

RESEARCH

A target-oriented approach to neutrality in vowel harmony: Evidence from Hungarian

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This paper provides a novel perspective on neutrality in vowel harmony, using evidence from Hungarian. Despite the extensive study of Hungarian vowel harmony, the intermediate neutrality of [e:], which can alternate harmonically with [a:], is rarely addressed in existing analyses. While many standard accounts of harmony assume that front unrounded vowels like [e:] are neutral due to the lack of back counterpart, the [a:]~[e:] alternation makes this approach unsupportable. Specifically, since both [a:] and [e:] lack harmonic counterparts, but [a:] participates in harmony by re-pairing to [e:], the theory must explain why [e:] is not consistently harmonic. I argue that this pattern forces a new, target-focused approach, where participation is based on the vowel-specific drive to undergo harmony; neutrality results when this drive is insufficient to force unfaithfulness. This idea is motivated by cross-linguistic and phonetic facts suggesting that vowels that are low and/or rounded are inherently better targets of front/back harmony. I implement this approach formally in Harmonic Grammar; the harmony constraint is scaled by the quality of a vowel as a potential target, parallel to Kimper's (2011) trigger strength scaling. This account can capture not only the basic Hungarian facts, but also the gradience of neutrality (the height effect) and the variability in Hungarian harmony. Moreover, I argue that this view of harmony is necessary beyond Hungarian and beyond front/back harmony: neutrality is crucially about the quality of a vowel as a potential target of harmony, where target quality is determined in a cross-linguistic, phonetically motivated way.

Keywords: neutrality; vowel harmony; Hungarian; targets; Harmonic Grammar

1 Introduction

Widely discussed in the study of vowel harmony (e.g. Vago 1973; Goldsmith 1985; van der Hulst 1985; Ringen 1988; Archangeli & Pulleyblank 1994; Pulleyblank 1996; Ringen & Vago 1998; Kiparsky & Pajusalu 2003; Krämer 2003; Pulleyblank 2004; Archangeli & Pulleyblank 2007; Nevins 2010; Gafos and Dye 2011; Kimper 2011; Törkenczy et al. 2013; etc.), *neutral* vowels are those that are exempt from undergoing harmony. Neutral vowels are typically classified into two types: *opaque* and *transparent*, where the former type interrupts harmony while the latter allows harmony to pass through it (Archangeli & Pulleyblank 2007; Gafos and Dye 2011). While considerable attention has been paid to distinguishing between these types (e.g. Kiparsky & Pajusalu 2003; Kimper 2011; Walker 2012; van der Hulst 2016), less research has focused on why neutrality occurs at all. In much of the literature, either implicitly or explicitly, the standard assumption is that a vowel will participate in harmony except when doing so is impossible due to a lack of harmonic counterpart in the inventory (e.g. Ringen and Vago 1998; Kimper 2011; Walker 2012; van der Hulst 2016). For example, van der Hulst (2016) draws a direct equivalence between neutrality and unpairedness in stating that “The non-advanced low vowel /a/ in Tangale misses a harmonic counterpart. This is what we call a neutral vowel.”

However, the connection between neutrality and incompatibility with the harmonic feature is false in both directions. Vowels that are perfectly compatible with the harmonic

feature may nonetheless be neutral, as in Mayak, where low vowels contrast in [ATR] but generally do not undergo tongue root harmony (Andersen 1999). Similarly, vowels that are incompatible with the harmonic feature may nonetheless undergo harmony through a change in an additional feature, in a process known as *re-pairing* (Baković 2000). For example, in Maasai, [a] has no [ATR] counterpart, yet undergoes progressive ATR harmony by re-pairing with [o] (Archangeli & Pulleyblank 1994; Baković 2000).

Even in Hungarian, one of the most studied languages for neutrality and its connection to unpairedness, it has been noted that neutrality is not as simple as the traditional view might suggest, and that this view is fundamentally flawed. For example, Törkenczy (2013) notes problems with many common claims about neutrality, including that some Hungarian neutral vowels are not harmonically unpaired, and that whether a given neutral vowel is opaque or transparent can depend on whether it occurs in an alternating or invariant suffix. Similarly, Siptár (2015: 3), in discussing Hungarian, notes that the concept of neutral vowel is “variable, gradual, and context-dependent”. Benkő et al. (2017) further note that it is a problem for Hungarian that traditional approaches consider neutrality to be categorical and that gradience is often unintegrated into the phonological analysis. In front/back harmony more broadly, Kiparsky & Pajusalu (2003) mention in their typology that there are multiple possible reasons for a vowel to be unable to alternate harmonically.

This paper proposes a revised analytical and intuitive framework for viewing participation and neutrality in harmony, by considering a variety of data from Hungarian that are problematic for a traditional view of neutrality and most theoretical analyses. For example, the vowel [e:], while generally transparent in roots, alternates harmonically in some suffixes by re-pairing with [a:]. I argue that this and other patterns in Hungarian necessitate a new view of participation in harmony, in which the main cause of neutrality is not necessarily incompatibility with the harmony feature, but rather a weak vowel-specific drive to undergo harmony. Articulatory and perceptual facts suggest that vowels that are rounded and/or low are better participators in front/back harmony than vowels that are non-low and unrounded (e.g. Benus 2005; Gafos and Dye 2011). This fact gives independent motivation for the height-based vowel-specific asymmetries in the requirement to undergo harmony. I formalize this view by extending Kimper’s (2011) trigger-based analysis of harmony to targets, showing that such an account can capture the basic facts of Hungarian, in addition to predicting a variety of other patterns that are problematic in other analyses. Moreover, the inherent gradience of this approach allows for integration into the account of the non-categorical divide between harmonic and neutral vowels, and allows for the incorporation of a morpheme-specific component for lexically determined behaviour.

The paper is organized as follows. Section 2 describes the facts about Hungarian harmony, and Section 3 details the phonetic motivations for the relevant patterns. Section 4 discusses the implications that the Hungarian data has for the view of neutrality and why it is problematic to previous accounts. Section 5 presents the target-oriented approach, while Section 6 applies it to the Hungarian data. Section 7 describes some further implications of target-focused harmony for other languages, and Section 8 concludes.

2 Hungarian harmony

This section overviews the facts about Hungarian vowel harmony. Section 2.1 discusses the vowel inventory and basic harmony pattern. Section 2.2 describes the patterns of neutrality within roots, while Section 2.3 deals with neutrality in suffixes. Section 2.4 summarizes the patterns in terms of gradience in triggers and targets of harmony.

2.1 Vowel inventory and basic harmony pattern

The Hungarian vowel inventory is given in Table 1.

Table 1: Hungarian vowel inventory (Siptár & Törkenczy 2000).

	Front				Back			
	Unrounded		Rounded		Unrounded		Rounded	
	Short	Long	Short	Long	Short	Long	Short	Long
High	i	i:	y	y:			u	u:
Mid		e:	ø	ø:			o	o:
Low	ɛ					a:	ɔ	

Phonetic descriptions have noted that [a:] is produced as central or even front, but it patterns phonologically as a back vowel and has been argued to be phonologically classified as such (e.g. Gósy & Siptár 2015). Throughout this paper, I will consider [a:] a back vowel, despite its phonetic implementation. It is worth noting that for all other vowels, the distinction between front and back is synchronically based in the phonetics; the phonetics does have bearing on the phonological patterning, despite the phonetics/phonology mismatch in the behaviour of [a:].

By some researchers, [e:] has been analyzed as being at least sometimes a phonologically low vowel, due to its alternations with [ɛ], [a:], and [ɔ]. For example, Siptár & Törkenczy (2000: 158) class non-alternating [e:] as mid in their feature system, but alternating [e:] emerges as a low vowel in their analysis. However, I follow the phonetic inventory in Siptár & Törkenczy (2000: 52), Hayes & Londe (2006), and Törkenczy (2010), among many others, in categorizing it as mid. Given the height effect among front unrounded vowels in Hungarian harmony, to be discussed in Section 2.2, the distinction between [e:] and [ɛ] in height is relevant to the phonological system. In general, as Törkenczy (2010) notes, the system requires two degrees of backness and three of height.

Notable in this inventory are the gaps where vowels do not have a counterpart that differs only along the front/back dimension. Only non-low rounded vowels have direct harmonic counterparts; the front unrounded vowels and the low vowels ([i], [i:], [e:], [ɛ], [a:], and [ɔ]) do not have counterparts that differ only in the feature [back].¹ Given that short, rounded, back vowels have a three-way height distinction, both [high] and [low] must be active features within the Hungarian phonological system.²

Hungarian has an extensively studied system of front/back harmony, as well as a more limited system of rounding harmony that will not be discussed here (e.g. Vago 1973; Goldsmith 1985; van der Hulst 1985; Ringen 1988; Ringen & Vago 1998; Siptár & Törkenczy 2000; Hayes & Londe 2006; Nevins 2010; Törkenczy 2010; Gafos and Dye 2011; Kimper 2011; Törkenczy et al. 2013; etc.). In general, disregarding the front unrounded vowels, vowels that disagree in the feature [back] are not permitted to co-occur within (native) roots, and suffixes alternate according to the [back] value of the root vowels. Examples are given in (1), with the dative suffix [nɔk]~[nɛk].³

¹ However, there is ambiguity in the identity of the vowel [ɔ], with some researchers using the symbols [ɒ], [ɑ], or [a], suggesting that this vowel may not in fact be rounded. If that is the case, then [ɛ] and [ɔ] are a direct harmonic pair. Whether they are or not has no bearing on the analysis here.

² Following a Contrastive Hierarchy style approach (Dresher 2009), we could claim that [low] is not contrastive or specified among unrounded vowels, which would allow [e:] and [a:] to be direct harmonic counterparts. Nonetheless, doing so would not resolve the issue of their asymmetrical behaviour (to be discussed in Section 2.3), and would require [ɛ] and [e:] to be of the same height, which is inconsistent with their distinct phonological patterning (see e.g. Ringen & Vago 1998 for discussion and references about [ɛ], and Benus 2005 for arguments that the distinction results from the difference in height).

³ Note that this alternation involves re-pairing, since neither vowel has a direct harmonic counterpart.

- (1) Front/back harmony (Siptár & Törkenczy 2000); back vowel roots in (a–c), front vowel roots in (d–f)
- | | | |
|----|-------------|------------|
| a. | ha:z-nək | house-DAT |
| b. | va:roʃ-nək | town-DAT |
| c. | kosoru:-nək | wreath-DAT |
| d. | ty:z-nək | fire-DAT |
| e. | tykør-nək | mirror-DAT |
| f. | ørøm-nək | joy-DAT |

2.2 Neutrality in roots

The front unrounded vowels are generally considered transparent to this harmony; they can co-occur in roots with any other vowel, and are skipped over in determining the harmonic value of the suffix (Siptár & Törkenczy 2000; Törkenczy 2010). Thus, suffixes generally surface as back when they attach to stems that contain a back vowel followed by a (non-low) front unrounded vowel. Examples are shown in (2a–f). While the high front unrounded vowels [i] and [i:] are consistently transparent⁴ (as long as there is only a single one; see below), the mid front unrounded vowel [e:] shows variable behaviour; some back-[e:] stems show consistent transparency (2d–f), while others are able to take either front or back stems (“vacillating”), as in (2g) (Törkenczy et al. 2013). The low front unrounded vowel [ɛ] shows an even greater degree of variable behaviour and is sometimes considered front harmonic (e.g. Ringen 1975; 1978; 1980); while there exist some back-[ɛ] stems that take only back suffixes (2h), most such stems either vacillate (2i) or take only front suffixes (2j) (Törkenczy et al. 2013). This is a morpheme-specific property: different stems have different preferences for front or back suffixes, and the choice is lexically arbitrary (Hayes et al. 2009; Rebrus et al. 2017). Moreover, although a single [i] or [i:] is always transparent, multiple high front unrounded vowels are variably opaque, as shown in (2k).

- (2) Transparency of front unrounded vowels (Siptár & Törkenczy 2000; Rebrus et al. 2012)
- | | | |
|----|-------------------|----------------|
| a. | pəpi:r-nək | paper-DAT |
| b. | rədi:r-nək | eraser-DAT |
| c. | kuvik-nək | little owl-DAT |
| d. | ka:ve:-nək | coffee-DAT |
| e. | korde:-nək | cart-DAT |
| f. | ta:pe:r-nək | plate-DAT |
| g. | ɔste:k-nək/nək | Aztec-DAT |
| h. | hɔvɛr-nək | pal-DAT |
| i. | ma:gneʃ-nək/nək | magnet-DAT |
| j. | ko:deks-nək | codex-DAT |
| k. | ɔnɔli:ziʃ-nək/nək | analysis-DAT |

The distinction between the degree of transparency for high, mid, and low vowels, in terms of how consistently they are transparent, is known as the height effect; it is strongly

⁴ A reviewer points out that in very rare cases, a single [i] may be opaque, as in “abszint-nak/nek” and “Auschwitz-ból/ből”, but also notes that these words may be analyzed as complex, as [sint] and [vits:] are both independent words. I will assume that the variability possible in these words comes from ambiguity in their morphological structure, rather than from any phonological factors. In other words, speakers may or may not treat these words as compounds. When they are treated as compounds, the back vowel is outside of the harmony domain, allowing the possibility of front suffixes. In contrast, when they are not treated as compounds, they behave like other back-[i] words, in taking back suffixes.

supported by a large body of data and wug test judgements from native speakers (Hayes & Londe 2006). Essentially, [i(:)] is more transparent than [e:], which is more transparent than [ɛ]; this “transparency scale” is supported by ratios of front suffixation to all suffixation for back-neutral stems calculated from corpus counts (Rebrus & Törkenczy 2016b), with total transparency for [i(:)], a low ratio for [e:], and a high ratio for [ɛ]. The example in (2k), showing that multiple neutral vowels are less transparent, illustrates what is known as the count effect, and also applies to the other front unrounded vowels; again, this effect has been shown to be productive and robust (Hayes & Londe 2006).

While (2) shows that (non-low) front unrounded vowels do not generally trigger harmony when other potential triggers are present, they are “last-resort” triggers, in that roots with only front unrounded vowels typically take front suffixes (e.g. Siptár & Törkenczy 2000).⁵ Examples are shown in (3), with the dative suffix seen in previous examples and the ablative suffix [tø:l]~[to:l]. It is worth noting that within roots, neutral vowels can precede back vowels, as in [bikɔ] ‘bull’; the pattern in (3) occurs solely across morpheme boundaries, in that root-internal harmony for front unrounded vowels is not required even in native vocabulary.

- (3) Last-resort triggering by front unrounded vowels (Siptár & Törkenczy 2000)
- | | | |
|----|------------------------|-----------|
| a. | vi:z-nɛk | water-DAT |
| b. | vi:s-tø:l ⁶ | water-ABL |
| c. | sɛge:n-nɛk | poor-DAT |
| d. | sɛge:n-tø:l | poor-ABL |

I will consider these examples in (3) to be last-resort triggering, as opposed to a default value, because it is clear from vacillating stems that front unrounded vowels are able to trigger front harmony in some contexts; the same can be thought to apply here.⁷ In new loans and nonce words, front unrounded vowels also always take front suffixes, providing an additional argument for them to behave as triggers.⁸ As I adopt binary features, I also assume for simplicity that both [+back] and [-back] are active in triggering harmony in Hungarian, as has been widely assumed (e.g. Vago 1973; 1976; Farkas & Beddor 1987).

Whether Hungarian has root-internal harmony is a matter of some debate. Many analyses assume that it does not, and that harmony only affects suffixes; in analyses of this type formulated in OT, a high-ranked root faithfulness constraint is assumed (e.g. Ringen & Vago 1998). However, aside from recent loans, Hungarian roots obey similar harmonic restrictions to root-suffix combinations: Törkenczy et al. (2013) note that bisyllabic stems containing both front and back vowels are rare with front rounded vowels (“dis-harmonic roots”), with all cases being recent loans, but frequent with front unrounded

⁵ There is a small class of about 50-60 exceptions to this generalization (“anti-harmonic” stems), exemplified by *híd + nak* (see e.g. van der Hulst 1985; Ringen and Vago 1998), which are beyond the scope of this paper. Most of these roots have [i] or [i:]; a few have [e:].

⁶ Note that Hungarian has obstruent cluster voicing assimilation; the root-final consonant in this form assimilates in voicing to the suffix-initial [t].

⁷ An additional argument, well-known but most often rejected in the recent literature, comes from the behaviour of personal pronouns that are formed by adding person suffixes to case suffixes. The front/back value of the vowels in such pronouns is consistent for a given case, but varies across cases. For example, the ablative case [to:l]~[tø:l] is front in personal pronouns, as in [tø:l-ɛm] ‘ABL-1SG’; in contrast, the relative case [ro:l]~[rø:l], in which the same vowels alternate, is back in personal pronouns, as in [ro:l-ɔm] ‘DEL-1SG’. Vago (1973; 1980a) argues that such forms, in absence of a stem, allow the underlying suffix vowel to surface and therefore provide evidence for its feature value. However, this argument is generally rejected; most researchers assume that personal pronouns are formed from independent stems that look like alternating suffixes, but whose vowels have no bearing on the question of underlying suffix vowels (e.g. Ringen 1978). Moreover, a reviewer points out that most suffixes do not have a stem form, so Vago’s argument is at most applicable to a small number of suffixes.

⁸ Thank you to a reviewer for this information.

vowels (“mixed roots”), though with [ɛ] most are loanwords. This difference corresponds to the strong versus weak disharmony distinction drawn by Rebrus & Törkenczy (2015). Törkenczy (2010: 8) provides corpus counts supporting this distinction and notes that intuitively for native speakers, disharmonic roots “feel foreign”, while mixed roots do not. In other words, front rounded vowels cannot co-occur with back vowels within roots, while mixed roots containing front unrounded vowels with back vowels are permitted. This fact suggests that, disregarding recent loans, Hungarian roots do show a harmony pattern that should be analyzed, because it works in essentially the same way as the root-to-suffix harmony.

To summarize, Hungarian has a pattern of front/back harmony, in which front unrounded vowels tend to be transparent, but can trigger harmony in certain stems or when there are multiple of them, and behave as last-resort triggers when they are the only vowel in the root. The different front unrounded vowels behave differently with respect to various aspects and degrees of neutrality, with height affecting whether a single neutral vowel is consistently transparent ([i(:)]), usually transparent ([e:]), or usually variable or opaque ([ɛ]). The back vowels and front rounded vowels are generally harmonic, and typically occur only with neutral vowels or vowels in the same harmonic class.

2.3 Patterns of neutrality in suffixes

I turn now to additional complications from suffix alternations and their interaction with neutrality. Törkenczy et al. (2013) discuss the fact that there are both invariant and alternating suffixes containing neutral vowels, but their analysis focuses on paradigm uniformity, not the issue of neutrality. Other literature also notes the presence of alternating suffixes as a factor in the scale of neutrality (e.g. Rebrus & Törkenczy 2016a), but again does not provide any detailed theoretical implementation.

The Hungarian inventory in Table 1 showed that only non-low rounded vowels are paired for [back], but other vowel pairs also alternate harmonically in suffixes. An example is the dative suffix in (1–3), since neither [ɔ] nor [ɛ] is paired. Siptár & Törkenczy (2000), among others, provide a complete list of alternating vowel pairs, shown with examples in Table 2.

Table 2: Suffix alternations in Hungarian (Siptár & Törkenczy 2000).

Back vowel	Front vowel	Example
u:	y:	la:b-u: ‘legged’ fɛj-y: ‘headed’
u	y	ha:z-unk ‘our house’ kert-ynk ‘our garden’
o:	ø:	va:r-o: ‘waiting (adj.)’ ke:r-ø: ‘asking (adj.)’
o	ø, ɛ (varies based on rounding harmony)	ha:s-hoz ‘to (the) house’ ⁹ føld-høz ‘to (the) land’ kert-hez ‘to (the) garden’
a:	e:	va:r-na: ‘he would wait for it’ ke:r-ne: ‘he would ask for it’
ɔ	ɛ	ha:z-bɔn ‘in (the) house’ kɛrd-bɛn ‘in (the) garden’ ⁹

⁹ As in (3b), voicing assimilation from the suffix consonant applies here to the root-final obstruent.

Despite the large literature on Hungarian vowel harmony, the suffix alternations between [a:] and [e:], in the penultimate row of Table 2, are rarely explicitly analyzed theoretically. However, this pair is problematic for the widely stated view that neutral vowels are harmonically unpaired, which would suggest that they should be non-alternating (e.g. van der Hulst 2016; see also Törkenczy 2013 on this issue). Under categorical definitions of neutrality, [e:] (unlike [ɛ]) is widely considered a neutral vowel in Hungarian (e.g. Vago 1978; Ringen 1988; Siptár & Törkenczy 2000), but Table 2 shows that it does participate in suffix alternations. Indeed, [a:]~[e:] alternations occur regularly and consistently through Hungarian morphology, in a variety of suffixes. Like for other pairs in alternating suffixes, the front vowel [e:] occurs after stems with front vowels, while the back vowel [a:] occurs following stems with back vowels (Siptár & Törkenczy 2000). Moreover, [e:] is the only possible counterpart for the harmonic vowel [a:] in alternating suffixes (cf. Table 2). Additional examples of the [a:]~[e:] alternation are shown in (4) with four different suffixes, namely the adessive, translative, 3SG definite conditional, and 2SG indefinite conjunctive/imperative; Törkenczy (2010) and Rebrus et al. (2012) note 10 productive suffixes containing this alternation.¹⁰ Note that these are native Hungarian suffixes.

(4) Suffix alternations with [a:] and [e:] (Törkenczy 1997)

	Word	Gloss
a.	dob-na:l	drum-ADE
b.	tøk-ne:l	pumpkin-ADE
c.	dob-ba:	drum-TRANSL ¹¹
d.	tøk-ke:	pumpkin-TRANSL
e.	ɔd-na:	give-3.SG.DEF.COND
f.	øl-ne:	kill-3.SG.DEF.COND
g.	ɔj:a:l (ɔd-ja:l) ¹²	give-2.SG.INDF.CONJ/IMP
h.	øj:e:l (øl-je:l) ¹²	kill-2.SG.INDF.CONJ/IMP

Despite such alternations, there is a distinction between [e:] and [a:] in terms of the number and nature of non-alternating suffixes with these vowels. Siptár & Törkenczy (2000) list twelve non-alternating suffixes with [e:], comparable to the number with [i]. These are common suffixes that are fundamental to the grammatical system of Hungarian, such as the possessive and the causal; implicit in Siptár & Törkenczy's (2000) discussion of these affixes is that they are native to Hungarian. In contrast, there are only three non-alternating suffixes with [a:], comparable to the four containing [o]; these suffixes are borrowed, mostly Latinate, and their exact semantic content is not always clear from the glosses. Given this and the fact that all three end in [a:l], they may in fact all be the same suffix.¹³ Examples of non-alternating [e:] suffixes are given in (5), and a complete list of the potential non-alternating [a:] suffixes is given in (6).

¹⁰ Other sources differ in the number; for instance Törkenczy et al. (2013) note only 8 suffixes with this alternation.

¹¹ The translative suffix is [va:]~[ve:] with vowel-final stems; the /v/ assimilates to the root-final consonant in consonant-final stems like the examples given here (Siptár and Törkenczy 2000).

¹² The combination of [d] + [j] and [l] + [j] in these examples cause consonant changes; the examples in parentheses indicate the morpheme-by-morpheme transcription, while outside the parentheses are the combined surface forms.

¹³ A reviewer points out that this is indeed considered one suffix, and it is lexicalized and not productive, because it truncates stems and/or shortens the stem vowels; these examples in (6) might be taken to be monomorphemic. Törkenczy (2010), in listing vowels occurring in invariant suffixes in Hungarian, does not list any with [a:], suggesting that he may consider them monomorphemic.

- (5) Non-alternating suffixes with [e:] (Siptár & Törkenczy 2000)
- | | Word | Gloss |
|----|-----------------------|-----------------------|
| a. | la:ɲ-e: | girl-POSS |
| b. | hɔza:-e:rt | (one's) country-CAUS |
| c. | kova:tʃ-ne: | Kovács (surname)-Mrs. |
| d. | ɔd-ne:k ¹⁴ | give-1.SG.INDF.COND |
| e. | kultʃ-ke:nt | key-ESS |
- (6) Non-alternating suffix(es) with [a:] (Siptár & Törkenczy 2000)
- | | Word | Gloss |
|----|----------------|------------------|
| a. | rɛtsɛnz-a:l | review (verb) |
| b. | ɛlɛktr-ifika:l | electrify |
| c. | fɛtiʃ-iza:l | make a fetish of |

As mentioned, the status of [a:] as a harmonic vowel and of [e:] as a transparent vowel in Hungarian is widely assumed; this is supported by the data on non-alternating suffixes in (5–6), because [e:] is neutral in a variety of suffixes, while [a:] is not (see Ringen 1978 for argumentation connecting neutrality to non-alternating suffixes in Hungarian). However, the data in (4) clearly illustrate that [a:] and [e:] are a harmonic pair in suffix alternations.

Traditional work has at least implicitly assumed that the underlying vowel in [a:]~[e:] alternations is /a:/, with /e:/ in suffixes surfacing faithfully as a non-alternating neutral vowel. In contrast, in more modern literature on Hungarian, the presence of a neutral vowel in alternating suffixes is considered an aspect of gradient neutrality (e.g. Rebrus & Törkenczy 2016a). As illustrated in Table 2, there are no alternating suffixes with high front unrounded vowels; these vowels occur only in invariant suffixes (Törkenczy 2010; Törkenczy et al. 2013).¹⁵ The data in (4–5) has shown that [e:] is present in both invariant and alternating suffixes. Table 2 also shows that [ɛ] occurs in alternating suffixes; however, it never occurs in invariant suffixes (Törkenczy 2010; Törkenczy et al. 2013). Thus, in this respect too, there is a height effect: high [i] and [i:] are the most neutral, in that they occur only in invariant suffixes; low [ɛ] is the least neutral, in that it occurs only in alternating suffixes; and mid [e:] is intermediate. Under a gradient view of neutrality, this pattern is sensible and consistent with the patterns in Section 2.2, but it is problematic under a categorical view of neutrality, and it needs to be analyzed.

2.4 Summary of patterns

In Hungarian, the distinction between neutral and harmonic vowels is not always clear, and there are multiple distinct aspects and degrees of neutrality; the front unrounded vowels show a variety of behaviours, as shown in Sections 2.2 and 2.3. This has been noted extensively in recent literature on Hungarian. For example, Rebrus & Törkenczy (2016a) note three different notions that are often included as part of neutrality: (i) neutrality as a target (invariant suffixes; see (5)), (ii) neutrality as a trigger with respect to other targets (transparency; see (2)), and (iii) neutrality as the source trigger (anti-harmony; see footnote 5). In Hungarian, these three properties create a scale of neutrality among the front unrounded vowels, which show [i(:)] to be the most neutral, followed by [e:], and finally [ɛ].

In slightly different terms, we can summarize the behaviour of Hungarian vowels based on whether and when they are triggers or targets of harmony (Table 3). As is evident here, there are two primary factors that can affect whether a given vowel is a trigger or target

¹⁴ However, a reviewer points out that for many speakers, this suffix is alternating, with the example ɔd-na:k 'give-1.SG.INDEF.COND', compared to fɛd-ne:k 'cover-1.SG.INDEF.COND'. For these speakers, this suffix simply patterns like those in (4).

¹⁵ [i] alternates in only a single suppletive suffix [-i]/[-jɔ] '3.SG.DEF' (Rebrus et al. 2012).

Table 3: Trigger and target status of Hungarian vowels.

Vowel	Trigger (root-to-suffix)?	Target (in suffix)?
i/i:	Only if there is no alternative or (variably) when multiple i/i: are present	Never
e:	Variably in a few morphemes, or if no alternative is present	Sometimes
ε	In most morphemes (often variably)	Always
All others	Always	Always

of harmony: the specific vowel quality and the specific morpheme in which the vowel appears (see Rebrus et al. 2012). Additionally, harmony is affected by whether a vowel is in a root or suffix and how many neutral vowels there are.

Despite the discussion of these issues of variability in the literature, theoretical treatments of these issues are lacking. In the present paper, I focus primarily on one aspect of differential neutrality, namely the non-neutrality of [e:] in suffixes. As will be discussed in more detail in the analysis section, the way of understanding harmony targets presented here ties in closely with the view of neutrality as gradient and variable that is dominant in modern literature on Hungarian (e.g. Rebrus et al. 2012; Törkenczy et al. 2013; Rebrus & Törkenczy 2016a).

3 Motivations for the asymmetries

Section 2 has shown that Hungarian neutrality has a height effect, with variability in the degree of neutrality depending on the height of the vowel. The lowest front unrounded vowel [ε] is sometimes considered harmonic (e.g. Ringen 1975; 1978; 1980; Ringen & Vago 1998); it is less transparent than higher [e:], which is in turn less transparent than high [i, i:]. This generalization holds across multiple facets of neutrality, and is clearly an active part of Hungarian phonology.

This height effect is a manifestation of a broader, cross-linguistic pattern in front/back harmony, namely that lower vowels are more likely to undergo this type of harmony (e.g. Anderson 1980; Benus 2005; Finley 2015, etc.). Within front unrounded vowels, which are commonly transparent to front/back harmony, the most common transparent vowel is [i], followed by [e]; moreover, there is an implicational generalization that if a lower vowel like [e] is transparent, then so is [i] (e.g. Anderson 1980; Benus 2005; Finley 2015, etc.). This height asymmetry also extends beyond front unrounded vowels: in loanwords in Finnish, [y] is often transparent to front/back harmony, while the lower front rounded vowel [ø] is more consistently harmonic (Ringen & Heinämäki 1999).

These cross-linguistic and Hungarian-internal patterns are not surprising, given that there is phonetic motivation for this height asymmetry. As argued for instance by Benus (2005), Benus & Gafos (2007), and Gafos & Dye (2011), higher vowels have a greater degree of perceptual stability along the front/back dimension; higher front vowels can be articulatorily retracted to a greater degree without changing categorical front/back perception. Lower vowels, along with rounded vowels, have less perceptual stability with respect to articulatory perturbations in the front/back dimension, and are therefore less phonetically likely to be neutral. These authors specifically refer to vowels being less or more transparent, but that is equivalent to being a better or worse trigger and target of harmony, because they are discussing the possibility of vowels being skipped over (i.e. both not targeted by harmony and not triggering it themselves).

Benus & Gafos (2007) argue that these properties relate directly to articulatory facts. To explain the effect of rounding, they note that rounding lengthens the vocal tract, but the vowel constriction remains in the same horizontal location; this advances the area of perceptual stability, so that a front rounded vowel can be retracted less than a front unrounded one before changing perceptual categories. Similarly, for height, they note

that the constriction required for lower vowels has less flexibility along the horizontal dimension, so that the potential for perceptually stable retraction of a lower front vowel is less than that of a higher vowel. Overall, they suggest that the effect of height and rounding on neutrality has a phonetic basis in the relationship between articulation, acoustics, and perception for vowels of different height and rounding.

Moreover, Beddor et al. (2001) suggest that the tendency of non-low front unrounded vowels, specifically [i] and [e], to be neutral in front/back harmony comes from smaller effects of vowel-to-vowel coarticulation on these sounds. These authors and others (e.g., Ohala 1994; Beddor & Yavuz 1995; Majors 1998) have suggested that vowel-to-vowel coarticulation can evolve into phonological harmony. As such, if coarticulation has a smaller effect on higher vowels, then these vowels are less likely to harmonize in a phonological system (i.e. are more likely to be neutral). Thus, the height effect could be attributed to phonetic properties of coarticulation, independent of phonological harmony.

In summary, cross-linguistic and phonetic evidence all suggest that lower vowels (and rounded vowels) are better potential targets of front/back harmony. A proper account of the behaviour of Hungarian front unrounded vowels must consider their quality as potential targets in order to capture this critical broader generalization. Specifically, the theory should predict the Hungarian pattern, but not a case where lower vowels are neutral and higher vowels are not, which is unattested. Additionally, beyond front unrounded vowels, the [a:]~[e:] alternation follows this height generalization, in that low back vowels like [a:] are consistently harmonic despite being unpaired. A “reverse Hungarian” pattern in which [e:] consistently harmonizes to [a:], while [a:] generally behaves neutrally, should be impossible, because it contradicts the cross-linguistic, phonetically motivated generalization that low vowels are better undergoers of front/back harmony.

4 Implications for views of neutrality

Although it is typically ignored in analyses, the non-neutrality of Hungarian [e:] in suffixes (i.e. the [a:]~[e:] alternation described in Section 2) has significant implications for the understanding of neutrality in vowel harmony. This section describes the problems that this alternation poses to standard categorical analyses of Hungarian and the new view of neutrality that it suggests.

4.1 The problem

In standard analyses of Hungarian vowel harmony (e.g. Vago 1980a; Ringen & Vago 1998; etc.), [e:] does not undergo vowel harmony because there is no mid, back, unrounded, long vowel to which it could harmonize. For example, Ringen & Vago (1998) propose a constraint $*i_A$, which requires [+back, -low] vowels to also be round. Ranked above the harmony-enforcing constraint, this general markedness constraint prevents [e:] from undergoing harmony and allows it to be neutral. To my knowledge, there is no discussion in the theoretical literature about why [a:] does undergo harmony, despite also being unpaired.

The fact that [e:] can act as the harmonic counterpart for [a:] raises critical questions about this view of neutrality. Even if the [a:]~[e:] alternation is always underlying /a:/, precisely the same mechanisms that allow [a:] to undergo re-pairing to [e:] should force the same possibility for [e:]. Indeed, if changing the feature [low] is allowed in order for /a:/ to harmonize to [e:], then it is unclear what blocks changes in [low] in so many cases of /e:/ in suffixes surfacing faithfully. The tableaux in Tables 4 and 5 demonstrate this problem, adapting the analysis of Maasai re-pairing from Pulleyblank et al. (1995) and using BACKNESS-HARMONY to stand in for any constraint that enforces harmony. Table 4 derives the correct result, with /a:/ re-pairing to [e:] when it follows a front vowel, but

Table 4: /a:/ undergoes re-pairing to [e:].

/y...a:/	*ɣ:	*æ:	BACKNESS-HARMONY	IDENT-IO[low]
y...a:			*!	
☞ y...e:				*
y...æ:		*!		

Table 5: Incorrect prediction that /e:/ undergoes re-pairing to [a:].

/u...e:/	*ɣ:	*æ:	BACKNESS-HARMONY	IDENT-IO[low]
⊖ u...e:			*!	
☞ u...a:				*
u...ɣ:	*!			

Table 5 incorrectly predicts that /e:/ should consistently surface as [a:] in a back vowel environment. The reverse ranking of BACKNESS-HARMONY and IDENT-IO[low] would predict that /e:/ can surface faithfully in Table 5, but gives an incorrect result in Table 4. Either way, the result is incorrect according to a categorical view, and it is also impossible to derive a gradient view in which /e:/ is variably neutral but /a:/ is not.

Thus, the disparate behaviour of the two unpaired vowels [a:] and [e:] in Hungarian means that we cannot assume that general markedness, alone or in combination with faithfulness to other features, determines whether a vowel is a harmony target. Instead, neutrality must be derived in some other, more vowel-specific way.

4.2 Problems for possible solutions within traditional frameworks

Before considering the target-based view adopted here, I outline two potential solutions that are formulated within more traditional views of harmony, as well as the reasons for rejecting them. First, I consider separating IDENT-IO[–low] from IDENT-IO[+low], and then the possibility that harmony is triggered only by [–back]. Note that neither of these solutions has actually been proposed in the literature to deal with the Hungarian [e:]~[a:] alternation, unsurprisingly given the lack of discussion about this pattern within these kinds of analyses.

4.2.1 Ident-IO[–low] vs. Ident-IO[+low]

The problem illustrated in Tables 4 and 5 is that BACKNESS-HARMONY needs to outrank IDENT-IO[low] for /a:/, but the reverse ranking is required for /e:/. A possible way to deal with such an asymmetry is to incorporate it into the faithfulness constraint, with separate constraints IDENT-IO[–low] and IDENT-IO[+low]; this type of separation of faithfulness constraints by feature value has been used by McCarthy & Prince (1995; 1999). Respectively, these constraints prevent changing a [–low] feature to [+low], and a [+low] feature to [–low]. With a ranking of IDENT-IO[–low] >> BACKNESS-HARMONY >> IDENT-IO[+low], changing [+low] to [–low] is permitted to satisfy harmony, but the reverse feature change is not. Tables 6 and 7 demonstrate that this approach would correctly account for the Hungarian pattern, if we consider all such alternating suffixes to be underlyingly /a:/.

However, this option is highly stipulative, in that it just as easily predicts the reverse of the Hungarian pattern, with neutral [a:] and harmonic [e:], simply by switching the positions within the ranking of IDENT-IO[–low] and IDENT-IO[+low]. As discussed in

Table 6: /a:/ undergoes re-pairing to [e:].

/y...a:/	*ɣ:	*æ:	IDENT-IO[-low]	BACKNESS-HARMONY	IDENT-IO[+low]
y...a:				*!	
☞ y...e:					*
y...æ:		*!			

Table 7: /e:/ does not re-pair to [a:].

/u...e:/	*ɣ:	*æ:	IDENT-IO[-low]	BACKNESS-HARMONY	IDENT-IO[+low]
☞ u...e:				*	
u...a:			*!		
u...ɣ:	*!				

Section 3, this result is undesirable, because it misses a crucial cross-linguistic, phonetically motivated generalization: low vowels are better undergoers of front/back harmony than non-low vowels, and so “reverse Hungarian” is an improbable language. Moreover, it would be typologically odd to claim that the ranking IDENT-IO[-low] >> IDENT-IO[+low] is universal, in contexts beyond front/back harmony. Thus, the height generalization cannot be captured in an analysis where the asymmetry falls to the separation of faithfulness constraints. In this type of analysis, it is also impossible to connect this alternation to the idea that [e:] is intermediately neutral.

4.2.2 Triggering by only [-back]

A second possibility framed within more traditional work is that only [-back] vowels trigger harmony, and (non-low) front unrounded vowels are unspecified for [back]. In that case, only back vowels can undergo harmony. Assuming again for the purposes of this argument that alternating [a:]~[e:] suffixes are all underlyingly /a:/, this would account for why /e:/ is exempt.

Such an approach fails to account for why front rounded vowels are not neutral in suffixes. Given Richness of the Base and the wide inventory of suffixes in Hungarian, we expect the possibility of underlying front rounded vowels in Hungarian suffixes. Under an account where only [-back] triggers harmony, any suffixes with underlying front rounded vowels would have no reason to harmonize, because a root containing [+back] vowels cannot trigger harmony. For example, for a UR like /ha:z + tø:l/, /a:/ would be unable to trigger harmony; since Hungarian harmony is strictly root-to-suffix, this UR should surface as *[ha:ztø:l]. In other words, we would predict a divide in which all front vowels can occur in native non-alternating suffixes, while back vowels cannot. Instead, in Hungarian, only /i, i:, e:/ as underlying suffix vowels are exempt from being targets of harmony; these vowels regularly behave as non-alternating in suffixes, while rounded front vowels are consistently alternating. This is unexplained if only [-back] can trigger harmony. Thus, this solution is undesirable as a way to explain the asymmetry between [a:] and [e:].

Moreover, if only [-back] can trigger harmony and front unrounded vowels are unspecified, there is no way to derive the variability described in Section 2.2, particularly that which occurs with the vowel [ɛ]. If [ɛ] is unspecified for [back], then it should be unable to trigger harmony ever, which leaves the possibility of front suffixes in (2i-j) unexplained. Similarly, if [ɛ] is specified as [-back], then it should always trigger front harmony, which

leaves the possibility of back suffixes in (2h–i) unexplained. This argument also extends to the behaviour of disharmonic roots (i.e. those with a combination of back vowels and front rounded vowels), which consistently take suffix values based on the last stem vowel. If only [–back] can trigger harmony, then back vowels cannot trigger backness in the suffix, and so it is incorrectly predicted that front-back disharmonic stems should take front suffixes. We might try to claim that stem-internal disharmony begins a new harmony domain, and that back suffixes are a default value; however, doing so would leave the last-resort triggering in (3) unexplained. Indeed, if front unrounded vowels are unspecified for [back], suffixes for neutral-only stems should also contain a default value, yet the value in this case is front. Thus, it is inconsistent with the Hungarian data to claim that only [–back] can trigger harmony.

4.3 *New view of neutrality*

Due to the aforementioned problems with solutions in which neutrality is determined by lack of a harmonic counterpart, I argue that the Hungarian patterns require a fundamental change in how we view targets of vowel harmony: it suggests the need to consider the nature of each vowel as a possible harmony target. This view works not only for the [e:]~[a:] asymmetry, but more broadly for the height effect in Hungarian. I propose that the drive to undergo vowel harmony differs by vowel, in a way motivated by cross-linguistic and phonetic properties, and that cases of neutrality do not occur simply because harmony is impossible, but because the vowel-specific drive to undergo harmony is too weak to force unfaithfulness. This notion is gradient, and so will be able to avoid the issues of the categorical views.

In the case of front/back harmony, phonetic and cross-linguistic facts outlined in Section 3 show that vowels that are lower and/or rounded are preferred targets. As such, the drive for lower vowels, such as [a:], to undergo harmony should be stronger than the drive for the non-low, unrounded vowel [e:]. The result, in Hungarian, is that [a:] is consistently a harmonic vowel, while [e:] can be neutral. The additional fact that [a:] is unpaired in the inventory, yet required to be a target, is what forces it to re-pair to [e:]. Moreover, the basic height effect in Hungarian is in direct accordance with the phonetic facts: the higher the vowel, the worse it is as a target of harmony, and therefore the more likely it will be to be neutral.

5 *New theoretical approach: Target quality*

To formally implement the new view of neutrality described in Section 4.3, I adopt the Harmonic Grammar (HG) framework (Legendre et al. 1990a; b; Smolensky & Legendre 2006; Pater 2009) and propose to extend Kimper's (2011) trigger strength analysis to targets. I also posit a target-oriented harmony constraint, which is a modification to Pulleyblank's (2004) no-disagreement harmony-driving constraints. This section provides the theoretical background, assumptions and motivations of my analysis; the application to Hungarian is left for Section 6.

5.1 *Harmonic Grammar (HG)*

Harmonic Grammar (HG; Legendre et al. 1990a; b; Smolensky & Legendre 2006; Pater 2009) is a model of phonology that is similar to standard Optimality Theory (OT; Prince & Smolensky 1993) except that constraints are weighted (Potts et al. 2010). In the specific implementation that I adopt here, I follow Potts et al. (2010) in assuming that constraints are negatively formulated, as in standard OT, and weights are positive integers. There are often many options that will work for the weight of each constraint; the specific choice is arbitrary (e.g. Bowman 2013).

Within HG, it has been proposed that violations of a constraint can be multiplied by a *scaling factor*, which allows properties of a specific violation to influence the degree to which the violation is weighted (e.g. Kimper 2011; see also Coetzee and Kawahara 2013 for scaling factors of a different type). A scaling factor x is a positive constant by which the constraint weight is multiplied; this has the effect of increasing the penalty incurred for a violation if $x > 1$ and decreasing it if $0 < x < 1$. As an example, in this paper, a scaling factor based on target quality will be applied to the harmony constraint. For example, the disharmonic combinations [u...y] and [u...i] both violate a progressive front/back harmony constraint once. However, if the vowels [y] and [i] have target scaling factors of 4 and 2 respectively, then [u...y] will incur twice the penalty for this disharmony than will [u...i]. Further details are reserved for Sections 5.3 and 5.4.

For a given violation, the total penalty assigned by a constraint to a candidate (for a single locus of violation) is $-W*S$, where W is the weight of the constraint and S is any relevant scaling factors; such penalties are summed across all violations that the candidate incurs for all constraints (adapted from Potts et al. 2010). For example, given a harmony constraint with weight 3 and the target scaling factors defined in the previous paragraph, the harmony violation incurred by [u...y] would receive a penalty of $-3*4 = -12$, while [u...i] would have one of $-3*2 = -6$. The total of all penalties for all constraints is called the harmony score, and the candidate with the highest harmony score wins. Since the expression is always negative, the winning candidate will be the one with a harmony score closest to zero (Potts et al. 2010).

5.2 The nature of the harmony-driving constraint

An important theoretical implication of the Hungarian pattern is that the target-sensitive harmony constraint must be negatively formulated, in the sense that disharmony is penalized. While negative constraints are quite common, they are not universal; Kimper (2011) uses a positively formulated harmony constraint, in which harmony is rewarded, and Archangeli & Pulleyblank (2002) propose positive target conditions. However, in Hungarian, the good target [a:] becomes a poor target, [e:], while the reverse does not always occur. If harmonizing to good targets were rewarded, then we would predict the opposite pattern; the poor target [e:] would become the good target [a:] in order to benefit from the reward; /a:/ surfacing unfaithfully as [e:] would be rewarded less and therefore be less likely to occur. Instead, the direction of the Hungarian asymmetry necessitates a penalty for good targets that have not undergone harmony. Non-harmonized [a:] will be heavily penalized, and so [a:] is required to harmonize, whereas non-harmonized [e:] will be penalized less and therefore permitted.

As long as there is a mechanism to distinguish trigger and target, the specific constraint used to enforce harmony is independent of both the principle of target scaling and the perspective that neutrality is caused by the drive to undergo harmony being too weak. I adopt a variation on Pulleyblank's (2004) infinite distance no-disagreement constraints, defined in (7) and subject to trigger and target scaling as in Sections 5.3 and 5.4.

- (7) *[- α Back] ∞ [**α Back**]: Assign a violation for every vowel that is [**α Back**] and is preceded at any distance by a vowel that is [- α Back].

The boldface indicates that this constraint is oriented towards the second vowel; it is the focus, and therefore the locus of violation, while the first vowel is the context/environment. Violations are counted for each [**α Back**] preceded by a [- α Back] vowel, and the infinity symbol indicates that such a configuration is a violation regardless of the distance or intervening segments. Only one violation is possible per potential [**α Back**] target. For example, a sequence such as [u...y₁...y₂] violates (7) twice, once for [y₁] and once for

[y₂], both of which are preceded at some distance by a back vowel [u]. The fact that [y₁] intervenes between [u] and [y₂] is irrelevant to the fact that a violation is assigned. On the other hand, the sequence [y₁...y₂...u] violates (7) only once, for the [u] that is preceded by a front vowel.

Since Hungarian harmony is progressive, this constraint counts violations based on the number of vowels that could be targets of harmony but are not. For the purposes of trigger scaling, it is counted from the closest possible potential [-αBack] trigger. Thus, for each pair of vowels violating the constraint, the target scaling factor is based on the vowel for which the violation is counted (the focus), while the trigger is the closest preceding vowel of the opposite [back] value (the context). For example, in [y₁...y₂...u], the one violation has trigger [y₂] and target [u]. The two violations in [u...y₁...y₂] both have trigger [u], and the targets are [y₁] and [y₂] respectively.

The constraint in (7) is equivalent to the two separate constraints *[-Back] ∞ [+Back] and *[+Back] ∞ [-Back]. This approach therefore differs from that of Pulleyblank (2004) in that the constraint is consistently oriented not to a specific value of the feature [back], but rather to the second vowel in a disharmonic sequence. This choice offers a conceptual advantage for a case of harmony like Hungarian, which is arguably progressive and triggered by either feature value, because it offers an easy way of identifying the trigger and target for each violation. In comparison, other types of harmony constraints, such as AGREE[back] (e.g. Baković 2000), do not have a natural way of referring to the potential triggers and targets of harmony.

In addition to providing an inherent definition of trigger and target, this type of constraint has a more natural way of dealing with transparency than other options. Spreading-type constraints like ALIGN[back] or SPREAD[back] generally require significant representational complexity, such as line crossing, gapped configurations, or output underspecification, to deal with transparency (e.g. Ringen & Vago 1998; Walker 1998; 2012 Jurgec 2011; Ní Chiosáin & Padgett 2001). Further, constraints like AGREE[back] do not have a natural way of referring to non-adjacent vowels, and they naturally prefer opacity to transparency in order to reduce the number of disharmonic transitions (Baković & Wilson 2000). In contrast, a target-oriented constraint captures the generalization that all vowels should be targets of harmony when a potential trigger is present; no additional representational complexity is required, and transparency is derived because whether other potential targets intervene is irrelevant to whether the constraint is violated.¹⁶ See Pulleyblank (2004) for additional argumentation for this style of constraint. Some of the constraints used by Hayes & Londe (2006) in dealing with Hungarian are of a similar type, though formulated differently.

It is worth noting that the main cases of harmony that Pulleyblank (2004) discusses are dominant-recessive systems, and the constraints are oriented towards the recessive (target) feature value, such as ATR in Yoruba. Thus, although Pulleyblank (2004) does not discuss targets, the constraint here is consistent with the insight of his constraints, despite the distinct implementation. Nonetheless, in the standard OT framework adopted by Pulleyblank (2004), without weights or scaling, the constraint in (7) could not predict the Hungarian transparency facts; both Back-Front-Back and Back-Front-Front sequences violate *[-αBack] ∞ [αBack] twice, and so this constraint without scaling could not distinguish these candidates. The next two subsections deal with how this constraint will be scaled in the current framework to allow for transparency.

¹⁶ Note, however, that it is not necessarily irrelevant to the weight of that violation: the violation can be scaled by distance, as Kimper (2011) and Bowman (2013) do, so that harmony violations at a greater distance will be weighted less than those at a closer distance. This type of scaling can capture the count effect in Hungarian transparency.

5.3 Kimper's (2011) trigger strength

In order to explain asymmetries in triggering behaviour in vowel harmony, Kimper (2011) introduces a trigger strength scaling factor for his harmony constraint. As described in Section 5.1, this scaling is a constant for a given vowel, and the weight of a violation of the harmony constraint is multiplied by this scaling value to determine the penalty (or, in Kimper's framework, reward) of a particular trigger configuration. Thus, it has the effect of increasing the likelihood of harmony when the potential trigger is perceptually impoverished for the harmony feature, which is a characteristic of good harmony triggers (Kimper 2011). Trigger strength is therefore vowel-specific, but cross-linguistic and phonetically motivated, exactly parallel to the concept of target-specific harmony advocated for here.

Kimper (2011) employs a more complex formal model than the one necessary here, but the scaling factor that he develops for trigger strength forms the basis for the current approach to vowel-specific targeting. A simplified version of Kimper's (2011) trigger scaling factor, quoted from Bowman (2013: 4), is given in (8).

- (8) "Scaling factor: trigger strength
For a trigger α , a target β , and a feature F , multiply the reward earned by a constant x (such that $x > 1$) for each degree i to which α is perceptually impoverished with respect to $\pm F$ (simplified from Kimper 2011)"

This constraint refers to rewards, since Kimper (2011) and Bowman (2013) use a harmony constraint that is formulated positively, meaning that harmonic configurations are rewarded. As discussed in Section 5.2, such a constraint is impossible here. However, the trigger strength scaling factor can easily be reformulated for a negative constraint, as in (9).¹⁷

- (9) Scaling factor: trigger strength
For a trigger α , a target β , and a feature F , multiply the penalty earned by a constant x (such that $x \geq 1$) for each degree i to which α is perceptually impoverished with respect to $\pm F$.

This scaling factor has the effect of increasing the penalty incurred for a disharmonic trigger/target pair when the trigger is perceptually impoverished. The result is that not harmonizing is worse with a good trigger than with a bad trigger. For example, in a front/back harmony system, if [y] is more perceptually impoverished for [back] than [i] (i.e. [y] is a better trigger), then the trigger strength scaling for [y] should be greater than or equal to that of [i]. This scaling factor is then applied to the weight of the harmony constraint in the way described in Section 5.1. As such, a disharmonic sequence in which [y] is the potential trigger will receive a greater penalty than one in which [i] is the potential trigger. In order to capture the fact that Hungarian neutral vowels are transparent instead of opaque, I adopt the trigger scaling factor in (9) in addition to the target one introduced in Section 5.4. (See Kimper 2011 and Bowman 2013 on the application of trigger strength to Hungarian.)

Kimper (2011) also proposes a distance scaling factor, which is particularly relevant for the count effect in Hungarian; he suggests that the reward of harmony decreases as the distance between the trigger and target increases. Since I formulate the harmony constraint negatively here, in this case, the penalty will decrease. A definition of the distance scaling factor, based on the simplified version in Bowman (2013), is given in (10).

¹⁷ Of course, Kimper (2011) has reasons for assuming a positive harmony constraint, and using a negative one instead will have implications to the theory. However, this issue is beyond the scope of the present paper.

- (10) **Scaling factor: distance**
 For a trigger α and a target β , multiply the penalty earned by a constant x (such that $0 < x < 1$) for each unit (e.g. syllable) of distance d intervening between α and β .

In Hungarian, this factor will have the effect of penalizing disharmony less at a greater distance, which will create the count effect; with multiple neutral vowels, the back vowel in the root is further from the suffix target, and so a front suffix will be penalized less than it would with only a single neutral vowel.

5.4 Target quality

As argued in Sections 2 through 4, whether a vowel undergoes harmony or not is sensitive to its quality as a potential target. This observation is similar to Kimper's (2011) discussion about triggers, and so I formalize it by adapting Kimper's (2011) trigger strength scaling factor in (8–9) for use with targets. The statement of this scaling factor is given in (11).

- (11) **Scaling factor: target quality**
 For a trigger α , a target β , and a feature F , multiply the penalty earned by a constant x (such that $x \geq 1$) for each degree i to which β is a quality target (defined by phonetic factors discussed in Section 3) with respect to $\pm F$.

Parallel to the one for trigger strength, this scaling factor has the effect of increasing the penalty for disharmonic pairs when the potential target is a good harmony target. In this definition, I remain agnostic on the precise factors that determine target quality; an in-depth analysis of the underlying mechanisms behind target quality is left for future research. However, as discussed in Section 3, it is clear from cross-linguistic patterns that low and round vowels are better targets of front/back harmony than non-low, unrounded vowels, and there is significant phonetic motivation for this asymmetry. As such, for front/back harmony, the target quality scaling factor of vowels that are low and/or round should be greater than or equal to that of non-low, unrounded vowels. This scaling is implemented within the model as described in Section 5.1.

5.5 Markedness conflation

Both trigger and target scaling factors are hypothesized to be universal, but only in the sense that they are motivated by cross-linguistic phonetic facts and are options across languages. A language may choose to treat all vowels equally in terms of triggering harmony and/or being targets; in such cases, the harmony system would be symmetrical. However, if a language chooses to scale for trigger strength and/or target quality, there are limited options for the relative scaling factors across vowels, and these options are built into the definition through the phonetic motivations. For example, since target quality in front/back harmony is motivated by articulatory and perceptual properties of height and rounding with respect to backness, languages can pattern like Hungarian, with only vowels that are round and/or low undergoing harmony, but reverse Hungarian is predicted to be impossible. Specifically, for front/back harmony systems the target scaling factor for non-low, unrounded vowels must be less than or equal to that of vowels that are low and/or rounded. The option for equality allows for symmetry, but if there is asymmetry, it must be in the direction of less participation of non-low, unrounded vowels.

While the formalization differs, this approach parallels previous work on similar hierarchies, such as de Lacy's (2004) concept of markedness conflation. The target concept here is similar in that it reflects universal properties of which vowels are better targets, and the

“ranking” of possible targets can be conflated. For example, considering only height, since lower vowels are better targets of front/back harmony, we predict the following possibilities: no vowels participate, only low vowels participate (neutrality of mid and high vowels), low and mid vowels participate (neutrality of high vowels), or all vowels participate (no neutrality). Languages where front/back harmony does not fit within these categories, such as with neutrality of low vowels to front/back harmony but participation of high and mid vowels, are not expected. These predictions are consistent with the cross-linguistic height generalizations in front/back harmony.

Formally, this universal hierarchy is implemented here through the phonetic motivations behind the target scaling factor in the definition, and the possibility of conflation comes from the option for multiple categories to have the same scaling factor. Thus, the target scaling values by height for front/back harmony (given consistent rounding) must be such that $\text{low} \geq \text{mid} \geq \text{high}$; the different patterns are derived by the possibility of equality. Recall that the target scaling factor itself is defined in terms of phonetic correlates of target quality, so that this hierarchy is not simply stipulated.

Similar to de Lacy’s (2004) markedness conflation constraints, this approach does not require a stipulated universal ranking, because the scaling factor is defined to be motivated by universal, cross-linguistic properties. It remains for future research to determine whether the scaling factors described here and the stringency hierarchy of constraints discussed by de Lacy (2004) are notational variants or whether they in fact make distinct predictions.

5.6 Morpheme-specificity

As discussed in Section 2.4, whether a particular vowel is a trigger or target in Hungarian depends not only on vowel quality, but also whether it is in a stem or suffix, as well as the specific morpheme. The former property is simple to account for in terms of root faithfulness (Beckman 1998), since in general in Hungarian, there are stricter harmony requirements on suffixes than on roots (e.g. [ɛ] is required to harmonize in a suffix, but not in a root).

Morpheme-specific behaviour is more complicated, in particular given its interaction with vowel quality; variation is lexically determined only for [e:] and [ɛ] (Rebrus et al. 2012). In particular, under the more modern assumption that [a:] ~ [e:] suffixes are not all underlyingly /a:/, we need to be able to capture the fact that [e:], unlike all other vowels, can be a target in some but not all suffixes. Further, both [e:] and [ɛ], unlike other vowels, can be triggers in some but not all roots in which they follow back vowels. For example, (2d) showed a back-[e:] root that takes only back suffixes, [ka:ve:-nɔk], while (2g) showed a similar root that can take either back or front suffixes, [ɔste:k-nɔk/nɛk]. Similarly, (2i) showed a back-[ɛ] root that can take either back or front suffixes, [ma:gneʃ-nɔk/nɛk], while (2j) showed one that takes only front suffixes, [ko:dɛks-nɛk]. In other words, whether a given vowel is a trigger or target depends not only on its quality, but also on the morpheme it occurs in. The choice of a given morpheme is arbitrary, except that it is limited to the “zones of variation” (Hayes et al. 2009: 835) that are possible for morphemes of its type.

It would be conceivable to think of Hungarian harmony as scaled entirely by morpheme rather than by vowel quality, with each root morpheme specified to take certain types of suffixes. A full analysis does require a morpheme-specific component, in order to account for the fact that a given morpheme patterns consistently in the system, in a way that can be distinct from other morphemes of the same phonological shape (e.g. the different back-[ɛ] roots in (2)). However, allocating all of the phonological work to morpheme-specific factors would be highly stipulative, given that the set of options for the behaviour of a given morpheme is predictable based on vowel quality in Hungarian. Incorporating factors of trigger and target vowel quality into the analysis reduces this stipulation, by limiting the set of possibilities for morpheme-specific behaviour to the existing phonologically-defined trends, in a way that is

typologically and phonetically motivated. Thus, an analysis that incorporates both morpheme- and vowel-specific factors is preferable to an account that deals with only one of these.

The morpheme-specific behaviour seen in Hungarian is of a very predictable type: a vowel may exceptionally have the normal behaviour of a vowel that is one step better as a trigger or target, in the scale (from low to high) of [i(:)] – [e:] – [ɛ] – harmonic vowels. Specifically, [i(:)] and the harmonic vowels are not variable, the former because the normal behaviour of [e:], like that of [i(:)], is neither triggering nor being a target of harmony, and the latter because there is no category above. In contrast, [e:] can, in some morphemes, show the normal triggering and targeting behaviour of [ɛ], in that it variably triggers harmony (vacillation) in some roots (e.g. (2g)) and can be a target of harmony in some suffixes; both of these are the normal behaviour of [ɛ]. Similarly, in some morphemes, [ɛ] can show the normal behaviour of the fully harmonic vowels, in consistently triggering harmony (e.g. (2j)). Note that [ɛ] already shows the typical targeting behaviour of the other vowels, since it does not occur in invariant suffixes.

Due to these generalizations about the possible morpheme-specific behaviour, I will encode morpheme-specific behaviour into the trigger and target scaling factors, with vowels exceptionally able to take the trigger and target scaling of a vowel in the category above. It remains an open question why there appears to be this one-step limit in morpheme-specific behaviour (e.g. why [i] cannot behave like [ɛ]), but this issue is beyond the scope of the present paper. I suggest the possibility that a one-step change can be consistent with the phonetic properties of a given vowel, which motivate its normal behaviour in relation to how the language sets its scaling factors, but a larger change cannot be.

6 Account of Hungarian

Using the principles outlined in Section 5, I now pursue a formal account of the Hungarian data described in Section 2. I show that with the correct constraint weights and scaling factors, this approach can capture the gradient, variable patterning of Hungarian neutral vowels, in addition to the basic facts that are accounted for in previous analyses.

6.1 Constraints, weights, and scaling

As discussed in Section 5.2, I adopt a target-oriented harmony constraint that reflects that Hungarian harmony is progressive and triggered by either feature value. This constraint is repeated in (12). One violation of this constraint is counted for each [α Back] vowel preceded by a [$-\alpha$ Back] vowel at any distance.¹⁸

- (12) * $[-\alpha\text{Back}] \infty [\alpha\text{Back}]$: Assign a violation for every vowel that is [α Back] and is preceded at any distance by a vowel that is [$-\alpha$ Back].

In addition to this harmony constraint, we require general markedness constraints to prevent vowels that are unattested in Hungarian from surfacing, as well as a faithfulness constraint against changes to [low]. These constraints are defined in (13).

- (13) * $[\gamma:]$: Long, [$-\text{high}$, $-\text{low}$, $-\text{round}$] vowels must not be [$+\text{back}$].
 * $[\text{æ}:]$: Long, [$+\text{low}$, $-\text{round}$] vowels must not be [$-\text{back}$].¹⁹
 IDENT-IO[low]: Assign a violation for every change in the feature [low] between a vowel in the input and its correspondent in the output.

¹⁸ I will assume that this constraint applies only within the domain of the phonological word. In particular, I assume that the two parts of a compound are separate phonological words, and therefore this constraint does not affect compounds.

¹⁹ Note that this constraint operates on phonological features. While [a:] is pronounced by many speakers as front, as mentioned previously, it behaves phonologically as [$+\text{back}$], and is therefore not subject to this constraint.

While the harmony constraint is in conflict with faithfulness to the feature [back], the general constraint IDENT-IO[back] is not active within the Hungarian system, and so I omit it from the analysis.²⁰ Instead, I will assume that there is an active positional faithfulness constraint (e.g. Beckman 1998), specifically a highly weighted constraint to preserve the [back] specification of the word-initial vowel. This constraint will not be illustrated in the tableaux for space reasons, but will ensure that the initial vowel is the trigger of harmony.²¹ Since Hungarian also has rounding harmony, I assume the same about IDENT-IO[round] as about IDENT-IO[back].

Many previous analyses of Hungarian harmony (e.g. Ringen & Vago 1998) ignore root-internal harmony, assuming a highly ranked root faithfulness constraint. In reality, a high ranking of such a constraint is only necessary for loanwords (see footnote 21 on loanword treatment). As discussed in Section 2, disharmonic roots consisting of non-neutral vowels are recent loans; within native Hungarian roots, non-neutral vowels must agree in backness, while front unrounded vowels may both precede and follow either front or back vowels. This pattern is in contrast to the behaviour of neutral-back sequences across morpheme boundaries, because neutral vowels trigger last-resort harmony (see (3)). I suggest that these facts can be accounted for using root-specific faithfulness to [back], defined as in (14).

- (14) IDENT-IO[back]_{ROOT}: For vowels within the domain of the root, assign a violation for every change in the feature [back] between a vowel in the input and its correspondent in the output.

Weighted correctly with respect to harmony, this constraint will allow non-neutral vowels to harmonize within a root, but require root-internal disharmony involving neutral vowels to surface faithfully. Given that the constraint is root-specific, it will not affect last-resort triggering in which suffix vowels harmonize to neutral root vowels.

The constraint weights and scaling factors are set as in (15). There are many choices that would work, and the specific numbers are arbitrary, as long as certain conditions are satisfied; throughout the analysis, I will argue for these specific conditions on weighting that are required for Hungarian. Note that the scaling factors in (15b–d) are specific to the particular constraint *[-αBack] ∞ [αBack], and are not applied to the grammar as a whole; this follows Kimper (2011) and Bowman (2013).

- (15) a. Constraint weights
 * [ɣ:]: weight 400
 * [æ:]: weight 400
 IDENT-IO[back]_{ROOT}: weight 200
 IDENT-IO[low]: weight 20
 * [-αBack] ∞ [αBack]: weight 1

²⁰ Formally, this could be accomplished by giving it a weight of zero (see Potts et al. 2010 on zero weights in HG).

²¹ Note that something distinct needs to be proposed for loanwords, in which there can be root-internal disharmony and the final root vowel triggers harmony to the suffix. It is common for loanwords to have less restrictive phonotactic patterns compared to native words; this occurs in a variety of languages, for many phonotactic patterns (e.g. Itô & Mester 1995; Inkelas et al. 1997; Jurgec 2010). Such cases could be accounted for with co-phonologies (e.g. Inkelas & Zoll 2007), or by scaling faithfulness constraints by lexical stratum (foreign versus native), as done by Hsu & Jesney (2017). It is worth noting that Hsu & Jesney's (2017) approach is insufficient to explain morpheme-specific behaviour in Hungarian, even though many of the exceptional morphemes are loans. This is because such morphemes may exceptionally trigger harmony, which should be prevented if faithfulness is higher ranked in the loan stratum. Instead, an analysis of Hungarian that considers loans would require both the foreign stratum and the morpheme-specific category chosen in this paper.

- b. Trigger strength scaling
 - 2 for [i] and [i:]
 - 2 for [e:]
 - 4 for [ɛ]
 - 16 for all other vowels
- c. Target quality scaling
 - 1 for [i] and [i:]
 - 1 for [e:]
 - 8 for [ɛ]
 - 16 for all other vowels
- d. Distance scaling
 - $1/2^n$, where n is the number of syllables intervening between trigger and target

As discussed in Section 5.6, note that both trigger and target scaling can vary morpheme-specifically, in that a morpheme may select for its vowel to behave like the vowel one category above it. This will be discussed further in Section 6.4.

6.2 Basic harmony facts

The present analysis retains the ability to capture the basic facts of Hungarian harmony that are the focus of other analyses. Tables 8–13 illustrate. Following Vago (1980b), among others, I assume that the dative suffix underlyingly has a front vowel; this assumption is not critical to the analysis, due to the low (zero) hypothesized weight of the general IDENT-IO[back].

Table 8 shows that suffix [ɛ] is required to harmonize following non-neutral roots; the same will apply for front rounded and back vowels. Disharmony violates $*[-\alpha\text{Back}] \infty [\alpha\text{Back}]$, while the harmonic form does not violate any of the constraints due to the absence of IDENT-IO[back] in the analysis (i.e. its very low hypothesized weight). This tableau does not demonstrate any weighting of the included constraints.

Table 9 shows that front rounded and back vowels are required to harmonize within a root; disharmony violates $*[-\alpha\text{Back}] \infty [\alpha\text{Back}]$, while the harmonic form in this case violates IDENT-IO[back]_{ROOT}. This tableau demonstrates the need for the weighting condition in (16). (See footnote 21 on the distinct analysis required for loanwords, in which disharmony is allowed.)

Table 8: Harmony with non-neutral vowels.

/va:roj-nɛk/	*[ɣ:]	*[æ:]	IDENT-IO[back] _{ROOT}	IDENT-IO[low]	*[-αBack]∞[αBack]	H
	400	400	200	20	1	
a. va:rojnek					-1*16(a:)*8(ɛ)	-128
☞ b. va:rojɔk						0

Table 9: Root-internal harmony with non-neutral vowels.

/va:røʃ/	*[ɣ:]	*[æ:]	IDENT-IO[back] _{ROOT}	IDENT-IO[low]	*[-αBack]∞[αBack]	H
	400	400	200	20	1	
a. va:røʃ					-1*16(a:)*16(ø)	-256
☞ b. va:roj				-1		-200

$$(16) \quad \text{weight}(\text{IDENT-IO}[\text{back}]_{\text{ROOT}}) < \text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{good trigger}) * \text{scaling}(\text{good target})$$

Table 10 demonstrates that front unrounded vowels are able to be transparent. In candidate (a), the neutral vowel [e:] is opaque, with the suffix surfacing as front. This candidate has two violations of $*[-\alpha\text{Back}] \infty [\alpha\text{Back}]$: one for the potential target [e:], with trigger [a:], and the other for the potential target [ɛ], again with trigger [a:]. The first violation is scaled by $16(a:)*1(e:) = 16$. The second is scaled by $16(a:)*8(\epsilon)*1/2(\text{distance}) = 64$, since there is one syllable intervening between them. The total score for candidate (a) is therefore -80 . Candidate (b), with transparency, similarly has two violations of $*[-\alpha\text{Back}] \infty [\alpha\text{Back}]$: one is again for the potential target [e:], with trigger [a:], but the other is for the potential target [ɔ] with trigger [e:]. Again, the first violation is scaled by 16, but this time, the second is scaled by $2(e:)*16(\text{ɔ}) = 32$. There is no distance scaling here, since the vowels are in adjacent syllables. The total for candidate (b) is thus -48 . A fully harmonic candidate, changing the /e:/ to [a:], violates both root faithfulness to [back] and faithfulness to low, and therefore receives a score of -220 . Thus, candidate (b) wins, since -48 is the highest score; transparency (b) is preferred over opacity (a) because [e:] is a poor trigger, and over full harmony (c) due to root faithfulness. The required weighting conditions demonstrated in this tableau are given in (17); note that here is where it is necessary to maintain Kimber’s (2011) trigger strength scaling in order to derive transparency rather than opacity.

$$(17) \quad \begin{aligned} \text{a.} & \quad \text{scaling}(\text{trigger [e:]}) * \text{scaling}(\text{good target}) \\ & \quad < \text{scaling}(\text{good trigger}) * \text{scaling}(\text{target [ɛ]}) * \text{scaling}(\text{1 syllable distance}) \\ \text{b.} & \quad \text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{good trigger}) * \text{scaling}(\text{target [e:]}) \\ & \quad + \text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{trigger [e:]}) * \text{scaling}(\text{good target}) \\ & \quad < \text{weight}(\text{IDENT-IO}[\text{low}]) + \text{weight}(\text{IDENT-IO}[\text{back}]_{\text{ROOT}}) \end{aligned}$$

Table 11 illustrates that neutral vowels are last-resort triggers of suffix harmony, even in cases where harmony involves an additional faithfulness violation. Candidate (a) is faithful, but violates harmony, with scaling of 2 for trigger [i:] and 16 for target [a:]. The total is therefore -32 . In contrast, candidate (b) harmonizes, violating only IDENT-IO[low],

Table 10: Transparency of neutral vowels.

/ka:ve:nɛk/	*[y:] 400	*[æ:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[-αBack]∞[αBack] 1	H
a. ka:ve:nɛk					-1*16(a:)*1(e:) -1*16(a:)*8(ε)*1/2	-80
☞ b. ka:ve:nɔk					-1*16(a:)*1(e:) -1*2(e:)*16(ɔ)	-48
c. ka:va:nɔk			-1	-1		-220

Table 11: Last-resort triggering by neutral vowels.

/vi:z+nɑ:l/	*[y:] 400	*[æ:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[-αBack]∞[αBack] 1	H
a. vi:zna:l					-1*2(i:)*16(a:)	-32
☞ b. vi:zne:l				-1		-20

which gives a score of -20 . The harmonic candidate is the winner. The same result will also hold for suffixes that do not violate IDENT-IO[low]. The weighting condition from this tableau is given in (18).

$$(18) \quad \text{weight}(\text{IDENT-IO}[\text{low}]) < \text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{trigger } [i:]) * \text{scaling}(\text{good target})$$

Importantly, the last-resort triggering in Table 11 happens only across a suffix boundary; root-internal neutral-back sequences surface faithfully due to IDENT-IO[back]_{ROOT}. Table 12 illustrates; the faithful candidate wins because harmony violates IDENT-IO[back]_{ROOT}. (19) gives the required weighting conditions. This result will also hold for any combination of back vowels with front unrounded vowels (i.e. any of these vowels, in any order), because of the high weight of IDENT-IO[back]_{ROOT} relative to the trigger and target scaling factors of front unrounded vowels. Specifically, they highest trigger or target scaling of a front unrounded vowel is 8; because $8 * 16 = 128 < 200$, even root-internal disharmony involving [ɛ] can surface faithfully. This is in contrast to Table 9, where root faithfulness is not maintained with harmonic vowels; in that case, the harmony constraint was scaled such that it outweighed root faithfulness. This result is consistent with the generalization that non-neutral vowels in native Hungarian roots are from the same harmonic class, whereas front unrounded vowels can co-occur with either class.

$$(19) \quad \text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{trigger } [i]) * \text{scaling}(\text{good target}) < \text{weight}(\text{IDENT-IO}[\text{back}]_{\text{ROOT}})$$

6.3 [a:]-[e:] alternation

Given the assumptions and constraints outlined in Section 6.1, this analysis can also accurately capture the asymmetric re-pairing behaviour of Hungarian [a:] and [e:], in which [a:] is required to re-pair but [e:] is not. Table 13 shows that /a:/ re-pairs to surface as [e:] when it follows a front rounded vowel. Direct harmony in [back], as in candidate (c), violates the highly weighted constraint *[\u00e6:]. The decision is then between re-pairing, in (b), and faithfulness, in (a). Re-pairing violates IDENT-IO[low], with a weight of -20 . The faithful candidate is disharmonic, therefore violates *[-\u03b1Back] \u221e [\u03b1Back]. Trigger and target scaling are each 16, giving a total of $1 * (-1 * 16 * 16) = -256$ as the score for candidate (a). Since $-20 > -256$, candidate (b) wins, and /a:/ is required to re-pair to [e:].

Table 12: Root-internal neutral-back sequences surface faithfully.

/bik\u0254/	*[\u028a:] 400	*[\u00e6:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[-\u03b1Back]\u221e[\u03b1Back] 1	H
\u2192 a. bik\u0254					$-1 * 2(i) * 16(\u0254)$	-32
b. bike			-1			-200

Table 13: Re-pairing of [a:] with [e:].

/t\u0254kna:l/	*[\u028a:] 400	*[\u00e6:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[-\u03b1Back]\u221e[\u03b1Back] 1	H
a. t\u0254kna:l					$-1 * 16(\u0254) * 16(a:)$	-256
\u2192 b. t\u0254kne:l				-1		-20
c. t\u0254kn\u00e6:l		-1				-400

To ensure that harmony occurs in this case, we require the weighting conditions stated in (20). Note that /a:/ will not re-pair to [i:] or [y:] because such candidates are harmonically bounded by the one in which /a:/ re-pairs to [e:]: all of these candidates violate IDENT-IO[low], but re-pairing to a high vowel also violates IDENT-IO[high]. I therefore omit candidates in which /a:/ re-pairs to a high vowel, as well as the constraint IDENT-IO[high], from the tableaux for presentation reasons. The generalization here is that /a:/ re-pairs to the front vowel that requires the fewest feature changes, and so changing [high] in addition to [low] will be worse than changing only [low].

- (20) a. $\text{weight}(\text{IDENT-IO}[\text{low}]) < \text{weight}(*[\text{æ:}])$
- b. $\text{weight}(\text{IDENT-IO}[\text{low}]) < \text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{good trigger}) * \text{scaling}(\text{good target})$

In contrast, Table 14 demonstrates that /e:/ is not required to re-pair when it follows a back vowel. Similarly to Table 13, direct harmony in [back], as in candidate (c), violates the highly weighted constraint $*[\gamma:]$, and the decision is then between re-pairing, in (b), and faithfulness, in (a). Again, re-pairing violates IDENT-IO[low], with a weight of -20 , while the faithful candidate is disharmonic and therefore violates $*[-\alpha\text{Back}] \infty [\alpha\text{Back}]$. However, since the potential target is [e:], target scaling is only 1. Thus, the total score for candidate (a) is $1 * (-1 * 16 * 1) = -16$. Since $-16 > -20$, candidate (a) wins in this case, meaning that /e:/ is not required to re-pair to [a:]. This tableau demonstrates the need for the weighting conditions given in (21). Critically, comparing the second condition in (21) to the second condition in (20) shows the need for $\text{scaling}(\text{target [e:]}) < \text{scaling}(\text{target [a:]})$, illustrating the need for the target quality concept argued for here.

- (21) $\text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{good trigger}) * \text{scaling}(\text{target [e:]}) < \text{weight}(*[\gamma:])$
- $\text{weight}(*[-\alpha\text{Back}] \infty [\alpha\text{Back}]) * \text{scaling}(\text{good trigger}) * \text{scaling}(\text{target [e:]}) < \text{weight}(\text{IDENT-IO}[\text{low}])$

These examples show that this analysis correctly predicts the asymmetry between [a:] and [e:] in Hungarian, by appealing to the fact that [a:] is a better target of front/back harmony than [e:] is. Disharmony involving the potential target [a:] is therefore penalized to a greater extent than disharmony involving the potential target [e:]; the result is that harmony outweighs faithfulness for /a:/, but the reverse is true for /e:/. Notably, unlike an analysis that uses separate faithfulness constraints for [+low] and [-low], the current approach does not predict the possibility of reverse Hungarian. Indeed, due to the phonetic basis and markedness conflation inherent in the definition of target scaling, the target scaling factor for [e:] must be less than or equal to that of [a:]. As such, these vowels must either pattern like they do in Hungarian or behave symmetrically.

Table 14: [e:] does not re-pair with [a:].

/la:j+e:/	*[γ:]	*[æ:]	IDENT-IO[back] _{ROOT}	IDENT-IO[low]	*[-αBack]∞[αBack]	H
	400	400	200	20	1	
☞ a. la:jne:					$-1 * 16(a:) * 1(e:)$	-16
b. la:jna:				-1		-20
c. la:jnγ:	-1					-400

6.4 Variability

The behaviour in Table 14 is not the only possibility for how [e:] will behave in suffixes. As noted in Section 2, [e:] has intermediate neutrality along this dimension; the recent literature seems to assume that the underlying form of affixes that alternate between [a:] and [e:] is not necessarily /a:/, but rather that /e:/ is not fully neutral and could be required to harmonize in suffixes. This is possible under the current analysis due to the option for morpheme-specific target scaling factors. As discussed in Section 5.6, Hungarian morphemes may exceptionally select for their vowels to take the scaling trigger and/or target factors of a vowel that is one step better as a trigger/target. If we have such a suffix with [e:], it will be required to harmonize, as shown in Table 15, where the subscript “ ϵ ” indicates an [e:] that morpheme-specifically behaves like [ϵ], in the way justified in Section 5.6.

In other words, while rounded vowels and back vowels are required to harmonize, [e:] may or may not: it is of intermediate neutrality with respect to being a target in a suffix. This possibility does not exist for [i(:)], because the next category up is [e:], which has the same target scaling as [i(:)]. It also does not exist for [ϵ] or other vowels, which already have target scaling factors sufficient to ensure that harmony in suffixes must always occur. Thus, [i(:)] is consistently invariant, [e:] is variable, and [ϵ] and other vowels are consistently targets, reflecting the suffix height effect illustrated in Table 3 in Section 2.

I turn now to variability in triggering, which occurs in distinct ways for both [e:] and [ϵ]: the former can be transparent or variable, while the latter is typically variable or opaque. An example of transparent [e:] was given in Table 10; for it to be variable, it must select for the morpheme-specific trigger scaling of [ϵ]. This is shown in Table 16, where the subscript “ ϵ ” indicates that the vowel morpheme-specifically behaves like [ϵ]. In such a case, the front and back variants of the suffix receive identical harmonic scores, meaning that either one could surface. Note that this result holds regardless of whether we assume that [e:] is also morpheme-specifically a better target in this case.

Given that this trigger scaling factor is the usual one for [ϵ], the analysis predicts that back-[ϵ] roots will typically vacillate. Moreover, [ϵ] can morpheme-specifically have the trigger strength of a fully harmonic vowel; in such a case, the suffix will be consistently

Table 15: Re-pairing of [a:] with [e:].

/dob+ne: _{ϵ} l/	*[y:] 400	*[æ:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[- α Back] ∞ [α Back] 1	H
a. dobne:l					-1*16(o)*8(e: _{ϵ})	-128
☞ b. dobna:l				-1		-20
c. dobn ν :l		-1				-400

Table 16: Variable opacity of [e:].

/ɔste: _{ϵ} k+n ϵ k/	*[y:] 400	*[æ:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[- α Back] ∞ [α Back] 1	H
☞ a. ɔste:kn ϵ k					-1*16(ɔ)*8(e: _{ϵ}) -1*16(ɔ)*8(ϵ)*1/2	-192
☞ b. ɔste:knɔk					-1*16(ɔ)*8(e: _{ϵ}) -1*4(e: _{ϵ})*16(ɔ)	-192
c. ɔsta:knɔk			-1	-1		-220

front, with [ɛ] opaque, similarly to the case of harmony with non-neutral vowels in Table 8.²² In contrast, [i(:)] can never behave as vacillating or opaque, because its only morpheme-specific option is to have the trigger scaling of [e:], which generally behaves as transparent. Thus, the analysis is able to derive the height effect in transparency, in which high vowels are consistently transparent, mid vowels are sometimes variable, and low vowels are generally variable or opaque. This is due to the fact that morpheme-specificity in Hungarian is limited to a vowel behaving as “one category up”, which I hypothesize could relate to the phonetic motivations for trigger and target; a vowel cannot morpheme-specifically take on the behaviour of one too distinct from its own phonetic properties.

Finally, multiple neutral vowels can also show vacillation, taking both front and back versions of the suffix. This is a simple effect of distance scaling, as shown in Table 17.

Note that this view of vacillation is a simplification; a more nuanced analysis, which is beyond the scope of the present paper, would convert harmonic scores to percentages, because the Hungarian vacillation data is not as simple as each possible suffix form surfacing half the time. This issue will be discussed further in Section 6.5. Moreover, there is a role for paradigm uniformity in the behaviour of vacillating roots; generalizations of other aspects of paradigm uniformity in Hungarian harmony have previously been made by Törkenczy et al. (2013) and Rebrus et al. (2017). In this case, paradigm uniformity is required to ensure that vacillating roots behave the same way across multiple types of suffix vowels; specifically, we might otherwise predict suffixes with alternants containing [ɛ] or [e:] to behave differently than suffixes with fully harmonic vowels, because the target scaling factors are different. Again, a full implementation is beyond the scope of the present paper. The critical aspect of the current analysis is that paradigm uniformity and morpheme-specificity do not need to bear the entire burden of explanation. Instead, the explanation here is shared by vowel-specific factors, which are less arbitrary because they are motivated by cross-linguistic and phonetic evidence.

To summarize, this section and those preceding it have demonstrated that the target-focused framework developed in Section 5 maintains the ability to capture the crucial facts about Hungarian harmony that have been previously analyzed, while also extending to the gradient nature of neutrality in the language. The specific numbers given here work, but what is crucial is that all of the relative weighting requirements are satisfied, specifically in terms of the relative ranges of trigger and target scaling factors for the different vowels.

Table 17: Variable opacity of multiple neutral vowels.

/ɔɓɓli:zif+nɛk/	*[ɣ:] 400	*[æ:] 400	IDENT-IO[back] _{ROOT} 200	IDENT-IO[low] 20	*[-αBack]∞[αBack] 1	H
☞ a. ɔɓɓli:zifnɛk					-1*16(ɔ)*1(i: -1*16(ɔ)*1(i)*1/2 -1*16(ɔ)*8(ɛ)*1/4	-56
☞ b. ɔɓɓli:zifnɔk					-1*16(ɔ)*1(i: -1*16(ɔ)*1(i)*1/2 -1*2(i)*16(ɔ)	-56

²² The number of examples like (2h), in which [ɛ] is consistently transparent, is quite small. These few roots are not captured here, but could be if we assume that morpheme-specificity could also occasionally go in the other direction, with [ɛ] behaving like [e:].

6.5 Further directions for Hungarian

While it captures much of the gradient variability in Hungarian, this analysis still abstracts away from some of the more problematic aspects of Hungarian harmony. In this section, I consider how the analysis could be extended to additional data for which a full treatment is beyond the scope of this paper.

First, as mentioned in Section 2, Hungarian has some anti-harmonic roots, which contain only front unrounded vowels, yet take back suffixes. An adequate analysis of these roots should explain why they all contain only front unrounded vowels, and why the majority of them contain [i(:)]. This patterning exactly parallels the other aspects of neutrality (invariant suffixes and transparency), and so should receive a similar account. One possibility in the framework here is that all alternating Hungarian suffixes are by default [+back], and that there is additional variability in the trigger strength of [i(:)], and to a lesser extent [e:]. If the trigger strength of these vowels can, in specific morphemes, be low enough to not trigger harmony at all, then default suffix vowels should occur; if the default is [+back], then anti-harmony is derived. The assumption of a default [+back] for suffixes changes a number of aspects of the above analysis, in particular the generalizations related to [e:] sometimes undergoing harmony in suffixes, but it is worth exploring as a future direction for explaining anti-harmony.

A further property that this analysis could be extended to deal with is stem/suffix interactions. Research has shown that of the vacillating stems that can take either front or back suffixes, stems vary in terms of their preference for front or back, and this further varies by the specific suffix attached to the stem. For example, Törkenczy (2013) notes that the root [fotɛl] ‘armchair’ more often takes the back version of the illative suffix [bɔ]/[bɛ], while the root [kontsɛrt] ‘concert’ takes only the front version of this suffix. With the plural [ok]/[ɛk], [fotɛl] instead takes the front version more often, while the root [hɔvɛr] ‘friend’ almost always takes the back version. In other words, the preferred choice for vacillating cases depends on both the stem and suffix.²³ Since the present analysis deals with morpheme-specific properties, a more nuanced version of it could be derived, in which there is some correlation between the harmonic scores of candidates and their percentage frequency, and this could depend on both the specific stem and suffix. This direction ties in with the general comment about the nuances of vacillating roots as discussed in Section 6.4. Moreover, it could reduce the need for an appeal to paradigm uniformity to explain the similarity in behaviour of vacillating roots across suffixes, regardless of whether the suffix alternants contain [e:], [ɛ], or only harmonic vowels.

Recent literature on Hungarian has noted that invariant and alternating suffixes with [e:] behave differently with respect to vacillating roots: the invariant ones (e.g. [e:] in Table 14) are transparent, in that the root + suffix combination remains vacillating, while the alternating ones (e.g. [na:l]~[ne:l] in Tables 13 and 15) are opaque, in that the root + suffix combination can only take front suffixes (e.g. Törkenczy et al. 2013). As Törkenczy et al. (2013) note, part of the explanation can be due to paradigm uniformity. In the present analysis, another factor to consider is the correlation between morpheme-specific trigger and target scaling. It is clear in Hungarian that a correlation between trigger and target behaviour exists in the general case: the height effect for triggering follows

²³ A reviewer notes that this can be influenced by whether the suffix is consonant-initial, giving the examples *haver-ok* (**haverek*), *férfi-as* (**férfi-es*), but *haver-nak/nek*, *férfi-val/vel*. This pattern is reminiscent of several other languages in which the harmony process is influenced by whether an affix is C-initial or V-initial, such as Alur (Kutsch Lojenga 1991). There is no standard way of dealing with such cases, and it is beyond the scope of the present paper to account for it in Hungarian. However, future work on Hungarian should examine the influence of the suffix-initial segment on the preferred suffix choice with vacillating stems.

the exact same pattern as the height effect for being targeted. Since this analysis treats morpheme-specific variation as bumping a vowel into the behaviour of a vowel one level better on the trigger or target scale, we predict the possibility that in cases where [e:] behaves like [ɛ] as a target, it could also behave like [ɛ] as a trigger. As such, alternating [e:] should behave differently than invariant [e:], as the former is morpheme-specifically a better trigger than the latter. This possible correlation between trigger and target factors, including in morpheme-specific cases, should be explored further in additional research.

A question arising from this analysis is why the trigger and target scaling can change morpheme-specifically. It is clear that they must, with limited options given the type of morpheme, because the variable patterning in Hungarian shows morpheme-specific properties in addition to vowel-specific ones. A direction to explore here is the effect of loans: vacillating back-[e:] roots tend to be loans, as do many of the roots in which [ɛ] co-occurs with a back vowel, regardless of their behaviour. A potential hypothesis is that loanwords come into the lexicon with trigger and target scaling that may not match the typical pattern of native words, but that a degree of closeness to the phonetically motivated behaviour of native words is required (i.e. the one category limit). This idea could also potentially be extended to “disharmonic” roots, in which back vowels co-occur with front rounded vowels. As noted, such roots are always recent loans, and perhaps the factor that prevents root-internal harmony from applying is a difference in the scaling factors for these vowels. Thus, examining the connection between loans and (dis)harmonic behaviour in Hungarian, in relation to the issue of “one category up” variability, is a worthwhile future direction.

7 Implications and discussion

This paper has proposed a novel, target-oriented account of Hungarian harmony, arguing that the data requires a new way of incorporating targets into an analysis. Specifically, neutrality is not simply a lack of ability to harmonize, but rather that the dispreference for disharmony is too weak to outweigh faithfulness. This approach to Hungarian has many implications for the study of neutrality and targets more broadly in vowel harmony, some of which are considered in this section.

7.1 Target conditions in other languages

Hungarian [e:] is not alone in the fact that it is generally neutral to harmony despite appearing to have the option to participate through pairing with [a:]. As noted in Section 1, vowels that are able to undergo harmony do not always do so; moreover, there is a degree of cross-linguistic consistency in the choice between neutrality and participation, regardless of whether a vowel is paired. Mayak is one such case: the low vowels [a] and [ʌ] are paired for [ATR] and participate in tongue root harmony in limited contexts, but they are generally neutral (Andersen 1999). Moreover, low vowels in tongue root harmony systems are often unpaired and neutral, as in languages like Yoruba, which has an opaque [a] but no [+ATR] low vowel (Archangeli & Pulleyblank 1994). Archangeli & Pulleyblank (1994) note that this kind of consistency is in fact a cross-linguistic pattern: paired vowels that are idiosyncratically neutral, as is the case in Mayak, tend to be the same types of vowels that are unpaired and neutral in other languages.

Any theory in which neutrality is based on the impossibility of undergoing harmony will have difficulty explaining cases like Mayak. More importantly, they miss the generalization that which vowels are neutral tends to be the same cross-linguistically regardless of whether the neutral vowels are paired or unpaired. This consistency is clear evidence that vowel-specific, harmony-specific factors beyond inventory pairing (and the associated general markedness) affect whether a vowel is a target for harmony or is neutral, contra many claims in the literature.

The analysis presented here can also be extended to cases not commonly considered as neutrality, namely harmony that targets only certain vowels. Previous analyses of vowel

harmony have also noted that harmony may be subject to target conditions. An example is the constraint HI/ATR “if [+high], then [+ATR]”, which Archangeli & Pulleyblank (2002) use to account for high vowels being preferred targets in Kinande ATR harmony. This mechanism for incorporating features of targets differs from the current proposal in that it directly references the harmony-independent notion of feature compatibility, rather than the quality of a vowel as a potential harmony target. These notions are clearly related, as feature compatibility affects the phonetic and cross-linguistic factors that determine target quality. Though the details of the present approach are novel, the idea that harmony may be subject to target conditions is not, and target-specific harmony is necessary outside of Hungarian.

It is worth noting that the approach of Archangeli & Pulleyblank (2002) differs from the one here, for instance in the case of low vowels in front/back harmony; neither LO/BACK nor LO/FRONT would capture that low vowels are good targets, the former because it cannot explain why the low back vowel [a:] undergoes fronting in front harmony contexts, and the latter because it is unmotivated both cross-linguistically and in Hungarian, in which low vowels tend to be back, in terms of the number of such vowels in the phonologically defined inventory.²⁴ In contrast, in the present approach, the phonetic motivation for low vowels to be good targets for front/back harmony is built into the theory’s prediction of their behaviour.

Overall, target conditions are necessary beyond Hungarian, and the present approach has the ability to extend to other languages and types of harmony. With the cross-linguistic concept of target quality, this analysis accounts for generalizations missed by a featural compatibility approach to neutrality, and can capture more complex cases like paired neutral vowels.

7.2 Trigger/target interactions

An additional implication concerns the interactions between triggers and targets, considered in this subsection. Given the use of scaling for both triggers and targets, the present analysis predicts that trigger and target should be able to interact in such a way that harmony depends on both of them. In other words, we should find cases in which harmony occurs only with both a strong trigger and a quality target, or in which disharmony is permitted only with a weak trigger and a poor target.

This prediction is borne out in rounding harmony in Kirgiz and Altai. Kaun (1995; 2004) shows that in rounding harmony, good triggers are vowels that are non-high and/or front, while good targets are those that are high.²⁵ In Kirgiz and Altai, rounding harmony is obligatory except when the potential trigger is high and back and the potential trigger is low; only in such cases is disharmony permitted (Korn 1969). Table 18 summarizes, with examples from Korn (1969).

Table 18: Kirgiz and Altai harmony pattern.

<i>Trigger</i>	<i>Target</i>	<i>Harmony?</i>	<i>Kirgiz example</i>	<i>Gloss</i>
Non-high	Non-high	Required	ot-ko	‘to the fire’
Non-high	High	Required	kök-tun	‘of the sky’
High (and back)	Non-high	Optional in Kirgiz; absent in Altai	uluk-tan~uluk-ton	‘from the magnate’
High	High	Required	su-nun	‘of the water’

²⁴ While a target condition that refers to [low] cannot capture the Hungarian alternation between [a:] and [e:], one that refers to [round] could. Specifically, NON-ROUND/FRONT would be a motivated target condition in Hungarian and cross-linguistically; this is effectively the *iA constraint mentioned earlier. However, such an approach is unable to account for why the low vowel [ɔ], which is round, is also subject to harmony.

²⁵ It is worth noting that this generalization fails in Hungarian, where rounding harmony targets only mid vowels. However, rounding harmony is quite restricted in Hungarian (e.g. Törkenczy 2010).

The only trigger/target combination where disharmony is permitted is precisely the one that is predicted: high, back vowels are weak triggers, while low vowels are poor targets. Thus, Kirgiz and Altai manifest a trigger/target interaction predicted and easily accounted for by the present framework.

Nonetheless, the more common trigger/target relationship in rounding harmony is that trigger and target must agree in height, which is known as parasitic harmony and occurs for example in Yokuts (Kaun 1995). On the surface, this pattern would be problematic under the present analysis; as Kaun (1995) notes, good triggers of rounding harmony are non-high, while good targets are high, which means that height agreement involves either a bad trigger or a bad target. The approach here, without modifications, therefore predicts that if harmony occurs in cases of height agreement, then it should also occur when both the trigger and target are good.

However, this problem only occurs under the assumption that what it means to be a good trigger is independent of what it means to be a good target, and vice versa. Particularly in rounding harmony, this assumption is false; as Kaun (1995) argues, rounding is realized distinctly on high versus non-high vowels, meaning that height agreement allows for uniformity in the phonetic realization of [round]. Based on this argument, the relationship between trigger and target scaling factors should be dependent, which would permit an account of parasitic harmony. Formally, this could be implemented with either a single scaling factor for each trigger/target pair or with the addition of a scaling factor for the interaction effect.

To summarize, the prediction that trigger strength and target quality can interact is borne out in Kirghiz and Altai rounding harmony. Parasitic rounding harmony, which appears at first glance problematic for this approach, is in fact possible to analyze; it requires the addition of an interaction factor, which is motivated by the fact that triggers and targets are not independent.

8 Conclusions

To conclude, this paper proposes a new view of participation in vowel harmony, in which neutrality results not from featural incompatibility, but rather from the vowel-specific drive to undergo harmony being too weak. Under such a perspective, vowels are neutral when they are poor targets of harmony, and so the drive for them to be targeted is insufficient to force unfaithfulness.

This view of neutrality is motivated here by an under-analyzed alternation in Hungarian between harmonic [a:] and generally neutral [e:], which challenges many analyses of Hungarian harmony. Under the standard view, Hungarian (non-low) front unrounded vowels are neutral because they lack harmonic counterparts. Such an approach leaves completely unexplained the fact that [a:] also lacks a direct harmonic counterpart, yet consistently participates in harmony and alternates with neutral [e:]. This paper explains this behaviour, by appealing to the cross-linguistic and phonetically motivated fact that low vowels are better targets of front/back harmony than higher vowels. The concept of target quality directly incorporates the phonetic basis, within the definition, and allows for an account of the gradience of neutrality.

In doing so, the approach captures this broader typological height generalization, which goes beyond Hungarian, but also reflects the Hungarian-internal distinction in degree of neutrality for [i]/[i:], [e:] and [ɛ]. In contrast, in other formal analyses, the effects of height on harmony participation are determined arbitrarily and in a way that does not reflect the gradience of the behaviour, such as by stipulating that [ɛ] is harmonic.

This analysis has broad implications to the study of neutrality and target conditions; it has the explanatory power to account for complex patterns in a simple way, yet is appropriately constrained in its predictions by the phonetic motivations of trigger strength and

target quality. Beyond Hungarian, the approach can be extended to deal with neutral paired vowels like in Mayak, target asymmetries like in Kinande, trigger/target interactions like in Kirghiz and Altai, and many other patterns that require distinct, complex accounts in other frameworks. Here, instead, the central insight that captures multiple diverse phenomena is that whether harmony applies and whether disharmony matters crucially depends on the nature of the trigger and target.

Abbreviations

ABL = ablative, ADE = adessive, CAUS = causative, COND = conditional, CONJ/IMP = conjunctive/imperative, DAT = dative, DEF = definite, DEL = delative, ESS = essive, HG = Harmonic Grammar, INDF = indefinite, OT = Optimality Theory, POSS = possessive, SG = singular, TRANSL = translative

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Competing Interests

The author has no competing interests to declare.

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