Gradient feature activity in Korean place assimilation[*]

Rachel Walker

University of Southern California

1.   Introduction

In many languages, place assimilation in consonant clusters operates in the same fashion across all places of articulation in targets and triggers. However, in some patterns, place assimilation shows place-specific restrictions on targets and/or triggers. Place assimilation in Korean stop clusters presents an example with dual place-specific restrictions: whether place assimilation operates depends on the place of both a trigger and its target. The pattern shows sensitivity to a three-step scale for place features, [Dorsal] > [Labial] > [Coronal], such that assimilation in a heterorganic cluster operates only when the target is lower on the scale relative to the trigger (Kim-Renaud 1974, Jun 1995, 2004, de Lacy 2002, 2006).

Taking the the place feature scale as a tentative universal, in this paper I develop a proposal in which the scale is encoded via gradient activity over features. In this approach, place features are represented with a gradient degree of activity α scaled such that $\alpha_{[Dorsal]}$ > $\alpha_{[Labial]}$ > $\alpha_{[Coronal]}$. The concept of scalar feature activity builds upon the proposal of Gradient Symbolic Representations (Smolensky & Goldrick 2016), but it is modified in some respects here. First, gradient activity is applied to features (e.g. Rosen 2016). Second, gradient activity scaled over the class of place features is posited as a primitive of phonological representation; it is thus consistently present in the representation of features, both in the input and output, and is not altered by GEN. Gradient activity factors into the penalty assigned for violation of constraints. A key benefit of this approach is that it provides an intrinsic mechanism to capture a parallel in scalar place-sensitive effects involving markedness constraints, which govern triggers of assimilation, and faithfulness constraints, which govern targets of assimilation. I also touch upon possible extensions of this approach to other phenomena involving place, as well as other scales in phonology.

This paper is organized as follows. Section 2 provides a description of place assimilation in Korean with exemplification. The proposed analysis of the pattern is

presented in section 3, couched in the framework of Harmonic Grammar (Legendre et al. 1990, Smolensky & Legendre 2006). The representation of features with gradient activity is introduced, and the applicable constraints for place assimilation are provided. These constraints are general to the class of place features rather than place specific, since hierarchical place effects emerge from gradient activity in the representation. The workings of the account are illustrated, including a scaling factor in constraints which operates over scalar activity. Section 4 discusses extensions of the approach, and section 5 considers an alternative using families of markedness and faithfulness constraints specified for subsets of values for place (CoMP, de Lacy 2002, 2006). Section 6 presents the conclusion.

2.　　Korean place assimilation

In Korean stop clusters (C1C2), the first stop may assimilate in place to the following stop (Kim-Renaud 1974, Cho 1990, 1991, Jun 1995, 2004, Ahn 1998, de Lacy 2002, 2006, Rice 2007). Participating stops are oral or nasal. Korean place assimilation has been characterized as occurring in fast or informal speech (Kim-Renaud 1974, Jun 1995). The process is sensitive to the place of the potential target (C1) and the trigger (C2): coronals may assimilate to dorsals and labials (1a-b), labials may assimilate to dorsals but not coronals (1c-d), and dorsals do not assimilate to labials or coronals (1e-f). In contexts where assimilation is available, only the assimilated form is shown in (1). C' represents a tense consonant.

(1) *Korean place assimilation*

a.	/cor-dor/	/patʰ-kwa/	[pakk'wa]	'field and'
		/son-kalak/	[soŋk'arak]	'finger'
b.	/cor-lab/	/patʰ-pota/	[papp'oda]	'rather than the field'
		/son-patak/	[somp'adak]	'palm'
		/son-mok/	[sommok]	'wrist'
c.	/lab-dor/	/tʰop-kʰal/	[tʰokkʰal]	'handsaw'
		/kaːm-ki/	[kaːŋgi]	'cold'
d.	/lab-cor/	/pap-to/	[papt'o]	'rice also'
		/sam-tək/	[samdək]	'three virtues'
e.	/dor-lab/	/kuk-po/	[kukp'o]	'national treasury'
		/səŋ-pjək/	[səŋbjək]	'rampart, castle wall'
		/tʃaŋ-mjən/	[tʃaŋmjən]	'scene, spectacle'
f.	/dor-cor/	/pak'-to/	[pakt'o]	'outside also'
		/kaŋ-to/	[kaŋdo]	'river also
		/tʃaŋ-nal/	[tʃaŋnal]	'market day'

Experimental investigation has found that place assimilation in Korean is chiefly categorical in nature, but variable (Kochetov & Pouplier 2008). The focus in this paper is on deriving the variants with assimilation.

The chart in (2) summarizes the behavior of clusters by place of target and trigger. Heterorganic clusters in non-shaded cells may assimilate in the output, while those in shaded cells do not. Cells corresponding to clusters that are homorganic in the input are marked with a dash. Under the assumption that place-feature markedness is scaled as [Dorsal] > [Labial] > [Coronal] (de Lacy 2002, 2006, cf. Jun 2004), Korean place assimilation can be characterized as operating only when the target is less marked than the trigger.

(2) *Summary by place of target C1 & trigger C2*

Target: Markedness →	Cor	Lab	Dor
Dor	/kt/ →[kt]	/kp/ →[kp]	–
Lab	/pt/ →[pt]	–	/pk/ →[kk]
Cor	–	/tp/ → [pp]	/tk/ → [kk]
	Cor	Lab	Dor

Trigger: Markedness →

Labial stops are pivotal in this pattern because they bifurcate the behavior of dorsal and coronal stops as targets and triggers. Dorsals *resist* place assimilation from labials, but coronals do not, which suggests a place-sensitive difference in enforcement of faithfulness (i.e. Faith-[Place]). Further, dorsals *trigger* place assimilation in labials, but coronals do not, which suggests a place-sensitive difference in enforcement of markedness (i.e. the place-assimilation imperative). This duality, where a greater degree of markedness for place stands alongside a greater tendency for preservation of place, is supported within the cross-linguistic typology of place assimilation (de Lacy 2002, 2006). The Korean pattern is notable, because it shows evidence of scaled markedness and faithfulness for place features in the same language.

3. Analysis: Scalar feature activity

The aim for this analysis is to derive place assimilation only in those clusters where it may occur. A challenge is understanding why features further to the left on the place-feature markedness scale potentially display both a higher degree of markedness and faithfulness. The proposal pursued here is that parallels in strength of markedness and faithfulness for place originate in a scale of activity for place features, where activity values (α) respect the scalar relationship $\alpha_{[Dorsal]} > \alpha_{[Labial]} > \alpha_{[Coronal]}$.

3.1 Featural representations

The featural representations employed in this account here take inspiration from the proposal of Gradient Symbolic Representations by Smolensky & Goldrick (2016) and build upon aspects of that work. First, I assume that features may be gradiently active, with an activity value that may range from 0–1 (Rosen 2016, Jang 2019, Lee 2019, McCollum 2019, Walker 2019, Sande & Oakley 2020, cf. Boersma 1998, Flemming 2001, Lionnet 2016, 2017). While Smolensky & Goldrick (2016) considered gradience only in inputs,

several studies have posited gradient activity in outputs, which I assume also (e.g. Faust 2017, Faust & Smolensky 2017, Zimmermann 2018, Jang 2019, McCollum 2019).

A novel proposal here is that gradient activity values for place features are part of the representational primitives of phonology: they are present in the input and output representation of features and are not altered by GEN.[2] Activity is scaled with markedness, assuming the markedness scale for supralaryngeal place is [Dorsal] > [Labial] > [Coronal], as mentioned above. The proposed representations for place features in this analysis are [Dorsal].9, [Labial].8, [Coronal].7, with subscripted activity values. The particular activity values assigned here are not critical. What is essential is that the values are scalar and that they are ordered so that a more marked feature has a higher value. I will refer to this type of representation as *scalar feature activity*.

As in other work that employs gradient activity in representations, activity factors into the calculation of penalties for violations. Elements with greater activity in the output incur a greater violation of an applicable markedness constraint, and deletion of elements with greater activity in the input incurs a greater violation of an applicable MAX constraint. The account is implemented in Harmonic Grammar, in which constraints are weighted (Legendre et al. 1990, Smolensky & Legendre 2006). A basic familiarity with this framework is assumed.

3.2 Constraints

Scalar activity in the representation of place features enables the constraints involved in place assimilation to be general for the class of Place, that is, they do not reference specific place features. Two constraints are central in the account. The sequential markedness constraint in (3) drives place assimilation; [xPlace] and [yPlace] represent variables over place features. Following Pulleyblank (2002), the locus of violation is underlined. The locus is [yPlace], in C2, to encode scalar sensitivity to triggers. The faithfulness constraint, MAX-IO[Place], in (4), is violated when a place feature is deleted (McCarthy & Prince 1995, Padgett 1995), as when a target segment assimilates for place with a neighboring consonant. Enforcement of this constraint thus blocks assimilation.

(3) *C[xPlace] C[yPlace], $x \neq y$: Assign a violation to the place feature of a stop that is immediately preceded by a heterorganic stop. (Short form: *C[xPl] C[yPl].)

(4) MAX-IO[Place]: Assign a violation for every place feature in the input that does not have a correspondent in the output. (Short form: MAX[Pl].)

I assume that place assimilation among adjacent consonants is achieved by feature spreading. Assimilation to C2 rather than C1 is attributed to a version of MAX-IO[Place]

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[2] A kind of gradient feature activity related to a scale is also proposed by Sande & Oakley (2020). In their proposal, the feature [sonorant] has different activity values depending on the type of segment in which it occurs, with higher levels of activity associated with [sonorant] in segments that are higher on the sonority scale. In that proposal a single feature has different activity values, rather than activity being scaled over a class of features as proposed here.

specific to released positions (Padgett 1995). For reasons of focus, this constraint will not be shown in tableaux and only candidates that obey it are considered.

Place feature activity defines the scale over which a scaling factor operates in constraints for which place features are the locus of violation. The computation using a scaling factor has been argued to be necessary based on other place assimilation patterns (Walker 2019). The scaling factor makes an additive contribution to the penalty assigned for a violation (e.g. Coetzee & Kawahara 2013, Gouskova & Linzen 2015, Hsu & Jesney 2016, 2018, Hsu 2019). For each instance of a violation of a constraint for which a place feature is the locus of violation, the penalty P is calculated according to the equation in (5), where w is the basic constraint weight, α is the activity of the place feature and s is the scaling factor; $w, s \geq 0$ and $0 \leq \alpha \leq 1$.

(5) $P = w + (s * \alpha)$

The values for w and s are specified for each constraint. Place assimilation is derived in the appropriate clusters for Korean with weights and scaling factors specified as *C[xPl] C[yPl]: $w = 2$, $s = 20$ and MAX[Pl]: $w = 1$, $s = 20$. These values were derived by hand for the Korean pattern.
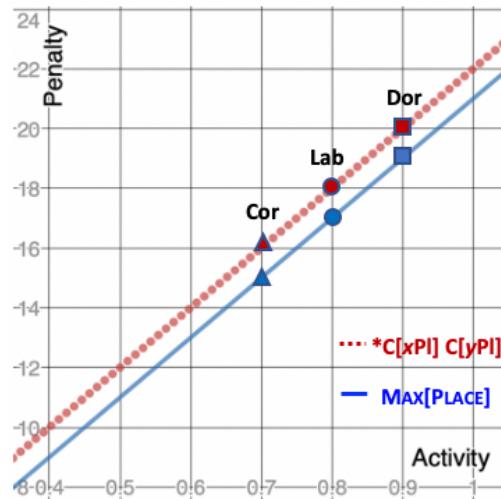

Figure 1. Penalties with scalar place feature activity, [Dor].9 (square) [Lab].8 (circle) [Cor].7 (triangle), *C[xPl] C[yPl] (w = 2, s = 20, red) and MAX[Pl] (w = 1, s = 20, blue).

Figure 1 illustrates the penalty assigned for a single violation of each constraint for place features with different degrees of activity. The scaling factor s determines the slope of each line. Though w and s are constraint specific, the value for s is the same for both constraints here, so the lines are parallel, remaining in a consistent relationship over equal increments in α. The weight w for *C[xPl] C[yPl] is greater than that of MAX[Pl]. Therefore, *C[xPl] C[yPl] is enforced at the cost of MAX[Pl] when the activity of the place feature in the trigger is greater than or equal to that of the target. For example, the penalty assigned for *C[xPl] C[yPl] for [Dorsal] (red square) is greater than the penalty assigned for MAX[Pl] for [Labial] (blue circle). However, the structure of the activity-based scaling and penalty assignment causes assimilation to be blocked by targets that have a place

feature with higher activity than the trigger, due to the penalty for MAX[Pl] exceeding that of *C[xPl] C[yPl]. For instance, the penalty assigned for MAX[Pl] for [Dorsal] (blue square) is greater than the penalty for a violation of *C[xPl] C[yPl] for [Labial] (red circle).[3]

3.3   Tableaux

I will demonstrate the workings of the analysis with tableaux for inputs with heterorganic clusters. The inputs and output candidates presented in tableaux consist of schematic stop clusters, focusing on the place of the stops and their activity value. The clusters are assumed to be intervocalic, but the flanking context is not shown. The stops are schematically represented as voiceless, abstracting away from laryngeal properties and release.

Tableaux are augmented with some annotations. For inputs, it is notated whether the activity of C1 or C2 is greater. This pointer is provided because place assimilation is blocked when the activity of a potential trigger is less than that of the target. For each input, two labeled output candidates are considered: the candidate with place assimilation and the faithful candidate without assimilation. In cells where a constraint violation is recorded, the calculation of the penalty accrued is provided on the second line.

Tableaux for clusters containing a labial stop in the input are presented first. Recall that dorsals and coronals show different behavior as targets and triggers in clusters with labials. The tableaux in (6i-ii) show the evaluation of inputs with a labial stop in C2 position, where the labial is a potential trigger. The activity of the place feature for each stop is subscripted. As discussed in §3.1, the activity of place features in the input is given as a phonological primitive, and it is not subject to change by GEN. In these tableaux, the output candidates with place-assimilated clusters are assumed to share a single place feature that is linked across both consonants, as in the assimilated cluster in (6ia) represented as [pp$_{.8}$].

The input in (6i) has a coronal followed by a labial, where the activity of the place feature in C1 is less than that in C2. In this case, the faithful output candidate earns a greater penalty than the assimilated output. The faithful output in (6ib) violates *C[xPl] C[yPl]. The locus of violation for this constraint is place in C2 ([Labial]), which has an activity of .8. The score for this violation is calculated as -1 (for the single violation, a negative value by convention) times the total of the basic constraint weight (w) of 2 added to the product of the scaling factor (s) of 20 and the place feature activity of .8, yielding -18, which is the total harmony score for this candidate. The assimilated output in (6ia) violates MAX[Pl], which has a locus of violation in C1 for the deleted [Coronal] feature, with an activity of .7. The score for this violation is calculated as -1 times the total of the basic constraint weight of 1 added to the product of the scaling factor of 20 and the activity of .7, amounting to -15. With a greater harmony score, the assimilation candidate is selected.

The input in (6ii), with a dorsal followed by a labial, has the opposite relation between C1 and C2 for magnitude of place feature activity, with greater activity in C1. The faithful output in (6iib) [k$_{.9}$p$_{.8}$] earns the same score of -18 as that for (6ia) [t$_{.7}$p$_{.8}$], because the locus

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[3] If the penalty were instead calculated as $w * \alpha$, the lines representing the penalty incurred for a violation of each constraint would differ in slope for constraints with different weights. The magnitude of difference in penalty between constraints would then differ over steps of equal magnitude on the activity scale rather than remaining consistent as in Fig. 1. I assume the consistent relationship is appropriate for Korean, unless evidence to the contrary should emerge.

of violation in both is [Labial]. However, the penalty earned by the assimilation candidate in (6iia) for violation of MAX[Pl] is greater for the target /k.9/ than for target /t.7/ in (6ia), due to the higher activity of the deleted place feature. In this case, the assimilation candidate, with a harmony score of -19, loses to the higher scoring faithful candidate.

(6) *Heterorganic inputs with a labial stop in C2 position*

Input	Output	*C[xPl] C[yPl] w = 2, s =20	MAX[Pl] w = 1, s =20	H
i. /t.7p.8/ α(C1) < α(C2)	a. → [pp.8] *assimilation*		-1 (-1(1 + 20 * .7))	-15
	b. [t.7p.8] *faithful*	-1 (-1(2 + 20 * .8))		-18
ii. /k.9p.8/ α(C1) > α(C2)	a. [pp.8] *assimilation*		-1 (-1(1 + 20 * .9))	-19
	b. → [k.9p.8] *faithful*	-1 (-1(2 + 20 * .8))		-18

The evaluation of inputs with a labial in C2 position shows that place assimilation occurs when the activity of the trigger is greater than that of the target, but is blocked when the activity relation is reversed. The same scenario is illustrated by tableaux for candidates with a labial stop in C1 position. In (7i), the input contains a labial stop followed by a coronal. In this case, the faithful candidate is optimal, because the locus of violation for *C[xPl] C[yPl] is [Coronal], with activity of just .7 (H = -16), while the locus of violation for MAX[Pl] in the assimilation candidate is [Labial], with activity of .8 (H = -17).

In (7ii) the input contains a labial followed by a dorsal. The assimilation candidate here has the same harmony score as that in (7i), because both involve deletion of [Labial]. The faithful candidate, however, earns a higher penalty with respect to *C[xPl] C[yPl], because the locus of violation is [Dorsal], with activity of .9 (H = -20). Assimilation is thus optimal for this cluster.

(7) *Heterorganic inputs with a labial stop in C1 position*

Input	Output	*C[xPl] C[yPl] w = 2, s =20	MAX[Pl] w = 1, s =20	H
i. /p.8t.7/ α(C1) > α(C2)	a. [tt.7] *assimilation*		-1 (-1(1 + 20 * .8))	-17
	b. → [p.8t.7] *faithful*	-1 (-1(2 + 20 * .7))		-16
ii. /p.8k.9/ α(C1) < α(C2)	a. → [kk.9] *assimilation*		-1 (-1(1 + 20 * .8))	-17
	b. [p.8k.9] *faithful*	-1 (-1(2 + 20 * .9))		-20

For completeness, tableaux for input clusters containing a dorsal stop and a coronal are provided in (8). In the input in (8i), the dorsal precedes the coronal. In this case the activity

of C1 is greater than C2 with the result that assimilation is blocked, and the faithful candidate (8ib) is optimal. In (8ii), the positions of the dorsal and coronal are reserved with the effect that assimilation becomes optimal (8iia).

(8) *Heterorganic inputs with a dorsal and coronal stop*

Input	Output	*C[xPl] C[yPl]$w = 2, s = 20$	Max[Pl]$w = 1, s = 20$	H
i. /k.9t.7/ α(C1) > α(C2)	a. [tt.7]*assimilation*		-1(-1(1 + 20 * .9))	-19
	b. → [k.9t.7]*faithful*	-1(-1(2 + 20 * .7))		-16
ii. /t.7k.9/ α(C1) < α(C2)	a. → [kk.9]*assimilation*		-1(-1(1 + 20 * .7))	-15
	b. [t.7k.9]*faithful*	-1(-1(2 + 20 * .9))		-20

In summary, a key proposal of this account is that place features are represented with scalar degrees of activity in the relationship $\alpha_{[\text{Dorsal}]} > \alpha_{[\text{Labial}]} > \alpha_{[\text{Coronal}]}$. Intrinsic to this approach is the potential for features with greater activity to incur a greater violation of both markedness and faithfulness constraints. This is cashed out in Korean place assimilation where place features with higher activity show greater strength as triggers, which is a markedness-driven effect, and greater resistance as targets, which is faithfulness driven. Within the grammar proposed for Korean, place assimilation occurs only when the activity of the trigger is greater than or equal to that of the target. The different strength patterns of place features in this system derives from their representation; the relevant markedness and faithfulness constraints are general to the class of Place.

4.   Extensions

Scalar feature activity has applications beyond Korean place assimilation. First, with respect to place assimilation in other languages, scalar activity of place features has been applied to patterns that are sensitive to whether a potential target is coronal (Walker 2019). De Lacy's typological study identified both a markedness-based pattern, in which coronals are exempted as targets of place assimilation (Sri Lankan Portuguese Creole), and a faithfulness-based pattern, in which coronals alone are targets (Catalan). In the scalar feature activity approach these systems are handled with higher-activity place features [Dorsal] and [Labial] incurring a greater violation of the relevant markedness or faithfulness constraint, placing their violation above the cusp of a competing constraint and differentiating them from [Coronal], with lower activity.[4]

There are other promising areas for extending the application of scalar activity for place features. In Korean, it may be applicable to an OCP effect for the class of Place that operates over the lexicon. Ito (2007) examined the place of consonants in Korean

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[4] As noted by de Lacy (2006: 190), a "marked-undergoer" pattern as in Sri Lankan Portuguese Creole was not included in the survey of place assimilation discussed by Jun (1995). Such patterns are not predicted in the cue-based approach to targets of place assimilation (Jun 1995, 2004).

monosyllabic stems with a simplex coda and onset (n =1346). Ito's analysis of observed and expected values revealed a statistically significant cooccurrence restriction over onset and coda consonants with the same place of articulation. Observed/Expected (O/E) values calculated by Ito are given in (9), where O/E < 1 indicates underrepresentation. The values in square brackets are adjusted values calculated by Ito using upper confidence limit statistics. Ito separated the analysis of coronal consonants into obstruents {t, t^h, t', c, c^h, c', s, s'} and sonorants {l, n}. The labial and dorsal categories consist of oral and nasal stops.

(9) *Observed, Expected, and O/E values for homorganic onset and coda in Korean*

Labial	Cor Obs	Cor Son	Dorsal
34/52.0	49/69.1	22/17.7	15/31.4
(0.65 [0.74])	(0.71 [0.78])	(1.25)	(0.48 [0.60])

Pairs of homorganic consonants were found to be underrepresented for dorsals, labials, and coronal obstruents but not coronal sonorants. [5] Heterorganic pairs were not under-represented (with one exception plausibly interpreted as an accidental gap). The underrepresented pairs point to the operation of OCP[Place] in the grammar. The magnitude of the O/E values are scaled across place of articulation as Dorsal < Labial < Coronal. The ordering is consistent with the place markedness scale such that higher markedness correlates with greater underrepresentation. While the calculated values were based on particular subcategorizations for coronals, they are suggestive of stronger restrictions on homorganic pairs of place features with greater activity, which would incur a greater violation of OCP[Place]. This is a possible direction for further development.

In a related vein, it could be fruitful to examine extensions of scalar feature activity to variability and gradience in place assimilation. An articulatory study of Korean by Kochetov and Pouplier (2008) found that the rate of assimilation was sensitive to various factors such as speech rate, context, word boundaries, and speaker. Further, while the majority of place assimilation was found to be categorical in nature, some sporadic gradient reduction occurred (see also Jun 1995, 2004). In future work it would be valuable to examine whether scalar place feature activity could provide insight on variable and gradient characteristics that are sensitive to place in the realization of Korean stop clusters. The approach to gradient speech errors discussed by Goldrick & Chu (2014) provides framing ideas that could be applied in investigating an extension to gradient reduction.

Using activity to represent scales opens possibilities for the analysis of other scales in phonology. For activity that is represented in both the input and the output, scalar effects are predicted with respect to both markedness and faithfulness. Patterns of loanword adaptation may be amenable to such a treatment. Studies by Hsu & Jesney (2017, 2018) proposed a scale over nativization of loanwords progressing from the core (native words) to the periphery (least nativized words). They discuss two relevant types of patterns. In superset-at-periphery patterns, less nativized loanwords display a greater range of marked structures than native words (e.g. Guaraní), while in subset-at-periphery patterns, less nativized loanwords show a smaller range of marked structures than native words (e.g.

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[5] Monosyllabic stems with a coronal obstruent onset and a coronal sonorant coda were also underrepresented (0.91 [0.95]), but not in the reverse order with an sonorant onset and obstruent coda.

Hungarian). These patterns differ in whether loanwords at greater distance from the core show greater faithfulness or a greater markedness effect.

Hsu & Jesney (2018) propose an account in which the penalty for a constraint violation is calculated using a scaling factor operating on distance from the core added to the basic constraint weight for a violation. This scaling factor structure is like that used in the analysis proposed here for Korean place assimilation. Scalar activity could be applied in this approach by scaling the activity over loanwords relative to distance from the core: $\alpha_{Periphery} > \alpha_{Intermediate} > \alpha_{Core}$. Due to higher activity, elements closer to the periphery would have the potential to show stricter enforcement of faithfulness, as in superset-at-periphery patterns, or stricter enforcement of markedness, as in subset-at-periphery patterns. The analysis would remain intact except that the scale in question, i.e. distance from the core, would be accounted for in terms of gradient activity in the representation. More generally, scalar activity could constitute the basis for the scales over which scaling factors operate.

5.   An alternative

An alternative analysis of hierarchical effects in Korean place assimilation employs families of markedness and faithfulness constraints specified for subsets of values for place (de Lacy 2002, 2006). The analysis is framed in the approach referred to as CoMP (de Lacy 2006: 335).

This approach involves two key proposals: one involving the structure of feature values and the other involving restrictions on constraint form. First, the place of articulation hierarchy is formalized as a multi-valued feature [Place]. Using a grid theory for feature values, the hierarchy is expressed as [*xxx*Place] (dorsal) > [*xxo*Place] (labial) > [*xoo*Place] (coronal), where markedness is proportional to *x* content. [6] Second, schemata for markedness and faithfulness constraints referring to multi-valued features regulate the relation between the assignment of violations and substrings of *x*'s in the feature value. In practice, the proposed schemata give rise to sets of constraints like those in (10), where constraints in a family are in a subset relation with respect to their assignment of violation marks, and each markedness constraint is mirrored by a corresponding faithfulness constraint.

(10) a. Place markedness constraints   b. Place faithfulness constraints
      *{Dor, Lab, Cor}   IDENT-IO{Dor, Lab, Cor}
      *{Dor, Lab}   IDENT-IO{Dor, Lab}
      *{Dor}   IDENT-IO{Dor}

In the CoMP approach, place assimilation is derived by anti-heterorganic constraints over consonant sequences restricted by hierarchically derived subsets of place features. These constraints take the form *XY, defined in (11) (de Lacy 2006: 183).

(11)   *XY: Assign a violation for every pair of adjacent segments such that the first segment has a feature f_1 from set X and the second segment has a feature f_2 from set Y and $f_1 \neq f_2$.

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[6] De Lacy assumes a fourth step to the place feature scale: [*ooo*Place], corresponding to glottal.

For example, *{Dor, Lab}{Dor, Lab, Cor} prohibits a dorsal or labial segment that is followed by a heterorganic segment that is dorsal, labial or coronal.

The CoMP account of Korean place assimilation employs the constraint ranking in (12) (de Lacy 2002: 352). A constraint that prohibits any heterorganic cluster is ranked in the third tier between IDENT-IO{Dor, Lab} and IDENT-IO{Dor, Lab, Cor} to drive assimilation in coronals by labials and dorsals. IDENT-IO{Dor, Lab} prevents dorsals and labials from undergoing assimilation except that the top-ranked constraint, which prohibits heterorganic clusters with a dorsal in C2 position, enforces assimilation in labial-dorsal clusters.

(12) *Hasse diagram: CoMP Korean assimilation ranking*

*{Dor, Lab, Cor}{Dor}
|
IDENT-IO{Dor, Lab}
|
*{Dor, Lab, Cor}{Dor, Lab, Cor}, *{Dor, Lab, Cor}{Dor, Lab}
|
IDENT-IO{Dor, Lab, Cor}
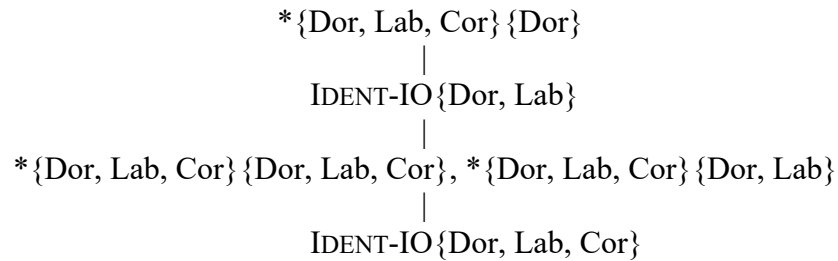
The CoMP approach relies both on multi-valued features and restrictions on the form of constraints that operate over those features. The scalar feature activity approach to Korean place assimilation instead utilizes the general mechanisms of constraint weighting and scaling factors in Harmonic Grammar so that the place hierarchy is limited to the representation of features alone. It eliminates the need for subset-based constraint families, as in (10), reducing the size of CON. In addition, the role of the place feature scale in both markedness and faithfulness constraints is intrinsic to the architecture of the activity-based account.[7] Scalar activity is systematically integrated into the assignment of penalties for constraints via scaling factors. This avoids the necessity to dictate schemata governing the relationship between multi-valued features and constraint form. An area in which to evaluate the CoMP and scalar feature activity approaches in the future is to examine their typological predictions regarding markedness conflation (de Lacy 2006), or lack thereof, and compare against attested patterns.

Finally, as discussed in section 4, scalar activity has explanatory potential beyond feature hierarchies, such as representing other scales in phonology and the possible extension to gradient and variable phenomena. Further development of these applications would strengthen the evidence for the scalar activity approach.

6.   Conclusion

In conclusion, in this paper I have proposed that gradient activity in the representation of place features captures hierarchical effects in place assimilation. Specifically, in Korean, segments that have a place feature with a greater degree of activity are more likely to be

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[7] See Faust (2017, 2019) and Zimmermann (2018, 2019) for related observations about the mutual relevance of markedness and faithfulness to degree of activity in representations.

triggers of assimilation (a markedness effect) and less likely to be targets (a faithfulness effect). This approach predicts hierarchical phenomena for both markedness and/or faithfulness, as seen in Korean place assimilation and other patterns involving the place hierarchy. The implementation of gradient activity in the account obviates subset-based families of markedness and faithfulness constraints for place, simplifying the inventory of constraints in CON. In the bigger picture, activity scales provide a mechanism for a representational treatment of scalar strength in phonology, which is a valuable direction for research going forward.

It is noteworthy that the capacity of this approach to represent degrees of distance on a scale offers a potential advantage over simple fixed hierarchical orderings. Flemming (2020) has identified unwanted predictions deriving from a standard approach to formalizing implicational universals using fixed constraint rankings that emerge when different constraint hierarchies are interleaved. He argues that both ordering and relative spacing are needed to resolve the problem, which he formalizes using constraint scales. In the present proposal, both of these components – ordering and spacing – are incorporated for scales encoded in representations. As underscored above, the representational approach predicts that a scale is relevant for both markedness and faithfulness constraints that operate over the elements in question. Other points of comparison between constraint hierarchies and scalar representations can be probed in future study, especially in relation to how implicational universals play out.

In another vein, a question to consider in future work is where the values for place feature activity come from. Some possible origins for the lesser activity of [Coronal] are discussed in Walker (2019), connected to articulation and learning simulations wth transmission noise. The lesser markedness of [Coronal] relative to [Dorsal] and [Labial] has been especially well supported in a wide range of work (see de Lacy 2006 for a review). It is conceivable that the difference in activity of place features is not evenly spaced over steps on the scale so that there could be a greater gap in the degree of activity between [Coronal] and [Labial] than [Labial] and [Dorsal]. In fact, the opposite markedness ordering for [Dorsal] and [Labial] was proposed by Coetzee (2004) for English. It remains an open question whether the place markedness hierarchy ever varies across languages, and if so, why. If there is indeed cross-language variation in place markedness, language-specific effects on learning might play a role in shaping the representations.

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Rachel Walker
rwalker@usc.edu