not co-indexed to the preceding C as well as to the following C. Therefore, as clearly evidenced in (21a) and (21b), the best way to avoid the violation of both Ident-IO(Pal)/Stop and Ident-CC(Pal) is that the velar *k* is not in a correspondence relation, i.e. non-indexed, since it is neutral or inactive to long-distance palatal harmony in Kinyarwanda though Max-CC is somehow violated.

Finally, let us take into account the data of palatal harmony at a distance, but it occurs inside a morpheme as repeated here in (22) where, following Kimenyi (1979: 44), the phonetic forms of the data are only represented.

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[12] As observed in the case of (21) where any plosive Cs do not undergo palatalization in Kinyarwanda, the possibility that any sonorant C experiences palatal harmony is not surface-attested, either as verified in [ašamaažiže] from (16b) above. Accordingly, we may venture that Ident-IO(Pal)/Sonorant is top-ranked over all CC correspondence constraints.

(22) Palatal harmony inside a morpheme

[gušišimura]	'to tear up'
[gušiišikara]	'to get excited'
[gušigiša]	'to prepare alcoholic beverages'
[gušušaaňa][13]	'to draw'

As discussed earlier, since both palatal fricatives *š/ž* and alveolar fricatives *s/z* exist in Kinyarwanda phonemic inventory, it is hard to tell the first palatal fricatives of the words in (22) are underlyingly alveolar or palatal. However, as claimed in Kimenyi (1979: 44), the palatal harmony rule given in (4) is applied inside the morpheme as well given the fact that there appears a dialectal variation between [išeengešo] and [iseengešo] 'prayer'. Though the tableau is not full-fledged here, for the former speech, on the analogy of the tableau in (18) above, the palatal fricative *š* must be co-indexed with its preceding alveolar targets to satisfy Max-CC and further the co-indexed Cs get palatalized to satisfy Ident-CC(Pal)[14].

Thus far, it has been shown that long-distance palatal harmony found in Kinyarwanda well-fits for the CC correspondence approach via Max-CC. No matter where the palatal trigger is located, within a morpheme or over a morpheme boundary, all Cs in the output must hold the same palatal place if they are co-indexed with respect to each other. Palatal harmony in this language targets only an alveolar fricative at a distance from the palatal trigger. More interestingly, even in the case where the trigger is not a palatal underlyingly but palatalized, it plays a key role as a trigger for long-distance palatal harmony as well.

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[13] Do not be confused with the palatal nasal *ň* in [gušušaaňa] since it is not derived but phonemic underlyingly, thus it is not the target of palatalization. In other words, an alveolar fricative is only the participant to long-distance palatal harmony in Kinyarwanda.

[14] Kimenyi (1979) does not clearly state whether or not there appears a dialectal difference with respect to the whole data of long-distance palatal harmony adopted here as well as its obligatory or optional occurrence. However, as Kimenyi (1979) points out, the data in (22) reflect a variant where palatalization is preferred, thus all CC correspondence constraints are ranked over Ident-IO(Pal) as witnessed so far. However, for the standard speech that much favors the lack of palatalization, it is presumed that Ident-IO(Pal) is ranked over all CC correspondence constraints.

5. Conclusion

Under OT grammar (Prince and Smolensky 1993/2004, McCarthy and Prince 1995), consonant harmony has been mainly dealt with via Align equivalent to feature spreading rules in AP (Goldsmith 1976a, 1976b). However, as argued at length above, previous research (McCarthy 2003, 2009, Wilson 2003, 2004, 2006) has reported that Align is not quite straightforward to the phonology of harmony in that it wrongly predicts surface-unattested languages. In the meantime, Walker (1999, 2000a, 2000b) diagnoses that feature spreading approach to harmony well-fits for the instances of strict segmental locality at the level of root node adjacency. However, for the cases of segmental interaction at a distance, she proposes an alternative idea by adopting the correspondence model of faithfulness (McCarthy and Prince 1995, 1999). In her CC correspondence schema, feature agreement between Cs at a distance results from the correspondence relation between similar Cs in the output.

However, Walker's (1999, 2000a, 2000b) intersegmental correspondence is subject to criticism as well since two different types of constraints, Corr constraints and Ident-CC(F), both refer to featural identity, i.e. redundant. As argued in McCarthy (2010), Corr constraints can be dispensed with and the role of checking featural identity is solely left up to Ident-CC(F). Instead of Corr constraints, McCarthy (2010) newly proposes Max-CC as a constraint requiring CC correspondence but insensitive to featural identity. Via removing Corr and adding Max to CC correspondence along with Ident-CC(F), consonant harmony at a distance can be dealt with successfully and straightforwardly.

In order to verify and support that McCarthy's (2010) Max-CC approach via CC correspondence is adequate and appropriate to long-distance harmony in phonology, this paper examines and analyzes the data of palatal harmony found in Kinyarwanda. Across a morpheme boundary as well as inside a morpheme, an alveolar fricative gets palatalized under the influence of the following palatal fricative. Two things are mainly spotlighted; the agreeing Cs are at a distance skipping over neutral segments, i.e. non-local, and further the trigger, no matter whether it is phonemic or derived, affects its preceding alveolar targets. Ident-CC(Pal) ranked over Max-CC is responsible for the long-distance palatal harmony found in Kinyarwanda. Furthermore, for the CV syllable intervened between a trigger and a target in which the C is not a fricative but a stop, Ident-IO(Pal)/Stop plays a vital role as a blocker to ban any plosive Cs to be wrongly palatalized.

As such, the target data dealt with thus far are fully compatible with the CC correspondence schema based upon Max-CC without resorting to identity-sensitive Corr constraints and further consonant harmony as action-at-a-distance comes from not feature spreading but C-to-C correspondence or intersegmental correspondence in the output under OT.

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received: October 18, 2018
revised: December 16, 2018
accepted: December 21, 2018