Neutrality and Harmony: a Finnish Perspective

Paul Kiparsky
Stanford University

Keywords: Vowel harmony, disharmony, neutral vowels, Finnish, cyclicity, Stratal OT

1 The problem of neutral vowels

The main stumbling block for modeling vowel harmony in generative phonology are neutral vowels. They are harmonically ambivalent, in that they transmit harmony without being affected by it, yet trigger harmony themselves from prominent positions. In this article I offer a new account of harmonic neutrality and support it with evidence from Finnish.

Vowel harmony has spurred phonologists to develop new harmony-specific devices and constraint types. They include global AGREE (McPherson & Hayes 2016; McCollum & Essegbey 2020), SPREAD (Kaun 1995; Padgett 2002), target-centric Search-and-Copy (Nevins 2010; Ozburn 2019), extensions of Correspondence Theory (Agreement by Correspondence, Krämer 2003; Rose & Walker 2004; Rhodes 2012) and of the theoretically problematic ALIGN family of constraints (Ringen & Kontra 1989; Cole & Kisseberth 1994; Pulleyblank 1996), and, in Harmonic Serialism, SHARE (McCarthy 2011) and SPAN THEORY (McCarthy 2004).

I think it is possible to reduce non-local harmony effects to the iteration of local operations without invoking any novel special machinery, and without positing opaque participation of intervening neutral vowels. That way vowel harmony can be formalized, like all phonology, as a negotiation of the conflicting claims of faithfulness and syntagmatic and paradigmatic markedness. For the well-understood cases at least, we only need the standard off-the-shelf faithfulness and markedness constraints listed in schematic form in (1) (from Kiparsky 2024):

(1) a. Faithfulness constraints:

(i) MAX[μF] (Archangeli & Pulleyblank 2002; Lamontagne & Rice 1995; Causley 1997; Wheeler 2005; Coetzee 2006).

(ii) IDENT-ROOT(F), IDENT-STEM(F), (iii) IDENT-σ_1(F)... (positional faithfulness, Beckman 1997).

Input [αF] does not correspond to output [–αF], (i) where [αF] is the marked value of F, (ii) where [αF] is in a stem, (iii) where [αF] is in an initial syllable.

b. Syntagmatic markedness constraints: *[αF][–αF] (Baković 2000)

There is no sequence of an [αF] vowel followed by a [–αF] vowel. This is a strictly local constraint, in the sense that it is not violated if another vowel, another instance of [F], or another element linked to [F] intervenes between the [αF] and [–αF] vowels.

c. Paradigmatic markedness constraints (minimization of segment complexity):
(i) *[αF]
(ii) $*\left[\begin{smallmatrix}\alpha F\\ \beta G\end{smallmatrix}\right]$, where αF is the marked value of F.

My approach does however rely on the following specific assumptions about the architecture of morphology and phonology and their interaction, about the lexicon, and about featural markedness.

I take markedness to be privileged visibility to constraints. The idea is that each constraint that applies to the feature F has a counterpart that applies specifically to its marked value μF (Kiparsky 1994). The asymmetrical constraints derived by this principle achieve much of what unary and particle-type features were designed for, but without abandoning feature binarity.

I adopt a strong form of lexicon optimization which requires that predictable information is omitted in lexical representations, and in particular that unmarked default feature values are unspecified in them. In standard OT, lexicon optimization is no more than a bookkeeping convention without empirical import for phonological analyses. Features must be specified in lexical input representations only in order to defeat the contrary specifications that would otherwise be assigned by the language's phonological constraints. Predictable default feature values can either be left unspecified or equally well be redundantly specified in the lexicon. Not so in a derivational OT system such as Stratal OT, where the derivation proceeds cyclically from the innermost constituent outwards – via two or even more layers of morphology in at least some languages. There underspecification has real consequences, for the output of the grammar depends on when the redundant feature specifications are introduced.

Vowel harmony itself is driven by constraints of the form (1b). There are two main types of harmony: dominant harmony, which extends the marked feature value from any vowel in a word to all others by (1ai), and directional harmony, which extends the feature value from a privileged position, most commonly the stem (1aii), to the rest of the harmony domain. Finnish harmony is of the latter type. It operates cyclically from the innermost constituent outwards (Baković 2000), with phonology and morphology interleaved in each cycle.[1] I'll capitalize on the cyclicity of harmony to solve another problem which arises prominently in Finnish – the opaque conditioning of harmony by underlying vowels that are phonologically deleted in the output. The key point is that bound roots and affixes do not constitute cyclic constituents. Inkelas (1989) grounds this principle in Prosodic Lexical Phonology (see also Kiparsky (1982); Harris (1983); Hargus (1988); Benua (1997); Itô & Mester (2003); Inkelas (2005) for additional evidence and related discussion). It means that they are not by themselves

[1]Because prefixes in Finnish are not integrated into the same harmony domain as their hosts, harmony is almost always left to right. A clue that it really works from the stem outward is that in poetic language and dialects, the proclitic nominative forms of the 1./2.Sg. pronouns *mä-*, *sä-* harmonize with their host verb, with neutral vowels counting as front (for reasons that will become clear below): *ma tulen* 'I'm coming', *mä menen* 'I'm going', *mä lähden* 'I'm leaving'.

subject to stem-level constraints, and phonology does not apply to them before they combine with affixes. The category of bound root is distinct from a stem, which in Finnish is in practice equivalent to a lexical item (lexeme) minus its inflectional morphology. The distinction is unavoidable even in English, let alone in morphologically richer languages such as Finnish (Kiparsky 2020). But I see no justification for the notion that *every* lexical item is derived from a root with an abstract categorizer. In particular, morphologically simplex nouns and adjectives like *dog* and *good* can just be entered in the lexicon as nominal stems, and Finnish furnishes some positive evidence for doing so.

My proposal eliminates two false predictions made by systems based on symmetric IDENT and global AGREE: first, that among outputs that fully satisfy AGREE, the one with fewer IDENT-[F] violations is optimal – the "Majority Rule" problem (Lombardi 1999; Baković 2000), and secondly, that a feature either spreads entirely throughout a domain or not at all – the "Sour Grapes" problem (different versions in Padgett 1995; Wilson 2003; McCarthy 2004). The Faithfulness constraints (1a) and the strictly local harmony constraint (1b) do not have these pathological consequences (Kiparsky 2024).

Another welcome consequence of this approach is that it correctly predicts a so far neglected type of bidirectional vowel harmony: a hybrid of dominant and directional vowel harmony where roots combine with their first affix in dominant-recessive fashion, outputting a derived stem that then cyclically passes the harmonic feature outward to subsequently added affixes by stem faithfulness. It is instantiated in Warlpiri and Telugu, unrelated languages with eerily similar phonologies where rounding harmony applies right to left from the first suffix to a root, and otherwise left to right from stems to suffixes (Kiparsky 2024).

Finnish harmony has no such systematically flipped directionality, for all suffixes and enclitics are unspecified for backness and harmonize with their hosts, and prefixes and proclitics do not belong in the same harmony domain as their hosts.[2] But I submit that the cyclic application of harmony and default feature assignment, and the non-cyclic status of bound roots, shed light on a different puzzle that arises in Finnish vowel harmony: the mysterious harmonic ambivalence of the vowels *i, e*.

2 The Finnish neutral vowels between back and front

Finnish has eight vowels; back *u, o, a* and front *y, ö, ä* do not co-occur in words.

(2)

	u	o	a	y	ö	ä	i	e
Back	+	+	+	−	−	−	−	−
Round	+	+	−	+	+	−	−	−
High	+	−	−	+	−	−	+	−
Low	−	−	+	−	−	+	−	−

(3) a. Stems: *suopa* 'soft soap', *syöpä* 'cancer', **suopä, *suöpä, *suöpa, *süopa...*

[2] A tiny instance of it is the suffix *-kko*, which imposes [+Back] on its base in a handful of words: *venakko* 'Russian woman', *erakko* 'hermit', *emakko* 'sow' — respectively from *venä-* 'Russia', *erä-* 'wilderness', *emä* 'female animal', but *sisäkkö* 'housemaid', from *sisä* 'inside', *leväkkö* 'Scheuchzeria', 'pod grass', from *levä* 'algae'.

b. Suffixes: *maa-ta* 'land' (Part.Sg.), *maa-ton* 'landless' vs. *pää-tä* 'head' (Part.Sg.), *pää-tön* 'headless'

The front vowel *i* and *e* behave phonologically in a seemingly inconsistent way, as harmonically indifferent in some respects, harmonically front in others, and seemingly even harmonically back in yet others.

(4) a. /i/ and /e/ are invariant front vowels: *maa-ni* 'my land', *pää-ni* 'my head'.

b. They have no underlying back counterparts */ə/, */ɨ/ (differing in this respect from Hungarian /i/ and /e/).

c. Being front vowels, they trigger front harmony: *teh-dä* 'do/make', *tee-ttä-ä* 'cause to do', *teke-vä* (participle) 'doing', *tek-ijä* 'author, factor', *teke-yty-ä* 'pretend'.

Although /i/ and /e/ are plainly front vowels, their distribution differs from that of the other front vowels /ä, ö, y/.

(5) a. Unlike /ä, ö, y/, the vowels /i/ and /e/ combine freely with /a, o, u/ within basic underived stems: *hella* 'stove', *hellä* 'tender'; *passi* 'passport', *pässi* 'ram', *tukki* 'log', *tykki* 'cannon'.

b. Back harmony operates across /i/ and /e/.

i. *passi-lla* 'with a passport', *pässi-llä* 'with a ram'

ii. *hullu-tt-ele-mise-lle-si-ko?* 'to your fooling around?'
hylly-tt-ele-mise-lle-si-kö? 'to your wobbling?'
hell-i-tt-ele-mise-lle-si-kö? 'to your letting loose/caressing?'

c. Monosyllabic root allomorphs with /i/, /e/ impose back harmony on a large class of derivational suffixes.

i. *teke-* 'to do', 'to work': *tek-o* 'a deed', *tek-ais-ta* 'do quickly/carelessly', *te-os* 'a work', *teh-das* 'factory' (contrast the front endings in (4c)).

ii. *kiertä-* 'to turn': *kiert-o* 'circulation', *kierr-os* 'a turn', 'a round', *kiert-ue* 'tour'

Long sequences of neutral vowels can intervene between the harmony trigger and target, as in in (5bii). It is unlikely that the backness feature in long sequences like (5b) migrates by coarticulation from the first vowel to the last as a phonetic nuance of the intervening neutral vowels. Positing a phonological harmony process that skips these vowels, or a harmony rule that turns /i/ and /e/ to /ɨ/ and /ɤ/ or to [i̪], [e̪], followed by another rule that turns them back to [i] and [e] again, are mere restatements of the problem.

On a closer look, the distribution of *i, e* in underived stems seems even more surprising than (5a) lets on. Not only *can* they co-occur with back vowels in stems, but they seem to *preferably* do so – see (6), where I = *i,e* and C = C, CC...:[3]

[3]These percentages are based on a total of 808 underived disyllabic stems with neutral first syllables from Tuomi (1972). The relative frequencies of the reverse combinations aCI, uCI, oCI, äCI, yCI, öCI trend in the same direction, though much less sharply.

(6)

a. Back:				b. Front:			
	ICa	39.6%	(N=320)		ICä	7.5%	(N=61)
	ICu	24.6%	(N=199)		ICy	2.2%	(N=18)
	ICo	26.0%	(N=210)		ICö	0%	(N=0)

The data in (6) demonstrate that /i/ and /e/ are neutral in the lexicon, and that each harmonic vowel pairs with *i, e* in proportion to its overall frequency *a* > *u* > *o* > *ä* > *y* > *ö*:

(7)

	lexical frequency	text frequency	features/elements
i	24.13%	22,34%	0
a	23.81%	24,24%	1
e	14.84%	17,13%	1
u	12.46%	10,43%	1
o	10.03%	11,07%	2
ä	8.07%	10,03%	2
y	4.98%	3,78%	2
ö	1.67%	0,99%	3

But a closer look at the numbers in (6) and (7) already reveals a subtle hint of disharmony. (7) shows that every back vowel *a, o, u* outnumbers its front counterpart overall, but (6) shows that this disparity is significantly enhanced in the second syllable after neutral *i, e*, for each of the three vowel pairs. In productive processes of loanword adaptation, language variation, and language acquisition, this preference for pairing the unmarked neutral vowels with the unmarked back vowels within disyllabic stems becomes categorical. First, any harmonic vowels that are epenthesized after loanwords with *i, e* roots are [+Back].

(8)
a. Swedish *sprit* > *pirtu* 'alcohol', *sik* > *siika* 'whitefish', *dricks* > *riksa* 'tip', *själ* > *sielu* 'soul', *tält* > *teltta* 'tent',
b. German *Herr* > *herra* 'master', 'mister', *Beil* > *piilu* 'axe'
c. Russian *les* 'wood' > *liesa* 'collar beam' ' *mir* 'world' > *miero* 'away from home', 'penury'

The treatment of vowel combinations in child language and vernacular accommodations of loan vocabulary tells the same story. 2;6-year-olds sometimes substitute *kenka* for *kenkä* 'shoe' (Leiwo et al. 2006), but no substitutions in the opposite direction, such as **kelkkä* for *kelkka* 'sled', have been reported. Speakers may regularize disharmonic words, substituting *pösö* for *Peugeot*, *olumpia-* for *olympia-*, *pulituuri* for *polityyri* 'shellac furniture polish', *rotuli* for *trotyyli* 'TNT'. But the vocalism of nonnative words of the type (6a), such as *revolveri, Tesla*, *metro*, and *disko*, is entirely stable. No-one would replace them by **revölveri*, **Teslä*, **metrö*, and **diskö*. This does point to an affinity of neutral vowels with back vowels, for the harmonic front vowels *ä, ö, y* by themselves are perfectly stable: *vyötärö* does not become **vuotaro* in vernacular speech.

In certain derived environments, the association of /i/ and /e/ with back harmonic vowels actually becomes obligatory. A small example is emphatic reduplication, where *i, e* trigger back *-o* rather than *-ö*. In the emphatic prefix /C_1VC_2O-/, the first syllable reduplicates the first syllable of the base, and C_2 is usually *p*. The second syllable's mid vowel /O/ then harmonizes with the first syllable: *tiessään* 'gone', 'vanished' *tipotiessään* (not **tipötiessään*) 'all gone'.

(9) täpö-täysi upo-uusi tipo-tiessään

More examples of the pattern, with (10c) being the case of interest:

(10) a. *täysi* 'full', *täpötäysi* 'chock full'; *tyhjä* 'empty', *typötyhjä* 'completely empty'; *yksin* 'alone', *ypöyksin* 'all alone'

b. *uusi* 'new', *upouusi* 'brand new'; *alasti* 'naked', *apoalasti* 'stark naked' *hiljaa* 'quiet', *hipohiljaa* 'totally quiet'; *selällään* 'open', *seposelällään* ∼ *selkoselällään* 'wide open' (not **hipö-, *sepö-, *selkö-*)

More evidence comes from morphological truncation. Inserted vowels in shortened hypocoristics and colloquialisms are [+Back], even if the full form contains *ä, ö, y*, as in (11b), and this holds also for suffixes added to all-neutral suppletive stem allomorphs, as in (11c).[4]

(11) a. *Eero* (< *Eerik*), *Vilho* (< *Vilhelm*), *Viku* < *Vickers*, *Pena* < *Pentti, Eppu* < *Erkki*, *veikko* (< *veli*) 'brother', *viitonen* 'a fiver' (< *viisi*) *vessa* 'WC' (< *veesee*), *helkkari* 'hell' (< helvetti), *senttari* 'freelance journalist' (< *sentti[metri]* 'centimeter'), *penkkarit* (< *penkin[painajaiset]*) 'high school graduation celebration', *teekkari* (< *teknologi*) 'engineering student', *nimmari (< nimipäivä)* 'nameday', *peppu* 'ass' (< *perse*), *sinkku (< singeli)* 'single'

b. *eka* 'first' (< *ensimmäinen*), *nelonen* 'a four' (< *neljä*), *seiska* 'a seven' (< *seitsemän*), *Kekäläinen* > *Keku*, *Vepsäläinen* > *Vepsu*, *Finnberg* [fin:bærj] > *Fimppu*, *Lindberg* [lindbærj] > *Limppu*, *Ensiö* > *Enska*

c. *pituus (*pitkuus)* 'length', *pituinen (*pitkuinen)* 'of X length', from *pitkä* 'long', *nelonen (*neljonen)* 'a four', from *neljä* 'four'.

The conclusion is that truncated stems are separate allomorphs, which undergo phonology on their own. When the harmonic vowels of the stem are lost and only neutral vowels are left, the remainder behaves as an all-neutral stem and pairs with back harmonic vowels under the same conditions as original all-neutral stems. This is evidence against analyses that posit [Back] as a feature associated with entire morphemes.[5]

Finally, all-neutral roots that become monosyllabic by regular phonological truncation impose [+Back] harmony on vocalic derivational suffixes:

(12)

/ime-/	'suck'	/ime-u/	*imu*	'suction'
/pese-/	'wash'	/pese-u/	*pesu*	'washing'
/mene-/	'go'	/mene-o/	*meno*	'going'
/iske-/	'strike'	/iske-uri/	*iskuri*	'striker'
/potki-/	'kick'	/potki-uri/	*potkuri*	'propeller'
/teke-/	'do, make'	/teke-okse/	*teos*	'work'
/retke-/	'trip'	/retke-ue'/	*retkue*	'group'

[4]Some of the nicknames are cited from Koski (2004).

[5]Morphological truncation works this way in Hungarian too (Rebrus et al. 2013).

To summarize: within morphologically simple stems the neutral vowels *i* and *e* freely co-occur with back harmonic vowels in proportion to their frequency. In morphologically complex words, neutral vowels generally impose front harmony on suffixes, except for monosyllabic roots like (5c) and (12).

My attempt at explaining these generalizations is framed in Stratal OT, and relies on the abovementioned assumptions that lexical representations are minimally specified, and that phonology and morphology are cyclically interleaved, with bound roots not constituting cyclic domains.

3 The analysis

Underlying representations in OT are characterized by the stem-level constraint system, and what rule-based phonology does by leaving a feature value unspecified a given context corresponds in classical OT to a constraint ranking that allows it to be arbitrarily specified in that context, in virtue of not being protected by any faithfulness constraint. Those feature values that in classical OT may be arbitrarily specified or unspecified in the input, with no effect in the output, are lexically unspecified in this approach, by lexicon optimization. The set of vowels that are unmarked for the feature [Back] is the golden quintet *a, o, u, i, e* of cross-linguistically favored vowels.[6] Their backness values are assigned by default on the basis of height and rounding. The markedness of a segment is formally modeled by the number of feature specifications in the lexicon required to represent it. (7) shows an almost perfect inverse correlation of frequency with markedness in this sense.[7]

The unspecified vowels get specified for backness in the cyclic phonological derivation by (13), harmony permitting: *i, e* as [–Back] and harmonic *a, o, u* as [+Back].

(13) a. $*\begin{bmatrix}+\text{Back}\\-\text{Round}\\-\text{Low}\end{bmatrix}$ (*ɨ, *ʉ, undominated)

b. *[αBack] [–αBack] (in the lexical phonology)

c. A vowel is [+Back].

d. A vowel is [–Back].

Neutral *i, e* thereby become front harmony triggers in subsequent cycles. For example, the first vowel of *passi* 'passport' is lexically unspecified for the feature [Back] and gets specified as [+Back] by (13c). The first vowel of *pässi* 'ram' is specified as [–Back] in order to defeat that constraint. The second, neutral vowel is unspecified in the

[6] Cf. Goldsmith (1990: 302) for Turkish.

[7] The formal markedness of vowels as measured by the minimal specifications of the features in (2) (or the corresponding elements, van der Hulst 2018) correlates exactly with their lexical frequencies in a 75.000 word electronic word list (Tuomi 1972), and fairly well also with the text frequencies determined by Pääkkönen (1991) from a corpus of 534,400 words. For consistency with the latter, I counted long vowels in the word list doubly, which lowers the frequencies of *e* and *o* a bit and raises those of *i* and *u* (due to the diphthongization /ee/, /oo/ → *ie*, *uo*) but without altering the relative frequencies of the vowels.

lexicon in both words.[8] (13b) assigns a violation mark to a sequence of a [αBack] vowel locally followed by a [–αBack] vowel. The resolution of violations is governed by the faithfulness constraints (1aii). (14) shows the derivations of the Essive Singular forms of *lasi* 'glass' and *väri* 'color'. The harmonic feature [Back] is represented autosegmentally for perspicuity. Capitalized vowels are unspecified for the feature [Back]. M = morphology.

(14) a. värI $\xrightarrow{(13b,d)}$ väri $\xrightarrow{M}$ väri-nA $\xrightarrow{(13b,d)}$ väri-nä 'as color' (Essive Sg.)
–B –B –B –B

b. /lAsI/ $\xrightarrow{(13a,c)}$ lasI $\xrightarrow{M}$ lasI-nA $\xrightarrow{(13c)}$ lasI-na $\xrightarrow{\text{Postlex.(13d)}}$ la si-na 'as glass'
+B +B +B +B +B –B +B

In (14a), (13b) prevents *-nA* from undergoing (13c), so it becomes *-nä* by (13d). In (14b), (13c), which outranks (13c),[9] makes *a* [+Back], but /I/ cannot become [+Back] because of (13a), nor [–Back] because of (13b). (13c) is therefore free to back *-nA* to *-na*. /I/ is then assigned [–Back] by (13d) postlexically, where (13b) is demoted.

4 Opacity as a consequence of cyclicity

A stem-final vowel is deleted before a vocalic suffix, in satisfaction of an anti-hiatus requirement, which outranks the harmony constraints: *V.V ≫ No ɨ,ʏ ≫ Harmony ≫ +B ≫ –B. But what happens if the deleted vowel is the only harmonic vowel of a base? Does the suffix still harmonize with it, or not?

In most cases, deleted harmonic front vowels do trigger front suffix harmony, as the examples in (5c) already show. This typically happens in denominal derivatives, and in a class of deverbal derivatives as well. Let us consider them in turn.

Examples of harmonic contrast preservation in nominal → nominal derivation are given in (15a) and (15b). The lexically distinctive harmonic contrast between the nouns in (a) and (b) is preserved in their derivatives even though the vowel that carries it is deleted.[10]

[8] When word-final *-e* is raised to *-i* in Finnish, it triggers assibilation, e.g., /kante/ → *kansi*. The assibilation context must be specified as [+High] to exclude *e* and as [–Round] to exclude *y*, and this is sufficient to identify *i*. In Votic, *i* is neutral for harmony, but [–Back] for lateral assimilation (Blumenfeld & Toivonen 2016).

[9] The principle is that the constraint assigning the complement value of the lexically marked ranks higher, in this case (13c) ≫ (13d).

[10] Exceptions are *metsuri* 'lumberjack' from *metsä* 'forest', and *pitko* 'baguette', from *pitkä* 'long'. The suffixes *-ue* and *-us* with its extended form *-us-ta* show variation, e.g. *retkue* ∼ *retkye* 'touring group', from *retki* 'excursion', *pesue* ∼ *pesue* 'brood', from *pesä* 'nest'; *kehä* 'rim, circle, periphery, enclosure' > *kehys* 'frame' vs. *seinä* 'wall' > *seinus(ta)* 'area by the wall', *selkä* 'back' > *selusta* 'rear'. Importantly, the exceptions are all in one direction: there are no cases like *teltta* ∼ **telttye*.

(15)	a.	*isä*	'father'	/isä-uute/	*isyys*	'fatherhood'
		herkkä	'sensitive'	/herkkä-uute/	*herkkyys*	'sensitivity'
		pesä	'nest'	/pesä-ue/	*pesye* ∼ *pesue*	'litter'
		kehä	'circle'	/keh-ukse/	*kehys*	'frame'
		leveä	'broad'	/leveä-uinen/	*levyinen*	'of X breadth'
		tiheä	'dense'	/tiheä-uinen/	*tiheyinen*	'of X density'
	b.	*piispa*	'bishop'	/piispa-uute/	*piispuus*	'episcopate'
		piru	'devil'	/piru-uute/	*piruus*	'devilry'
		linna	'castle'	/linna-ue'/	*linnue*	'castle personnel'
		lippu	'flag'	/lippu-ue'/	*lippue*	'flotilla'
		teltta	'tent'	/teltta-ue'/	*telttue*	'group in a tent'
		melu	'noise'	/melu-uinen/	*meluinen*	'noisy'

The cyclic application of harmony explains the opaque fronting, as illustrated by the derivation of *isyys* 'fatherhood'.

(16) $[\text{Isä}]_{\text{N}} \xrightarrow{\text{(13d)}} [\text{isä}]_{\text{N}} \xrightarrow{\text{M}} [[\text{isä}]_{\text{N}}\text{-UUs}]_{\text{N}} \xrightarrow{\text{VD}} [\text{isUUs}]_{\text{N}} \xrightarrow{\text{(13d)}} [\text{isyys}]_{\text{N}}$

–B	–B	–B	–B	–B

As a cyclic domain, the noun stem gets fully specified as [–Back] by (13d) before suffixation applies in the second cycle, as in (14b). (13b) then prevents (13c) from marking the suffix as [+Back], and it defaults to [–Back] by (13d). The constraint interactions are again transparent at each stage; the opacity comes from the layered morphology.

Turning to verbs derived from nouns and adjectives, we find again that a deleted front harmonic vowel in the stem triggers front suffix harmony.[11]

(17)	a.	*lipeä*	'lye'	*lipeöidä*	'to treat with lye'
		rettelö	'riot'	*rettelöidä*	'to riot'
		vispilä	'whisk'	*vispilöidä*	'to whisk'
		esitelmä	'lecture'	*esitelmöidä*	'to lecture'
		kipinä	'spark'	*kipinöidä*	'emit sparks'
	b.	*televisio*	'TV'	*televisioida*	'televise'
		ristikko	'lattice'	*ristikoida*	'to screen'
		nimikko	'someone's own'	*nimikoida*	'mark as someone's'
		tiirikka	'lock pick'	*tiirikoida*	'pick locks'
		penikka	'puppy'	*penikoida*	'have puppies'

Deverbal derivation is of two types. In verb → verb derivatives, built by productive inner aspect morphemes, we find once again that a deleted harmonic vowel in the stem triggers suffix harmony.[12]

(18) Momentaneous *-ahta-*

[11]The cases in (17) would also be compatible with parsing the suffix as *-i-* with raising and rounding of preceding *a, ä* to *o, ö*. But words like *entis-öi-dä* 'restore', from *entise-* 'previous', and *aktiv-oi-da* 'activate', from *aktiivi* 'active' show that the suffix is *-oi-*.

[12]An exception is *repäistä* 'tear off', from *repi-* 'tear'.

a.	/lentä-/	‘fly’	/lentä-ahta-/	*lennähtä-*	‘fly off (abruptly)’
	/viipy-/	‘stay’	/viipy-ahta-/	*viivähtä-*	‘stay (a while)’
	/veny-/	‘stretch’	/veny-ahta-/	*venähtä-*	‘stretch (suddenly)’
b.	/liikku-/	‘move’	/liikku-ahta-/	*liikahta-*	‘budge (a little)’
	/seiso-/	‘stand’	/seiso-ahta-/	*seisahta-*	‘stop (briefly)’
	/kiehu-/	‘boil’	/kiehu-ahta-/	*kiehahta-*	‘boil up, boil briefly’

(19) Semelfactive *-aise-*

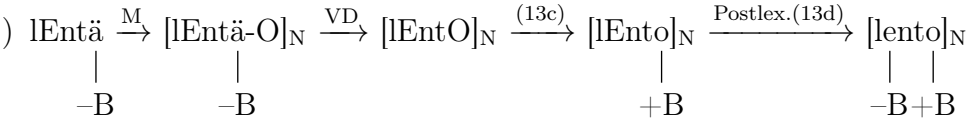
a.	/vetä-/	‘pull’	/vetä-aise-/	*vetäise-*	‘tug’
	/silmä-t-/	‘to eye’	/silmä-aise-/	*silmäise-*	‘to glance at’
b.	/vihlo-/	‘twinge’	/vihl-aise-/	*vihlaise-*	‘suddenly twinge’
	/kehu-/	‘praise’	/kehu-aise-/	*kehaise-*	‘make a praising remark’
	/kieto-/	‘wrap’	/kiet-aise-/	*kietaise-*	‘wind, wrap quickly’

In all these cases, vowel harmony takes effect “before” the final harmonic vowel is deleted at the stem boundary. But in nouns derivatived from simple verbs, a deleted harmonic vowel usually does *not* trigger suffix harmony.

(20)

/-o/	/lentä-/	‘fly’	/lentä-o/	*lento*	‘flight’
/-o/	/sietä-/	‘tolerate’	/sietä-o/	*sieto*	‘tolerance’
/-oks/	/pettä-/	‘deceive’	/pettä-okse/	*petos*	‘deception’
/-uu/	/kerät-/	‘collect’	/kerät-uu/	*keruu*	‘collecting’
/-ue/	/kiertä-/	‘circulate’	/kiertä-ue’/	*kiertue*	‘tour’
/-ue/	/lentä-/	‘fly’	/lentä-ue’/	*lentue*	‘squadron’
/-uri/	/pettä-/	‘betray’	/pettä-uri/	*petturi*	‘betrayer’
/-uri/	/vetä-/	‘pull’	/vetä-uri/	*veturi*	‘locomotive’

This could be explained on the assumption that monomorphemic verbal bases enter the derivation as bound *roots*, rather than as verb stems. If the nouns are derived from bound roots, the correct output is derived as shown for *lentä-* → *lento* in (21).

(21) 

The key is that roots, not being cyclic constituents, do not undergo any phonology prior to combining with the affix, and specifically do not undergo (13b). Consequently the first vowel in (21) remains unspecified for backness when it first enters the phonology in the base of the derived noun. At that point its final *-ä* is deleted along with its [–Back] feature. The residue then gets [+Back] cyclically assigned to the suffix vowel. The neutral *e* is specified as [–Back] in the postlexical phonology where harmony is no longer operative. The transparent (bleeding) interaction of vowel deletion and harmony in the derivation is dictated by OT itself.

There is some independent morphological support for the idea that the verb → noun suffixes in (20) that are [+Back] after all-neutral stems are root-based. It comes from distributional restrictions and from semantics. These suffixes may select special bound allomorphs of their bases, e.g. /pit-/ for *pitkä* ‘long’ in *pit-uus* ‘length’. Some of them (*-o, -os*) go only on morphologically simple stems. In contrast, suffixes that can be added to morphologically complex stems appear with regular front harmony after them.

(22)

		a. root derivatives		b. stem derivatives	
/itke-/	'cry'	itk-u	'crying'	itke-sk-el-y	'continuous crying'
/piene-/	'small'	pien-uus	'small size'	pien-emm-yys	'smaller size'
/miese-/	'man'	mieh-uus	'manhood'	suur-mieh-yys	'being a great man'
/teke-/	'do'	tek-o	'deed'	tee-sk-ent-el-y	'pretending'
/pese-/	'wash'	pes-u	'washing'	pes-ais-u	'a quick wash'
/piere-/	'fart'	pier-u	'fart'	pier-esk-el-y	'farting around'
/hiihtä-/	'ski'	hiiht-o	'skiing'	hiiht-el-y	'skiing around'
/vetä-/	'pull'	vet-o	'a pull'	vet-äis-y	'a yank'

On the semantic side, the relationship of root derivatives like (21) and (22a) to their base verb is often tenuous, and you can't reliably guess the meaning of the derived noun from the source verb. Often it is based on a specialized meaning of it, and sometimes it has a meaning which is not present in the verb. *Veturi*, from *vetä-* 'pull', is not any puller, but specifically a locomotive. *Vedos* is not any pulling, but specifically a proof, a test print. *Veto* means not only 'pulling', but also 'attraction', 'stroke', and 'release'. *Iskos*, from *iske-* 'strike' is not any striking, but a chip or flake struck from stone. *Lentue* 'flight', with the collective-noun forming *-ue* from *lentä-* 'fly', is not any group of fliers, but specifically a squadron, the air force equivalent of a platoon. *Piirturi*, from *piirtä-* 'draw', is not any drawer, but specifically a graphing device. *Keitto*, from *keittä-* 'boil', 'cook', is soup. *Pito-*, from *pitä-* 'hold', is not only a holding, but also, in the plural, a party. *Veistos*, from *veistä-* 'carve' is a sculpture, whether produced by carving, chiseling, casting, welding or some other technique. Although I have specially cited examples where a final harmonic front vowel of the stem is lost, the tendency to semantic drift is seen in deverbal root-based nominalizations regardless of the phonological form of the base.

In contrast, the derivatives in (15)-(19) maintain a closer relationship to their bases. For example, inner aspect suffixes generally don't modify the lexical semantic content but just add an adverbial *Aktionsart* modification, nouns in *-uus* from morphologically complex stems typically denote simply the property denoted by the stem, and adjectives in *-uinen* mean having that property.

5 A note on the origins of the disharmonic tendency

The dischrony of the disharmonic tendency observed with neutral vowels is intertwined with controversial issues of Balto-Finnic vocalism, in particular the origin and phonological status of the back unrounded vowel *õ* (now thoroughly treated by Mattsson 2021). I conclude with a few tentative remarks on the question.

In the oldest Finnish vocabulary, neutral *i, e* is followed only by front vowels. Inherited from Uralic are Finnish *silmä* 'eye', *isä* 'father', *setä* 'uncle', *vehnä* 'wheat', *elä-* 'live', and *lintu* 'bird'. Later but still pre-Balto-Finnic are *veistä-* 'carve', *niel-lä* 'swallow', *petäjä* 'pine', *neljä* 'four', *sepä* 'curved part of sled', *pies-tä* 'beat', *emä* 'female animal', *enä-* 'many', *itä-* 'germinate', *itä* 'east'. Among these words, only *lintu* has a back vowel in the second syllabler, but its *i* may be of secondary origin, for on the basis of the likely Saami cognate it is reconstructed with initial *u*, though this leaves the Finnish *i* unexplained.)

Combinations of neutral *i, e* in the first syllable and a back vowel in the second syllable vowel and a following back vowel do not seem to be reconstructible for Uralic, nor even for any stage prior to Balto-Finnic. They seem to appear first about two millennia ago in the large layer of Baltic and Germanic loanwords. The back vowel was retained in most of them, such as Finnish *sisar* 'sister', *miekka* 'sword', *silta* 'bridge', *tila* 'place', *rengas* 'ring', *verta* 'like', 'comparable', *verkko* 'net', *heimo* 'clan', *rieska* 'unleavened bread', *neula* 'needle', *seula* 'sieve', *kerta* 'level', 'time' *('fois', 'Mal')*, *kelpat-* 'to be adequate' (*'taugen'*), *leuka* 'jaw', *rehto* 'distance between two stakes', *pilkka* 'mockery', *lieka* 'tether', *seikka* 'matter', 'circumstance', *kelkka* 'sled', *tela* 'log', 'roller', *kelta* 'yellow', *viitta* 'sign'. Notably, even words whose citation form was monosyllabic followed this pattern, e.g. *riita* 'strife' from *strīþ*. However, there were other words of Baltic ar Germanic provenance where *-a* was rendered with a front *-ä*: *seiväs* 'pole', *heinä* 'hay', *seinä* 'wall', *vielä* 'still, yet', *keihäs* 'spear', *leipä* 'bread', *heittä-* 'throw', *peittä-* 'cover'.[13] This influx of loanwords, probably carried by bilingual speakers, is likely to have been responsible for the introduction of the neutral+back combination and its rise to unmarked status, beginning with the productive stratum of the vocabulary.

6 Conclusions

Finnish vowel harmony requires no domain-specific analytic machinery. Contrary to appearances it propagates from vowel to vowel in strictly local structure-preserving fashion. Opaque vowel harmony can be accounted for with the resources of Stratal OT, which supports a cyclic account that predicts that a final vowel in hiatus is deleted "before" harmony in roots and "after" harmony in stems.

Acknowledgements

I am grateful to two referees (one of whom I suspect of being Andrew Garrett) for their astute and constructive comments.

References

Archangeli, Diana & Douglas Pulleyblank. 2002. Kinande vowel harmony: domains, grounded conditions and one-sided alignment. *Phonology* 19(2):139–188.

Baković, Eric. 2000. *Harmony, dominance, and control.* New Brunswick, NJ: Rutgers University dissertation.

Beckman, Jill N. 1997. Positional faithfulness, positional neutralization, and Shona vowel harmony. *Phonology* 14(1):1–46.

Benua, Laura. 1997. *Transderivational identity: Phonological relations between words*: U. Mass. dissertation.

[13]To avoid misunderstanding: the most frequent nativizer vowel for words ending in consonants in modern Finnish is *-i*, e.g. *test* > *testi*; *miss* > *missi*; *president* > *presidentti*.

Blumenfeld, Lev & Ida Toivonen. 2016. A featural paradox in Votic harmony. *Natural Language and Linguistic Theory* 34:1167–1180.

Causley, Trisha. 1997. Identity and featural correspondence: the Athapaskan case. *North East Linguistics Society* 27(8).

Coetzee, Andries. 2006. Variation as accessing 'non-optimal' candidates. *Phonology* 23:337–85.

Cole, Jenifer & C. W. Kisseberth. 1994. An Optimal Domains Theory of harmony. *Studies in the Linguistic Sciences* 24(2):101–114.

Goldsmith, John. 1990. *Autosegmental and metrical phonology*. Oxford and Cambridge, MA: Blackwell.

Hargus, Sharon. 1988. *The lexical phonology of Sekani*. New York: Garland.

Harris, James W. 1983. *Syllable structure and stress in Spanish: a nonlinear analysis*, vol. 8 Linguistic Inquiry Monograph. Cambridge, MA: MIT Press.

van der Hulst, Harry. 2018. *Asymmetries in vowel harmony*. Oxford: Oxford University Press.

Inkelas, Sharon. 1989. *Prosodic constituency in the lexicon*: Stanford University dissertation.

Inkelas, Sharon. 2005. *The interplay of morphology and phonology* Oxford Syrveys in Syntax and Morphology. Oxford: Oxford University Press.

Itô, Junko & Armin Mester. 2003. *Japanese morphophonemics: Markedness and word structure* (Linguistic Inquiry Monograph Series 41). Cambridge, Massachusetts: MIT Press.

Kaun, Abigail R. 1995. *The typology of rounding harmony: an Optimality Theoretic approach*. Los Angeles: UCLA dissertation.

Kiparsky, Paul. 1982. Lexical morphology and phonology. In I.-S. Yang (ed.), *Linguistics in the morning calm*, Seoul: Hanshin.

Kiparsky, Paul. 1994. Remarks on markedness. Handout for TREND (Trilateral Phonology Weekend), Santa Cruz. https://web.stanford.edu/~kiparsky/Papers/trend.pdf.

Kiparsky, Paul. 2020. Morphological units: Stems. In *Oxford research encyclopedia of linguistics*, Oxford: Oxford University Press.

Kiparsky, Paul. 2024. Domains of vowel harmony. In Nancy A. Ritter & Harry van der Hulst (eds.), *The Oxford handbook of vowel harmony*, chap. 17. Oxford: Oxford University Press.

Koski, Mauno. 2004. Sekundaarinimiä ja opettajien viittausnimiä. *Sananjalka* 46(1):40–80.

Krämer, Martin. 2003. *Vowel harmony and Correspondence Theory.* Berlin: Mouton De Gruyter.

Lamontagne, Greg & Keren Rice. 1995. A correspondence account of coalescence. *UMOP* 18:249–384.

Leiwo, Matti, Pirjo Kulju & Katsura Aoyama. 2006. The acquisition of Finnish vowel harmony. In Mickael Suominen et al. (edd.) A Man of Measure : Festschrift in Honour of Fred Karlsson (ed.), *A man of measure: Festschrift in honour of Fred Karlsson on his 60th birthday*, 149–161. The Linguistic Association of Finland.

Lombardi, Linda. 1999. Positional faithfulness and voicing assimilation in optimality theory. *Natural Language and Linguistic Theory* 17(2):267–302.

Mattsson, Katja. 2021. *Zur Herkunft von ostseefinnisch õ.* Göttingen: Georg-August Universität dissertation.

McCarthy, John. 2004. Headed spans and autosegmental spreading. *ROA* 685.

McCarthy, John. 2011. Autosegmental spreading in Optimality Theory. In John Goldsmith, Elizabeth Hume & Leo Wetzels (eds.), *Tones and features*, 195– 222. Berlin: Mouton de Gruyter.

McCollum, Adam G. & James Essegbey. 2020. Initial prominence and progressive vowel harmony in Tutrugbu. *Phonological Data and Analysis* 3:1–37.

McPherson, Laura & Bruce Hayes. 2016. Relating application frequency to morphological structure: the case of Tommo So vowel harmony. *Phonology* 33:125–167. doi:doi:10.1017/S0952675716000051.

Nevins, Andrew. 2010. *Locality in vowel harmony.* Cambridge, MA: MIT Press.

Ozburn, Avery. 2019. *A target-oriented approach to neutrality in vowel harmony.* Vancouver: University of British Columbia dissertation.

Pääkkönen, Matti. 1991. A:sta o:hön: Suomen yleiskielen kirjaintilastoja. *Kielikello* 1. https://jkorpela.fi/kielikello/kirjtil.html.

Padgett, Jaye. 1995. Partial class behavior and nasal place assimilation. In Keiichiro Suzuki & Dirk Elzinga (eds.), *Proceedings of the 1995 Southwestern Workshop on Optimality Theory (SWOT)*, Tucson: Department of Linguistics, University of Arizona.

Padgett, Jaye. 2002. Feature classes in phonology. *Language* 78:81–110.

Pulleyblank, Douglas. 1996. Neutral vowels in Optimality Theory: a comparison of Yoruba and Wolof. *Canadian Journal of Linguistics* 41(4):285–347.

Rebrus, Péter, Péter Szigetvári & Miklós Törkenczy. 2013. Dark secrets of Hungarian vowel harmony. In Eugeniusz Cyran, Henryk Kardela & Bogdan Szymanek (eds.), *Sound, structure and sense: Studies in memory of Edmund Gussmann*, Lublin. Wydawnictwo KUL. https://www.researchgate.net/publication/279750289_Dark_secrets_of_Hungarian_vowel_harmony.

Rhodes, R. 2012. Vowel harmony as Agreement by Correspondence. Tech. Rep. 8 UC Berkeley Phonology Lab.

Ringen, Catherine O. & Miklós Kontra. 1989. Hungarian neutral vowels. *Lingua* 78:181–191.

Rose, Sharon & Rachel Walker. 2004. A typology of consonant agreement as correspondence. *Language* 80:475–531.

Tuomi, Tuomo. 1972. *Reverse dictionary of modern standard Finnish.* Helsinki: Suomalaisen Kirjallisuuden Seura.

Wheeler, Max W. 2005. Cluster reduction: Deletion or coalescence? *Catalan Journal of Linguistics* 4:57–82.

Wilson, Colin. 2003. Analyzing unbounded spreading with constraints: marks, targets, and derivations. Unpublished manuscript, UCLA.