Two arguments for vowel harmony by trigger competition

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1 Introduction and background

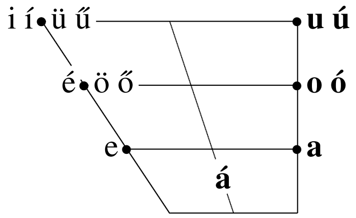
How best to describe vowel harmony in a constraint based grammar remains an open question. A huge variety of constraints have been proposed for OT and related weighted or serial frameworks, each reflecting its own interpretation of the phenomenon, and many basic theoretical points are still under debate, including what kinds of segment harmony makes reference to, whether harmony in enforced only between adjacent pairs of those segments, and to what extent universal grammar limits the distribution of exceptions to harmony.

In this paper, I present two arguments for Kimper's (2011) Trigger Competition (TC) approach to harmony, a system set in Serial Harmonic Grammar which allows for explicit links between segments that are in no way adjacent, and that explicitly considers vowel quality in its assessment of candidates with harmony. The first of these arguments is based on a pattern in the Hungarian vowel harmony data and concerns the interaction of vowel quality and adjacency, and the second is based on the structure of the Seto vowel inventory, and concerns the conditions under which vowel types are able to be transparent.

1.1 Hungarian vacillation

Hungarian shows progressive backness harmony: Hungarian vowel harmony generally spreads the value of [BACK] forward through a word stem and onto any suffixes (Ringen & Vago 1998, Benus *et al.* 2003, Hayes & Londe 2006). We follow the inventory shown here, with as back vowels (from the perspective of harmony) marked in bold, and contrastively long vowels marked with acute accents (´):

(1)



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[*] I am indebted to Paul Kiparsky and Karl Pajusalu for providing the Seto data, to Paul Kiparsky and Arto Anttila for their ample advice on this project, and to Meghan Sumner, Chris Manning, Matt Faytak, Jackson Lee, Andrew Alexander, and the participants in Stanford's and Edinburgh's phonology workshops, and the 86th LSA annual meeting for their comments on earlier versions of the paper. Usual disclaimers apply.

Four of the front vowels are neutral: /i/, /í/, /é/, and /e/ can be observed after back vowels, but they do not behave uniformly as a group with respect to what vowels may follow them. Different combinations of them participate in harmony to varying degrees, yielding transparency, opacity, or optionality:

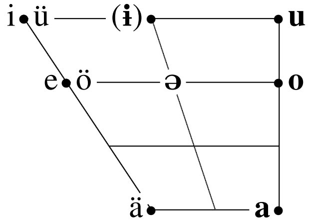
(2) a. Transparency with a single TV: *papír-ban* ∼ **papír-ben*
b. Optionality with /e/: *ágnes-ban* ∼ *ágnes-ben*
c. Optionality with two TVs: *oxigén-ban* ∼ *oxigén-ben*
d. Opacity with TV plus /e/: **kabinet-ban* ∼ *kabinet-ben*

Hungarian has a number of unusual types of exception to harmony—see Törkenczy (2013) for a thorough survey, or Ringen & Vago (1998) for earlier OT work—many of which have not been successfully analyzed in any harmony system. The pattern above is one of the most discussed of these, and I show that TC has the capacity to offer an explanation without needing to explicitly reference all four cases in the grammar, as in prior analyses like Hayes & Londe (2006).

1.2 Seto paired neutral vowels

This paper presents the first full generative account of the Finno-Ugric language Seto, drawing on the description in Kiparsky & Pajusalu's (2001) manuscript. The language is spoken in southern Estonia by about 10,000 people. Like Hungarian, it shows progressive backness harmony, and has an unusual set of neutral vowels. We use the inventory presented here:

(3)



Segments in parentheses occur only in the word-initial syllable, which bears primary stress. I borrow the /ə/ notation from Kiparsky and Pajusalu for the lax central phoneme, which can surface somewhat back of center word-initially and corresponds to orthographic 'õ.'

The most noteworthy property of the language involves the vowels /i/ and /e/. Both are transparent in initial syllables (they may precede back vowels), and /i/ is transparent in all positions:

(4) *teeda* 'grandpa' ∼ *esä* 'father'

(5) *ilma* 'without' ∼ *hinneq* 'fiber'

(6) *opp:a-ji-lə* 'teacher-PL-ALL' ∼ *rebäs-i-le* 'fox-PL-ALL'

Crucially, both of these have clear counterparts in the inventory: acoustically and harmonically back vowels that differ from them only in their backness. This presents a problem for conventional constraint-based approaches to harmony that rely on strict locality (i.e. AGREE and ALIGN constraints), since neither of the conventional approaches to transparency under strictly local systems work for Seto's paired transparent vowels.

One can achieve transparency under strict locality by implementing some kind of segment-specific postlexical neutralization to prevent the back counterpart of /i/ from surfacing (after Bach 1968, Clements 1976, Walker 1998, and Baković & Wilson 2000), but this prevents us from generating that counterpart even in back contexts where it is licit:

(7) /ɨlma/ → /ɨlma/ → [ilma]

(8) /ilma/ → /ilmä/ → [ilmä]

(9) ? → [ɨlma]

One can also achieve transparency by positing that high unrounded vowels like /i/ are unspecified for backness (after Clements 1976, Kiparsky 1980, Archangeli & Pulleyblank 1994, and Ringen & Vago 1998), but this makes it impossible to lexically specify the real contrast between the two surfacing in back contexts:

(10) /Ilma/ → /Ilma/ → [ilma]

(11) /Ilmä/ → /Ilmä/ → [ilmä]

(12) ? → [ɨlma]

This paper presents an analysis of Seto vowel harmony which is capable of generating this pattern, in addition to some additional challenging patterns involving certain tokens of /ə/.

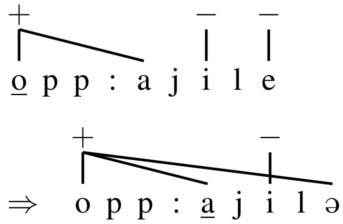
2 A solution: Trigger Competition

My proposed analyses for both the Hungarian data and the Seto are set in Trigger Competition. TC is a framework for vowel harmony set in Serial Harmonic Grammar (SHG, Pater *et al.* 2008, Pater 2010, and Mullin 2010). SHG, unlike OT and traditional parallel HG, has no problem with positively formulated constraints (a.k.a., reward functions or imperatives), and TC uses one of these:

> **SPREAD(±F):** For a feature F, assign +1 for each segment linked to F beyond the first. (simplified from Kimper 2011)

The links that the constraint refers to are autosegmental links (Goldsmith 1976) between segments and feature specifications, which may cross in cases of transparency:

(13)



The constraint crucially does not assign the same score to every link: two additional pieces influence these scores. The first, the distance multiplier, expresses a preference for local spreading over non-local spreading:

> **Scaling factor: non-locality**
> For a trigger α and a target β, multiply the reward earned by a constant k (such that $1 > k > 0$) for each unit[1] of distance d intervening between α and β. (simplified from Kimper 2011)

The second, the trigger strength multiplier,[2] expresses a preference for spreading initiated by vowels that are weakly cued for the harmonic feature:

> **Scaling factor: trigger strength**
> For a trigger α, a target β, and a feature F, multiply the reward earned by a constant x (such that $x > 1$) for each degree[3] i to which α is perceptually impoverished with respect to ±F. (simplified from Kimper 2011)

This notion of trigger strength as something tied to a vowel type is central to TC, and Kimper justifies it using experimental evidence that suggests the following teleological generalization about harmony:

> Segments which are better triggers (by virtue of being perceptually impoverished, and therefore in most need of the advantages conferred by harmony) are more likely to be opaque, and segments which are poor triggers are more likely to be treated as transparent. (Kimper 2011)

It should be noted that, in the TC terminology, any segment is a potential trigger: segments need not be the 'head' of any domain to spread harmony, and multiple segments in the same word can spread harmony for the same feature.

Neutrality and transparency are fairly straightforward to implement in TC: a vowel is neutral if any constraint prevents it from undergoing spreading, and transparent if it is also too weak a trigger to spread itself. It is this ability to govern transparency using trigger strength that makes TC suitable for the Seto case, and the related interaction of trigger strength and distance that makes it suitable for Hungarian.

Unfortunately, TC's use of weighted constraints and stepwise derivations means that it is difficult to generate a full OT-style factorial typology. Kimper presents a thorough analysis of the (reasonable) predicted typology in his original presentation which is too long to excerpt here, and I present a brief discussion of the effects of my modifications in section 5.1 below.

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[1] I adopt the vowel segment as the unit for d.

[2] These multipliers serve as a way to tell the grammar to prefer closer triggers to farther ones for all possible distances, and stronger triggers to weaker ones for all possible strengths. This could be done using a hierarchy of simpler constraints, but there would need to be as many hierarchies as there are different trigger strengths, and each such hierarchy would need to contain potentially infinitely many constraints to capture every possible distance.

[3] There is not presently any way to separately establish x and i values, so I refer to vowel types as having a single trigger strength value which could, at least abstractly, be decomposed into these two values. –SB

TC is not the only non-local theory of harmony in constraint based grammar under active development: Most prominently, Agreement by Correspondence (ABC, Walker 2001, Rhodes 2010) shares many pieces of its basic non-local viewpoint with trigger competition, but it is limited in its conventional formulation in how it determines which segments are transparent. TC's direct use of both trigger quality and distance are crucial to the cases discussed here.

3 Hungarian vacillation and tied candidates

Kimper does briefly address distance effects in Hungarian vowel harmony, though in his work he does not attempt to generate the full vacillation pattern. Here, I show that no substantial extension to the theory is necessary to generate the full range of data described above, including the interaction between distance and vowel type (i.e., the behavior of /e/ vs. the other transparent vowels), and even the patterns of variation. Accounting for this requires nothing more than an appropriate setting of the parameters of SPREAD. There is considerable flexibility in this choice, and for these examples I use the following simple configuration:

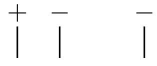
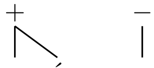
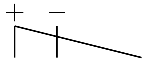
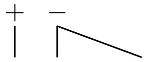
(14) Back vowels are strong triggers, with a strength of 4.

(15) The translucent /e/ is a weaker trigger with a strength of 2.

(16) The transparent /i/, /í/, and /é/ are weaker still with a strength of 1.

(17) The distance multiplier is equal to the ratios between these, 0.5.

Given this, and the constraint weights shown, a single transparent vowel allows harmony to propagate past it:

 /p a p í r + b e n/	STEMID[±BK] −5	SPREAD[±BK] +1	$\mathcal{H}$
a.  p a p í r + b e n	0	0	0
b.  p a̲ p Í r + b e n	1	4	−1
☞ *c.*  p a̲ p í r + b a n	0	$4 \times .5^1$ $= 2$	2
d.  p a p í̲ r + b e n	0	1	1

Note, also, that in the examples here, all of the candidates considered contain only rightward spreading. This is crucial to the success of the grammar in directional harmony languages like Hungarian and Seto, and I return to this issue below.

If we substitute the transparent vowel above with the translucent /e/, tied harmony results:

+ − − /ágnes+ben/	STEMID[±BK] −5	SPREAD[±BK] +1	$\mathcal{H}$
a. + − − ágnes+ben	0	0	0
b. + − á̲gnas+ben	1	4	−1
☞ *c.* + − á̲gnes+ban	0	$4 \times .5^{1}$ $= 2$	2
☞ *d.* + − ágne̲s+ben	0	2	2

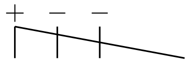
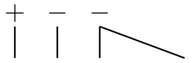
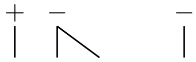
A typical interpretation of this perfect tie would say that both winning outputs can be expected to surface. However, a fair objection might be raised here that this grammar is requiring a learner to learn a grammar of several real-valued weights that yield a numerically exact tie, since even the slightest deviation from the ratios described here fails to yield vacillation under the framing presented so far. However, a solution is readily at hand. Under the noisy HG (Jesney 2007) approach to variation, constraint weights (and parameters) vary slightly with each evaluation; variation emerges from merely approximate ties (which learners are likely to converge on under these circumstances). Further, it makes it possible to tune the grammar somewhat to better reflect the observed frequencies of each variant.

Returning to the data, multiple consecutive normal transparent vowels also yield tied harmony, though by way of a somewhat more complex derivation. In the first step of the example, three candidates tie:

+ − − − /oxigén+ben/	STEMID[±BK] −5	SPREAD[±BK] +1	$\mathcal{H}$
a. + − − − oxigén+ben	0	0	0
b. + − − o̲xɨgén+ben	1	4	−1
☞ *c.* + − − o̲xigén+ban	0	$4 \times .5^{2}$ $= 1$	1
☞ *d.* + − − oxigé̲n+ben	0	1	1
☞ *e.* + − − oxi̲gén+ben	0	1	1

SHG derivations like this one proceed stepwise: after a winner has been chosen—making at most a single change to the output—a new tableau is generated taking that winner as the input. This process repeats until the derivation converges by choosing an output that is identical to the input. In the cases shown previously, no further harmonic spreading is worthwhile after the first step, and the derivation converges, but convergence is not immediate in this case: If candidate c is selected in the tied first step, the middle two vowels are linked, and back harmony results. If candidate d is selected in the first step, then a similar stem-internal harmony takes place, and front harmony results. And candidate e wins, then similar derivations make both front and back harmony possible with the same two output structures as result from choosing c and d. Hence, a sequence of a transparent vowel and an /e/ yields free variation in this grammar, with an equal number of derivations for both back and front harmony.

Finally, this system correctly predicts that a transparent vowel followed by the translucent /e/ will categorically select for front suffixes. In the first step, harmony spreads to the suffix:

 /k a b i n e t + b e n/	STEMID[±BK] −5	SPREAD[±BK] +1	$\mathcal{H}$
 *a.* k a b i n e t + b e n	0	0	0
 *b.* k a̲ b i n e t + b e n	0	$4 \times .5^2$ $= 1$	1
 ☞ *c.* k a b i n e̲ t + b e n	0	2	2
 *d.* k a b i̲ n e t + b e n	0	1	1
 *e.* k a̲ b ɨ n e t + b e n	1	4	−1

In the next step the two front vowels in the stem are linked, and the derivation converges, with no optionality and front harmony on the affix.

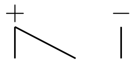
This analysis requires nothing more than the most basic components of a Trigger Competition grammar: the harmony constraint SPREAD, and some other constraint to prevent transparent vowels from undergoing back harmony. By contrast, in any system which treats different vowel types identically for the purposes of the harmony constraint, and in any system which does not explicitly recognize the scalar effect of locality on harmony, an analysis like this would require considerable additional theoretical technology.

4 Seto and paired neutral vowels

Since TC doesn't require that neutral vowels be harmonically un-paired, an account of the basic Seto facts requires only an appropriate setting the trigger strengths and the other parameters of the grammar.

The Seto data described above do not place many restrictions on the trigger strengths used, essentially only that stressed /e/ is weaker than the other vowels, and that /i/ is weaker still. Further, Kimper's system of determining contrastiveness on the basis of acoustic cue quality is not yet developed to the point that it can be used to generate trigger strength hypotheses. Without adequate motivation for any particular setting, then, I must choose somewhat arbitrarily: I set the distance multiplier to 0.4, the trigger strength of normal harmonic vowels to 5, that of stressed /e/ to 1, and that of /i/ to 0.2.

In the derivation for *opp:a-ji-lə* 'teacher-PL-ALL', /i/ surfaces as a transparent vowel, failing to either undergo harmony or propagate it. In the first cycle of derivation[4] shown here, we add one affix and harmonize:

 /opp:a+ji/	INITID[BK] −25	*{ö, ɨ} -20	STID[BK] −1	SPR[±BK] +.75	$\mathcal{H}$
a.  opp:a+ji	0	0	0	0	0
☞ *b.*  o̲pp:a+ji	0	0	0	5	3.75
c.  opp:a̲+jɨ	0	1	0	5	−16.25

In the next cycle, the first affix becomes part of the stem, a second affix is added, and harmony is extended onto it from the nearest back vowel over the objections of the distance penalty:

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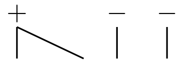
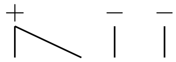
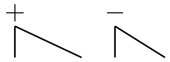
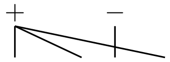
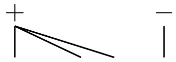
[4] In the derivations shown here, affixes are added cyclically as in Stratal OT (Kiparsky 2000). This is not essential, and for Seto we need only a grammar that expresses preferential faithfulness towards roots over affixes.

 /opp:aji+le/	INITID[BK] −25	*{ö, ɨ} -20	STID[BK] −1	SPR[±BK] +.75	$\mathcal{H}$
a.  opp:aji+le	0	0	0	5	3.75
b.  opp:aji̲+le	0	0	0	5+ .2 = 5.2	3.9
☞ *c.*  opp:a̲ji+lə	0	0	0	5+ 5 × .4 = 7	5.25
d.  opp:a̲jɨ+le	0	1	1	5+ 5 = 10	−13.5

4.1 Initial /e/ and the missing /ə/

Seto avoids the particular combination of /e/ in an initial syllable (usually transparent) with /ə/ in a second syllable:

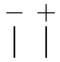
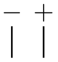
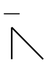
(18) *teeda* 'grandpa'

(19) *killə* 'shrill'

(20) **kellə*

This cooccurrence restriction would appear to be independent harmony in most frameworks, but TC allows us to fold it in to our account, merely by allowing that the lax noninitial /ə/ is not as well protected by faithfulness as other vowels. To do this, I propose to divide stem faithfulness into two constraints, one protecting all vowels, and another protecting only tense vowels. I also introduce a low-weighted constraint against lax vowels also needed elsewhere, and show it here to ensure that this data can be generated with it in place.

Given this, /e/ and /i/ are both too weak to trigger harmony on most vowels, but when the target is the weakly protected /ə/, the somewhat stronger /e/ is just barely able to trigger harmony:

 /e.ə/	STID[BK] −0.75	SPR[±BK] +0.75	STID[BK]$_{\text{TNS}}$ -0.25	*[-TENSE] −0.1	$\mathcal{H}$
a.  e.ə	0	0	0	1	−0.1
☞ *b.*  e̲.e	1	1	0	0	0

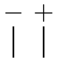
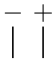
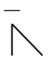
4.2 Transparent stems

In another behavior for which TC provides a ready analysis, stems like /pet/ or /ihft^j/ which contain only front transparent vowels categorically select front suffixes:

(21) *pet-mä*/*ma 'deceive-INF'

(22) *ihft^j-mä*/*ma 'poison-INF[5]'

Since /i/ and initial /e/ have non-zero trigger strength, they can still trigger harmony when nothing else (like a competing trigger or faithfulness constraint) interferes. We have no reason to hypothesize any backness faithfulness in affixes, so they alternate:

 /i+a/	STID[BK] −1	SPR[±BK] +.75	$\mathcal{H}$
a.  i+a	0	0	0
☞ *b.*  i̲+ä	0	0.2	0.15

The possibility for harmony from transparent stems is central to TC: If the learner learns that a vowel has low but positive trigger strength, this effect will emerge.

4.3 Remaining issues in Seto vowel harmony

I have focused up to this point on that subset of the Seto data which seems to present a challenge to many existing theories, but which can be explained under TC. Of those patterns not investigated above, two were omitted because they seem relatively straightforward and don't bear on the discussions at hand, and one because it was a substantial puzzle that no theory I am aware of can account for.

/o/ is an opaque (or blocking) vowel in Seto: it is neutral and may thus occur in either context, but is only followed by back vowels. This is straightforward to analyze under most harmony systems, and Kimper presents several similar cases in TC in his dissertation.

In addition, a few morphemes—both affixes and word stems—contain audible lexically idiosyncratic stresses and are opaque to harmony, suggesting additional, but likely straightforward, interactions between stress and harmony.

Finally, and much more curiously, Kiparsky and Pajusalu report that suffixes beginning with /k/ show alternation between mid-high non-round vowels (/e/–/ə/), but not any other vowels. In other words, the inventory in these suffixes is limited to {a, i, u, e, o, ə}, ruling out the more marked {*ä, *ɨ, ü, ö}. I am aware of no simple explanation of this odd context-specific markedness restriction under any framework, and do not attempt to provide an account here.

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[5] The diacritic represents palatalization.

5 Patching the theory

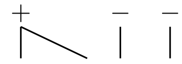
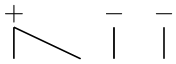
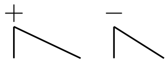
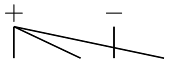
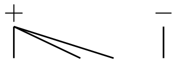
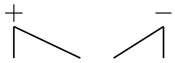
In this section, I attempt to tie up a few loose ends in the original proposal for Trigger Competition that allow me to present fully functional generative analysis of the Seto and Hungarian data at hand. In particular, Kimper leaves directionality in harmony largely unaccounted-for, and imposes a hard restriction on certain configurations of triggers that excessively limits the types of transparency that can be generated.

5.1 Rightward directionality

Harmony in Seto and Hungarian (like many other languages) is only rightward: Suffixes never force stems to alternate, and opaque vowels only force harmony on vowels to their right. Kimper stipulates directionality restrictions, and suggests that they may be necessary, but does not provide a mechanism by which to enforce them. An account in TC must take a hybrid approach, limiting both in which direction harmony can spread from a given trigger, and the order in which triggers may initiate spreading.

5.1.1 Leftward spreading

Here, I return to the derivation of opp:ajilə above, but allow candidates in which leftward spreading occurs:

 /opp : a j i + l e/	InitID[Bk] -25	*{ö, ɨ} -20	StID[Bk] −1	Spr[±Bk] +.75	$\mathcal{H}$
a.  opp : a j i + l e	0	0	0	5	3.75
b.  opp : a j i̲ + l e	0	0	0	$5 + .1$ $= 5.1$	3.825
☹ *c.*  opp : a̲ j i + l ə	0	0	0	$5 + 5 \times .4$ $= 7$	5.25
d.  opp : a̲ j ɨ + l e	0	1	1	$5 + 5$ $= 10$	−13.5
☞ *e.*  opp : a j i + l e̲	0	0	0	$5 + 5$ $= 10$	7.5

Unwanted leftward spreading occurs in any XYZ sequence where Y is transparent, Y and Z are front, and X is back. To resolve this, I introduce multipliers l and r that apply to instances of spreading in which the target is to the left or right of the trigger, respectively. If l is zero and r is one, we get rightward spreading as before: the reward for candidate e is diminished by 5 and candidate c wins.

While it is not straightforwardly possible to describe a full OT-style factorial typology for an SHG grammar, the consequences of adding these two multipliers are easy to describe:

(23) **Typology: Directionality multipliers**

a. $l = 0 \quad r = 0$
No vowel harmony (English).

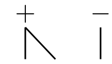
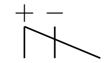
b. $l = 0 \quad r > 0$
Strictly rightward harmony (Seto).

c. $l = r \quad l, r > 0$
Non-directional harmony (bidirectional stem control or dominance harmony, described in Baković 2000).

d. $l > r > 0$
Non-directional harmony, with the potential for vowels that are opaque to rightward spreading but transparent to leftward spreading (Dagbani and Southern Palestinian Arabic, Mullin 2010).

5.1.2 Left-first spreading and the HARMONIZEFROMLEFT constraint

Another pathology persists even with after applying the l and r multipliers:

 /nose+se/	StID[Bk] −1	Spr[±Bk] +.75	$\mathcal{H}$
☞ *a.*  nose̲+se	0	5	3.75
☹ *b.*  no̲sə+se	1	5	2.75
c.  nose+se	0	0	0
d.  no̲se+sə	0	5 × .4 = 2	1.5

After the vacuous linking shown here, the derivation converges without incorporating the back first syllable into the harmony domain. The observed output is the harmonic *nosə-sə* (‘rise-3’).

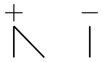
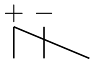
One might attempt to address this failure of harmony by using a constraint that penalizes harmony triggers for being far from the left edge of the word, but every formulation of such a constraint that I have been able to design either fails on words with initial transparent vowels, or on long words. It is however possible to encourage the observed behaviour using a constraint that, rather than counting the distance between the trigger and the edge of the word, counts the distance between the trigger and the *nearest harmony participant* to its left. The constraint is formalized, somewhat tortuously, as follows:

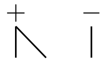
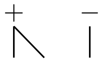
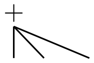
> **HARMONIZEFROMLEFT[±f]:** Assigns as its violation count the number of consecutive nodes on the f tier associated with only one segment

each which are also to the immediate left of the left edge of any harmonic domain (i.e., the segments associated with any node on the f tier which is itself associated with multiple segments).

Under this definition, a word-initial trigger is assigned the exact same violation count—zero—as a word-medial trigger, provided that all of the segments to the left of the word-medial trigger are participants in harmony. However, by penalizing word-medial triggers in words for which no harmony has yet occurred, the constraint promotes derivations in which harmony is propagated from left to right.

If this constraint is weighted just highly enough to barely prefer spreading from the first syllable, the problem is solved, with the two-step derivation of the harmonic *nosə-sə* shown here:

 /nose+se/	FromLeft −1.25	StID[Bk] −1	Spr[±Bk] +.75	$\mathcal{H}$
 *a.* nose+se	1	0	5	2.5
 ☞ *b.* nosə+se	0	1	5	2.75
 *c.* nose+sə	0	0	5 × .4 = 2	1.5
 *d.* nose+se	0	0	0	0

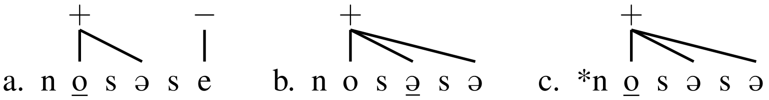
 /nosə+se/	FromLeft −1.25	StID[Bk] −1	Spr[±Bk] +.75	$\mathcal{H}$
 *a.* nosə+se	0	1	5	2.75
 ☞ *b.* nosə+sə	0	1	5 + 5 = 10	6.5

Initial transparent vowels can still surface: The new constraint is not weighted highly enough to block non-initial harmony when there are no earlier strong triggers.

Unfortunately, this constraint does not, it should be noted, rule out the bidirectional pathology in 5.1.1 on its own: both this constraint and the directionality parameter are necessary.

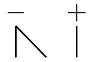
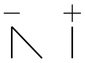
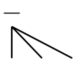
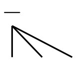
5.2 What can be a trigger?

Kimper's restricts which segments can be triggers, explicitly limiting spreading to only segments that are at the edges of harmony domains (i.e., that are not already linked to something else in the direction that they are attempting to spread), banning spreading from /o/ in c:



(24) a. n o̲ s ə s e   b. n o s ə̲ s ə   c. *n o̲ s ə s ə

This breaks transparency even in fairly simple cases like the toy example /bäbiba/. If /bäbiba/ as the input, the two already-agreeing segments will be linked *in the first step*: they are adjacent, and the first of them is a perfectly good trigger. In the second step (shown here), harmony cannot spread further, however, because the transparent /i/ is the only legal trigger for rightward spreading:

 /bäbiba/	STID[BK] −1	SPR[±BK] +.75	$\mathcal{H}$
☞  *a.* bäbiba	0	5	3.75
 *b.* bäbi̲bä	1	5 + 0.2	2.9
☹  *c.* (bä̲bibä)	1	5 + 5 × 0.4 = 7	4.25

Fixing this problematic prediction requires merely allowing banned candidates like c above, but Kimper's restriction is empirically necessary for icy targets in languages like Khalkha Mongolian. I propose a (potentially binary) multiplier on SPREAD that is applied to instances of spreading in which the trigger is not at the domain-edge nearest to the target: If it is 1, c is legal and rewarded as shown, if it is 0, than the icy target candidate a wins.

6 General conclusions

In this paper, I have presented two examples of linguistic phenomena for which TC presents the most compelling analysis of any theory of harmony of which I am aware: TC readily makes the correct predictions about subtle partial transparency and distance-sensitive transparency cases of the kind that have been observed in Hungarian. TC can also capture cases of paired transparent vowels, which occur in the previously undescribed language Seto, and which are not predicted by conventional local frameworks. Finally, I have defined a fleshed-out implementation of Trigger Competition, complete with a treatment of directionality, and a working account of transparency and potential triggers.

Despite strong empirical motivation, including considerable experimental work from Kimper not discussed here, Trigger Competition is a worryingly complex theory. This fact is not ideal, but there may be no cleaner alternative: I claim that no substantially less powerful system should be able to account for the full range of harmony phenomena.

References

Archangeli, D., & D. Pulleyblank. 1994. *Grounded phonology*. Cambridge, MA: MIT Press.

Bach, E. 1968. Two proposals concerning the simplicity metric in phonology. *Glossa* 2.128–149.

Baković, E., 2000. *Harmony, Dominance and Control*. Rutgers University dissertation.

——, & C. Wilson. 2000. Transparency, strict locality, and targeted constraints. In *Proc. WCCFL 19, Stanford*, 43–56, Somerville, MA. Cascadilla Press.

Benus, S., A. Gafos, & L. Goldstein. 2003. Phonetics and phonology of transparent vowels in Hungarian. In *Proc. BLS 29*, 485–497.

Clements, G. 1976. Neutral vowels in Hungarian vowel harmony: An autosegmental interpretation. In *Proc. NELS 7, MIT*, 49–64.

Goldsmith, J. 1976. *Autosegmental Phonology*. New York: Garland Publishing.

Hayes, B., & Z. Londe. 2006. Stochastic phonological knowledge: The case of Hungarian vowel harmony. *Phonology* 23.59–104.

Jesney, K., 2007. The locus of variation in weighted constraint grammars. Poster presented at the Workshop on Variation, Gradience and Frequency in Phonology Stanford.

Kimper, W., 2011. *Competing triggers: Transparency and opacity in vowel harmony*. University of Massachusetts Amherst dissertation.

Kiparsky, P. 1980. Remarks on the metrical structure of the syllable. *Phonologica* 1980.245–256.

—— 2000. Opacity and cyclicity. *The Linguistic Review* 17.

——, & K. Pajusalu, 2001. Seto vowel harmony and the typology of disharmony. Unpublished ms., Stanford University.

Mullin, K., 2010. Strength in harmony. Unpublished ms., University of Massachusetts Amherst.

Pater, J. 2010. Serial harmonic grammar and Berber syllabification. In *Prosody Matters: Essays in Honor of Lisa Selkirk*. London: Equinox Publishing.

——, P. Boersma, & A. Coetzee, 2008. Lexically conditioned variation in harmonic grammar. Presentation at OCP-5 Université de Toulouse-Le Mirail.

Rhodes, R., 2010. Vowel harmony as agreement by correspondence. Unpublished ms., UC Berkeley.

Ringen, C., & R. Vago. 1998. Hungarian vowel harmony in optimality theory. *Phonology* 15.393–416.

Törkenczy, M., 2013. The close-ups can get rough: exceptional behaviour, transparency & variation in hungarian vowel harmony. Handout presented at 21mfm.

Walker, R., 1998. *Nasalization, neutral segments, and opacity effects*. University of California, Santa Cruz dissertation.

—— 2001. Consonantal correspondence. In *Proc. of the Workshop on the Lexicon in Phonetics and Phonology University of Alberta*.