

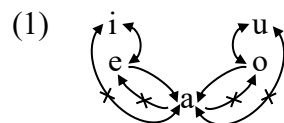
6. HEIGHT HARMONY

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6.1 Introduction

Height harmonies are robustly attested across languages. Drawing on this rich landscape, our goal is to document patterns that are well-attested and call attention to those that are not. To this end, we first question whether lowering harmony parallels raising harmony, and whether processes involving alternations between high and mid vowels parallel those involving alternations between mid and low. We will observe that while lowering harmony targets both high (high→mid) and mid vowels (mid→low), raising harmony targets mid vowels (mid→high) but seemingly not low vowels (*low→mid).

A second question stems from how we have expressed the attested patterns, as one-step changes in height. We will see that harmony does appear to be restricted in this manner: two-step changes are unattested (*high→low, *low→high). Our observations from these first two questions are sketched in (1), where arrows indicate the direction of change induced by harmony.



The restriction to one-step changes suggests that a given harmony rule implicates only two heights. As most languages contrast three heights, a third question we address is whether vowels of the third height ever pattern as triggers. Given (1), this question is constrained to high vowel lowering. We will observe that low vowels, along with mid vowels, can trigger high→mid in some languages. Low vowels otherwise pattern as opaque.

The final question we ask is whether height harmonies are confined to systems with maximally three heights, as may be implied by (1). We will see that this is generally the case. Although in some languages, [ATR] or [tense] is required to support more contrasts on the vertical dimension, these features typically interact with, rather than pattern as, height.

6.2 High/mid alternations

We define prototypical height harmony as one-step lowering or raising that is triggered by a single feature on the aperture dimension, independent of [ATR] or [tense]. We begin by documenting lowering and raising processes involving alternations between high and mid vowels. For each language detailed, the inventory is provided; as mentioned, arrows indicate the direction of change and triggers are in bold.

6.2.1 High vowel lowering

High vowel lowering is widely attested throughout Bantu (Hyman 1999; Odden 2014; chapter 52). Shona illustrates a common pattern where high-vowelled suffixes are realized as mid following root-initial mid vowels; compare (2a-b) (Fortune 1955; Beckman 1997). The observation that high vowels follow low vowels (2c) supports an analysis involving lowering of high vowels, rather than raising of mid vowels.¹ Low vowels are non-triggers and, in fact, are opaque (2d).

(2) Shona (Beckman 1997:1-2):

| | | | | |
|---|---|----|--------------|-------------------|
| i | u | a. | [bvum-isa] | ‘make agree’ |
| e | o | b. | [tond-esa] | ‘make to face’ |
| a | | c. | [ʃamb-isa] | ‘make wash’ |
| | | d. | [tʃejam-isa] | ‘make be twisted’ |

Mbuunda is like Shona, except that low vowels participate as triggers (Gowlett 1970). However, low and mid vowels could be analyzed as one height (non-high) in such systems, so we must turn to other languages where lowering is triggered by vowels that indisputably belong to different heights. In such languages, we question whether the triggers can be captured with a single height feature and, relatedly, whether these systems can be expressed by supplementing height features (akin to [high] and [low]) with [tense] or [ATR], or whether they instead motivate a scalar approach to height.

We begin with Buchan Scots. (3a-d) show that /i/ lowers to mid when preceded by a non-high vowel of any quality (Paster 2004). Buchan Scots exemplifies partial height harmony: when /i/ lowers, it doesn’t reach the height of the trigger, (3c-d). Parkinson (1996) asserts that partial height harmonies do not involve lowering. We therefore examine two of Paster’s arguments for high vowel lowering as opposed to mid vowel raising.² One, in Paster’s analysis, lowering is blocked by (roughly) voiced obstruents, (3e); if the final vowel in (3e) were instead underlyingly mid, with raising (pharyngeal expansion) triggered by preceding voiced obstruents or high vowels, raising should also be observed in (3f). Two, (3g) shows that high+mid strings where the intervening consonant is transparent are well-formed, unexpected if final mid vowels undergo raising.

(3) Buchan Scots (Paster 2004:365-370):

| | | | | | | | |
|---|---|----|----------|----------|----|----------|-------------|
| i | u | a. | [dir-i] | ‘dearie’ | e. | [bɛd-i] | ‘beddie’ |
| e | o | b. | [tost-e] | ‘toasty’ | f. | [fraide] | ‘Friday’ |
| ɛ | ɜ | c. | [lɜle] | ‘lily’ | g. | [rile] | ‘relay’ (N) |
| ʌ | ɔ | d. | [las-e] | ‘lassie’ | | | |
| a | | | | | | | |

In short, Buchan Scots demonstrates that all non-high vowels can trigger lowering, indicating that the feature implicated must have scope over mid and low vowels in some languages.

¹ Beckman’s analysis, however, involves raising alongside lowering.

² Smith (chapter 11) suggests that lowering and pharyngeal expansion (raising) are both candidate analyses.

Further, any mid vowel, regardless of its value for [tense], triggers harmony, thereby indicating that [tense] is independent of height.

We consider next Kimatuumbi. (4a-c) show that lowering targets the causative suffix /ij/ (Odden 1991). (4d) reveals that when no height harmony takes place, the suffix surfaces as high, consistent with lowering, rather than raising. Unlike in Mbuunda and Buchan Scots, low vowels do not trigger lowering; as in Shona, they are opaque (4e) (Odden p.c.). What makes Kimatuumbi different from the other languages discussed thus far is that two harmonies, height and [ATR], operate on the vertical dimension. However, they apply independently: the trigger for height harmony is the [-high] feature associated with /ε,ɔ/; the trigger for ATR harmony, by contrast, is any non-low [-ATR] vowel.³

(4) Kimatuumbi ((4a-d) from Odden 1991:281; (4e) from Odden p.c.):

| | | | | |
|---|---|----|----------------|----------------------------|
| i | u | a. | [út-ij-a] | ‘make pull’ |
| ɪ | ʊ | b. | [jújʊt-ij-a] | ‘make whisper’ |
| ε | ɔ | c. | [góɔnj-εj-a] | ‘make sleep’ |
| | | d. | [káat-ij-a] | ‘make cut’ |
| | | e. | [bómwaan-ij-a] | ‘make destroy pointlessly’ |

To summarize, high vowel lowering is seemingly confined to systems that can be captured with maximally three heights (high, mid, low).⁴ Some of these systems support more contrasts on the vertical dimension, indicating that height features must be supplemented with [ATR] or [tense]; however, these features interact with but do not pattern as height features, consistent with [-high] (or equivalent) being the only dominant feature in this type of process. Low vowels can be opaque or they can trigger lowering, demonstrating that feature systems must be able to identify mid vowels as well as non-high vowels as natural classes (Pulleyblank 2011).

6.2.2 Mid vowel raising

Mid vowel raising harmony occurs in Romance, a family also known for metaphony (Calabrese 2011). Metaphony involves agreement between a post-tonic trigger and stressed target. In mid vowel raising harmony, by contrast, triggers are often stressed (Walker 2005; see also chapters 23, 69).

One such language is Pasiego, where mid vowels raise to high when the stressed vowel is high (Penny 1969). McCarthy (1984) analyzes Pasiego as involving raising and lowering, but Vago (1988) convincingly argues that only raising is productive. Raising harmony alone is illustrated in (5a). (5b) shows that /-ʊ/ (‘masculine singular count’) triggers metaphonic raising of the preceding stressed vowel which, in turn, triggers height harmony (Hualde 1989). This

³ The harmonies do though operate under the same conditions. Accordingly, Odden (1991) organizes [high] and [ATR] under a single Height node, which he assumes spreads in harmony (see Goad 1993 for other languages that motivate this grouping). Clements (1990/2015) and Parkinson (1996) instead analyze Kimatuumbi using a hierarchically nested [open] feature.

⁴ Perhaps minimally three heights as well: high vowel lowering in two height systems is seemingly rare. Chukchi may be a candidate but there is disagreement on how many heights the language employs and on whether harmony involves lowering (van der Hulst 1988, 2018) or [-ATR] (Kenstowicz 1979; Archangeli & Pulleyblank 1994).

example also reveals that /-ʊ/ triggers centralization harmony. The two harmonies are largely independent: a stressed trigger is not necessary for centralization harmony (5c), as it is for height harmony (5a-b); further, (5d) shows that low vowels are transparent to height harmony but are targeted by centralization (/a/→[ɜ]).

(5) Pasiego (data from McCarthy 1984:294-300):

| | | | | |
|--|----|-----------------|---------------|-------------------|
| $\begin{array}{c} i/ɪ \\ e \end{array} \rightarrow \begin{array}{c} u \\ o/ɔ \end{array}$ <p style="text-align: center;">a/ɜ</p> | a. | /kox-er-ían/ | [kuxirían] | ‘take’ (4PL.COND) |
| | b. | /el pél-ʊ/ | [ɪl pílo] | ‘hair’ (COUNT) |
| | c. | /simpátik-ʊ/ | [simpátikʊ] | ‘congenial’ (SG) |
| | d. | /po el kamín-ʊ/ | [pʊ l kɜmínʊ] | ‘along the path’ |

A language where stress is not implicated in raising is Menomini (Bloomfield 1962; Milligan 2015). Harmony yielding high vowels from mid operates right-to-left (6a-c); mid vowels surface intact in (6e-g). Low vowels are neutral: /a/ is transparent (6b-c), while /æ/ is opaque (6d). Forms displaying harmony show that the trigger can be stressed (6a) or not (6b-c); the target can be stressed (6a,c) or not (6b).

(6) Menomini (Bloomfield 1962:3,96; stress added per Milligan 2015):

| | | | | | | |
|---|----|---------------|------------------------|----|-------------|-----------------------|
| $\begin{array}{c} i \\ e \end{array} \rightarrow \begin{array}{c} u \\ o \end{array}$ <p style="text-align: center;">æ a</p> | a. | [kì:wíanæ:w] | ‘he takes him home’ | e. | [ké:wæ:w] | ‘he goes home’ |
| | b. | [kuʔnátuaʔ] | ‘if thou fearest them’ | f. | [koʔnát] | ‘if thou fearest him’ |
| | c. | [mú:skamit] | ‘if he emerges’ | g. | [mó:skamow] | ‘he emerges’ |
| | d. | [kè:wæ:tuaʔ] | ‘when they go home’ | | | |
| | | *[kì:wæ:tuaʔ] | | | | |

In sum, Pasiego and Menomini demonstrate that stress can trigger mid vowel raising harmony or it can play no role; both patterns differ from metaphonic raising, where targets are stressed. Pasiego further shows that height and the feature implicated in centralization ([ATR] per Vago 1988; [tense] per McCarthy 1994) are independent, similar to what was seen earlier for [ATR] in Kimatuumbi and [tense] in Buchan Scots.

Turning to the behavior of low vowels, we observed that in high vowel lowering, low vowels pattern as triggers with mid vowels (Buchan Scots, Mbuunda) or they behave as neutral (opaque in Shona and Kimatuumbi; seemingly never as transparent). In vowel raising, by contrast, low vowels do not pattern as targets with mid vowels; rather, they behave as neutral (transparent in Pasiego; transparent and opaque in Menomini). If low vowels were targets in the latter process, they would necessarily raise two steps (low→high). It seems that height harmony always involves a change of one step (see Parkinson 1996 on partial raising; Pulleyblank 2011 on metaphony). Apparent two-step cases, like Kimatuumbi (4), implicate the feature [ATR] alongside [high].

6.3 Mid/low alternations

Height harmonies involving alternations between mid and low vowels are less common than those involving alternations between high and mid (Rose and Walker 2011). They are also skewed in favor of lowering; indeed, raising triggered by low vowels is rare at best (setting aside metaphonic raising; van der Hulst 2018).

6.3.1 Mid vowel lowering

Mid vowel lowering is observed in Tunica (Haas 1953). (7e,f) show that /a/ triggers lowering of /e,o/ to [ɛ,ɔ]; compare (7a-d) where /e,o/ surface intact. Haas transcribes the lowered allophones as [ɛ,ɔ], but describes them as [+low], equating them with the vowels in English ‘mat’ and ‘fought’/‘caw’, respectively.

(7) Tunica (Haas 1953:222-223,246):

| | | | | | | | | | |
|---|---|---|---|----|---------|-------------|----|---------|----------------|
| i | u | i | u | a. | [kéri] | ‘clip, mow’ | e. | [kéra] | ‘scatter, sow’ |
| e | o | → | e | b. | [póhtu] | ‘cut’ | f. | [póhta] | ‘boil’ |
| | | | ε | c. | [ké] | ‘wasp’ | | | |
| | | | a | d. | [pó] | ‘look’ | | | |

Since most three-height systems are symmetrical and triangular in shape, mid vowel lowering in this type of language is not structure preserving; it derives new vowels, as in Tunica. Although this differs from how vowel harmony typically operates (Kiparsky and Pajusalu 2003; Archangeli and Pulleyblank 2007; van der Hulst 2018), a constraint against neutralization of contrasts is presumably responsible (*e,o/→[a]).

This concern does not arise in Tindal Dusun in (8), as there is a gap in the class of potential targets (*e/). (8a) shows that harmony applies regressively, lowering /o/ to [a] (Robinson 2006). High vowels are opaque (8b). They could not be targets without resulting in a two-step change from high→low, similar to what was discussed for mid vowel raising.

(8) Tindal Dusun (Robinson 2006:3):

| | | | | | |
|---|---|----|------------|-----------------------|--------------------------|
| i | u | a. | /tigog-an/ | [tigagan] | ‘shock, startle’-BEN/LOC |
| | o | b. | /kodut-aj/ | [kodutaj], *[kadutaj] | ‘pinch’-IMP |
| | a | | | | |

Mid vowel lowering harmony is potentially attested in seven-vowel triangular systems (/i,e,ɛ,a,ɔ,o,u/), depending on the analysis of lower mid vowels. In the absence of [-ATR] high vowels (*i,u/), harmony that derives [ɛ,ɔ] from /e,o/ adjacent to /ɛ,a,ɔ/, as in Yoruba, has been analyzed as [+low] harmony (Oyelaran 1970; Goad 1993) or as [-ATR] harmony (Archangeli and Pulleyblank 1989) (see Casali 2003 for correlations between inventory shape and the active value of [ATR]; also chapter 15). Arbitrating between these options on articulatory grounds is challenging: lowering the tongue body involves retracting the tongue root, and vice versa (e.g., Archangeli and Pulleyblank 1994).

Support for [-ATR] in Yoruba, however, can be found in Orie (2003; see also chapter 51). She observes that in Ekiti Yoruba, high vowels are not opaque, unlike in Standard Yoruba, but instead undergo harmony, yielding [-ATR] [i,u]. Clearly, then, not all [-ATR] harmonies can be reanalyzed as [+low] harmony. As for whether all [+low] harmonies can be reanalyzed as [-ATR] harmony, revisiting Tunica suggests that the answer is no. The underlying vowels in Tunica are /i,e,a,o,u/ and, thus, it is difficult to make a case that [ATR] (or [tense]) is active in this language. Further, Haas describes the harmony deriving [ɛ,ɔ] as lowering rather than retraction or laxing. In sum, [+low] is active in some lowering/retraction harmonies while [-ATR] is active in others.

6.3.2 Low vowel raising

We turn now to low vowel raising, which is curiously rare. Aside from Woleaian, where /a/ raises to [e] when flanked by /i,i,u/ (Sohn, 1971), low vowel raising is often subject to alternative analyses. Jiménez (1998) and Hyman (1999) discuss languages where /a/ raises to [ɛ] after /ɛ/ and to [ɔ] after /ɔ/ (e.g., Valencian, Londo), but this pattern has been analyzed as color harmony, rather than as height harmony (Jiménez 1998; van der Hulst 2018). Raising of lower-mid vowels to mid may implicate [ATR]. van der Hulst (2018) provides such an analysis for languages like Zulu, where /ɛ,ɔ/ allophonically raise to [e,o] before /i,u/. Kikuria displays a similar pattern. However, /e,o/, which are phonemic, may also trigger the process (Chacha and Odden 1998:140); this clearly motivates defining the triggers as [+ATR]. Kikuria could then be analyzed as a three-height system where [-ATR] mid vowels undergo ATR harmony, rather than lower-mid vowels undergoing raising to mid.⁵

Another possible case of low vowel raising is Eastern Khanty (Filchenko 2007). This language also appears to involve two-step raising. Low vowels in harmonizing suffixes become high when the root vowel is high, shown in (9c-d); compare (9a-b).

(9) Eastern Khanty (Filchenko 2007:28,50,133):

| | | | | | | |
|----------|----------|----------|----------|----|-----------|------------------------|
| i | y | i | u | a. | [joyl-am] | ‘hunting bow’-POSS.1SG |
| ↑ | e | ø | ↑ | b. | [æmp-æm] | ‘dog’-POSS.1SG |
| æ | | a | o | c. | [ik-im] | ‘uncle’-POSS.1SG |
| | | | | d. | [sir-im] | ‘part’-POSS.1SG |

Further probing indicates that Eastern Khanty can be reanalyzed as a two-height system, where /e/ lacks height features and /æ,ø,a,o/ form one class of non-high vowels. In the vowel chart provided by Filchenko, /e/ is intermediate in height between /i,y,i,u/ and /ø,o/, suggesting that it patterns with neither class. Consistent with this, there is variation in how harmonizing suffixes are realized after /e/: [sesq-æm]~[sesq-im] ‘trap’-POSS.1SG. Harmony in the reanalyzed system involves one-step raising targeting unrounded non-high vowels.

Consider finally Sesotho, which has a generous system of height contrasts, shown in (10) (Harris 1987; Clements 1990/2015). Mid vowel harmony raises /ɛ,ɔ/ to [e,o] before /i,u/ (10c) and /ɪ,ʊ/ (10d); compare (10a-b). Harmony is also likely triggered by /e,o/, as the lexicon lacks words where [ɛ,ɔ] and [e,o] appear in adjacent syllables (Clements 2015:83).

(10) Sesotho (Clements 2015:80,88):

| | | | | |
|----------|----------|----|-----------|------------------------|
| i | u | a. | -tetema | ‘shake, tremble’ |
| ɪ | ʊ | b. | -kəbehela | ‘curve towards’ |
| e | o | c. | -tetemisa | ‘cause to shake’ |
| ↘ ε | ↘ ɔ | d. | -kobeheli | ‘not to curve towards’ |
| a | | | | |

⁵ van der Hulst (2018) also proposes that Kikuria implicates [ATR], but where /e,o/ are underlyingly analyzed as /ɪ,ʊ/. Parkinson (1996) argues for a scalar approach involving four heights.

To express harmony in a unified way, Harris analyzes /ε,ɔ/ as [+low] and raising as spreading of [-low] from /i,u,ɪ,ʊ,e,o/; his analysis thus requires us to revisit the claim that low vowel raising is largely unattested. Harris's analysis, however, faces an empirical challenge: Sesotho contains high vowel allophones, [ɪ,ʊ] (between /i,u/ and /ɪ,ʊ/), which are derived from /ɪ,ʊ/ adjacent to /i,u/ (e.g., [mʊɪɪɪri] 'vagabond'). Under Harris's account, it is not obvious what feature to employ for [ɪ,ʊ], because [ATR] has been expended to capture /i,u/ versus /ɪ,ʊ/. Sesotho instead motivates a scalar approach to height, seemingly without [ATR] (see Clements 1990/2015; Parkinson 1996).

6.4 Conclusion

We have observed that high vowel lowering and mid vowel raising are well attested, suggesting that features akin to [+high] and [-high] are robustly manipulated by phonological grammars. In comparing mid vowel lowering and low vowel raising, however, only the former is commonly attested, motivating a feature akin to [+low], but not to [-low]. Consistent with this, many theories of vowel representation have dispensed with a primitive corresponding to [-low]: Particle Phonology (Schane 1984), Government Phonology (Kaye, Lowenstamm and Vergnaud 1985; Backley 2011), Dependency Phonology (Anderson and Ewen 1987), and Radical cv Phonology (van der Hulst 2018).

Of the features that are active in height harmony, two partially overlap: vowels that are [+low] can additionally behave as [-high]. Consistent with this, we saw that in high vowel lowering, low vowels pattern with mid vowels in the class of triggers or they pattern as neutral (opaque). Similar dual behavior was not observed for low vowels in vowel raising: low vowels never pattern as targets in such systems; rather, they are always neutral (transparent or opaque). This asymmetry proved to be unsurprising: low vowel participation in the class of targets would require harmonies to sanction two-step raising, which is seemingly unattested.

Finally, we showed that height harmonies are largely confined to maximally three-height systems. Although some of these systems have more contrasts on the vertical dimension than [+high], [-high] and [+low] (or their analogs) can accommodate, supplementing height features with [ATR] or [tense] seemed to be supported by the observation that [ATR]/[tense] interacts with, but does not pattern as, height. When confronted with Sesotho, however, it became evident that a scalar approach to height is sometimes warranted. This may suggest that features are not universal but, rather, emerge based on observed phonological behavior, as proposed by Mielke (2008) and explored for contrasts on the vertical dimension by Archangeli & Pulleyblank (2018).

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