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Representing Opacity in Kinyarwanda Coronal Harmony

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1.0 Introduction

Generative phonological research on the Bantu language Kinyarwanda began in 1976, when Alexandre Kimenyi conducted linguistic fieldwork on the language. He described several phonological processes including palatal harmony. Years later, Walker and Mpiranya (2005) re-evaluated the process, describing it instead as coronal (retroflex) harmony. Additionally, they discovered opaque segments in the harmony, a typologically rare phenomenon. As of 2017, only four of the world's languages are known to present opacity effects in coronal harmony: Sanskrit, Slovenian, Imdlawn Tashlhiyt and the Bantu language Kinyarwanda (Hansson, to appear). The rarity and complexity of this phenomenon presents challenges to its theoretical representation. Past literature argues primarily for two different forms of analysis: (1) feature spreading (Mpiranya and Walker 2005, Walker 2006) and (2) constraint-based Analysis by Correspondence (ABC) (Walker and Rose 2004, Hansson 2010). This paper explores these analyses, commenting critically on the description, predictions, and limitations of each theory in its representation of the known facts about Kinyarwanda's coronal harmony, with particular focus on the representation of the opaque segments. Additionally, a feature spreading approach without the use of constraints is proposed.

2.0 Kinyarwanda Consonant Harmony

Consonant harmony "refers to a class of systematic sound patterns, in which consonants interact in some assimilatory way even though they are not adjacent to each other in the word" (Hansson, to appear, 1). Hansson (to appear) suggests that there are 170 languages that present consonant harmony. Of these, coronal harmony is the most common (Hansson, to appear).

2.1 Coronal Harmony

In Kinyarwanda, coronal harmony is triggered by the retroflex fricatives [ʂ] [ʐ] and targets the alveolar fricatives [s] and [z]. This means that the target segments are changed to become more similar to the trigger segments (in this case the addition of retroflexion).

2.2 Obligatory vs Optional Harmony

Kinyarwanda coronal harmony is obligatory in local contexts, specifically leftward adjacent syllables. The process operates *regressively* from right to left within the domain of the stem. As seen in 1a) the trigger segment [ʂ] targets the alveolar fricative in the first syllable /sa/ resulting in the surface form represented in 1) a. Similar examples are shown in 1) b and 1) c. In longer distances of more than one syllable between the trigger and the target, the harmony is optional. In 1) d-f, the trigger ([z] in all examples) optionally targets the syllable-initial sibilant, resulting in two variable surface forms.

(1)

	Underlying Representation	Surface Form
a) Obligatory	/sasi/ "bed maker"	[ʂaʂi], *[saʂi]
b)	/-úzuz- + i-e/ fill + perf.	[úzʊzɐ], *[úzuzɐ]
c)	/-baaz- + iiʂ/ plane (woodwork) +perf.	[baazʊiiʂa], *[baaziiʂa]
d) Optional	/sákuz- + i-e/ to shout + perf.	[ʂákuzɐ] ~ [sákuzɐ]
e)	/ásamuz-i-e/ opened mouth +perf.	[ásamuzɐ] ~ [áʂamuzɐ]
f)	/zimagiz-i-e/ misled +perf.	[zimagizɐ] ~ [zʊimagizɐ]

*Data from Mpiranya and Walker (2005: 3,4)

2.3 Opacity

As previously mentioned, opacity in coronal harmony is extremely rare among the world's languages according to Hansson (to appear). Opacity is a phenomenon that "blocks" or "intervenes" in a harmonic process. Unlike transparent segments such as those seen in 1) a and 1) b, opaque segments are said to block the spread in a feature spreading approach (Walker and Mpiranya 2005, 2006) or intervene in the correspondence relation in the ABC approach (Hansson, 2010). In Kinyarwanda, the opaque segments are all coronal: alveolar oral stops [t] [d], affricate [ts] and the nasal stop [n], and the palatal consonants [ɲ] [j]. As seen in 2) a-c the presence of the opaque segments ([t] [j] and [ts]) result in only one grammatical form (despite being a long distance like 1) d-f. In this one form, the word initial sibilant does not have retroflexion, as the opaque coronal segments intervene.

(2)

	Underlying Representation	Surface Form
a)	/zituz- + i-e/ to cause someone to detach + perf.	[zituzɐ], *[zʊituzɐ]
b)	/zaujaaz+i-e/ become warm liquid + perf.	[zujaazɐ], *[zʊjaazɐ]
c)	/setsaguz+i-e/ cause to care up + perf.	[setsaguzɐ], *[ʂetsaguzɐ]

*Data from Mpiranya and Walker (2005, 9) and Walker and Mpiranya (2006, 3)

2.4 The Neutral Segment [ɾ]

Despite its retroflexion, the phoneme [ɾ] is *neutral* to the process, meaning it does not trigger or block as one might expect. As evident in 3a), [ɾ] is not opaque. The trigger and target are separated by a syllable, with the surface forms variable as seen in 1) d-f. Therefore, if [ɾ] was opaque, only a single form would be present such as the examples in 2) a-c. The segment is also not a trigger, as demonstrated in 3b). The surface form does not have retroflexion of the first syllable, which is would if [ɾ] was a trigger that patterned like the local harmony in 1) a-c. Walker and Mpiranya (2006) attribute this neutrality to the lack of a contrasting segment.

(3)

	Underlying Representation	Surface Form
a)	/seɾuz+ i-e/ provoke, irritate + perf.	[seɾuʐe] ~ [ʂeɾuʐe]
b)	/ziɾa/ be forbidden	[ziɾa], *[ʐiɾa]

*Data from Mpiranya and Walker (2005, 5)

As seen in the coronal phoneme inventory in (4), the retroflex sibilant triggers [ʂ] [ʐ] contrast with their alveolar targets [s] and [z], however, there is not another liquid phoneme for [ɾ] to contrast with, resulting in its neutrality. Another possibility relates to the positioning of liquid on the feature geometry, which will be further explored in section 3.0.

(4)

	Alveolar	**Retroflex**	**Palatal**
Stops	t d		
Fricatives	s z	ʂ ʐ	
Affricates	ts	ʈʂ	

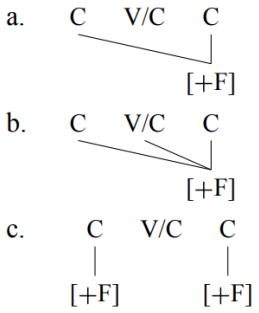
Nasals	n		ɲ
Liquids		ɾ	
Glides			j

*reformatted from Mpiranya and Walker (2005, 2)

3.0 Theoretical Representations

Due to the rarity of opaque segments in coronal harmony, the phenomenon presents challenges for theoretical representation. Past literature argues primarily for two different forms of analysis: (1) auto segmental feature spreading (Mpiranya and Walker 2005, Walker, Byrd and Mpiranya 2006) and (2) constraint-based Analysis by Correspondence (ABC) (Walker and Rose 2004, Hansson 2010). As seen in (5), feature spreading involves the spread of features across intervening transparent segments (a and b), while ABC (c) is concerned with copying (value-matching) between the trigger and target segments.

(5)



(Hannson, to appear, 27)

In their discussion of harmony, Archangeli and Pulleybank (2007) assert, “whatever the model, it must be possible to impose a variety of featural restrictions on the triggers and targets of harmony” (Archangeli and Pulleybank 2007: 376). In the discussion of each model in the next sections, the ability of each model to make these restrictions will be analyzed, in addition to the adequacy of the predictions made by each theory.

3.1 Analysis by Correspondence (ABC)

Analysis by Correspondence (ABC) is a form of feature agreement. In this theory, harmony is caused by feature matching in segments that stand in a *correspondence relation* (Walker and Mpiranya, 2006). A correspondence relation results when two differing segments' features are all or mostly similar in their surface form (Hansson, to appear). The process ignores intervening or transparent segments, focusing on copying feature(s) between the segments that stand in the correspondence relation. For example, in 1a) /sasi/ > [ʂaʂi], the trigger [ʂ] and target [s] stand in a correspondence relation, sharing all features except for retroflexion. The retroflexion is then *copied* from the trigger onto the target through satisfaction of constraints such as the following:

(6) CORR - S↔S

If sibilant segments S_i and S_i co-occur in the output, then x and y are correspondents of one another.

(7) IDENT [+retroflex] S_L - S_R

If segments S_L (left sibilant) and S_R (right sibilant) co-occur in the output, they must agree in the feature [+retroflex]

Since the trigger and target segments are both sibilants and do not require agreement of voicing, only one correspondence restraint is needed to determine manner of articulation (see 6). The secondary articulation is determined based upon the IDENT constraint in (7). As shown in (8), the optimal form is (b), as it satisfies both the CORR constraint and the IDENT constraint. Due to the limited number of constraints needed, this model is very economical in representing obligatory harmony.

(8) Correspondence Chart

/sasi/	CORR - S↔S	IDENT [+retroflex] SL - SR
a. [sʲaʂiˌi]	W	L
b. [ʂiaʂiˌi]	W	W

Due to this economy, many theorists (Hansson 2007, Rose and Walker 2004) favour ABC for representing harmony. However, the theory does have limitations in relation to representing opacity. The correspondence constraints ignore the transparent segments: "The ABC approach largely equates non-participation with non-correspondence. This would seem to predict that non-participants will always be transparent" (Hansson 2010: 26). The model's lack of focus on and predictions made about intervening segments is problematic for Kinyarwanda coronal harmony, as it overlooks the presence of opaque segments. Therefore, neither the existence of the opaque segments, nor the blocking they cause is accounted for with the constraints given in 6) and 7).

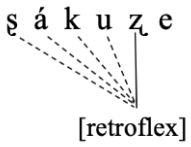
Hansson (2010) proposes a solution to this issue by adding additional constraints and creating constraint tiers that are ranked in a similar way to a feature geometry. In each tier, multiple constraints are ranked, thus requiring many more constraints than the economical obligatory harmony in (8). For the purposes of this paper, the constraint ranking will not be explored, although it is understood that opacity can be adequately represented in ABC. Authors (Hansson 2010, to appear, Walker and Mpiranya 2005, 2006) all agree that due to the many constraints needed to represent opacity in ABC, feature spreading is the more economical and optimal approach. Therefore, a feature spreading analysis will be the focus of the rest of the paper.

3.2 Feature Spreading

Specifically, this paper will consider the feature spreading approach proposed by Walker and Mpiranya (2005, 2006). Due to the complexity opacity presents for the ABC theory, Walker and Mpiranya (2005, 2006) proposed an approach of feature spreading or gestural extension. They

suggest that the feature [+retroflex] is spread across segments, only perceptibly altering the target segments. Their representation is shown in (9).

(9)



Mpiranya and Walker (2005, 8)

Although the spreading representation in (9) can adequately describe the phenomenon, Mpiranya and Walker (2005, 2006) use it more as a means of arguing that the retroflexion spreads over agreeing (feature spreading vs. agreement), avoiding a full auto segmental analysis. Instead, to predict the phenomena, Walker and Mpiranya (2005, 2006) proposed a set of spreading constraints:

(10) SPREAD-L-STEM-(retroflex)

Any [retroflex] feature associated to a [–sonorant, +continuant] segment x, is also associated to any segment y that precedes x in a stem.

(11) SPREAD-L-ADJσ-(retroflex)

Any [retroflex] feature associated to a [–son, +cont] segment x is also associated to any segment y that precedes x in the stem in an adjacent syllable

In (10), the constraint states that retroflex is spread to the left in the domain of the stem. This constraint ensures that the triggers are restricted to fricatives through the specification of [–sonorant, +continuant] and specifies the morpheme boundary (the stem). The second constraint in (11) predicts obligatory harmony by stating that retroflex is spread from right to left to an adjacent syllable.

The faithfulness constraint in (12) is ranked below (11) to represent obligatory harmony. It states

that segments in the input and output should agree for the feature [retroflex].

(12) IDENT-OI(retroflex)

Let α be a segment in the input and β be any correspondent segment of α in the output. If β is [retroflex], then α is [retroflex].

As seen in (13), form b) violates the SPREAD constraint since [+retroflex] is not spread to the first syllable. It also has one violation of IDENT since the surface form has retroflexion. In form a), only IDENT is violated. Since form b) violates the higher ranked SPREAD, it is a critical violation therefore optimizing a) over b).

(13)

/sáaz-i-e/	SPREAD-L-ADJσ-(retro)	IDENT-OI(retro)
☞ a. ʂáaʐe		***
b. sáaʐe	*!*	*

Mpiranya and Walker (2005, 10)

3.3 Optional Harmony

To produce a theory that accounts for the optional harmony over longer distances, variability is required. Since long distance harmony is optional and non-predictable, Walker and Mpiranya (2006) account for this by variably ranking constraints (10) and (12). As seen in (14) the IDENT constraint is ranked higher than the SPREAD constraint optimizing the form in (b) due to the critical violation of the higher ranked IDENT in (a). This ranking predicts the form without retroflexion of the first syllable. However, in (15) SPREAD is ranked over IDENT. Since b) critically violates SPREAD (a) is favoured over (b), predicting the form with retroflexion on both sibilants. Therefore, the variable ranking between (14) and (15) accurately predicts the optional harmony.

(14)

/sákuz-i-e/	IDENT-OI(retro)	SPREAD-L-STEM-(retro)
a. ʂákuzẹ	****!*	
☞ b. sákuzẹ	***	**

Mpiranya and Walker (2005, 11)

(15)

/sákuz-i-e/	SPREAD-L-STEM-(retro)	IDENT-OI(retro)
☞ a. ʂákuzẹ		*****
b. sákuzẹ	*!*	***

Mpiranya and Walker (2005, 11)

An alternate way of representing optionality in OT is proposed by Antilla (2007), with the use of a dotted line to show variability in a ranking of constraints. If this notation was applied to Mpiranya and Walker's (2006) theory, it would eliminate the necessity of two charts, making the approach even more economical.

3.4 Opacity

To account for the opacity, Walker and Mpiranya (2006) propose the following constraints (in order of ranking):

(16) *[retroflex]/CORSTOP: No retroflex coronal stops.

(17) *[retroflex]/PAL: No retroflex palatals.

(18) *[retroflex]/CORAFFRICATE: No retroflex coronal affricates.

These constraints are ranked above the spreading and faithfulness constraint, predicting opacity. Constraint (16) prohibits the existence of retroflex coronal stops, (17) retroflex palatal consonants and (18) retroflex coronal affricates. In (19), the ranking and two forms are shown. Although form a) has violations of SPREAD and IDENT, *retro/CORSTOP is ranked the highest. Form b) critically violates this constraint through the presence of the retroflex stop, rendering form a) the optimal form.

(19)

/síitaaz+i-e/	*[retro]/CorStop	Spread-L-stem-(retro)	Ident-OI(retro)
☞ a. síitaazẹ		***	**
b. ʂíiʈaazẹ	*!		*****

Mpiranya and Walker (2005, 12)

The ultimate constraint ranking is given in (20). The constraints restricting retroflexion (16-18) dominate the ranking. This is because the blocking caused by opacity requires critical violations. Below these constraints, the SPREAD (11) and IDENT (12) constraints are found, which predict obligatory harmony. Finally, the constraint SPREAD-L-STEM (retro), is variably ranked among (11) and (12) to represent the optionality. Therefore, these constraints allow for an adequate prediction of all factors known about coronal harmony and opacity in Kinyarwanda. Although there are six constraints in total, each form only requires maximum three constraints, making the model fairly economical.

(20)

*[retroflex]/CorStop/Pal/CorAffricate >> Spread-L-adjσ-(retro), (Spread-L-stem-(retro)) >> Ident-OI(retro) >> (Spread-L-stem-(retro))

Opacity

Obligatory and optional spreading

Walker and Mpiranya (2006,8)

4.0 Autosegmental Feature Spreading

It is clear from these two analyses that the debate between researchers surrounds the question of whether or not spreading or agreement occurs in Kinyarwanda coronal harmony. Theorists tend to agree that spreading occurs, which is supported by Walker et al.'s (2008) articulatory findings that retroflexion is spread across the transparent segments due to a slight raising of the tongue despite not being perceptibly noticeable. However, Mpiranya and Walker's (2005, 2006) spreading approach uses OT constraints to make predictions, avoiding a "true" autosegmental

approach. Therefore, in this paper an approach without the use of constraints will be offered, to determine whether the same predictions can be made as Mpiranya and Walker (2005, 2006).

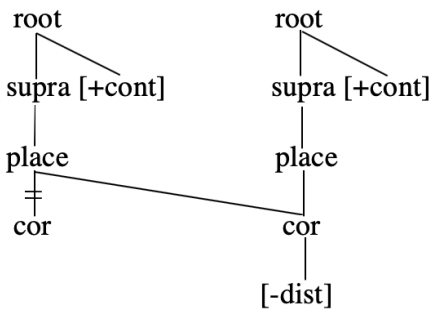
4.1 Feature Geometry

In working with feature spreading, it is crucial to first consider a specific feature geometry. A feature geometry is a "hypothesis about the structure of linguistic knowledge in the human brain" that can describe and predict phonological facts (Sagey, 1986, 10). The geometry seen in Figure 2.0 from Sagey (1986) forms the basis of the spreading approach proposed in this paper.

In her work, Sagey (1986) theorized about the placement of the "place" node. She analyzes Sanskrit which has blocking effects similar to Kinyarwanda. To avoid the blocking, she cites Steriade (1986), using a coronal node as the articulator node so that labials and dorsals cannot block the spread. She proposes, "it cannot be a spreading of the place node, for vowels, labials, and dorsals all have place nodes that would block such a spreading". Additionally, although the features [-anterior] and [-distributed] constitute retroflexion, they would require spreading two constituents.

Therefore, Sagey (1986) argues it is the coronal node that spreads. She asserts, "if the rule is characterized as spreading the coronal node, then we have an explanation for why intervening coronals block the rule, coronals block the rule by virtue of having a coronal node" (1986, 134). In my representation seen in (21), this theory is upheld, with coronal spreading from the trigger on the right to the target on the left. Both segments are dominated by the [+cont] to distinguish their manner as fricatives.

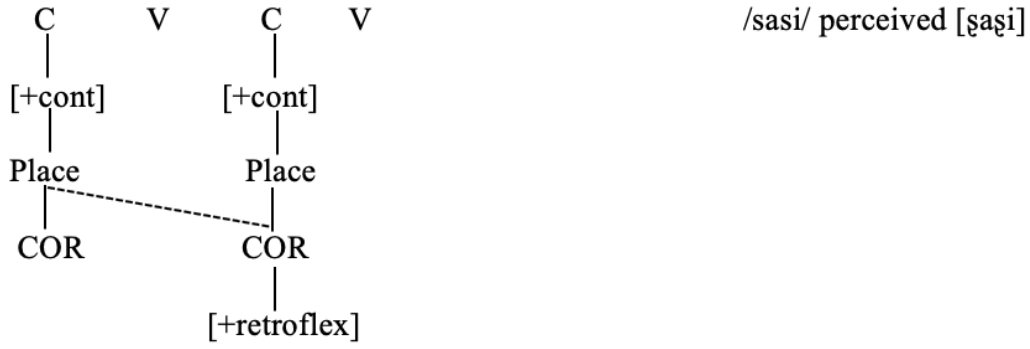
(21)



4.2 Proposed Theory

In a slight adaptation of Sagey (1986) and Steriade (1986) I have developed a similar spreading account. For the purposes of this paper and for clarity, only the spreads that are perceptible are shown despite understanding that the retroflexion is spread to the transparent segments as well. In my representations, the COR node which dominates [+retroflex] spreads to the left to the Place node. The spread is only successful if the target place node is dominated by [+cont] and dominates COR. As shown in (22), the obligatory harmony is satisfied as the second syllable COR spreads to the first syllable COR successfully.

(22)

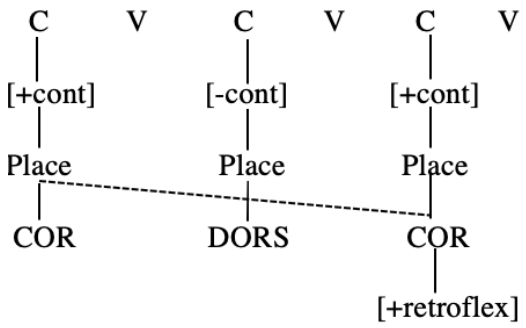


4.2.1 Optionality

To represent the optionality, two representations are needed. These spreads vary in the same way that the constraints are variably ranked in 4.2. In (23)a, the spread does reach the first syllable by

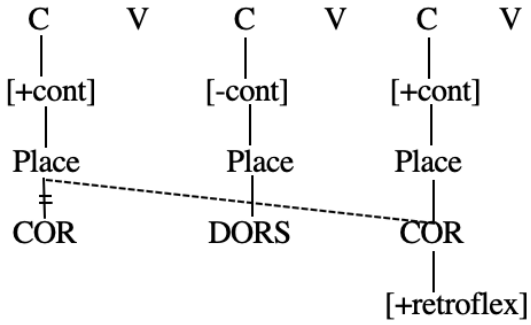
virtue of the presence of [+cont] and COR. Using the same logic as Steriade (1986) cited in Sagey (1986), and the DORSAL consonant does not block the spread since it does not have a COR node.

(23)a.



/sakuz+i-e/ perceived as [ʂákuzɐ]

23b.



/sakuz+i-e/ perceived as [sákuzɐ]

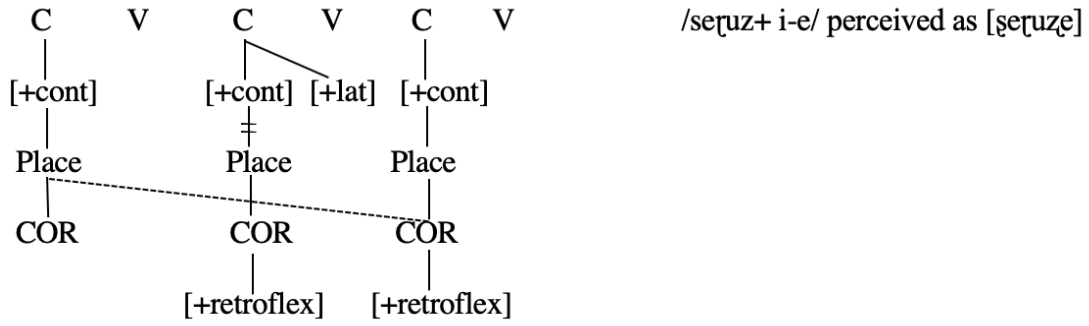
The other option without the spread is shown in (23)b. In this representation, COR successfully spreads across DORS, however it dissociates from place to COR in the first consonantal segment, resulting in a surface form without the presence of retroflexion.

4.2.2 Neutrality

Considering the form shown in 3a) /seɻuz+ i-e/ > [seɻuzɐ] ~ [ʂeɻuzɐ], on the pattern of the

spreads in (23a-b) the presence of [ɽ] would predict blocking of the spread of coronal due to its own coronal node. However, as seen in Figure 1.0, [ɽ] is the only liquid present in Kinyarwanda, suggesting that the phoneme possibly corresponds to the liquid tier over the coronal tier, therefore accounting for its neutrality. I therefore propose the following representation:

(24)



The delinking of the Place node and those below by association, represents the phonemes correspondence to Liquid ([+lat]) over COR. The rightmost COR is then able to spread over the disassociated COR segment to the target segment. It is noted that since this is a long-distance harmony, optionality does occur but only the form with successful spread is shown here for clarity.

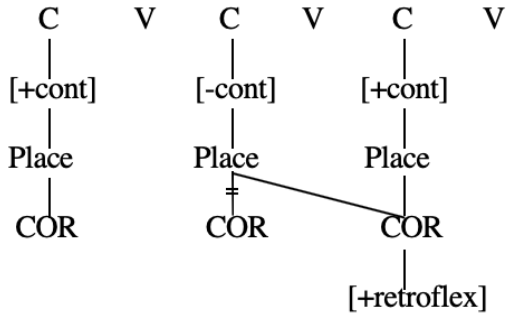
The representation in (24) also accounts for why I propose COR spreads over [retroflex]. If [retroflex] was to spread, the [retroflex] from [ɽ] would block it by virtue of having its own [retroflex] node. Therefore, based both on the logic of Sagey (1986) and the neutrality of [ɽ], I propose that COR is spread over [+retroflex]

4.2.3 Opacity

Finally, the opacity of non-continuant coronals is shown in (25). COR is unable to reach the syllable initial sibilant because it is blocked by the opaque segment [-co nt], COR. Since a COR can only spread to another COR that is [+cont], the [-cont] of medial stop blocks the

process. The disassociation does not allow the spread to go "over" to reach the target segment, resulting in the opacity effect. This would also account for the other opaque segments [j] and [d] (-cont, COR), [n] and [ɲ] (+nasal, COR), and [ts] (-cont, COR) as the specified [+cont], COR is not found in any of these options, but another presence of COR is therefore blocking the spread.

(25)



/zituz+i-e/ perceived as [zituẓe]

Therefore, as shown by these representations, an autosegmental feature spreading approach can adequately account for both the opaque and neutral segments, and the obligatory and optional harmony without the use of constraints proposed by Mpiranya and Walker (2005). A strength of this approach is the relatively easy description it provides of the data. The spreads provide a natural class for the opaque segments (COR and anything other than +cont) which adequately describes the harmonic process.

5.0 Conclusion

As evident through this analysis, although featural agreement is economical in its predictions about obligatory coronal harmony, accounting for optionality and opacity requires much more complicated constraints within the theory. Feature spreading as discussed by Walker and Mpiranya (2006) accounts for the opaque segments with fewer constraints, making it a more economical option. Additionally, the variable ranking of IDENT-OI (retroflex) and SPREAD-L-

STEM-(retroflex) adequately predicts the optionality, which is not as clearly determined in feature agreement.

A description of the phenomena using a more "traditional" autosegmental feature spreading approach without the use of constraints was offered, which adequately represents and describes the known facts of Kinyarwanda coronal harmony.

Although both spreading approaches account for all of the data, one limitation of the autosegmental spreading is that the spreads are drawn on a word by word basis, whereas the OT constraints can apply to any form given. Therefore, although the constraints offered by Walker and Mpiranya (2005, 2006) are not necessary, they do adequately predict the factors of Kinyarwanda coronal harmony and could be considered slightly more economical. I conclude that both approaches have their advantages and can be chosen based on the focus of what one is looking to represent. The autosegmental approach is precise in describing rather than predicting the facts of the data, while Walker and Mpiranya's (2005, 2006) approach economically predicts for all forms.

Word count:

Appendix

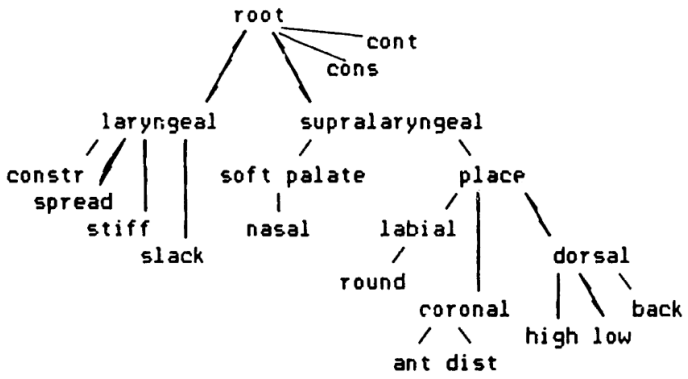
Figure 1.0: Phoneme Inventory

Kinyarwanda consonant inventory

	plosive		nasal	fricative		affricate	flap	approxi-mant
labial	p		m		β	pf		w
labio-dental				f	v			
alveolar	t	d	n	s	z	ts		
postalveolar (retroflex)				ʂ	ʐ	tʂ	ɾ	
palatal	c	ɟ	ɲ	ç				j
velar	k	g						
glottal				h				

Walker, Byrd and Mpiranya (2008, 3)

Figure 2.0: Feature Geometry



Sagey (1986, 2)

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