Integrating Preconditions on Parasitic Vowel Harmony

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1 Introduction

Parasitic vowel harmony (PVH; Steriade, 1981; Cole, 1987; Cole & Trigo, 1989; Mester, 1988; van der Hulst, 1988; Hong, 1994; Kaun, 1995; van der Hulst & van de Weijer, 2001; etc.) occurs when agreement on a *harmonic* feature is conditioned on agreement on some other *parasitic* feature. In the Yawelmani example below in (1), rounding agreement is only required if vowels already match in height (shaded cells).

(1) *Yawelmani rounding vowel harmony* (from Cole & Kisseberth, 1997):

Triggers(↓) \ Targets(→)		High	Non-high
		[hin]/[hun]	[al]/[ol]
High	/xil/ ‘tangles’	x**i**l-h**i**n	x**i**l-**a**l
	/dub/ ‘lead by the hand’	d**u**b-h**u**n	d**u**b-**a**l
Non-High	/xat/ ‘eat’	x**a**t-h**i**n	x**a**t-**a**l
	/bok/ ‘find’	b**o**k-h**i**n	b**o**k-**o**l

The existence of PVH suggests that the phonological system is sensitive to the similarity of representations, since the tendency for harmony is related to the similarity of triggers and targets. In (1) above, height similar [u],[i] interact ([dub-h**u**n],*[dub-h**i**n]) but height dissimilar [u],[a] do not ([d**u**b-**a**l],*[d**u**b-**o**l]). Thus, PVH exists where feature similarity acts as a *precondition*, determining the trigger-target pairs which result in harmony.

Now, the prospects for a similarity-based analysis of parasitic vowel harmony are hinted at by Rose & Walker (2004), Frisch, *et*. *al*. (2004), Burzio (2005), and Hansson (2007), but none provide a formal account. This paper aims to understand the nature of similarity preconditions and to provide a formal account thereof. The goals for this paper are to demonstrate the following:

1) The typical similarity preconditions of PVH may be implemented in Optimality Theory (Prince & Smolensky, 2004) using the proposed family of ATTRACTION constraints.
2) Phonetic similarity can play a direct role in determining parasitic and harmonic features.
3) Locality acts as another kind of similarity dependency, serving as a precondition to vowel harmony.

2 Generalizations for PVH

My survey (Wayment, 2009) suggests that sensitivity to phonological similarity is cross-linguistically robust: there are a number of parasitic systems for a range of harmonic features. Rounding and ATR harmony exhibit the strongest tendencies toward parasitism. However, I found no cases of *anti-parasitic harmony*, where harmony only occurs if trigger and target disagree on other features, like anti-Yawelmani, in (2) below.

(2) **Anti-Yawelmani rounding vowel harmony (unattested):*

Triggers(↓) \ Targets(→)		High	Non-high
		[hin]/[hun]	[al]/[ol]
High	/xil/ ‘tangles’	xil-hin	xil-al
	/dub/ ‘lead by the hand’	dub-hin	dub-**o**l
Non-High	/xat/ ‘eat’	xat-hin	xat-al
	/bok/ ‘find’	bok-h**u**n	bok-al

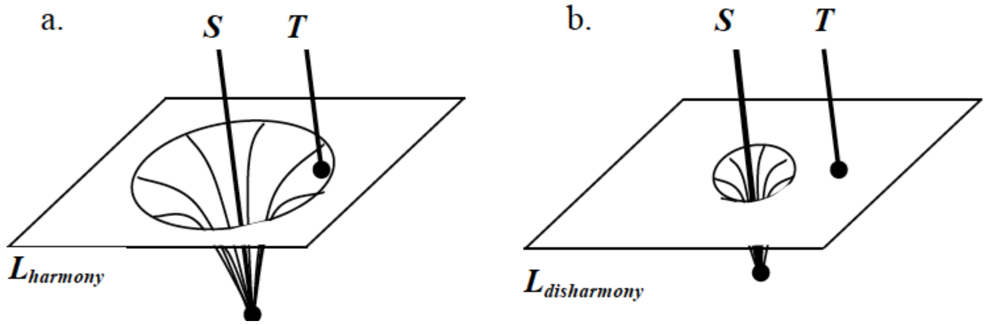
Of course, there are non-parasitic systems which allow triggers and targets to interact when the prerequisite similarity between them is very low. Most of these, however, at least require [consonantal] agreement. Also, asymmetric harmony systems, where certain feature values privilege triggers or targets, are *not* anti-parasitic. For example, it is not uncommon for only high or only non-high vowels to trigger rounding harmony (Kaun, 1995; Walker, 2001), but, as in (2), for anti-parasitism both high and non-high vowels trigger and undergo harmony, yet the trigger-target precondition is based on dissimilarity.

Another role for similarity in PVH is the overwhelming tendency for *parasitic features to be phonetically similar to harmonic features*. For example, the height/rounding interaction typified by Yawelmani has a basis in both acoustics and articulation (Hong, 1994; Kaun, 1995). Height (especially among front vowels) and rounding affect the spectral peak of the second formant (F2). Furthermore, the tongue raising associated with high vowels and the lip protrusion associated with round vowels are each facilitated by a closed jaw position.

3 Defining attraction in Optimality Theory

These multiple aspects of similarity can be explained by analyzing assimilation as a case of *attraction* (Burzio, 2002a,b, 2005a,b; Burzio & Tantalou, 2007; Wayment et. al 2007; Wayment, 2009). With analogy to conventional attraction systems such as household magnets, in an attraction model of assimilation, triggers are seen as sources of attraction and targets are seen as being subject to these attractive forces. Attractive forces have the crucial property of being related to *distance*, the closer a target is to a trigger in a representational space, the greater the pressure to assimilate, as indicated below, in (3):

(3) ***Attraction Landscapes**. In $L_{harmony}$, on the left (a), the trigger, **S**, attracts, a target, **T**. This contrasts with $L_{disharmony}$ on the right (b), where **S** does not attract **T.** In this illustration, **S** is a stronger attractor in $L_{harmony}$.*



Thus, attraction derives how similarity acts as a precondition on assimilation: only targets which are close enough to triggers are attracted, and attracted targets assimilate as they move closer to triggers.

Burzio (2002, et seq.) has shown how attraction can be formally implemented by considering the logical entailments among components of representations. This heritage assures a natural, computational implementation of an attraction model in Harmonic Grammar and in a Hopfield connectionist network (Wayment, et. al. 2007). It is beyond the scope of this paper to pursue these formal foundations, but it is important to note that attraction is significantly more computationally motivated than other approaches to assimilation.

I now sketch some of the other motivations for attraction constraints. For phenomena unrelated to PVH, Bakovic (2007) has proposed a STR/PL constraint and Reiss (2009) has proposed a VOI/NAS constraint, respectively in (4) and (5), which implement feature dependency as an Optimality Theory constraint.

(4) STR/PL (Bakovic, 2007):
"Adjacent output segments that have the same place feature value must also have the same value of the stricture feature [±cont]."

(5) VOI/NAS (Reiss, 2009):
"Adjacent [output] segments which agree in voicing must agree in nasality."

Such constraints may be separated into three parts:

	STR/PL	VOI/NAS
1. Locality precondition	Adjacent output segments	Adjacent output segments
2. Similarity precondition	Place	Voicing
3. Harmonic feature	Stricture features	Nasality

With the backdrop of attraction, STR/PL and VOI/NAS can be viewed as specific instances of attraction which create agreement dependencies between harmonic features and parasitic features. Following the above template, I propose a more general family of ATTRACTION constraints as defined below in (6):

(6) ATTRACT(**R**, **P**→*q*)

Let **R** be a correspondence relation between segments in a surface form, α.
P = {p_1, …, p_k} is a set of parasitic features, and *q* is a harmonic feature.

Let *x*, *y* be segments in α.

IF	(i)	*x***R***y*,
	(ii)	$\forall p_i \in \mathbf{P}$, *x* agrees with *y* on p_i,
THEN	(iii)	*x* and *y* must agree on feature *q*.

ATTRACTION constraints are segment-to-segment faithfulness constraints, which are ranked so that more similar segments violate higher ranked ATTRACTION constraints. Similarity may be universally defined in terms of subsets: if *x*, *y* agree on all the features of *x* and *z*, and additionally *x* and *y* agree on other features, then *sim*(*x*, *y*) >*sim*(*x*, *z*).[1] Therefore, ranking by subset similarity requires ATTRACT(**R**, **P**→*q*) $>>_{UG}$ATTRACT(**R**, **P**´→*q*), if **P** ⊃**P**´. For instance, ATT({[cons],[hi]}→[lab.]) $>>_{UG}$ ATT({[cons]}→[lab.]) $>>_{UG}$ ATT({}→[lab.]).[2]

These similarity rankings order ATTRACTION constraints in a specific to general fashion, preserving the weakening of attractive forces with distance. PVH represents the rankings where only the more stringent preconditions apply, so as shown in (8) below, the appropriate ranking of IO-FAITH ensures that harmony only obtains when the higher similarity preconditions are met.

Note, however, that ATTRACT does not stipulate that *x* and *y* be in correspondence, such correspondence must be explicitly posited by a separate family of correspondence constraints, as in (7):

(7) **CORR(*l*)**:

Let *x*, *y* be segments in surface form α.

IF	*x*, *y* satisfy locality precondition *l*
THEN	*x***R***y*.

Determining and controlling for locality preconditions is an important component of the analysis to come, but, in (8) below, $\text{CORR}_{L\rightarrow R}$ requires that if *x* linearly precedes *y* in a surface form, then *x* is related to *y*. Therefore, in addition to the

[1] Subset similarity is preserved by the commonly used Frisch similarity metric (Frisch, et. al, 2004): # of shared natural classes / (# of shared classes + # of non-shared classes).

[2] There are a number of different proposals for the feature corresponding to vowel height (Clements & Hume, 1995; Harrison, 2001). Using [hi], instead of an *aperture* node or [open] is not critical to the behavior of ATTRACTION.

relationships above, ATTRACTION constraints are also a variation on the framework posited by Rose & Walker (2004) and Hansson (2001) for Agreement by Correspondence (ABC).

This formal machinery of CORRESPONDENCE and ATTRACTION constraints yields a straightforward analysis of parasitic interaction, as in (8) below:

(8) *Attraction analysis of Yawelmani PVH*:

	CORR$_{L\to R}$	ATTRACT ({[cons],[hi]}→ [labial])	IDENT-IO ([labial])	ATTRACT ({[cons]}→ [labial])	ATTRACT ({}→ [labial])
a. d**u**b-h**i**n		*!		*	*
☞b. d**u**b-h**u**n			*		
☞c. d**u**b-**a**l				*	*
d. d**u**b-**o**l			*!		
☞e. b**o**k-h**i**n				*	*
f. b**o**k-h**u**n			*!		
g. b**o**k-**a**l		*!		*	*
☞h. b**o**k-**o**l			*		

(8) shows how the higher ranked ATTRACT constraint is only active when there is increased similarity (agreement on height) between trigger and target (8a-b,g-h). However, absent that feature similarity (8c-d, e-f) faithfulness blocks assimilation.

4 Case Study: True transparency in Finnish palatal vowel harmony

Correspondence-based assimilation has been primarily used for long-distance consonant harmony (Rose & Walker, 2004; Hansson, 2001), although see (Rhodes, 2009; Walker, 2009), so an immediate question is whether there are reliable instances of long-distance interaction in vowel harmony. In this section, I argue that Finnish palatal vowel harmony (Ringen & Heinamäki, 1999; Valimaa-Blum, 1999; Kim, 2005; Kiparsky & Pajusalu, 2003) is best analyzed as an instance of long-distance vowel agreement. In particular, I argue that Finnish palatal vowel harmony is (*i*) an instance of parasitic vowel harmony and (*ii*) a case of true transparency, requiring non local-application of attraction pressures.

4.1 Arguments for [lower F2]-parasitic palatal harmony

The basic facts of Finnish palatal harmony are in (9) and (10) below.

(9) *Finnish vowel inventory. Unpaired (neutral) vowels are shaded*:

	Front		Back	
	Unround	Round	Unround	Round
High	i [i]	ü [y]		u [u]
Mid	e [e]	ö [ø]		o [o]
Low	ä [æ]		a [ɑ]	

(10) *Finnish palatal vowel harmony*:

<u>*Fully harmonic roots*</u>			<u>*Roots with only neutral vowels*</u>		
a.	pöüdä-ll**ä**	'table, adessive'	e.	peili-ss**ä**	'in the mirror'
b.	pouda-ll**a**	'clear weather, adessive'	f.	sii-n**ä**	'it, essive'
<u>*Roots with neutral and front vowels*</u>			<u>*Roots with neutral and back vowels*</u>		
c.	isä-ll**ä**	'father, adessive'	g.	kesto-**a**	'of duration'
d.	säde-tt**ä**	'ray, partitive'	h.	sade-tt**a**	'rain, partitive'
e.	tädi-ll**ä**	'aunt, adessive'	i.	Kati-ll**a**	**'**(woman's name), adessive'

The relevant generalizations from the data in (10) are as follows:

1) *i* and *e* are neutral, neither triggers nor targets of root harmony, (10c-e,g-i).
2) stems only containing *i* and *e* trigger front agreement in suffixes, (10e-f).
3) *i* and *e* are transparent to affix harmony, suffixes agree with whatever non-*i*/*e* vowel happens to be in the root, (10c-e, g-i).

This section advances the view that the transparency of *i* and *e* is due to parasitic interaction. However, there is an initial dilemma for a PVH analysis: the set of participating vowels (*u~ü*, *o~ö*, and *a~ä*) does not form a natural class, being a disjoint set across features [low] and [round], so Finnish palatal harmony is not parasitic on any single feature or any combination thereof. The proposed solution is to argue based on phonetic studies by (Wiik, 1965; Kim, 2005) that Finnish back harmony is parasitic on an acoustic correlate common to the harmonic vowels, which may be characterized with an acoustic feature [lower F2]. The ramification of this proposal is that Finnish palatal harmony is directly parasitic on the phonetic correlates of vowel features.

Because of the lengthening of the front cavity, the acoustic correlate of backness is also a lowering of the spectral peak of the second formant (F2) (Stevens, Keyser, & Kawasaki, 1985). As discussed above in Section 2, vowel height also has an effect on F2. Therefore, it is appropriate to examine the F2 values of Finnish vowels, as in (11) below:

(11) *Average F2 values of long-vowels produced by male Finnish speakers; data from (Wiik, 1965). Vowels are ordered by descending F2*:

	Vowel	F2 (Hz)
Transparent vowels	i	2495
	e	2240
participation boundary		
Harmonizing vowels	ü	1995
	ä	1840
	ö	1805
	a	1240
	o	905
	u	605

Note that the F2-difference between high and low vowels is greater than the F2-difference due to rounding among front, high vowels (ΔF2(i − ä) = 655 Hz. vs. ΔF2(i − ü) = 500 Hz.). Because front, low vowels (*ä*), inhabit a F2 region containing other harmonizing vowels, (*i*) *ä* is acoustically similar to round, non-low vowels (*ü* and *ö*), and (*ii*) this acoustic similarity causes *ä* to behave like *ü* and *ö* with respect to palatal harmony.

Evidently, an acoustic feature, which may be termed [lower F2],[3] more aptly characterizes the Finnish vowel inventory for the purposes of harmony as indicated in (12).

(12) *Revised vowel space for Finnish palatal harmony. Neutral categories are shaded.*

	[− lower F2]	[+ lower F2]	
	Front	Front	Back
High	i [i]	ü [y]	u [u]
Mid	e [e]	ö [ø]	o [o]
Low		ä [æ]	a [ɑ]

In this space, Finnish palatal harmony receives a straightforward explanation as PVH: attraction demands that vowels which agree on [lower F2] must also agree in backness, i.e. ATTRACT({[cons],[lower F2]}→[back]) >>IDENT-IO([back]).

This PVH analysis of Finnish palatal harmony predicts both neutrality, (13), and transparency, (14), of *i*, *e*.

[3] [lower F2] may also be referred to as [color], but usually this refers to an F2 contrast due to backing and rounding (see Odden, 1991), unlike in Finnish, where some of the F2 differences are also due to height.

(13) *Neutrality*: The failure of *i* and *e* to be targets of palatal harmony, as in (10g), [kesto-**a**]:

/kesto-A/	CORR$_{L\rightarrow R}$	ATTRACT ({[cons],[color]}→ [back])	IDENT-IO([back])
☞a. kesto-**a**			*(a)
b. kesto-**ä**		*!(o→ä)	*(ä)
c. kestö-**a**		*!(ö→a)	*(ö), *(a)
d. kestö-**ä**			*!(ö), *(ä)

(14) *Transparency*: The failure of *i* and *e* to block the harmony of subsequent targets to previous triggers, as in (10h) [sade-tt**a**]:

/sade-ttA/	CORR$_{L\rightarrow R}$	ATTRACT ({[cons],[color]}→ [back])	IDENT-IO([back])
☞a. sade-tt**a**			*(a)
b. sade-tt**ä**		*!(a→ä)	*(ä)
c. sadö-tt**a**			*!(ö), *(a)
d. sadö-tt**ä**		*!(a→ä)	*(ö), *(ä)

Neutrality follows from a failure of *i* and *e* to satisfy the precondition of [lower F2] agreement when in the context of root-initial *u*, *o*, or *a*. Transparency follows from a failure of subsequent *u*, *o*, or *a* to agree with preceding *i* and *e* on [lower F2]. As an important contrast to other approaches for transparency, note that standard inventory markedness constraints which rule out [ɨ] and [õ] (back /i/ and back /e/ respectively), only predict the neutrality of *i* and *e*, but inventory markedness has no way of evaluating what should happen once vowels do not participate, i.e. whether or not they are triggers (blocking) or non-triggers (transparency).

In sum, in PVH, neutral vowels are not triggers of harmony by virtue of the same failure to meet similarity preconditions that prevents them from being targets of harmony. In this regard, Finnish palatal harmony is on par with LDCA phenomena (Hansson, 2001; Rose & Walker, 2004) in which any number of intervening consonants and vowels may be neutral and transparent to harmony. The next section argues that such a non-local correspondence is the right way to view transparency in Finnish.

4.2 Arguments for true transparency

In order to satisfy the locality conditions necessary for blocking, other influential proposals have suggested that transparent segments are covert undergoers (Gafos, 1996; Ní Chiosáin & Padgett, 2001; Walker & Mpiranya, 2005). Targeted Constraints (Bakovic & Wilson, 2000), sympathy theory (Walker, 2003), embedded feature domains (Smolensky, 2006), and non-linear dynamics (Benus & Gafos, 2007) have all been used to wrestle with the issues of locality vs. transparency. These frameworks are equivalent to the following derivational opacity in varying degrees (see discussion in Bakovic (2006)): At some higher 'phonological' level, transparent segments carry harmonic features, but, at a lower 'phonetic' level, these distinctions disappear (presumably due to markedness).

There are two reasons to doubt that Finnish palatal harmony is such a case of *covert harmony* and should instead be considered *true transparency*. Firstly, if there were some late-stage force causing the neutrality of *i* and *e*, then, at an earlier stage, /ɨ/ and /õ/ are available as possible triggers of harmony.

(15)	Input		Output
	/sade-tt**A**/	→ /sadõ-tt**a**/	→ *sade-tt**a***

By Richness of the Base (Prince & Smolensky 2004), allowing such triggering predicts the existence of forms where surface neutral vowels are [+back] at the abstract level, and therefore some all-neutral vowel roots ought to require back vowels suffixes, e.g. */dõ-tt**a**/→*de-tta*. However, as in (10e-f), all-neutral stems always require front suffixes (Kiparsky & Pajusalu, 2003), falsifying this prediction.

The literature on Finnish harmony notes the basically exceptionless regularity of all neutral roots requiring front suffixes, but also points out a few potential counter-examples. Välimaa-Blum (1999) reports that, in native vocabulary, there are two exceptions to suffix harmony, "both in the partitive case only. In all other grammatical cases … suffix harmony works normally"(p. 249). These exceptions are the roots *meri* 'sea' and *veri* 'blood', which take the back partitive suffix: *merta* 'of the sea' and *verta* 'of the blood'. However, because all other cases take predictably front forms, e.g. the inessive, *meressä* 'in the sea' and *veressä* 'in the blood', these roots are not exceptional in the way that is predicted by derivation. Therefore, the prediction of all-neutral roots which only take [+back] suffixes is not expressed by *meri*, *veri*, or for that matter any other word in the native vocabulary.[4]

Other potential counter-examples are presented by Kiparsky & Pasuja (2003), suggesting that a nominalizing suffix marker *-o* and *-u* is always [+back] in the context of monosyllabic, neutral roots. However, my own search of Finnish reference materials shows that, like *meri* and *veri*, everywhere else the monosyllabic roots that combine with *-o* and *-u* take front suffixes. Thus, I conclude that all of these potential counter-examples are driven by the idiosyncratic behavior of the suffix, not because of the properties of the root. It

[4] Loan word phonology is much less predictable, see (Valimaa-Blum, 1999 and Ringen & Heinamäki, 1999).

would be consistent, root-driven [+back] harmony from neutral vowels in roots that would support the derivational account. This does not occur. Thus, there are phonological reasons to eschew analyzing Finnish transparency as derivational.

Secondly, researchers (Gafos 1996, Benus & Gafos 2007, Walker & Mpiranya 2005, Walker, Byrd, & Mpiranya, 2008) have used phonetic evidence of segment-to-segment co-articulation to argue in favor of covert harmony. Kim (2005) performed a phonetic investigation aimed exactly at determining how the variation in neutral, Finnish vowels in harmonic contexts relates to V-to-V coarticulation. The strategy is to explore the variance of co-articulation, as expressed by the acoustic correlate F2. Kim reports that for harmonic pairs, like *ä~a*, F2 values vary categorically and distinctly in response to harmonic context, but there is much more overlap and gradiency in the F2 values of neutral *e* in differing harmonic contexts. Kim also found that the amount of coarticulation (as expressed by F2 values), decreased with the distance between trigger and neutral vowels, e.g. in forms, like *tuotteeseensa* 'product', the first long /e/ showed more V-to-V coarticulation than the second long /e/. These facts suggest that the phonetic behavior of neutral vowels is qualitatively different than harmonizing vowels, so the available phonetic evidence does not support covert transparency in Finnish. When the phonological and phonetic evidence are combined, a non-local interaction of the sort permitted by $\text{C}{\small ORR}_{L\rightarrow R}$, is preferred to a covert account.

5 Locality as similarity

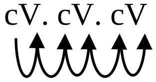
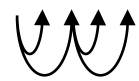
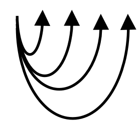
However, the long-distance nature of V-to-V harmony in Finnish must be seen as somewhat exceptional (although see Ayodeji & Pulleyblank, ms. for another case of V-to-V harmony in Moba Yoruba), since a number of studies that show that consonants can participate in harmony both subphonemically and as blockers are emerging (Casali 1995; Clements & Hume 1995; Ní Chiosáin & Padgett 2001, McCarthy 2003; Paster 2004). Therefore, it is desirable to also make allowances for locality preconditions. The Attraction Framework can predict the prevalence and preponderance of locality effects, by positing that locality is another kind of similarity precondition.

(16) **Similarity Hypothesis for Locality**
Proximate segments are more similar than distal segments.

Like anti-parasitic harmony, there are no *anti-local* languages which allow harmony at greater distances, but not when the same trigger and target are more proximate. PVH suggests that agreement on harmonic features can depend on agreement on phonological features, like [hi]. Likewise, (16) suggests that agreement on harmonic features can also depend on agreement on locality "features", like string adjacency.

Of course, locality is not a property of individual segments, but rather a property of pairs of segments. In the present proposal, locality is enforced by way of a family of segment-to-segment correspondence constraints, CORR(*l*). There are at least three locality preconditions, on which vowel harmony may depend:

(17) *Locality preconditions for vowel harmony (cf. Suzuki, 1998; Rose & Walker, 2004; Pulleyblank, 2002)*:

<u>Constraint</u>	<u>Locality precondition</u>	<u>Example Language</u>	<u>Template</u>
CORR $(x_i x_{(i+1)})_{L\rightarrow R}$	Segmental adjacency	Turkish	cV. cV. cV 
CORR$(\sigma_i\sigma_{(i+1)})_{L\rightarrow R}$	Syllable adjacency	Yawelmani	cV. cV. cV 
CORR$_{L\rightarrow R}$	No adjacency required	Finnish	cV. cV. cV 

As with similarity features, there is a subset relation in these constraints. For nucleic vowels, segmental adjacency ($V_1.V_2$) implies syllabic adjacency, but not vice versus ($V_1.cV_2$), and corresponding segments in adjacent syllables satisfy CORR$_{L\rightarrow R}$, but $V_1.V_2.V_3$ with V_1**R**V_3 does not satisfy CORR$(\sigma_i\sigma_{(i+1)})_{L\rightarrow R}$. Therefore, these constraints are also universally ranked in specific to general fashion: CORR $(x_i x_{(i+1)})_{L\rightarrow R} >>_{UG}$ CORR$(\sigma_i\sigma_{(i+1)})_{L\rightarrow R} >>_{UG}$ CORR$_{L\rightarrow R}$.

To illustrate how this range of correspondence constraints makes allowances for locality and blocking, again consider Yawelmani which exhibits a locality precondition of strict syllable locality, as shown below in (18):

(18) *Blocking by non-height matching intervening vowels*:
a. bok'-k'o 'find (it)!' b. bok'-sit-k'a 'find (it) for him!'

The analysis in (19) below shows that violations of IDENT-IO are incurred exactly when both locality preconditions and similarity preconditions are met (19a-b). If the trigger and target are not proximate enough (19c-e) or if the trigger and target are not featurally similar enough (19f-g), then no harmony takes place.

(19) *ATTRACTION analysis of blocking in Yawelmani PVH:*

	CORR ($\sigma_i\sigma_{(i+1)}$) L→R	ATTRACT ({[cons],[hi]}→[labial])	IDENT-IO ([labial])	CORR L→R	ATTRACT ({[cons]}→[labial])
a. b**o**k'-k'**a**		*!			*
☞b. b**o**k'-k'**o**			*		
☞c. b**o**k'-sit-k'**a**				*	*
d. b**o**k'-sit-k'**a**		*!			*
e. b**o**k'-sit-k'**o**			*!		
☞f. b**o**k-h**i**n					*
g. b**o**k-h**u**n			*!		

6 Exclusively local parasitism in Turkish

Positing an interaction between correspondence and attraction constraints predicts the existence of exclusively local parasitic assimilations. Such a case is found in optional repairs to vowel hiatus in Turkish (Kabak, 2007). Not all the conditions on this interaction are based on similarity, but the basic generalization is that in a derived environment, an optional coalescence repair to vowel hiatus has a precondition of agreement on both rounding and backing (cf. (20) vs. (21)).

(20) *V2 assimilates to V1 following medial consonant deletion:*

ağɨr →	[aɨr] ~ [aar], *[ɨɨr]	'heavy'
yoğurt →	[yourt] ~ [yoort], *[yuurt]	'yogurt'
öğür →	[öür] ~ [öör], *[üürt]	'to retch'

(21) *No alternation unless V1 and V2 agree on rounding and backness:*

döviz →	[döiz] ~ *[dööz],*[döez]	'foreign currency'
şair →	[şair] ~ *[şaar], *[şaer]	'poet'
saur →	[saur] ~ *[saar], *[saor]	'meal bf. fasting'
soğan →	[soan] ~ *[soon], *[saan]	'onion'
suit→	[süit] ~ *[süüt], *[siit]	'suite'

Unlike normal, productive Turkish Vowel Harmony, hiatus resolution results in lowering. The repairs in (20) may, thus, be termed vowel height assimilation.

Now, the more familiar Turkish rounding vowel harmony is parasitic on backness; apparently height harmony (for hiatus resolution) adds a further precondition of rounding agreement, otherwise the forms in (21) would alternate. Though height interacts with other aspects of harmony, there is no evidence of non-adjacent vowel height harmony in Turkish, so (20-21) exemplify a case of strictly local vowel assimilation also sensitive to feature similarity preconditions.

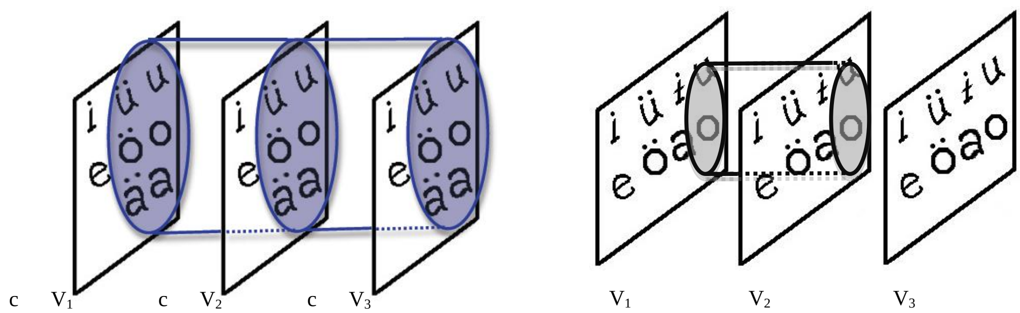
(22) *Analysis of optional repairs for vowel hiatus resolution*:

[yourt]→[yoort]	CORR $(x_i x_{(i+1)})_{L\rightarrow R}$	ATTRACT ({[labial], [back]} [hi])	IDENT-IO ([hi])	CORR $(\sigma_i\sigma_{(i+1)})_{L\rightarrow R}$	ATTRACT ({[back]} [hi])
a. yourt	*!			*	
b. yo$_x$u$_x$rt		*!			*
☞c. yo$_x$o$_x$rt			*		
[yoğurt]→[yoğurt]					
☞ d. yoğurt				*	
e. yo$_x$ğu$_x$rt		*!			*
f. yo$_x$ğo$_x$rt			*!		
[saur] →[saur]					
g. saur	*!			*	
☞h. sa$_x$u$_x$r					*
i. sa$_x$o$_x$r			*!		

7 Conclusion

The attraction analysis of PVH designates a similarity-based feature 'tier', a harmonic region embedded in a rich articulatory/acoustic space that extends across vowel sequences, as shown in (23). Such tunneling is possible because attraction integrates both locality and feature preconditions.

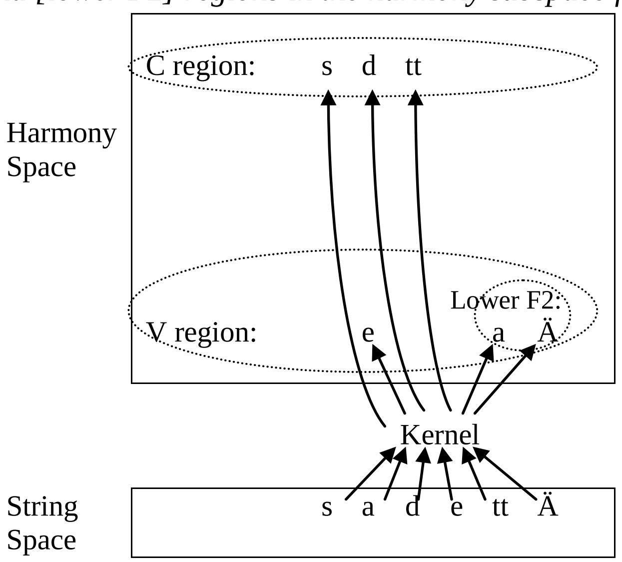
(23) a. *Finnish attraction basin* b. *Turkish attraction basin*



For Finnish, (23a), the attraction basin extends across multiple vowels and consonants and an intervening *i* or *e* is transparent because it fails to satisfy feature preconditions. In contrast, for Turkish vowel hiatus, (23b), the attraction basin is strictly local, so any non-participating intervener (consonants or vowels which fail to meet feature similarity preconditions) interrupts the parasitic domain, resulting in blocking. These differences in similarity preconditions derive from a language specific sensitivity to similarity expressed as the ranking of ATTRACTION constraints.

If non-local harmony is possible, as I have argued for Finnish, then a grammar of ATTRACTION constraints can be seen as a (similarity) kernel that classifies eligible and ineligible targets within a higher dimensional space, shown hierarchically below in (24) for the typical transparency found in the alternation: *sadettä→sadetta*. Here, trigger-*a* and target-*ä* map to the same region *of harmony space* because they agree on [lower F2], whereas more string-local trigger-*a* and target-*e* map to different regions of harmony space because they disagree on [lower F2].

(24) *C-V and [lower F2] regions in the harmony subspace for [back]:*



As in Turkish, distances in harmony space may depend on string distance, but as shown in (24) for Finnish, proximity in the string may be discounted in favor of feature similarity. In both cases, representational distance in harmony space remains paramount. For this reason, the present general similarity proposal can subsume both feature and locality preconditions on assimilation.

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