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*Hungarian vowel harmony in Optimality Theory**

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1 Introduction

Vowel harmony systems have presented descriptive challenges for virtually every well-articulated theory within the framework of generative phonology. Significantly, no comprehensive and completely satisfactory account in a rule-based theory exists for one of the best studied of these systems, that of Hungarian.[1] The novel approach of Optimality Theory (henceforth OT), as originally developed by Prince & Smolensky (1993) and McCarthy & Prince (1993a, b, 1995), has been shown to offer insightful solutions to vexing problems of prosodic phonology and morphology.[2] This paper seeks to relate the insights of OT to the

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[1] See, for example, the analyses and discussions in Battistella (1982), Booij (1984), Clements (1977), Farkas & Beddor (1987), Goldsmith (1985), van der Hulst (1985), Jensen (1971, 1978, 1984), Jensen & Stong-Jensen (1988), Kornai (1987), Phelps (1978), Ringen (1975, 1978, 1980, 1982, 1988a), Steriade (1987), Vago (1973, 1976, 1978, 1980b, 1980c) and Zonneveld (1980).

[2] We assume familiarity with the basic issues and assumptions of Optimality Theory.

description of Hungarian vowel harmony: it provides a detailed description of the facts, offers solutions to heretofore unresolved problems, and draws conclusions for general theoretical issues within the OT model.[3]

In §2 we present the facts of backness harmony as the empirical backdrop to the ensuing discussions. In §3 we present an analysis of backness harmony in OT. The 'spreading' of the feature [±back] is accounted for by an alignment constraint which is formulated as a constraint prohibiting vowels from intervening between the right edge of a backness feature and the right edge of the word, following proposals of Ellison (1995), Kirchner (1993) and Zoll (1996). We analyse certain roots with floating features, adopting a proposal by Zoll (1996) which ensures that floating features are in fact realised in outputs (unless blocked by satisfaction of higher-ranked constraints). We also assume, following much recent work in OT (Beckman 1995, 1997, 1998, McCarthy & Prince 1995, Steriade 1995, Zoll 1996), that certain prominent positions (e.g. roots) may be subject to more stringent faithfulness constraints than are less prominent positions (e.g. affixes). We further demonstrate that inventory constraints interact with other constraints to determine optimal outputs. In §4 roundness harmony data are presented. We argue that while backness harmony involves alignment constraints, so-called 'roundness harmony' does not, and hence that it is a mistake to assume that all cases of vowel harmony involve alignment constraints.

2 Data

The essential facts of backness harmony in Hungarian are well known. The surface vowels are given in (1).

(1)

	front				back		
	[−round]		[+round]		[−round]	[+round]	
	short	*long*	*short*	*long*	*long*	*short*	*long*
high	i [i]	í [iː]	ü [ü]	ű [üː]		u [u]	ú [uː]
mid		é [eː]	ö [ö]	ő [öː]		o [o]	ó [oː]
low	e [ɛ]				á [aː]	a [ɔ]	

The non-low front unrounded vowels [i], [iː] and [eː] are neutral or transparent; the other vowels are harmonic.[4] In native Hungarian roots,

[3] For a different view of how vowel harmony should be treated in OT, see Cole & Kisseberth (1994).

[4] The status of *e* ([ɛ]) is not uncontroversial (see Nádasdy & Siptár 1994 for some discussion). In native roots it does occur with back vowels, suggesting that it is neutral. On the other hand, it seems to function as a front harmonic vowel with respect to suffix harmony. For arguments for considering it to be front harmonic see Ringen (1975, 1978, 1980) and Ringen & Kontra (1989). Those who treat *e* as front harmonic include van der Hulst (1985), Papp (1975), Steriade (1987) and Szépe (1958). There is vacillation between front and back harmonic suffix vowels with some roots (mostly loans) with a back vowel followed by *e* (see Ringen & Kontra

front and back harmonic vowels do not generally cooccur.[5] Harmonic suffix vowels alternate depending on the quality of the last harmonic vowel of the root. The major types of roots from the perspective of backness harmony are given in (2a–g). The root sample in (2a) is back harmonic and that in (2b) is front harmonic; these govern back and front harmony, respectively, in suffixes. Like the root in (2c), most roots which contain a back vowel followed by a transparent vowel govern back harmony. Nearly all roots that contain only transparent vowels require front harmonic suffix vowels, as in (2d). However, about 50 roots of this type govern back harmony; an example is given in (2e). With disharmonic roots, i.e. those that contain both back harmonic and front harmonic vowels, the harmonic shape of suffixes is determined by the last harmonic root vowel. Thus, the root in (2f) requires back harmonic suffixes; that in (2g) front harmonic suffixes. As noted by Vago (1973, 1980c), although the vowel in the dative suffix *-nak/nek* alternates regularly, when it occurs independently with personal suffixes (e.g. *nek-em* 'to me') it has a front vowel and the suffix vowels are front. Other suffixes also occur independently with personal suffixes (e.g. *-nál/nél*: *nál-am* 'at me') but have back vowels and following (harmonic) suffix vowels are back.

(2) *Major harmony types*

			DATIVE	ADESSIVE
a.	ház	'house'	ház-nak	ház-nál
b.	tök	'pumpkin'	tök-nek	tök-nél
c.	radír	'eraser'	radír-nak	radír-nál
d.	víz	'water'	víz-nek	víz-nél
e.	híd	'bridge'	híd-nak	híd-nál
f.	nüansz	'nuance'	nüansz-nak	nüansz-nál
g.	sofőr	'chauffeur'	sofőr-nek	sofőr-nél

3 Backness harmony

In this section we will outline an analysis of the backness harmony data presented in §2. We assume that suffixes such as *-nak/nek* and *-nál/nél* are specified for backness as suggested by the quality they have when they function as roots. Hence we assume /nɛk/ and /naːl/. Following proposals by Ewen & van der Hulst (1985) and Steriade (1995), among others, we assume that the feature [ROUND] is privative.

Many recent analyses of vowel harmony in the framework of OT have followed Kirchner (1993) in assuming that harmony results from align-

1989 for data and discussion). Although it is beyond the scope of this paper to consider how these vacillating forms should be analysed, similar vacillation data in Finnish are analysed in Ringen & Heinämäki (to appear), where it is shown that the vacillation data can be predicted very accurately if some of the constraints are unranked. We believe that a similar account of the vacillating Hungarian forms is possible.

[5] The exception to this statement is that *e* occurs with back vowels in native roots. See note 4.

ment constraints (McCarthy & Prince 1993b). We also assume that backness harmony in Hungarian results from an alignment constraint, but we follow Zoll (1996), who argues convincingly for the adoption of Ellison's (1995) formulation of alignment as a constraint against segments which intervene between some element and the edge of some domain:

(3) Align-R
No vowel intervenes between the right edge of [back] and the right edge of the prosodic word.

One violation is assessed for each vowel that intervenes between the right edge of the feature [back] and the right edge of the word.[6]

The tableau in (4) illustrates how the constraint Align-R operates:

(4)

/haːz + nɛk/ +bk −bk	Align-R
a. haːz-nɛk +bk −bk	*!
b. haːz-nɔk[7] +bk	
c. hɛːz-nɛk −bk	
d. hAːz-nAk	
e. haːz-nɔk +bk +bk	*!

Throughout this paper, capital letters indicate segments unspecified for backness. The vowel A, as in (4) above, is low.

Candidate (b), which is the correct output, is better than (a) with respect to Align-R. Candidate (a) violates Align-R because there is a vowel which intervenes between [+back] and the right edge of the word. Candidate (e) also violates Align-R because there is a vowel intervening between the right edge of the word and the first [+back]. This constraint is not sufficient to distinguish between candidates (b), (c) and (d); another constraint is clearly needed. The problem with both (c) and (d) is that the [+back] that is associated with the root vowel in the input is not associated with the root vowel in the output. These candidates violate one of the family of faithfulness constraints of McCarthy & Prince (1993a, 1995) and Prince & Smolensky (1993), which requires that input and output forms be identical. Following McCarthy & Prince (1995), we assume the

[6] Technically, no vowels intervene between the right edge of any backness specification and the right edge of the word. A more precise formulation of this constraint would refer to anchors for back: no vowel intervenes between the rightmost anchor of a backness specification and the right edge of a word.

[7] How this vowel is specified for roundness will be considered below.

Correspondence Theory of Faithfulness and adopt both the general faithfulness constraint on [back] in (5a) and the positional faithfulness on backness in harmonic root vowels in (5b). Candidates (c) and (d) violate the positional identity constraint.

(5) a. IDENT-IO$_{back}$

Correspondent input and output segments have identical specifications for [αback].

b. IDENT-IO$_{harm/root}$

Correspondent input and output harmonic root vowels have identical specifications for [αback] (harmonic vowels are those specified as low or round).[8]

Segments in prominent positions such as roots, initial syllables and stressed syllables are often subject to higher-ranking faithfulness constraints, as has recently been well documented; see for example McCarthy & Prince (1995) and Beckman (1995, 1997, 1998). We will see below the reason for formulating the root-faithfulness constraint on harmonic root vowels rather than all root vowels.

As can be seen in (6), (c) and (d) violate IDENT-IO$_{harm/root}$, and are eliminated. These would have been PARSE violations in Containment Theory (McCarthy & Prince 1993a, Prince & Smolensky 1993). The correct candidate, (b), is judged to be optimal. We see in this tableau that IDENT-IO$_{harm/root}$ and ALIGN-R must be ranked above IDENT-IO$_{back}$. In this and subsequent tableaux, we will not indicate the backness tier. Since vowels which have the same specification for backness but which are not linked to the same feature will always violate ALIGN-R (see (4e) above), we do not include such forms among the output candidates. Hence [haːz-nɔk] will be understood to mean an output with multiply linked [+back]. A form such as [haːz-nɛk], with differing specifications for backness of its vowels, will, of course, violate ALIGN-R.

(6) ID-IO$_{harm/rt}$, ALIGN-R ≫ ID-IO$_{bk}$

/haːz + nɛk/	ID-IO$_{harm/rt}$	ALIGN-R	ID-IO$_{bk}$
a. haːz-nɛk		*!	
☞ b. haːz-nɔk			*
c. hɛːz-nɛk	*!		*
d. hAːz-nAk	*!		**

[8] IDENT-IO$_{harm/root}$ is actually two separate constraints. One, IDENT-IOback$_{low/root}$, requires that correspondent input and output root vowels that are low have identical specifications for backness and the other, IDENT-IOback$_{round/root}$, requires that correspondent input and output root vowels that are rounded have identical specifications for backness.

Consider next a root with a front harmonic vowel such as in (2b). Parallel to candidate (b) in tableau (6), we see that candidate (a) in (7), with the [−back] specification of the root vowel associated with the rightmost suffix vowel as well as with the root vowel, is optimal. Here we illustrate a suffix vowel that is underlyingly back.

(7)

/tök + naːl/	Id-IO$_{harm/rt}$	Align-R	Id-IO$_{bk}$
☞ a. tök-neːl			*
b. tök-naːl		*!	
c. tok-naːl	*!		*

Forms with only neutral vowels, as in (2d), show the need for two additional constraints. We assume, following Kaun (1995), that there is a constraint, Specify, that requires that segments be specified for (binary) features. We further assume a constraint *ɨʌ, which prohibits the relatively marked back unrounded vowels [ɨ] and [ʌ] and their long counterparts:

(8) a. Specify
Segments should be specified for features.
b. *ɨʌ
Vowels which are [+back] and [−low] must be specified as round.[9]

Tableau (9) illustrates our account of roots containing only neutral vowels:

(9)

/viːz + naːl/	*ɨʌ	Id-IO$_{harm/rt}$	Align-R	Spec	Id-IO$_{bk}$
☞ a. viːz-neːl					*
b. viːz-naːl			*!		
c. vIːz-naːl				*!	*
d. vɨːz-naːl	*!				*

The constraints discussed to this point will also account for mixed vowel roots with a back harmonic vowel followed by a transparent vowel such as in (2c), as illustrated in (10) and (12). Capital I represents a high vowel unspecified for backness and not specified for privative [round]:

9 Many analyses of Hungarian vowel harmony have assumed such a constraint, beginning with Kiparsky (1981).

(10) *ɨʌ, Id-IO$_{harm/rt}$ ≫ Align-R

/rɔdiːr/[10]	*ɨʌ	Id-IO$_{harm/rt}$	Align-R	Spec	Id-IO$_{bk}$
☞ a. rɔdiːr			*		
b. rɔdɨːr	*!				*
c. rɔdIːr			*	*!	*
d. rɛdiːr		*!			*

We see in (10) that *ɨʌ and Ident-IO$_{harm/root}$ should be ranked above Align-R. We saw above that Align-R must be ranked above Ident-IO$_{back}$. This means we have established the ranking in (11):

(11) Ident-IO$_{harm/root}$, *ɨʌ ≫ Align-R ≫ Ident-IO$_{back}$

(12)

/rɔdiːr + nɛk/	*ɨʌ	Id-IO$_{harm/rt}$	Align-R	Spec	Id-IO$_{bk}$
a. rɔdiːr-nɛk			*!*		
b. rɔdɨːr-nɔk	*!				**
☞ c. rɔdIːr-nɔk				*	**
d. rɛdiːr-nɛk		*!			*
e. rɔduːr-nɔk		*!			**

In candidate (c), the single [+back] specification is linked to both the first and last vowels. The intervening vowel is unspecified for backness. Assuming that vowels unspecified for backness in the output are interpreted as front, the optimal output, (c) is correct. Now the reason for formulating the root faithfulness constraint on harmonic vowels should be clear. If all root vowels must be faithful to their input specifications, (c) will not be optimal. In order for the quality of the harmonic root vowel to affect the quality of the suffix vowel, the neutral vowel of the root must be unfaithful to the input specification for backness.

In the case of an exceptional neutral vowel root such as in (2e), we assume that the root morpheme has a floating [+back] feature.[11] Note that Ident-IO$_{harm/root}$ would not be violated if this floating [+back] feature were not present in the output. Specifically, given that identity constraints, as defined by McCarthy & Prince (1995), only require that correspondent *segments* have identical specifications, Ident-IO constraints will never require that floating *features* in the input appear in the output. Such

[10] We give the underlying form of this root with an initial *rounded* short vowel. Nothing crucial depends on this assumption. If the initial root vowel were not specified as [round], output (c) would still be designated as optimal since we assume an inventory constraint (discussed below) which requires that all short, low, back vowels be [round]. We assume that the input has a vowel which is specified as [round], as mandated by Lexicon Optimisation (Prince & Smolensky 1993).

[11] Most recent analyses have used floating [+back] features to characterise this class of exceptions; see Clements (1977), van der Hulst (1985), Kiparsky (1981) and Nádasdy & Siptár (1994), among others.

constraints are only relevant when there are correspondent segments in the input and output, and in this case the feature [+back] is not associated with any *segment* in the input. We apparently need another constraint which preserves features that are not associated with any segment in the input and hence not covered by IDENT-IO constraints. Such a constraint, MAX_{subseg}, is motivated in Zoll (1996).[12] As will be argued below, we must assume that there is a constraint to preserve floating *root* features, $\text{MAX}_{subseg/root}$, as well as the more general constraint MAX_{subseg}.

(13) $\text{MAX}_{subseg/root}$
Every subsegment which belongs to a root morpheme in the input must be present in the output.[13]

$\text{MAX}_{subseg/root}$ interacts with the other constraints to correctly designate (14a) as the optimal output when the floating [+back] occurs with a neutral root vowel. (Floating features are superscripted.)

(14) $\text{MAX}_{subseg/rt} \gg \text{SPEC}$

/hiːd$^{+}_{bk}$ + nɛk/	*ɨʌ	ID-IO$_{harm/rt}$	ALIGN-R	MAX$_{subseg/rt}$	SPEC	ID-IO$_{bk}$
☞ a. hIːd-nɔk					*	*
b. hiːd-nɛk				*!		
c. hiːd-nɔk			*!			*
d. hɨːd-nɔk	*!					**

The exceptional form *híd*, without any suffixes, shows the necessity of ranking *ɨʌ higher than $\text{MAX}_{subseg/root}$, as illustrated in (15):

(15) $\text{*ɨʌ} \gg \text{MAX}_{subseg/rt}$

/hiːd^{+}bk/	*ɨʌ	ID-IO$_{harm/rt}$	MAX$_{subseg/rt}$
a. hɨːd	*!		
☞ b. hiːd			*

If $\text{MAX}_{subseg/root}$ were ranked higher than *ɨʌ, then (15a) rather than the correct (15b) would be optimal.

Forms with two floating features such as in (16) show the necessity of separating $\text{MAX}_{subseg/root}$ from MAX_{subseg}. Specifically, since there are no constraints on inputs, we must consider the possibility that there are two floating features, one for the root and one for the suffix. It is the floating

[12] A subsegment is a floating class node or a floating feature.

[13] MAX_{subseg} requires only that the subsegmental root material be present in the output, not that it be present in the output of the root. Note that we assume only that the MAX_{subseg} constraint refers to input features which are floating, not to input features with segmental affiliation, as is assumed elsewhere. We do not believe that a case for replacing IDENT-IO constraints with MAX-f and DEP-f constraints has been made; however, discussion of this issue is beyond the scope of this paper.

root feature which must be preserved, not the affix feature. This is the result if Max$_{\text{subseg}}$ is separate from Max$_{\text{subseg/root}}$.

(16) Align-R ≫ Max$_{\text{subseg}}$

/hiːd$^{+}_{\text{bk}}$ + nɛk$^{-}_{\text{bk}}$/[14]	*ɨA	Id-IO$_{\text{harm/rt}}$	Align-R	Max$_{\text{subseg/rt}}$	Max$_{\text{subseg}}$	Spec
a. hɨːd-nɛk	*!		*			
☞ b. hIːd-nɔk					*	*
c. hIːd-nɛk				*!	*	*
d. hiːd-nɔk			*!			

It might seem problematic that floating features have a restricted distribution: they are only found with neutral vowel roots. The constraints assumed so far actually *predict* that it is only with neutral vowel roots that floating features can have any effect if Ident-IO$_{\text{harm/root}}$ and Align-R are ranked above Max$_{\text{subseg/root}}$. Consider first a hypothetical root with a front rounded root vowel and a floating [+back] feature:

(17) Id-IO$_{\text{harm/rt}}$, Align-R ≫ Max$_{\text{subseg/rt}}$

/tök$^{+}_{\text{bk}}$ + nɛk/	Id-IO$_{\text{harm/rt}}$	Align-R	Max$_{\text{subseg/rt}}$	Spec	Id-IO$_{\text{bk}}$
☞ a. tök-nɛk			*		
b. tök-nɔk		*!			*
c. tok-nɔk	*!				**
d. tOk-nɔk	*!			*	**

If there were such an input, the optimal output would be a perfectly good Hungarian form – indeed one that is indistinguishable from an identical input without a floating feature.[15]

Similarly, a floating [−back] root feature with a back vowel root will have no effect:

(18)

/haːz$^{-}_{\text{bk}}$ + nɛk/	Id-IO$_{\text{harm/rt}}$	Align-R	Max$_{\text{subseg/rt}}$	Spec	Id-IO$_{\text{bk}}$
a. haːz-nɛk		*!			
☞ b. haːz-nɔk			*		*

[14] Clearly, it is necessary that we be able to determine to which morpheme the floating feature belongs.

[15] By Lexicon Optimisation (Prince & Smolensky 1993), the prediction is that the input without a floating feature is learned by speakers.

Whether the floating feature is present or absent, the same output is optimal.

Consider next disharmonic roots such as in (2f, g). These roots violate ALIGN-R, but suffix harmony is regular in that suffix vowels agree in backness with the final harmonic vowel of the root. In these tableaux we see that the rankings that worked for the native roots also work with disharmonic roots.

(19)

/nüɔnsz + nɛk/	ID-IO$_{harm/rt}$	ALIGN-R	SPEC	ID-IO$_{bk}$
☞ a. nüɔnsz-nɔk		**		*
b. nüɔnsz-nɛk		***!		
c. nuɔnsz-nɔk	*!			*
d. nUɔnsz-nɔk	*!		*	**
e. nüɛnsz-nɛk	*!			*
/soföːr + naːl/				
f. soföːr-naːl		***!		
☞ g. soföːr-neːl		**		*
h. sofoːr-naːl	*!			*
i. söföːr-neːl	*!			**
j. sofOːr-naːl	*!		*	*

We have assumed that the suffixes -*nál/nél* and -*nak/nek* have underlying back and front vowels, respectively, although these underlying specifications are always subordinate to the quality of the root vowels in the words in which they occur. However, when these suffixes function as roots, their underlying qualities do assert themselves. As illustrated in (20), the constraint system developed so far is able to account for this.[16] Since there is no evidence about the underlying quality of the vowel in the 1st person singular suffix -*am/em*, we consider the possibility that it is specified as front or back.

[16] Steriade (1995) suggests these suffix vowels do have backness specifications, but that backness specifications are only licensed word-initially. Her suggestion is problematic, however, because the [+back] necessary for the *second* vowel in roots with a transparent vowel followed by a back vowel (e.g. *béka* 'frog') would not then be licensed and the correct surface form could not be derived.

(20)

/nɛk + ɛm/	Id-IO$_{harm/rt}$	Align-R	Spec	Id-IO$_{bk}$
☞ a. nɛk-ɛm				
b. nɛk-ɔm		*!		*
c. nAk-ɛm	*!		*	
/nɛk + ɔm/				
d. nɛk-ɔm		*!		
☞ e. nɛk-ɛm				*
f. nɔk-ɔm	*!			
/naːl + ɛm/				
☞ g. naːl-ɔm				*
h. naːl-ɛm		*!		
/naːl + ɔm/				
☞ i. naːl-ɔm				*
j. naːl-ɛm		*!		*

Any analysis of backness harmony must ultimately deal with the fact that a suffix such as -*nak/nek* exhibits an alternation in roundness in addition to an alternation in backness, whereas -*nál/nél* does not. We assume that these differences result from a general inventory constraint on the distribution of roundness in Hungarian low vowels:

(21) Lo/R
A low vowel is [round] iff it is short and back.

This constraint belongs to the set of constraints that define the surface inventory in Hungarian. Short low back vowels are round; all other low vowels are unrounded.

We have been assuming that the low vowel in the suffix -*nak/nek* is underlyingly low, not specified as [round] and specified as [−back]. The tableau in (22) shows how Lo/R interacts with the other constraints to correctly predict the roundness of the dative suffix vowel following a back vowel root.

(22)

/haːz + nɛk/	Lo/R	*ɨʌ	Id-IO$_{harm/rt}$	Align-R	Spec	Id-IO$_{bk}$
a. haːz-nak	*!					*
☞ b. haːz-nɔk						*
c. haːz-nɛk				*!		

Up to this point we have only considered fully specified input representations. We have seen that, given the constraints we propose, some *outputs* will be unspecified. We turn now to consider the question of input underspecification. Most discussions in Optimality Theory never consider the possibility that some inputs contain unspecified segments.[17] Apparently, it is often implicitly assumed that inputs may not be unspecified. This is, of course, a possibility. On the other hand, if there are really no constraints on inputs, underspecified segments should be a possibility. The analysis outlined to this point does not work if inputs are underspecified. To be sure, some input underspecification causes no problem. For example, whether the suffix vowel in (20) above is assumed to be front, back or unspecified for backness is irrelevant – the same candidate will be optimal in all cases. But other underspecified inputs cause difficulties, as illustrated in (23). A hypothetical input in which the root vowel is unspecified for backness will have an optimal output with the root vowel unspecified for backness and the suffix vowel quality determined by the input quality of the suffix vowel. Since we assume that vowels that are unspecified for backness are interpreted as front, these roots will always have front vowels, but suffix vowels will sometimes be back (e.g. -*nál*/*nél*) and sometimes front (e.g. -*nak*/*nek*). There are, however, no such roots in Hungarian.[18]

(23)

/mAz + naːl/	ID-IO$_{harm/rt}$	ALIGN-R	SPEC	ID-IO$_{bk}$
a. mɔz-neːl	*!	*		*
b. mɔz-naːl	*!			
c. mɛz-neːl	*!			*
☞ d. mAz-naːl			*	
e. mAz-neːl			*	*!
f. mAz-nAːl			**!	*
/mAz + nɛk/				
☞ g. mAz-nɛk			*	
h. mɛz-nɛk	*!			
i. mɔz-nɔk	*!		*	*
j. mAz-nɔk			*	*!

In order to prevent root vowels which are unspecified for backness from surfacing, it is necessary to assume a high-ranked constraint requiring that harmonic root vowels be specified for backness. Such a constraint will be necessary in all root-controlled harmony systems, since, as we have just seen, without it the harmonic quality of a suffix vowel with some roots will

[17] Inkelas (1995) is a notable exception.

[18] It might appear that adding an ALIGN-L constraint would help, because then if the root vowel were a harmonic vowel unspecified for backness, the optimal output would always be one with the suffix vowel unspecified for backness. This would be a possible Hungarian form, because all vowels would be interpreted as front. But the introduction of an ALIGN-L constraint will not work in general. In particular, an input with underlying rounded vowels, unspecified for backness, and a floating [+back] feature would have as its optimal output a vowel with unspecified rounded vowels (interpreted as front), i.e. [ö], but a back suffix vowel, in compliance with MAX$_{subseg/root}$. There are no such roots in Hungarian.

be determined by its underlying vowel quality. While suffix vowel quality is important in some harmony systems (see Ringen 1988b and Vago 1994 for some discussion) there are no harmony systems in which suffix vowel quality is determined by the harmonic quality of root vowels in general, but with a certain *class of roots*, suffix harmony is determined by the underlying quality of the suffix vowel.

Given a constraint which requires that harmonic root vowels be specified for backness, as in (24), an input root vowel which is unspecified for backness will surface as a back vowel if the markedness constraints are appropriately ranked.

(24) $\text{Specify}_{\text{harm/root/V}}$
Harmonic root vowels (low or round) must be specified for backness.

We assume that the markedness constraints *ü, *ö and *ɛ are ranked above the constraints *u, *o and *ɔ/a, which will mean that the optimal outputs for the input root vowels U, O and A (i.e. vowels unspecified for backness) will be [u], [o] and [ɔ] (or [aː]), respectively. These constraints will guarantee that input harmonic root vowels which are unspecified for backness will behave as do inputs with back vowels, as illustrated in (25):

(25)

/mAz + naːl/	$\text{Spec}_{\text{harm/rt}}$	$\text{Id-IO}_{\text{harm/rt}}$	Align-R	Spec	*üöɛ[19]	Id-IO_{bk}
a. mɔz-neːl		*	*!			*
☞ b. mɔz-naːl		*				
c. mɛz-neːl		*			*!	*
d. mAz-naːl	*!			*		
e. mAz-neːl	*!			*		*
f. mAz-nAːl	*!			**		*
/mAz-nɛk/						
g. mAz-nɛk	*!			*		
h. mɛz-nɛk		*			*!*	
☞ i. mɔz-nɔk		*				**
j. mAz-nɔk	*!			*		

Because the faithfulness constraint on harmonic root vowels is highly ranked, the markedness constraints will never eliminate a marked input root vowel, as illustrated in (26):

(26)

/tök + naːl/	$\text{Spec}_{\text{harm/rt}}$	$\text{Id-IO}_{\text{harm/rt}}$	Align-R	*üöɛ	Id-IO_{bk}
☞ a. tök-neːl				*	*
b. tok-naːl		*!			
c. tök-naːl			*!	*	

[19] Here we collapse the three separate markedness constraints since their individual ranking is not relevant to our discussion.

4 Roundness harmony

Although most alternating suffixes have two alternants, those in which the rounded alternants are short and mid have three; examples are given in (27). Here the suffix has a back rounded vowel following roots with back harmonic vowels, a front rounded vowel if the preceding vowel is a front rounded vowel, and a front unrounded (low) vowel following a front unrounded vowel.

(27) *Roundness harmony*

a.			ALLATIVE -hoz/höz/hez	
	ház	'house'	ház-hoz	[hoz]
	fül	'ear'	fül-höz	[höz]
	radír	'eraser'	radír-hoz	[hoz]
	víz	'water'	víz-hez	[hɛz]
	híd	'bridge'	híd-hoz	[hoz]
	köret	'side dish'	köret-hez	[hɛz]
b.			2PL -tok/tök/tek	
	hoz	'bring'	hoz-tok	[tok]
	főz	'cook'	főz-tök	[tök]
	néz	'see'	néz-tek	[tɛk]

4.1 A licensing analysis

Earlier accounts of data as in (27) assume a rule of roundness harmony or an alignment constraint for roundness.[20] We suggest that a superior analysis involves a licensing constraint, specifically one that restricts the licensing of [ROUND] by short front mid vowels to roots.[21] In Hungarian, mid front rounded vowels are found only in roots (e.g. *tök* 'pumpkin') when they are long (e.g. *víz-től* 'water-ABL') or following front rounded vowels (e.g. *öröm-höz* 'joy-ALL'; *fül-höz* 'ear-ALL'; *viz-ünk-höz* 'water-1PL POSS-ALL').[22]

Mid front rounded vowels are highly marked segments. They are more marked than mid front unrounded vowels, and languages have mid front

[20] Rule-based accounts include Jensen & Stong-Jensen (1988), Steriade (1995), Vago (1980c).

[21] This analysis is inspired by the account of Hungarian roundness harmony in Polgárdi & Rebrus (1998) within the framework of Government Phonology. Although our analysis differs in significant ways from theirs, the basic insight that there is no roundness harmony in Hungarian is theirs.

[22] There are examples of *ö* in root syllables that are not initial (and not stressed): e.g. *szemölcs* 'wart'; hence an alternative is not to formulate the constraint as one preserving the input specification of the first syllable (or the stressed vowel). There are a few forms, such as *mérnök* 'engineer', that might be analysed as having a non-productive suffix *-nok/nök*. But these forms seem to be best analysed as monomorphemic.

rounded vowels only if they also have high front rounded vowels (but not the reverse).[23] We find many examples in which such highly marked segments are permitted only in prominent or strong positions, where prominent includes stressed, word-initial, bimoraic and roots (see Beckman 1995, 1997, 1998, Steriade 1995 and Zoll 1996, 1997).

(28) LINK[ROUND]
[ROUND] may be linked to a short (monomoraic) mid front suffix vowel only if it is also linked to a preceding vowel.

LINK[ROUND] has the effect that a short mid front vowel that is [ROUND] must be in a root, as in *tök*, or that the [ROUND] feature must also be associated with a root vowel, as in *öröm-höz*, or that the [ROUND] feature also be associated with a rounded vowel other than a short mid vowel, as in *viz-ünk-höz*. We also assume an Identity constraint on [ROUND], ranked below LINK[ROUND], which requires that input and output segments have identical specifications for [ROUND]:

(29) IDENT-IO$_{round}$
Corresponding input and output segments have identical specifications for [ROUND].

We assume that suffixes which have three alternants with *o/ö/e* have underlying rounded vowels.[24] Of this set, only allative *-hoz/höz/hez* occurs independently as a root. When it does, it shows up with a back vowel: e.g. *hozzá-m* 'to me'. This suffix has /o/ in the input. For the others, whether we assume /o/ or /ö/ does not make any difference.

In the tableaux below, we include only output candidates which satisfy ALIGN-R and IDENT-IO$_{harm/root}$; these constraints, as well as SPECIFY and MAX$_{subseg}$, are not relevant to the points being developed and are therefore omitted.

In (30) we see that the constraints developed so far are sufficient to guarantee that the correct output is designated as optimal when the root contains a back harmonic vowel:

(30)

/haːz + hoz/	*ɨʌ	LINK[ROUND]	ID-IO$_{rd}$	ID-IO$_{bk}$
☞ a. haːz-hoz				
b. haːz-hʌz	*!		*	

In (31) the same suffix follows a root with a front rounded vowel. We indicate adjacent rounded vowels which are not linked to the same

[23] Maddieson (1984) lists Wolof and Hopi as two languages that have mid front rounded vowels but not high front rounded vowels. Wolof does not, however, have front rounded vowels at all (Omar Ka, personal communication), leaving Hopi as the only possible exception to this claim.

[24] If a suffix had underlying /ɛ/ it would behave like *-nek/nak*.

[ROUND] specification with separate R specifications beneath the vowels. Rounded vowels in the same word without separate R specifications are linked to the same [ROUND] feature. In (31a) the [ROUND] feature of the suffix vowel violates LINK[ROUND] since it is associated with a monomoraic suffix vowel, but it is not associated with the preceding vowel. On the other hand, the [ROUND] feature of the suffix vowel in (b) does not violate LINK[ROUND] since it is also associated with the preceding vowel [ü]. Candidate (b) is better than (c), because (c) violates IDENT-IO_{round} (the [ROUND] feature of the suffix has been eliminated), whereas (b) does not. Note that the constraints *ö and *ü (conflated here with as *üö), which were discussed in the preceding section, must be ranked below IDENT-IO_{round}. If this ranking were reversed, output candidates with unrounded vowels would be optimal in all cases where the input candidates contained such marked vowels.

(31) ID-IO_{rd} ≫ *üö

/fül + hoz/ R R	*ɨʌ	LINK[ROUND]	ID-IO_{rd}	*üö	ID-IO_{bk}
a. fül-höz R R		*!		**	*
☞ b. fül-höz				**	*
c. fül-hez			*!	*	*

Consider next the suffix -*hoz*/*höz*/*hez* with a root such as *víz* in (27a), which has a front unrounded root vowel. Here we see that the suffix vowel is low ([viːz-hɛz]). Indeed, if a vowel is short, front, non-high and unrounded it must be low, and if it is long, it must be mid (see (2) above). A constraint to guarantee this is necessary in any analysis to account for the surface inventory of vowels. We formulate this inventory constraint, SHORT ɛ, in (32). We assume this constraint must be ranked with the other inventory constraints, above the faithfulness constraints, to prevent an input [e] or [ɛː] from being preserved in the output.

(32) SHORT ɛ

Short non-high unrounded front vowels are low, long; non-high unrounded front vowels are mid.

The tableau in (33) illustrates that the unrounding of the suffix vowel when it follows an unrounded vowel occurs because the [ROUND] feature that is associated with the mid front vowel violates LINK[ROUND], not because of any right alignment of the feature [−round]:

(33) LINK[ROUND] ≫ ID-IO$_{rd}$

/viːz + hoz/	SHORT ε	LINK[ROUND]	ID-IO$_{rd}$	*üö	ID-IO$_{bk}$
a. viːz-höz		*!		*	*
b. viːz-hez	*!		*		*
☞ c. viːz-hεz			*		*
d. vüːz-höz			*	*!*	*

Candidate (d) is eliminated because it violates the markedness constraints on front rounded vowels.[25]

We note finally that when the suffix *-hoz/höz/hez* is preceded by a root with a front rounded vowel and an unrounded vowel, as in *köret* 'side dish', the suffix vowel is unrounded (*köret-hez*). The constraints developed so far do not predict this outcome, as illustrated in (34).[26]

(34)

/körεt + hoz/	SHORT ε	LINK[ROUND]	ID-IO$_{rd}$	*üö	ID-IO$_{bk}$
☜ a. körεt-höz				**	*
b. körεt-hez			*!	*	*
c. körεt-höz R R		*!		**	*
d. körεt-hez	*!		*	*	*

Candidate (a) has a single [ROUND] feature linked to the first and last vowel but not to the intervening vowel. We see here the need for the constraint NO-GAP, which has been widely assumed in earlier works, to prevent the skipping of potential anchors. (Levergood 1984, Archangeli & Pulleyblank 1994):

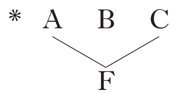
[25] Note that we assume that the markedness constraint *ε is ranked below the constraints *ö and *ü.

[26] P. Siptár points out to us that in the Szeged dialect there are no restrictions on the occurrence of [ö], and that the suffixes that are ternary in other dialects are binary. This follows if we assume that the only difference between the dialect we are discussing (Budapest) and the Szeged dialect is that the licensing constraint on ROUND is ranked below IDENT$_{round}$. See Ringen & Szentgyörgyi (1998) for a demonstration that this ranking also correctly predicts other differences between the Budapest and Szeged dialects.

A form such as [tüz-εk] 'fire-PL' might appear to present problems for our analysis because the plural suffix has an unrounded vowel rather than the rounded vowel that might be expected (cf. *kör-ök* 'circle-PL'). There is a straightforward explanation for the unrounded suffix vowel in [tüz-εk], however: this stem belongs to the class of (exceptional) 'lowering stems' which require that following suffix vowels be low (cf. Vago 1980c). The reason that the suffix vowel is unrounded is that it must be low following a lowering stem, and there is no low *rounded* front vowel in Hungarian.

(35) No-Gap

Gapped configurations are prohibited. A gapped configuration is illustrated below:



(where B is a possible anchor for F)

(36) No-Gap ≫ Id-IO$_{rd}$

/körɛt + hoz/	Short ɛ	No-Gap	Link[round]	Id-IO$_{rd}$	*üö	Id-IO$_{bk}$
a. körɛt-höz R R			*!		**	*
b. körɛt-höz		*!			**	*
☞ c. körɛt-hɛz				*	*	*
d. körœt-höz				*	**![27]	*
e. kɛrɛt-hɛz				**!		*

We see in (36) that No-Gap must be ranked above Ident-IO$_{round}$.[28]

It might seem that it is impossible to assume No-Gap and still obtain the correct results for backness harmony with a mixed vowel root such as *tányér-nál*, where No-Gap is violated. However, there is no problem as long as No-Gap is ranked below Align-R:

(37) Align-R ≫ No-Gap

/ta:nye:r + na:l/	*ɨʌ	Align-R	No-Gap	Link[round]
a. ta:nyʌ:r-na:l	*!			
☞ b. ta:nyE:r-na:l			*	
c. ta:nye:r-ne:l		*!*		
d. ta:nyE:r-nA:l		*!*		

In sum, our proposed OT analysis of roundness harmony provides not only an account of the roundness alternations which occur with the short mid vowel in the ternary suffixes, but also an account of why a mid front rounded vowel, unlike other vowels, has a defective distribution: it is permitted only in roots, when long, or when preceded by a front rounded vowel. No rule-based account has ever accounted for this defective distribution. In addition, all earlier accounts of roundness harmony have

[27] This output also violates an inventory constraint *œ.

[28] It would be possible to build the No-Gap restriction into Link[round] by requiring that any [round] feature which is linked to a short mid front suffix vowel also be linked to an *immediately preceding* [round] vowel. Since No-Gap has been claimed to be needed independently, it seems preferable not to build this restriction into the link[round] constraint.

depended on the feature [−round] and hence are inconsistent with the assumption of privative [ROUND]. It is, therefore, of some interest that the account presented here does not rely on [−round].

4.2 An alignment or spreading alternative

Steriade (1995: n. 31) sketches an analysis of Hungarian rounding harmony which she suggests is consistent with the assumption of privative [ROUND]. In this section we will briefly consider this alternative and show that it cannot be maintained.

Steriade suggest that the feature [ROUND] spreads and that the suffix *-hoz/höz/hez* is unspecified for backness and roundness. Let us assume a constraint $\text{SPREAD}_{\text{round}}$, which requires that [ROUND] be multiply linked. The problem is that privative [ROUND] must spread to the mid vowel in the suffix /hEz/, but not to neutral vowels, which are also not specified for [ROUND]. There is apparently no single ranking which will allow both forms to be derived correctly. This is illustrated in tableaux (38) and (39): *öröm-ért* 'joy-CAUSAL FINAL' requires that the faithfulness constraint on [ROUND], $\text{IDENT-IO}_{\text{round}}$, be ranked higher than $\text{SPREAD}_{\text{round}}$, while *öröm-höz* 'joy-ALL' requires the opposite ranking.[29]

(38)

/öröm + eːrt/	ID-IO_{rd}	$\text{SPREAD}_{\text{rd}}$
a. öröm-öːrt	*!	
☞ b. öröm-eːrt		*

(39)

/öröm + hez/	$\text{SPREAD}_{\text{rd}}$	ID-IO_{rd}
☞ a. öröm-höz		*
b. öröm-hɛz	*!	

The problem is that we do not want (privative) [ROUND] to spread to all (front) vowels which are not specified for [ROUND], only to those that are short and mid.[30] But even if we somehow restrict the $\text{SPREAD}_{\text{round}}$ constraint to target only short mid vowels, we are still left with the problem that this analysis is incapable of accounting for the distribution of [ö]. Unlike the other front rounded vowels, [ö] never occurs outside of roots unless it is preceded by a front rounded vowel. There is nothing that prevents, on this analysis, an underlying front rounded vowel [ö] from occurring in a suffix and retaining this rounding following a neutral vowel root such as *víz*. But such forms do not exist in Hungarian, as we have seen. We conclude, therefore, that Hungarian 'rounding harmony' actually does not involve any spreading or alignment of [ROUND], but rather involves a licensing of the feature [round], as discussed in §4.1 above.

29 Note that this problem cannot be solved by adding a constraint that excludes long front rounded vowels, since *ő* [öː] does occur in Hungarian.

30 This problem is independent of whether we assume that [eː] is specified as [−back] or not in the input. For the reasons discussed above, NO-GAP will not help.

5 Conclusion

In this paper we have proposed an OT analysis for the backness harmony system of Hungarian in which the interacting constraints fall into four broad categories: alignment, faithfulness, inventory and feature specification. It is significant to note that in our account, disharmonic roots do not require any special treatment; rather, the same constraints account for harmony with harmonic as well as disharmonic roots.[31] Typical discussions of vowel harmony within the OT framework either do not deal with disharmonic loans or require constraint rerankings to deal with such forms.[32] The account presented here in Optimality Theory resolves certain problems of earlier rule-based accounts. In particular, the transparent vowels receive a straightforward account without depending on *input* underspecification. The fact that certain suffixes apparently have underlying back or front vowels that emerge only when they function as roots, which have never been successfully treated in a non-linear rule-based account, is accounted for in our analysis. And we provide an account of roundness harmony, which has not been successfully treated in recent theoretical frameworks. We have shown that roundness harmony in Hungarian is best analysed in terms of licensing, and not alignment. We have provided an explanation, grounded in markedness, for the fact that of all the vowels of Hungarian, it is the short mid rounded vowel which has a defective distribution. Finally, our analysis is entirely consistent with the view that [ROUND] is privative.

With the constraint system proposed here, whether *inputs* are fully specified or partially specified is seen to be irrelevant; possible Hungarian forms result in all cases. In some cases *outputs* are underspecified, a result similar to that of Itô *et al*. (1995). This conclusion is in conflict with the recent claim by Kirchner (1997: 87–89) that Smolensky (1993) has shown that OT does not depend on underspecification to account for the transparency of neutral vowels in harmony systems like Finnish and Hungarian. It appears that Kirchner's analysis cannot be maintained.

Kirchner gives what he characterises as an account which is 'modified slightly from Smolensky's presentation'.[33] This account involves the constraints ALIGN(+bk-R), which requires that a [+back] specification be linked to a segment at the right edge of the word, *EMBED, which prohibits embedding of a [−back] domain inside a [+back] domain,

[31] Disharmonic roots are those with both front and back harmonic vowels.

[32] See Inkelas *et al*. (1997) and Itô & Mester (1995) for some discussion of the use of different constraint rankings to treat exceptional forms.

[33] Kirchner neglects to mention that in Smolensky's account, all suffix vowels are assumed to be *unspecified* for [back]. Hence while Smolensky's account does not involve crucial underspecification of *transparent* vowels in the input, it does involve crucial underspecification of *some input vowels*. Our account does not involve *any* input underspecification, but it does involve *output* underspecification. As we have shown in this paper, there are good reasons to assume that (some) Hungarian suffix vowels are specified for backness. If this is true, an account of transparent vowels such as Kirchner's (and Smolensky's) sketch cannot be maintained.

*[−low, −rd, +bk], which is the same as our *ɨʌ constraint, Parse(bk), which is a faithfulness constraint requiring that input and output be minimally different with respect to specific features, and *[−low, +rd, −bk], which prohibits [ü] and [ö]. Kirchner gives three hypothetical forms, repeated here in (40), and concludes that 'there is no need for restrictions on the presence of particular features at underlying or intermediate levels of representation'.

(40)

	*[−low,−rd, +bk]	Align(+bk-R)	Parse(bk)	*[−low,+rd, −bk]	*Embed
a. /u-I-U/					
☞ u-i-u					*
u-ɨ-u	*!				
u-i-ü		*!		*	
u-ɨ-ü	*!	*		*	
ü-i-ü			*!	**	
b. /u-i-u/					
☞ u-i-u					*
u-ɨ-u	*!		*		
u-i-ü		*!	*	*	
u-ɨ-ü	*!	*	**	*	
ü-i-ü			*!*	**	
c. /u-ɨ-ü/					
☞ u-i-u			**		*
u-ɨ-u	*!		*		
u-i-ü		*!	*	*	
u-ɨ-ü	*!	*		*	
ü-i-ü			**	*!*	

It is difficult to see how this constitutes a demonstration that underspecification is not needed to account for transparency. Note first that this set of constraints will not work with very simple cases, for example, when an input with a front rounded vowel (e.g. *tűz* 'fire') is followed by a suffix with an underlying back vowel (e.g. *-nál/nél*):

(41)

/üː + aː/	*[−low,−rd, +bk]	Align(+bk-R)	Parse(bk)	*[−low,+rd, −bk]	*Embed
☞ a. üː-aː				*	
b. uː-aː			*!		
c. üː-eː			*!	*	

The correct surface form should have front vowels (e.g. *tűz-nél*), yet this constraint system chooses *tűz-nál* (similar examples can be given for

Finnish.) Adding a constraint such as ALIGN(−bk-R) will not help, regardless of where it is ranked:

(42)

/üː + aː/	*[−low,−rd, +bk]	ALIGN (+bk-R)	ALIGN (−bk-R)	PARSE (bk)	*[−low,+rd, −bk]	*EMBED
a. üː-aː			*!		*	
☞ b. uː-aː				*		
c. üː-eː				*	*!	

Second, this constraint set will not work if we consider disharmonic roots such as *sofőr*, which take only front suffix vowels, *sofőr-nek*, as illustrated in (43):[34]

(43)

/o-öː + ɛ/	*[−low,−rd, +bk]	ALIGN(+bk-R)	PARSE(bk)	*[−low,+rd, −bk]	*EMBED
☞ a. o-oː-ɔ			*		
b. o-öː-ɛ		*!		*	*
c. ö-öː-ɛ			*	*!*	

While a complete discussion of the role of underspecification in OT is beyond the scope of this paper, we conclude that it is yet to be demonstrated that it is possible to provide an OT analysis of an interesting array of data in a vowel harmony language such as Hungarian or Finnish without any underspecification.

REFERENCES

Archangeli, Diana & Douglas Pulleyblank (1994). *Grounded phonology*. Cambridge, Mass.: MIT Press.

Battistella, Edwin (1982). More on Hungarian vowel harmony. *Linguistic Analysis* **9**. 95–118.

Beckman, Jill (1995). Shona height harmony: markedness and positional identity. In Beckman *et al*. (1995). 53–75.

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

Beckman, Jill (1998). *Positional faithfulness*. PhD dissertation, University of Massachusetts, Amherst.

Beckman, Jill, Laura Dickey & Suzanne Urbanczyk (eds.) (1995). *Papers in Optimality Theory*. Amherst: GLSA.

Booij, Geert (1984). Neutral vowels and the autosegmental analysis of Hungarian vowel harmony. *Linguistics* **22**. 629–641.

Clements, G. N. (1977). Neutral vowels in Hungarian vowel harmony: an autosegmental interpretation. *NELS* **7**. 49–64.

Cole, Jennifer & Charles Kisseberth (1994). An optimal domains theory of harmony. *Studies in the Linguistic Sciences* **24**. 101–114.

34 It is unclear to us whether the constraint PARSE(bk) would be violated by an output candidate with the sequence of vowels ö-o-ɔ. If it is not, then this is the optimal candidate, but our point remains, since this is not the correct form.

Ellison, T. Mark (1995). Phonological derivation in Optimality Theory. Ms, University of Edinburgh.

Ewen, Colin & Harry van der Hulst (1985). Single-valued features and the non-linear analysis of vowel harmony. In H. Bennis & F. Beukema (eds.) *Linguistics in the Netherlands 1985*. Dordrecht: Foris. 39–48.

Farkas, Donca & Patrice Beddor (1987). Privative and equipollent backness in Hungarian. *CLS* **23:2**. 90–105.

Goldsmith, John (1985). Vowel harmony in Khalkha Mongolian, Yaka, Finnish and Hungarian. *Phonology Yearbook* **2**. 253–275.

Hulst, Harry van der (1985). Vowel harmony in Hungarian: a comparison of segmental and autosegmental analysis. In H. van der Hulst & N. Smith (eds). *Advances in nonlinear phonology*. Dordrecht: Foris. 267–303.

Inkelas, Sharon (1995). The consequences of optimization for underspecification. *NELS* **25**. 287–302.

Inkelas, Sharon, Orhan Orgun & Cheryl Zoll (1997). The implications of lexical exceptions for the nature of grammar. In I. Roca (ed.) *Derivations and constraints in phonology*. Oxford: Clarendon Press. 393–418.

Itô, Junko & Armin Mester (1995). Core and periphery structure of the lexicon and constraints on reranking. In Beckman *et al*. (1995). 181–209.

Itô, Junko, Armin Mester & Jaye Padgett (1995). Licensing and underspecification in Optimality Theory. *LI* **26**. 571–613.

Jensen, John (1971). Theoretical implications of Hungarian vowel harmony. Paper presented at the 2nd Meeting of the North East Linguistic Society.

Jensen, John (1978). Reply to 'Theoretical implications of Hungarian vowel harmony'. *LI* **9**. 89–97.

Jensen, John (1984). A lexical phonology treatment of Hungarian vowel harmony. *Linguistic Analysis* **14**. 231–253.

Jensen, John & Margaret Stong-Jensen (1988). Ordering and locality in Hungarian vowel harmony. Paper presented at GLOW Workshop on Phonology, Budapest.

Kaun, Abigail (1995). *The typology of rounding harmony: an Optimality Theoretic approach*. PhD dissertation, UCLA.

Kiparsky, Paul (1981). Vowel harmony. Ms, MIT.

Kirchner, Robert (1993). Turkish vowel disharmony in optimality theory. Paper presented at the Rutgers Optimality Workshop.

Kirchner, Robert (1997). Contrastiveness and faithfulness. *Phonology* **14**. 83–111.

Kornai, András (1987). Hungarian vowel harmony. *WCCFL* **6**. 147–161.

Levergood, Barbara (1984). Rule-governed vowel harmony and the Strict Cycle. *NELS* **14**. 275–293.

McCarthy, John & Alan Prince (1993a). *Prosodic Morphology I: constraint interaction and satisfaction*. Ms, University of Massachusetts, Amherst & Rutgers University.

McCarthy, John & Alan Prince (1993b). Generalized alignment. *Yearbook of Morphology* 1993. 79–153.

McCarthy, John & Alan Prince (1995). Faithfulness and reduplicative identity. In Beckman *et al*. (1995). 249–384.

Maddieson, Ian (1984). *Patterns of sounds*. Cambridge: Cambridge University Press.

Nádasdy, Ádám & Péter Siptár (1994). A magánhangzók. In F. Kiefer (ed.) *Strukturális magyar nyelvtan*. 2. kötet: *Fonológia*. [*A structural grammar of Hungarian*. Vol. 2: *Phonology*.] Budapest: Akadémiai Kiadó. 42–182.

Papp, Ferenc (1975). *A magyar főnév paradigmatikus rendszere*. Budapest: Akadémiai Kiadó.

Phelps, Elaine (1978). Exceptions and vowel harmony in Hungarian. *LI* **9**. 98–105.

Polgárdi, Kristina & P. Péter Rebrus (1998). There is no labial harmony in Hungarian: a Government Phonology analysis. In C. de Groot & I. Kenesei (eds.) *Approaches to Hungarian*. Vol. 6. Szeged: JATE Press. 3–20.

Prince, Alan & Paul Smolensky (1993). *Optimality Theory : constraint interaction in generative grammar*. Ms, Rutgers University & University of Colorado, Boulder.
Ringen, Catherine (1975). *Vowel harmony : theoretical implications*. PhD dissertation, Indiana University. Published 1988, New York: Garland.
Ringen, Catherine (1978). Another view of the theoretical implications of Hungarian vowel harmony. *LI* **9**. 105–115.
Ringen, Catherine (1980). A concrete analysis of Hungarian vowel harmony. In Vago (1980b). 135–154.
Ringen, Catherine (1982). Abstractness and the theory of exceptions. *Linguistic Analysis* **10**. 191–202.
Ringen, Catherine (1988a). Transparency in Hungarian vowel harmony. *Phonology* **5**. 327–342.
Ringen, Catherine (1988b). Underspecification theory and binary features. In H. van der Hulst & N. Smith (eds.) *Features, segmental structure and harmony processes*. Vol. 2. Dordrecht: Foris. 145–160.
Ringen, Catherine & Orvokki Heinämäki (to appear). Variation in Finnish vowel harmony: an OT account. *NLLT* **17**.
Ringen, Catherine & Miklós Kontra (1989). Hungarian neutral vowels. *Lingua* **78**. 181–191.
Ringen, Catherine & Szilárd Szentgyörgyi (1998). Constraint reranking in the Szeged dialect of Hungarian. Paper presented at the 4th International Conference on the Structure of Hungarian, Pecs.
Smolensky, Paul (1993). Harmony, markedness and phonological activity. Ms, University of Colorado, Boulder (available as ROA-87 from the Rutgers Optimality Archive).
Steriade, Donca (1987). Redundant values. *CLS* **23:2**. 339–362.
Steriade, Donca (1995). Underspecification and markedness. In J. Goldsmith (ed.) *The handbook of phonological theory*. Cambridge, Mass. & Oxford: Blackwell. 114–174.
Szépe, György (1958). Vegyes magánhangzójú szavaink illeszkedésének kérdéséhez. *Nyelvtudományi Értekezések* **17**. 105–129.
Vago, Robert (1973). Abstract vowel harmony systems in Uralic and Altaic languages. *Lg* **49**. 579–605.
Vago, Robert (1976). Theoretical implications of Hungarian vowel harmony. *LI* **7**. 243–263.
Vago, Robert (1978). Some controversial questions concerning the description of Hungarian vowel harmony. *LI* **9**. 116–126.
Vago, Robert (ed.) (1980a). *Issues in vowel harmony*. Amsterdam: Benjamins.
Vago, Robert (1980b). A critique of suprasegmental theories of vowel harmony. In Vago (1980a). 155–183.
Vago, Robert (1980c). *The sound pattern of Hungarian*. Washington: Georgetown University Press.
Vago, Robert (1994). Vowel harmony. In R. E. Asher (ed.) *Encyclopedia of languages and linguistics*. Oxford: Pergamon Press. 4954–4958.
Zoll, Cheryl (1996). *Parsing below the segment in a constraint based framework*. PhD dissertation, UCB.
Zoll, Cheryl (1997). Multiple prominence theory: implications for tone association. Paper presented at the HOT Conference, Baltimore.
Zonneveld, Wim (1980). Hungarian vowel harmony and the theory of exceptions in generative phonology. *Linguistic Analysis* **6**. 21–39.