Chapter 2: The role of consonants in vowel harmony

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2.1 Introduction

Vowel harmony is defined as a phonological process, or co-occurrence restriction, that requires the vowels within some domain, such as the word, to share some property. Generally speaking, consonants are thus taken to be irrelevant and inert in the manifestation of vowel harmony patterns. Other things being equal, then, a consonant will neither undergo nor trigger assimilation in the harmonic property, nor will intervening consonants affect (e.g. block) enforcement of the harmony relation between a preceding and a following vowel.

This chapter examines the diverse ways in which individual vowel harmony systems may deviate from this default state of affairs. Consonants can be implicated in vowel harmony systems in a variety of ways, and such cross-over effects can have implications for phonological theory, informing theories of representation (e.g. distinctive feature theory, feature geometry, underspecification theory) and of the formal mechanisms that are understood to be involved in assimilation (e.g. feature spreading vs. agreement/copying, relations between segments vs. syllable nuclei).

I begin by considering the possibility that consonants may themselves be *undergoers* of vowel harmony, albeit only in a passive, allophonic sense (§2.2). I then turn to the various types of interference that consonants can display in vowel harmony patterns. Most commonly, specific consonants *block* the propagation of harmony from one vowel to another (§2.3); different manifestations of such blocking effects are discussed and illustrated. Alternatively, consonants may *trigger* vowel harmony (§2.4), or they may play a more subtle *facilitating* role (§2.5). Sometimes, it is the very *transparency* of certain consonants—that is, the absence of blocking—that is notable (§2.6). Finally, I address the relationship between vowel harmony and consonant harmony (§2.7), highlighting typological similarities and differences between the two.

2.2 Consonants as undergoers of vowel harmony

Many analyses that take vowel harmony to involve *feature spreading* see intervening consonants as passive undergoers, targeted by the spreading feature rather than being skipped over (transparent). If phonological feature spreading is equated with the temporal extension of a corresponding *articulatory gesture*, then this view entails that the gesture implementing the harmonic feature—e.g. lip rounding, tongue-body fronting, or tongue-root advancement—is just as present during the intervening consonant(s) as it is during the surrounding vowels (for related discussion, see chapters 32 and 40). Effectively, consonants are thus considered to exhibit phonological *harmony alternations* no less than the vowels do. However, such consonantal alternations due to harmony are typically *allophonic* (subphonemic). They might be subtle—perhaps only detectable with articulatory measurements, rather than in the acoustic signal—and may thus, it is argued, have gone unnoticed in previous descriptive literature. A view along these lines is a corollary of the hypothesis that all feature spreading is *strictly local* (Archangeli and Pulleyblank 1994; Pulleyblank 1996; Ní Chiosáin and Padgett 1997, 2001; Gafos 1998, 1999 [1996]; Gafos & Lombardi 1999; Walker 2000b [1998]; Walker and Pullum 1999).

This interpretation of the status of consonants as (passive) harmony targets receives support from phonetic studies of some vowel harmony systems, such as front/back harmony and rounding harmony in Turkish (see Ní Chiosáin & Padgett 2001 and works cited therein). For instance, Boyce (1990) found that when producing nonce words with two consecutive rounded vowels, such as [kuktuk], Turkish speakers exhibited a plateau pattern of lip protrusion that spanned the whole word, while English speakers appeared to have two separate lip rounding gestures, with less protrusion during the intervening consonants. (Ní Chiosáin & Padgett 2001 note that the latter pattern has also been observed for Swedish, Spanish and French.)

In certain well-studied vowel harmony systems, differences in the phonetic realization of consonants depending on harmonic context have long been known (see chapters 25 and 26). This is especially the case for front/back harmony in various Finno-Ugric languages (see chapter 67) and Turkic languages (see chapter 59, section §59.3.1). For instance, in many Turkic languages, dorsal consonants alternate between palatals or palatalized (front) velars in front-harmonic contexts and (back) velars or uvulars in back-harmonic contexts.[1] The same tends to be true for laterals as well; they are then typically realized as either clear [l] or palatalized [lʲ] (or even palatal [ʎ]) in front-harmonic words and velarized (dark) [lˠ] in back-harmonic environments. This has contributed to a tradition of viewing front/back harmony in these languages as operating at the level of the *syllable* as a whole, rather than vowels (e.g. Johansson 1991, Csató 1999).

However, it is often not quite clear whether such consonantal alternations should be viewed as part of the harmony as such—the consonants being *harmony targets* in their own right—or instead as resulting from separate, *local assimilation* processes involving the same feature as the vowel harmony. On the latter view, vowel harmony simply feeds the local assimilation process by dictating the feature specifications of the assimilation-triggering vowel.

Occasionally, mismatches between the consonantal alternations and the vowel harmony can be illuminating. For instance, in Votic, the lateral /l/ alternates between clear [l] and velarized [lˠ] in front- and back-harmonic words, respectively (Ariste 1968; Blumenfeld & Toivonen 2016); e.g. [eg.leː] 'yesterday', [ʧyl.vet.tæ] 'to wash' vs. [kɑ.lˠɑ] 'fish', [kəlˠ.mɑʒ] 'third'. However, the vowel /i/, which is neutral and transparent to the front/back vowel harmony (see chapter 33), nevertheless causes an immediately preceding (onset) /l/ to be realized as clear [l], even in an otherwise back-harmonic word; e.g. [mɑː.li.mɑ] 'paint', [tu.lin] 'came.1SG'. Coda laterals assimilate to a following rather than a preceding vowel; e.g. [milˠ.tɑ] 'from me'. These discrepancies suggest that the [l]~[lˠ] alternations are not a manifestation of the word-level harmony as such but rather a separate local assimilation that is superimposed on it. Blumenfeld & Toivonen (2016) posit two distinct constraints that require agreement in [±back], one targeting pairs of co-occurring vowels (other than /i/), the other targeting sequences of lateral + vowel (including /i/). Hall (2018) goes one step further, positing that these two processes involve distinct features: [±back] in the former case but [coronal] in the latter. Yet another possibility is that while the [l]~[lˠ] alternations in (non-moraic) onset position are due to local C-V assimilation, the analogous alternations in (moraic) coda position are a direct manifestation of harmony (Ozburn 2019).

[1] Similarly, velar vs. uvular alternations are found in many languages of Northeast Asia (e.g. Mongolic and Tungusic languages), and are often conditioned by ATR/RTR or vowel height rather than frontness/backness; see §2.7.2 and chapters 60 and 61.

A related but distinct problem is that it is often very difficult to distinguish alternations in consonantal realization that are subphonemic (allophonic), but still fundamentally *phonological*, from mere *coarticulatory* (phonetic) effects of vocalic context on consonants. This is especially true in that patterns of coarticulation—and of phonetic implementation in general—are now recognized to be planned and language-specific to a significant extent (Whalen 1990; Beddor et al. 2002). When faced with acoustic or articulatory evidence of phonetic differences in consonants between harmonic contexts, the analyst thus has to answer two separate questions. First, do these differences reflect a distinction in the *phonological output* representation, or do they instead emerge outside of the phonological grammar, as an aspect of the *phonology-phonetics mapping* (phonetic implementation)? Second, even if these differences are encoded in the phonological output representation, are they a *direct* reflection of whatever mechanisms (constraints, rules) cause the harmony alternations in vowels, or instead the *indirect* result of interaction between phonological processes?

What counts as valid evidence bearing on these questions—and whether the questions are even meaningful in the first place—is greatly dependent on one's assumptions about the *phonology-phonetics interface* (Zsiga 2021) and the nature of the phonological output representation. For relevant discussion, see also chapters 32, 40 and 41.

2.3 Consonants as blockers of vowel harmony

The best known type of interference effect involving consonants is where consonants act as *blockers* (opaque segments). That is, whenever a particular type of consonant occurs between two vowels that otherwise constitute a regular trigger–target pair for harmony, the target vowel fails to harmonize with the trigger vowel. Sometimes the blocking consonant can then be viewed as constituting a harmony *trigger* in its own right; this point is taken up in §2.4.

The range of consonants that are attested as blockers of vowel harmony is quite diverse, and partly depends on the type of harmony involved. In most cases a phonetic basis for the consonantal interference can be inferred (at least historically, if not synchronically), in that the class of blockers are segments with articulatory gestures and/or acoustic-perceptual cues that relate to the phonetic parameter corresponding to the harmony feature. Perhaps unsurprisingly, consonants with an essentially vocalic articulation, either primary (glides) or secondary (labialized, palatalized, velarized or pharyngealized consonants), are common blockers. So are consonants whose primary place involves an active articulator that is also implicated in the vowel harmony feature: labials (lips; [round]), palatals and velars (tongue dorsum; [front/back]), uvulars and pharyngeals (tongue root; [ATR/RTR]). Less commonly, properties such as phonation type (e.g. voicing), nasality, continuancy or sonority can also be what distinguishes blockers from non-blockers.

With respect to the relationship between the defining property of the blockers on the one hand and the harmonic feature on the other, there are two main patterns observed, broadly speaking. Adapting van der Hulst's (2018) terminology for different types of transparent segments (cf. Archangeli & Pulleyblank 2007; Rose & Walker 2011), I will refer to these as *antagonistic blocking* and *sympathetic blocking*, respectively. In antagonistic blocking (§2.3.1), the consonants in question carry some property that is contradictory (phonetically, and perhaps also phonologically) to the spreading harmony feature. In sympathetic blocking (§2.3.2), the consonants that block harmony are, conversely, ones that carry a property that seems similar or related to—and hence might have been expected to be compatible with—the harmony feature. In other cases, the set of blockers is hard to classify in these terms (§2.3.3). Finally, vowel harmony may be blocked when a *consonant cluster* intervenes, though this is more likely a matter of trigger-target distance than consonantal interference as such (§2.3.4).

2.3.1 Antagonistic blockers

Antagonistic blocking by intervening consonants is fairly well attested, and is also the easiest to make sense of in phonological terms. The classic example is Turkish (Clements & Sezer 1982), where a stem-final palatalized /lʲ/ appears to block progressive backness harmony onto suffixes and clitics, e.g. /petrolʲ-dI/ → [petrolʲ-dy] 'it is petrol', /usulʲ-sIz/ → [usulʲ-syz] 'without a system' (Kabak 2011; see chapters 22 and 59). The same is often reported to hold true for stem-final palatalized /kʲ/, which depalatalizes in syllable-final position, e.g. /idrɑkʲ/ → [idrɑk] 'comprehension', ACC /idrɑkʲ-I/ → [idrɑkʲ-i] (not *[idrɑkʲ-ɯ]) (Clements & Sezer 1982; Kabak 2011). However, Levi (2004) found that younger speakers have reinterpreted such stems as ending in non-palatalized /k/ and not exhibiting blocking (e.g. ACC [idrɑk-ɯ]). Furthermore, Kabak (2011) notes that the unexpected appearance of front-harmonic suffixes after a back stem vowel often seems unrelated to the intervening consonants, e.g. /sɑɑt-I/→ [sɑɑt-i] 'watch, clock (ACC)', /hɑrf-dE/→ [hɑrf-te] 'on the letter' (not *[sɑɑt-ɯ], *[hɑrf-tɑ]).

For analyses of vowel harmony that treat it as a feature-spreading process that respects locality at either a segmental level or on some sub-segmental (e.g. feature-geometric) tier, antagonistic blocking can be explained by positing that the consonant is specified for the opposing value of the harmonic property. Thus Levi (2004) explains the blocking effect of Turkish /lʲ/ by attributing to it a V-Place node (Clements & Hume 1995), which in turn dominates a Lingual node containing a frontness feature ([coronal]), the same as in front vowels. If front/back harmony involves rightward spreading of the Lingual node, this explains both why /lʲ/ blocks back ([dorsal]) harmony and why it initiates front ([coronal]) harmony (see §2.4). By contrast, rounding ([labial]) resides directly under V-Place, and rounding harmony spreads this feature from one V-Place node to the next. Since the V-Place node of /lʲ/ is not specified as unrounded, /lʲ/ is not predicted to interfere with rounding harmony (contra Kabak 2011); cf. /petrolʲ-dI/ → [petrolʲ-dy], not *[petrolʲ-di].

Another oft-cited case of antagonistic blocking is that of Warlpiri (Nash 1986; Harvey & Baker 2005; see chapter 74), in which the progressive unrounding harmony of /iC(C)u/ → [iC(C)i̲] (e.g. /maliki-kuɭu=ɭu=lku=cu=lu/ → [malikikiɭiɭilkicili] 'dog-PROP-ERG=then=me=they') is blocked if a labial consonant intervenes between the vowels (e.g. /milpiɾi-puɻu/ → [milpiɾi̲pu̲ɻu] 'cloud-during', not *[milpiɾi̲pi̲ɻi]). Furthermore, Nash (1986) states that morpheme-internally, [iC_1(C_2)u] sequences do not exist at all in Warlpiri except where the intervening C_1 (or C_2) is labial (e.g. /jiɾiwu/ 'species of bush [Acacia ancistrocarpa]'), with the exception of recent loanwords (e.g. /mijuɭu/ 'mule'). Harvey & Baker (2005) analyze the harmony as strictly local spreading of [-round], and account for the blocking by invoking a feature co-occurrence constraint *[labial, -round], which would be violated if [-round] were spread across—or rather, through—an intervening [labial] segment.

The analyses by Levi (2004) and Harvey & Baker (2005) nicely illustrate the two main explanatory strategies that are seen in phonological analyses of consonantal blocking effects (for related discussion, see chapter 27). One strategy is to blame blocking on a disruption of the *locality relation* between the two vowels. For instance, the spreading harmony feature (autosegment) cannot be shared by the trigger and target vowels without causing either crossed association lines or unfaithfulness in the intervening consonant (e.g. if Turkish /lʲ/ were depalatalized to [l] between back vowels). Another variant of this strategy is to incorporate a locality restriction into the definition of the harmony-driving constraint or rule, for example by prohibiting disharmonic vowel-vowel sequences that are *adjacent* on some autosegmental tier (e.g. that of the harmony feature). If an intervening consonant disrupts that adjacency relation, the vowel-vowel pair no longer meets the conditioning environment of the harmony constraint or rule. Levi's (2004) analysis of the Turkish blocking facts can be formulated in either of these ways.

A second strategy, illustrated by Harvey & Baker (2005), is to instead appeal to some high-ranked *well-formedness constraint* overriding harmony by penalizing the output configuration that would have resulted if harmony were applied across (or through) the intervening consonant. In Harvey & Baker (2005), the constraint in question regulates the internal properties of the consonant (a ban against *[labial, -round] segments); analyses appealing to gestural uniformity (see §2.3.3 and §2.6) are similar in spirit. Alternatively, the harmony-overriding constraint may be a phonotactic restriction, penalizing some aspect of the resulting segment sequence (see discussion of Laal and Assamese in §2.3.2 and §2.3.3, respectively).

Returning to the Turkish facts discussed above, a notable aspect about that case is that while palatal(ized) consonants like /lʲ/ block backness harmony, the palatal glide /j/ does not and is instead transparent to harmony, e.g. /koj-In/ → [koj-un] 'of a/the bay' (not *[koj-yn] or *[koj-in]) and /koj-lAr/ → [koj-lɑr] 'bays' (not *[koj-ler]). Levi (2004) accounts for this by positing that /j/ does not have a V-Place node at all but rather just a C-Place node; in other words, that Turkish /j/ is phonologically not a vocoid (non-syllabic vowel) but a true consonant. Other cases exist, however, where intervening glides do block assimilation between vowels, and where this can be viewed as antagonistic blocking.

One such case is Ainu, in which certain vocalic suffixes, including the transitivizer /-V/, exhibit copying of the last vowel of the base (Ito 1984); e.g. /tus-V/ → [tus-u] 'shake', /ker-V/ → [ker-e] 'touch', /mak-V/ → [mak-a] 'open'.[2] However, when either of the glides /j, w/ intervene, the suffix vowel is instead realized as [e]; e.g. /ʧaw-V/ → [ʧaw-e] 'solve', /moj-V/ → [moj-e] 'move' (not *[ʧaw-a], *[moj-o]). In a feature-spreading analysis, Halle (1995) derives this blocking by treating Ainu [j, w] as the non-syllabic equivalents of the high vowels [i, u], combined with the (implicit) stipulation that only syllabic vocoids trigger spreading. With

[2] After certain roots, these suffixes surface with a high vowel, either [-i] or [-u], partly depending on the root (e.g. [kar-i] 'rotate', [ram-u] 'think').

respect to the theoretical implications of Ainu and similar cases, some caution is in order. As van der Hulst (2018) notes, the vowel-to-vowel assimilation seen in Ainu is a local, non-iterative process, and such phenomena need not be entirely equivalent to across-the-board harmony. Furthermore, Ainu involves total assimilation; it is possible that such vowel copying involves (in some or all cases) other mechanisms than vowel harmony proper.

2.3.2 Sympathetic blockers

In the Ainu case just described, homorganic vowel-glide sequences /ow, uw, ej, ij/ happen not to occur root-finally. For this reason, all observed instances of blocking in Ainu can be characterized as antagonistic: the intervening glide conflicts with the triggering vowel in terms of [±back] and/or [±round] (and also [±high, ±low] in the case of /aj, aw/-final roots). However, glides may also act as *sympathetic* blockers, preventing harmony even though they appear to carry the very feature that is being spread.

An example of such sympathetic blocking by glides is palatal harmony in Mina (Frajzyngier & Johnston 2005), by which /i, e/ trigger fronting of subsequent back vowels /a, u/ to [e, y] (1a–b). This harmony is blocked if a palatal glide /j/ intervenes between the trigger and target vowels (1c):

(1) Mina: palatal harmony blocked by palatal /j/ (Frajzyngier & Johnston 2005)

a.	/mèɗ-ú/	→	mèɗý̲	‘swear it!’
b.	/í gìz-á-k zà/	→	í gìzé̲k zè̲	‘I was told’
c.	/kə́ tìj-á-k zà/	→	kə́ tìjá̲k zà	‘he looked at me’

Analogously, rounding harmony may be blocked by the rounded (labial-velar) glide /w/. This is attested in Laal (Lionnet 2017), where all types of regressive rounding harmony (not just the doubly-triggered one discussed in §2.5) are blocked if /w/ intervenes, e.g. /də̀g-nǔ/ → [dògnǔ] ‘drag us.EXCL’ but /kàw-nǔ/ → [kə̀wnǔ] (not *[kòwnǔ]) ‘be insufficient for us.EXCL’. Lionnet (2017) attributes this to an independently motivated phonotactic ban against rounded vowel + /(C)w/ sequences in Laal, which overrides harmony.

Another case where /w/ is reported to block rounding harmony is Bashkir (a.k.a. Bashqort; Poppe 1964). In Bashkir, rounding harmony is confined to the vowels rendered as <ĕ, ö̆, ï̆, ŏ> and traditionally described as “reduced mid vowels” (Berta 1998), but the phonetic and phonological status of these vowels is somewhat unclear. Van der Hulst (2018: 231–233) treats them as mid vowels [e, ø, ɜ, o], while I will follow Washington (chapter 59, citing Berkson et al. 2016) in taking them to be lax and (mostly) high vowels [ɪ, ʏ, ʌ, ʊ]. By rounding harmony, [ʊ, ʏ] in an initial syllable must be followed by [ʊ, ʏ] (respectively) rather than [ʌ, ɪ], and [ʊ, ʏ] otherwise never occur in non-initial syllables. The harmony does not target the low vowels [æ, a], and these block rounding harmony (e.g. [tʏðælmæθlɪk] ‘incurable’, not *[tʏðælmæθlʏk]). According to Poppe (1964) and Usmanova (2006; cited in chapter 59, section §59.5.2), so does the glide /w/: [kʏl-ʏw-ɪ] ‘laugh-VN-3.POSS’ [tʊr-ʊw-ʌ] ‘laugh-VN-3.POSS’ (not *[kʏl-ʏw-ʏ], *[tʊr-ʊw-ʊ]).[3] The Bashkir facts merit further investigation, especially in light of recent studies that find rounding harmony to be either absent or severely limited in closely-related Tatar, contrary to classic descriptions (Conklin 2015; McCollum & Kavitskaya 2018; cf. also McCollum 2015, 2018 on rounding harmony in Kazakh).

The abovementioned examples of sympathetic blocking all involve glides. Another oft-cited case is rounding harmony in Nawuri (Casali 1995) which, to the contrary, is blocked (in careful speech) by all labial consonants except the glide /w/, specifically /p, b, f, m/ as well as the labial-velars /k͡p, g͡b/, as seen in (2a) vs. (2b). However, it is not that /w/ is transparent in Nawuri the way non-labials are; rather, /w/ is itself a *trigger* of rounding harmony (2c). Contrastively labialized non-labial consonants /kʷ, ʧʷ, sʷ/ are likewise harmony triggers (2d), whereas contrastively labialized labials /pʷ, bʷ, fʷ, mʷ/ are not (2e).[4]

(2) Nawuri: interference of labials in rounding harmony (Casali 1995)

a.	/gI-keːliː/	→	gɨkeːliː	‘kapok tree’
	/gI-kuː/	→	gukuː	‘digging’
	/gI-lɔ/	→	gʊlɔ	‘illness’

[3] Note that van der Hulst & van de Weijer’s (1995: 529) claim that “in Bashkir /w/ blocks rounding just as the high vowels do” is inaccurate, as the fully-high (tense, “full”) vowels [i, y, u] do not occur in non-initial syllables and hence have no opportunity to interfere with harmony.

[4] Regarding (2d), Casali (1995) does not include any forms with the /gI-/ prefix before root-initial /kʷ, ʧʷ, sʷ/ (though he cites Ken Snider’s field notes on closely-related Chumburung, where such forms are transcribed with a rounded prefix vowel, unlike before /pʷ, bʷ, fʷ, mʷ/). However, he states the much stronger generalization that “rounding of a high vowel is obligatory before /w/ and […] /kʷ, čʷ, sʷ/” (p. 656). My use of underlying /I/ in (2d) is intended to reflect this predictability in the vowel’s realization as rounded in this context.

b.	/gI-boːtoː/	→	gɨboːtoː	‘leprosy’
	/gI-fufuli/	→	gɨfufuli	‘white’
	/gI-k͡poː/	→	gɨk͡poː	(type of dance)
c.	/gI-wɛː/	→	gʊwɛː	‘sympathy’
	/gI-wʊrʊː/	→	gʊwʊrʊː	‘hat’
d.	/kIkʷɪː/	→	kʊkʷɪː	‘different’
	/sIsʷaː/	→	sʊsʷaː	‘to grease’
e.	/gI-pʷɛː/	→	gɨ̞pʷɛː	‘guilt’
	/gI-bʷaːruː/	→	gɨ̞bʷaːruː	‘water yam’
	/gI-fʷɪ/	→	gɨ̞fʷɪ	‘bodily gas’

While Casali (1995: 662) sees “no way of resolving this dilemma in terms of a formal geometric solution that derives opacity effects by means of the ban on line crossing”, Halle et al. (2000) propose an autosegmental analysis (recapitulated in Mahanta 2007) that claims to capture the blocking patterns. They take /p, b, f, m/ to be specified as [-round] (given the contrast of /p/ vs. /pʷ/, etc.) and therefore block spreading of [+round]; other consonants are unspecified for [±round] and hence transparent. However, this analysis fails to explain why labial-velar /k͡p, g͡b/ are blockers, since they lack labialized counterparts and hence should not be [-round]. Secondly, it remains unexplained why /k, ʧ, s/ are not also blockers, given that they contrast with /kʷ, ʧʷ, sʷ/ and should thus be [-round] just like /p, b, f, m/. Finally, this analysis fails to relate the asymmetry between contrastively non-labialized /p, b, f, m/ and /k, ʧ, s/ on the one hand (opaque vs. transparent to [+round] spreading) to the analogous asymmetry between contrastively labialized /pʷ, bʷ, fʷ, mʷ/ and /kʷ, ʧʷ, sʷ/ on the other (non-triggers vs. triggers of [+round] spreading).

Casali (1995: 655, n. 7) observes that before a rounded vowel, all consonants “bear significant lip-rounding”, even the labials and labial-velars. Casali (1990) argues that this is not coarticulation but an independent phonological process of [+round] spreading from vowels onto a preceding consonant. More accurate transcriptions of the output forms in (2a) would thus be [gʷukʷuː], [gʷʊlʷɔ], and for (2b), [gɨbʷoːtʷoː], [gɨfʷufʷuli], [gɨk͡pʷoː]. If we take these revised surface realizations seriously, the descriptive generalizations become somewhat different. The feature [+round] spreads from a rounded vowel onto any preceding (root-initial) onset consonant, making it labialized (C^w). All [+round] *onset consonants*—including not only these predictably-labialized ones but also the glide /w/ and contrastively labialized consonants (e.g. /k^w/)—in turn spread [+round] onto a preceding (prefix) vowel, except when the consonant in question has [labial] as a primary (consonantal) place of articulation. Given that secondary-articulation gestures are typically anchored to the release phase (at least for onset consonants; Kochetov 2006; Hoole & Pouplier 2015), one may characterize this as leftward spreading/extension of a lip rounding gesture ([+round]), which is being blocked by an intervening constriction gesture that also involves the lips: full closure in the case of [p^w, b^w, m^w] (reflecting either /p^w, b^w, m^w/ or contextually labialized /p, b, m/), critical narrowing in the case of [f^w] (reflecting /f^w/ or labialized /f/). This could be characterized as a matter of enforcing *gestural uniformity* (see the discussion of liquid transparency in Italian dialects in §2.3.3).

2.3.3 Other types of blocking

A number of cases cannot be as straightforwardly classified as either antagonistic or sympathetic blocking. These typically involve tongue-root or height harmony, or else total (vowel-copy) harmony, though exceptions exist (e.g. blocking of rounding harmony by pharyngeals and ejectives in Tigre; Faust 2017).

Sonority and continuancy both appear to be possible criteria for blocking vs. transparency in such systems. For instance, in Dagbani (Hudu 2013), progressive [+ATR] harmony, triggered by /i/ and targeting high suffix vowels (/ɨ, ʊ/), applies across glottals [ʔ, h] as well as oral and nasal stops, as illustrated in (3a–b). Harmony is blocked by any (supra-laryngeal) [+continuant] consonant; this is seen for [s] and [l, ɾ] in (3c). By contrast, regressive [+ATR] harmony, which is triggered by word-final [e, o] and targets preceding non-high vowels, applies across [-cont] and [+cont] consonants alike (3d).[5]

(3) Dagbani: progressive [+ATR] harmony blocked by continuants (Hudu 2013)

a.	/bɨ́n-ɨ̂/	→	bɨ́nɨ̂	'thing-SG'
	/tʊ́-bʊ̂/	→	tʊ́bʊ̂	'pound-IMPF'

[5] The underlying representations in (3) simplify the situation somewhat. In reality, [e, o] and [ɛ, ɔ] are allophones in Dagbani: the [+ATR] realizations [e, o] appear predictably in domain-final position (or as a result of regressive harmony) while their [-ATR] counterparts [ɛ, ɔ] occur elsewhere (Hudu 2013).

	/bɛ́-hɨ̂/	→	bɛ́hɨ̂	‘shin-PL’	
b.	/pín-ɨ̂/	→	pínî	‘gift-SG’	
	/tí-bʊ̂/	→	tíbû	‘pound-IMPF’	
	/bí-hɨ́/	→	bíhí	‘child-PL’	
c.	/pìl-gʊ́/	→	pìlgʊ́	‘begin-NOM’	(not *[pìlgú])
	/k͡pì-ɾɨ́/	→	k͡pìɾɨ̀	‘die-IMPF’	(not *[k͡pìɾì])
	/jìn-sɨ́/	→	jìnsɨ́	‘house-PL’	(not *[jìnsí])
d.	/tàdáb-ô/	→	tədəbô	‘writing ink-SG’	
	/pál-ó/	→	pə́ló	‘new-PL.ANIM’	
	/ʧɔ̀ɾ-ê/	→	ʧòɾê	‘blow-SG’	

While liquids (as well as fricatives) act as blockers in Dagbani, they are conversely the sole non-blockers in certain varieties of Italian, where harmony among post-tonic syllables applies only across /l, r/, not obstruents or nasals (Canalis 2009; Walker 2016; see chapter 69, section §69.4.1). In most cases, the harmony involves total assimilation, as in the Umbertide (4a) or Sant’Oreste dialect (4b). In the Garfagnana dialect (4c), such trans-liquid harmony among post-tonic (non-low) vowels involves only [±high], not [±back] or [±round].

(4) Italian dialects: harmony blocked by non-liquids (Canalis 2009; Walker 2016)

a. Umbertide (northwestern Umbria)

ˈfragw<u>a</u>r-a	‘strawberry’	
ˈfragw<u>e</u>r-e	‘strawberries’	
ˈʤov<u>i</u>n-o	‘young man’	not *[ˈʤov<u>o</u>n-o]
ˈmon<u>i</u>k-a	‘nun’	not *[ˈmon<u>a</u>k-a]

b. Sant’Oreste (northern Lazio)

ˈrand<u>a</u>l-a	‘tarantula’	
ˈsig<u>u</u>r-u	‘cigar’	
ˈsig<u>i</u>r-i	‘cigars’	
ˈtrap<u>i</u>n-u	‘drill’	not *[ˈtrap<u>u</u>n-u]
ˈʃkɔmː<u>i</u>d-a	‘uncomfortable-FEM’	not *[ˈʃkɔmː<u>a</u>d-a]

c. Garfagnana (northwestern Tuscany)

ˈalbe̲r-o	‘tree’	not *[ˈalbo̲r-o]
ˈalbi̲r-i	‘trees’	
ˈkavo̲l-o	‘cabbage’	
ˈkavu̲l-i	‘cabbages’	not *[ˈkavi̲l-i]

Canalis (2009) analyzes these patterns in representational (autosegmental) terms, positing that liquids are completely underspecified for place features and hence do not block spreading. Walker (2016) instead appeals to a requirement for *gestural uniformity*, by which segments that share a single vowel feature must not differ in the major-class feature [±approximant]. On the assumption that all spreading is strictly local (§2.2), a feature like [+high] or [-back] can only spread from V_2 to V_1 in a V_1CV_2 sequence by also spreading to the intervening C; if that C is [-approx] (e.g. a nasal stop, or an obstruent), the resulting configuration would violate gestural uniformity. This is analogous to how gestural uniformity has been invoked to explain opacity vs. transparency of *neutral vowels*. An example is Kaun’s (1995) analysis of the opacity of Halh Mongolian, where [u] blocks rounding harmony among [-high] vowels. Kaun proposes that successive [+round] vowels must either be uniformly [-high] or [+high], as high vs. non-high vowels require distinct articulatory configurations for lip rounding. Note that those feature-sharing configurations that satisfy gestural uniformity will inevitably involve intervening segments that are more *similar* to the trigger-target segments on either side in some crucial respect—e.g., liquids are more similar to vowels than nasals or obstruents are, in being [+approx] rather than [-approx]. For this reason, explanations along these lines also relate to the broader question of the role of *similarity* in harmony systems (see §2.7.1).

In the Dagbani and Italian examples above, nasal stops pattern with plosives in blocking harmony. Some patterns of vowel copying appear instead to draw the distinction between all sonorants (including nasals) and obstruents, but not necessarily in a consistent way. Thus, in Shona, epenthetic (high) vowels in adapted loanwords assimilate across (labial and coronal) obstruents but not across sonorants, cf. [ʧifi̲] ‘chief’ vs. [timu̲] ‘team’ (Uffmann 2006). In many other cases, conversely, copy-vowel insertion is observed only across sonorants but not obstruents (Hall 2006).

As for nasals being singled out as blockers of harmony, this is often stated as being the case for regressive [+ATR] harmony in Assamese (Mahanta 2007; Archangeli & Yip 2019). It is not clear that such a characterization is entirely justified, however. The only environment in which regressive [+ATR] harmony fails to apply across an intervening nasal in Assamese is the specific configuration /ɔNi/; e.g. [kʰɔmir] ‘leavening agent’, [sɛkɔni] ‘strainer’, [dʰɔr-ɔni] (not *[kʰomir], *[sekoni], *[dʰor-oni]). It is not the case that [+ATR] harmony onto a mid vowel (or even onto /ɔ/ specifically) fails to apply across a nasal; cf. [somokit] ‘frightened suddenly’. Mahanta (2007) attributes the failure of harmony in words like /kʰɔmir/ is due to a rather parochial constraint *[oNi], which specifically bans the three-segment sequence (trigram) of a mid rounded [+ATR] vowel [o], a [+nasal] consonant, and a high [+ATR] vowel [i] or [u].[6] While it is true that this ban leads to the existence of ATR-disharmonic [ɔ…i] sequences, it may not be useful to view this state of affairs in terms of harmony being interrupted by a particular class of intervening consonants.

All of the abovementioned examples involve either tongue-root harmony or total assimilation (vowel copy). An intriguing case that appears to involve *height harmony* is that of Buchan Scots (Wölck 1965; Fitzgerald 2002; see also chapters 11 and 23). In disyllabic words or phrases with trochaic stress, the stressed and unstressed vowels agree in [±high], other things being equal; this results in [i]~[e] and [ɨ]~[ə] alternations in various suffixes and clitics (5a–b).[7] High…nonhigh sequences such as [ˈu…ə] or [ˈi…e] are not found, regardless of what consonants intervene; after a high stressed vowel, the unstressed vowel is always high ([ˈu…ɨ], etc.).[8] However, when certain types of consonants or clusters follow a stressed nonhigh vowel, we see only disharmonic [-high]…[+high], never harmonic [-high]…[-high] (5c). Paster (2004) interprets the pattern as progressive [-high] harmony, blocked by these intervening segments and clusters. However, the set of blockers is quite heterogeneous, consisting of /ŋ/ and some instances of /n/ (but crucially not /m/), all voiced obstruents (either as singletons or as part of clusters), and also clusters of /l, m, n/ + voiceless obstruent (in practice always a plosive). While

[6] Although Mahanta’s constraint definition entails that [oNu] sequences are banned as well, she cites no example of an /ɔNu/ sequence failing to harmonize, only /ɔNi/.

[7] I follow Youssef (2010) in transcribing the unstressed central high vowel as [ɨ], not [ɪ] as in Fitzgerald (2002).

[8] Paster (2004) finds that the suffixes and clitics described in previous works as displaying [ɨ]~[ə] alternation (e.g. *-ing*, *it*, *(h)im*) no longer alternate but instead have a consistently non-high vowel she transcribes as [ɜ]. She similarly finds no [i]~[e] alternation in the clitic *me* (not discussed in earlier works), and notes a handful of words with unstressed [e] after a high vowel (*Tuesday* [ˈtuzde], *relay* [ˈrile]). Paster therefore takes all the (still-)alternating vowels to be underlyingly [+high], and interprets the harmony as spreading only [-high], not [+high]. Youssef (2010) follows older descriptions in treating high…nonhigh vowel sequences as categorically absent in surface forms and hence ruled out by the phonology.

NT and lT clusters block harmony (T = voiceless plosive), rT clusters do not, and neither does a singleton T nor other CT clusters like [st] (5d).

(5) Buchan Scots: height harmony with consonantal blocking

a.	ˈfəfte	‘fifty’	ˈtwɨnti	‘twenty’
	ˈfer-le	‘fairly’	ˈlɨk-li	‘likely’
	ˈkʌrn-e	‘corn-DIM’	ˈklut-i	‘clout-DIM’
	ˈlem-e	‘loam-DIM’	ˈdim-i	‘dame-DIM’
b.	ˈʃalə	‘shell’	ˈhulɨt	‘owl’
	ˈafə	‘awful’	ˈmu-fɨ	‘mouthful’
	ˈskot-lən	‘Scotland’	ˈhi-lɨn	‘highland’
	ˈlost ət	‘lost it’	ˈθɨŋk ɨt	‘think it’
c.	ˈlaŋ-ɨr	‘longer’	(not *[ˈlaŋ-ər]; cf. [ˈʧamər] ‘chamber’)	
	ˈθʌnɨr	‘thunder’	ˈmenər	‘manner’
	ˈlad-i	‘lad-DIM’	(not *[ˈlad-e]; cf. [ˈsat-e] ‘salty’)	
	ˈhard-li	‘garden’	(not *[ˈhard-le]; cf. [ˈforte] ‘forty’)	
	ˈʃʌlt-i	‘sheltie’	(not *[ˈʃʌlt-e]; cf. [ˈnel-e] ‘nail-DIM’, [ˈtat-e] ‘potato, *tattie*’)	
	ˈkrʌmpɨt	‘crumpet’	(not *[ˈkrʌmpət]; cf. [ˈʌmən] ‘woman’, [ˈhapər] ‘hopper’)	
d.	ˈkwartər	‘quarter’	(not *[ˈkwartɨr])	
	ˈfʌske	‘whisky’	(not *[ˈfʌski])	
	ˈmerse	‘mercy’	(not *[ˈmersi])	
	ˈstanle	‘Stanley’	(not *[ˈstanli])	

Paster (2004) approaches the problem raised by this heterogeneous class of blockers from a *diachronic* perspective, suggesting that the phonetic motivations for the blocking pattern have been rendered obscure by later sound changes. On Paster’s diachronic analysis, [-high] harmony was blocked by any intervening [+voice] obstruent. She assumes that voiceless obstruents had first become phonologically [+voice] after /l/ or a nasal (but crucially not after /r/, which she conjectures was instead devoiced in that position); this accounts for why clusters like /lt/, /mp/, etc. are among the blockers. A weakness of this analysis is that it requires treating this phonological post-sonorant voicing process as phonetically non-neutralizing: while /t/ in a cluster like /lt/ becomes [+voice], and hence equivalent to /ld/ for the purpose of blocking [-high] harmony, the resulting cluster nevertheless remains phonetically distinct from [ld] = /ld/.

Paster (2004) does not discuss or account for the blocking by intervening singleton [ŋ] and (occasionally) [n], which contrasts with consistent transparency of [m]. However, these facts, too, can be understood diachronically. All instances of intervocalic [ŋ] derive historically (and perhaps also synchronically) from /ŋg/, and nearly all cases of blocking by intervocalic [n] likewise involve earlier /nd/ (e.g. *thunder* in 5c). Presumably the post-nasal voiced stop was still present in such words at the time the harmony and blocking pattern arose. While some cases of (transparent) intervocalic [m] likewise derive from /mb/ (e.g. *chamber*, referenced in 5c), we can infer that the change VmbV > VmV happened earlier than VndV > VnV and VŋgV > VŋV, and that in the relevant period such words already had [m] rather than [mb] (Youssef 2010).

Youssef (2010) points out several shortcomings of Paster's (2004) analysis, in particular its failure to connect the distribution of posttonic high vs. nonhigh vowels to that of the same vowels in (stressed) monosyllabic words. Here, it turns out, the same sets of consonants and clusters that (ostensibly) block the spreading of [-high] from a stressed to an unstressed vowel also cause a preceding stressed central vowel to be realized as high [ɨ] rather than non-high [ə]. Thus we find [ɨ] before a singleton voiced obstruent ([brɨg] 'bridge', [dɨv] 'do'), a nasal + obstruent cluster ([lɨmp] 'limp', [bɨnʃ] 'bench') or a singleton [n, ŋ] that historically reflects /nd, ŋg/ ([wɨn] 'wind', [sɨŋ] 'sing'), whereas [ə] is found before all other consonants and clusters, including voiceless obstruents, singleton sonorants and [r] + obstruent clusters (e.g. [pət] 'pit', [kəl] 'kill', [θəm] 'thumb', [wən] 'win', [stərk] 'stirk').

The striking correspondence between these two sets of height-alternation facts prompts Youssef (2010) to re-analyze the harmony pattern in (5a–b) as one of *raising* rather than lowering. He views this as involving a feature [Lowered Larynx] ([LL]), which he attributes to high vowels and voiced obstruents as well as to (phonetically) voiceless obstruents preceded by /l/ or a nasal.[9] Thus [LL] can spread onto a posttonic vowel either long-distance from the stressed

[9] Paster (2004) considers and rejects an analysis in which the defining property of the blockers is an *articulatorily* defined [Lowered Larynx] feature rather than [+voice]. For Youssef (2010), the [LL] feature is instead part of an

vowel (skipping across an intervening non-[LL] consonant or cluster), as in [ˈlɨ̲k-li̲] ‘likely’, or else locally from a [LL] consonant that intervenes between the stressed and unstressed vowel, as in [ˈlad̲-i̲] ‘lad-DIM’. Youssef stipulates that /ŋ/ is [LL] while /m/ is not, and that there exists a covert phonemic contrast between [LL] /n̬/ (which triggers raising, as in [ˈθʌn̲ɨ̲r] ‘thunder’) and non-[LL] /n/ (which does not, as in [ˈmenər] ‘manner’).

On Youssef’s (2010) reanalysis of the Buchan Scots facts, there is thus no [-high] harmony and hence no consonantal blocking. The cases that appear to display such blocking, as in (5c), instead involve a local C-V interaction whereby vowels are raised after consonants with a certain laryngeal feature ([LL]). Youssef’s analysis does not escape the problems faced by Paster (2004), however. He considers his use of [LL] rather than [+voice] to be advantageous in that clusters like /lt/, /mp/ etc. contain a plosive which is clearly not voiced; specification as [LL] “might not correspond directly to vocal fold vibration and thus a segment may have this feature without being phonetically voiced in all contexts” (Youssef 2010: 330). However, he makes no attempt at explaining how the surface contrast between clusters like [lt, nt] and [ld, nd] is to be represented phonologically, given that he treats both as containing a [LL] plosive, and his feature system includes no such property as [±voice].

2.3.4 Blocking by consonant clusters

A final phenomenon that might be categorized as consonantal blocking is when vowel harmony applies across a singleton consonant but not across a consonant cluster or geminate. Examples include vowel-copy harmony in Yucatec Maya (Krämer 2001) and ATR harmony in Assamese (Mahanta 2007) and Lango (Woock & Noonan 1979; Archangeli & Pulleyblank 1994), though sources disagree on the relevant descriptive facts and generalizations in Lango (Okello 1975; Noonan 1992); for detailed discussion of these and other examples, see chapter 16. In such cases, harmony is typically analyzed as a relation between adjacent vocalic (or nuclear) *moras*, interrupted by an intervening consonantal (coda) mora. This presupposes that all codas are moraic in the language, and also predicts the existence of languages in which some clusters are opaque (moraic coda + onset) and others transparent (complex onsets, or nonmoraic coda + onset); Javanese may be an example (see chapter 16, section §16.4).

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essentially *substance-free* analysis, couched in the feature-geometric Parallel Structures Model (Morén 2003, 2006; see chapter 27).

Another possibility is to view this type of blocking as an instance of a *proximity* restriction, where the key factor is the *distance* between the vowels rather than the moraicity of an intervening consonant. It may be more fruitful to regard cases like these as comparable to ones where application vs. non-application of harmony depends on the number of intervening neutral vowels, e.g. the so-called *count effect* in Hungarian front/back harmony (Ringen & Kontra 1989; Hayes & Londe 2006; Hayes et al. 2009; see chapter 67, section §3.1). Proximity effects are common in consonant harmony as well (Hansson 2010c, 2020; see §2.7.1). Some models of long-distance harmony and dissimilation incorporate a gradient decay function to capture the effect of trigger-target distance (Kimper 2011; Zymet 2014).

2.4 Consonants as triggers

Antagonistic blocking (§2.3.1) often appears to go hand in hand with the consonant triggering a new span of the harmonic feature. This is the case—or, at least, can be interpreted as being the case—whenever the blocking consonant can be argued to carry the opposite value of the harmonic feature. For instance, Turkish /l^j/ blocks progressive [+back] harmony, as discussed in §2.3.1. On the assumption that /l^j/ is phonologically [-back], the surface [-back] value observed on subsequent suffix vowels can be attributed to spreading of this feature from /l^j/.[10] The consonant in question is thus simultaneously opaque and a harmony trigger; this is analogous to a typical behaviour of opaque neutral vowels in vowel harmony systems (see e.g. van der Hulst 2018). Cases where consonants appear to trigger harmony do not always involve blocking, however; for instance, we saw in §2.3.2 how in Nawuri, the glide /w/ and the (non-labial) labialized consonants /k^w, s^w/ trigger the exact same regressive rounding harmony onto a prefix vowel as rounded vowels do.

The Turkish and Nawuri examples are representative in that the consonants that trigger vowel harmony are typically always either glides (/j/ and/or /w/) or else carry a secondary articulation (palatalization and/or labialization, /C^j, C^w, $C^ɥ$/).[11] One possible case of consonants

[10] The same line of argumentation can be translated into other feature systems, e.g. where the relevant property is a V-Place (or Lingual) node dominating the feature [coronal] (≈ [-back]).

[11] Of course, harmony systems that involve spreading of pharyngealization (retraction, emphasis) from consonants to vowels and consonants alike are well-studied, e.g. in language families like Semitic (Arabic, Aramaic; e.g. Hoberman 1988, Shahin 2002, Watson 2002; see chapter 47), Berber (e.g. Elmedlaoui 1995, Heath 2005), Salish (Shahin 2002) and Dene (Athabaskan; Cook 1993, Hansson 2007). However, since such phenomena are not usually

with secondary articulation acting as triggers is regressive [ATR] harmony in the Asante-Twi dialect of Akan, as described by Clements (1980, 1984, 1985; see also Kiparsky 1985). According to Clements, who in turn builds on the description by Stewart (1967; see also Stewart 1983), roots that begin in a consonant that is either a palatal (/tɕᶣ, dʑ, dʑᶣ, ɕᶣ, ɲ/) or else palatalized or labio-palatalized (/sʲ, sᶣ/), followed by the [-ATR] vowel /a/, trigger [+ATR] harmony onto prefixes (6a).[12] On the assumption that all of the palatals can be analyzed as being phonologically palatalized, i.e. specified as carrying a secondary vocalic articulation (e.g. [dʑ] = /dʑʲ/), the relevant set of roots consists of all and only those that begin in a /Cʲa…/ or /Cᶣa…/ sequence.[13] Roots where an initial /Cʲ, Cᶣ/ is followed by some [-ATR] vowel other than /a/ do not trigger regressive [+ATR] harmony (6b).

(6) Akan (Asante-Twi): [+ATR] harmony triggered by root-initial /Cʲa, Cᶣa/

	a.	o̲-tɕᶣa-ɪ	'he cut it'	not *[ɔ̲-tɕᶣa-ɪ]
		mi̲-sʲãnɪ	'I come down'	not *[mɪ̲-sʲãnɪ]
		o̲-ko̲-dʑᶣarɪ	'he goes and washes'	not *[ɔ̲-kɔ̲-dʑᶣarɪʔ]
		wu̲-be̲-dʑᶣarɪ	'you will bathe'	not *[wʊ̲-bɛ̲-dʑᶣarɪʔ]
	b.	ɔ̲-bɛ̲-dʑɪ	'he will drink it'	not *[o̲-be̲-dʑɪ]

Rather than treat the [+ATR] harmony in (6a) as being triggered by the initial palatalized consonant as such, Clements (1976/1980, 1984, 1985) and Kiparsky (1985) propose that the relevant root morphemes all contain a floating [+ATR] feature, which precedes the underlying [-ATR] feature of the low vowel /a/. In this respect, then, the roots in (6a) are analogous to ones that contain an /i…a/ or /u…a/ vowel sequence (e.g. /bisa/ 'ask', cf. [o̲-bisa-ɪ] 'he asked'). By

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subsumed under the "vowel harmony" rubric, I leave them aside here. The same goes for nasal harmony (chapter 3), which is typically triggered by a nasal consonant but targets vowels and (some) consonants.

[12] Here I have re-transcribed the [c, cʷ, j, jʷ, ɕʷ] of Clements (1984) as [tɕ, tɕᶣ, dʑ, dʑᶣ, ɕᶣ], and his [sʸ, sʷʸ] as [sʲ, sᶣ], in accordance with more recent literature (e.g. Amoako 2020). Clements (1976/1980) represented [dʑ, dʑᶣ] as [gʸ, gʷʸ]. In the Twi orthography, the (alveolo-)palatals [tɕ, dʑ, ɕ, ɲ] are generally represented as <ky, gy, hy, ny>, and their labio-palatalized counterparts [tɕᶣ, dʑᶣ, ɕᶣ, ɲᶣ] as <tw, dw, hw, nw>.

[13] Kiparsky (1985:123) states Clements' generalization as covering all roots beginning in /Cʷa…/ as well as /Cʲa…/, perhaps due to the fact that so many of the palatal consonants in question happen to be labialized (labio-palatalized, strictly speaking). However, Clements clearly restricts the scope to *palatals* (along with [sʲ, sᶣ]). Akan also has labialized [kʷ, gʷ, ŋʷ] (orthogr. <kw, gw, nw> not followed by a front vowel) but there is no mention of there being any roots beginning in sequences like [kʷa…] or [gʷa…] that trigger the same [+ATR] harmony.

assuming that /a/ is underlyingly associated with a feature [-ATR], whereas /ɪ, ʊ, ɛ, ɔ/ are underlyingly unspecified for [±ATR], Kiparsky (1985) is able to explain why such a covert floating [+ATR] feature would be limited to roots with /a/ in the initial syllable. However, by Kiparsky's analysis it remains a complete accident that all such roots should happen to begin in a (labio-)palatalized consonant.

In an Optimality Theory analysis of vowel harmony in the Asante-Twi dialect, Ballard (2010) treats the cases in (6a) as phonotactically motivated rather than as lexical exceptions. He posits a parochial constraint *[-ATR][+distributed][+low], which bans any and all VCV sequences of the type $V_{[\text{-ATR}]}C_{[\text{+dist}]}a$ (assuming palatals to be [+dist]) and hence results in [+ATR] prefix vowels before roots of the relevant shape.

One might perhaps conjecture that at some earlier historical stage, Akan roots like those in (6a) all contained a /Cia/ or /Cua/ sequence, with an overt prevocalic [+ATR] high vowel, and that their triggering of [+ATR] harmony reflects this earlier state of affairs. These sequences would then later have contracted to [C^ja] and [$C^{\text{ɥ}}$a], respectively. An explanation along these lines was in fact proposed by Stewart (1967:200), although Clements (1976/1980:16) quotes Stewart as having informing him "that he no longer holds this view". A connection between vocalic [+ATR] and consonant (labio)palatalization in Akan receives further support from Abakah (2012), who reports that in the Asante-Twi dialect, /Cua, Cue/ sequences are realized as [$C^{\text{ɥ}}$ia, $C^{\text{ɥ}}$ie] while /Cʊa/ surfaces as [C^wa].

Another case worth mentioning in this context—though it perhaps better belongs in the consonants-as-blockers category—is Ikoma (Higgins 2012). Here root-initial C^j or C^w causes an [-ATR] root to pattern with [+ATR] roots in failing to trigger height dissimilation in a preceding mid-vowel prefix, e.g. [ɣo-tena] 'to cut', [ɣu-ɣɛsa] 'to harvest', but [ɣo-s^wɛɣa] 'to clear land' (not *[ɣu-s^wɛɣa]). While the vowel-to-vowel interaction that is being disrupted in Ikoma is one of dissimilation, not harmony, Higgins (2012) analyzes it as being a response to a constraint that requires [±ATR] agreement among [-high] vowels (cf. also Gambarage & Pulleyblank 2017 on closely related Nata). Making the prefix vowel [+high] vacuously satisfies this (height-parasitic) [ATR] harmony requirement. Higgins (2012) does not provide a formal account of exactly how an intervening C^j or C^w comes disrupts this V-to-V agreement relation, leading to the surfacing of disharmonic mid-mid or mid-low sequences such as [oC^wɛ], [eC^wa], etc., but the problem such forms raise is analogous to the Akan case above.

As for glides, given their affinity with (ATR/tense) high vowels like [i] or [u], it is perhaps not surprising that they occasionally pattern with such vowels in triggering and/or blocking vowel harmony. This is attested in some tongue-root harmony systems, such as Turkana (Dimmendaal 1983, Noske 1996). In Turkana, /j, w/ trigger regressive [+ATR] harmony onto preceding vowels, just like the underlyingly [+ATR] vowels /i, u/ do. Thus, for instance, glide-initial roots take [+ATR] prefixes (/E-jEn-I / → [ejɛnɪ] 's/he knows', /E-wOrU/ → [ewɔrʊ] 'cloth'). Similarly, in roots with a medial glide the preceding vowel is predictably [+ATR] (e.g. [-imjɛl-] 'taste', [-kedjɛɲ-] 'be left-handed'). However, the glides /j, w/ differ from /i, u/ in failing to trigger progressive [+ATR] harmony.[14] In the analysis of Noske (1996), glides receive a [+ATR] specification by a redundancy rule which is stipulated to apply after the progressive [+ATR] harmony rule but prior to the regressive [+ATR] harmony rule. Turkana also has a set of underlyingly [-ATR] suffixes, which trigger regressive [-ATR] harmony onto preceding vowels. Again, the glides /j, w/ pattern with the high [+ATR] vowels /i, u/ in blocking this regressive [-ATR] harmony (e.g. /a-k-ido-Un-ɛt/ → [akɪdɔʊnɛt] 'birth' but /a-k-item(j)-ɛt/ → [akitemjɛt] 'attempt', /E-ɪtV-igor- I-A-rɛ/ → [izigɔrɛrɛ] '(why) is she made to cry?'); in other words, the regressive [+ATR] harmony triggered by an intervening [j, w] or [i, u] overrides the otherwise-expected regressive [-ATR] harmony from the following suffix vowel.[15] Finally, it is worth noting that the Turkana case is further complicated by the fact that the glides [j, w] are in many cases surface alternants of [+ATR] high vowels [i, u] in prevocalic environments (e.g. /ŋI-kori-A/ → [ŋiqorjo] 'giraffes', /ŋI-kOrI-A/ → [ŋɪqɔrɪa] 'ratels').

2.5 Consonants as facilitators

Rather than being outright triggers of vowel harmony, consonants may sometimes play a more subtle facilitatory role. Thus, a vowel which would not otherwise undergo harmony may do so only if it happens to be adjacent to a consonant of a particular kind. A particularly striking example of such consonantal facilitation is the "doubly-triggered" rounding harmony seen in

[14] There is some evidence that /j, w/ cause an immediately following mid vowel to be realized with a more advanced quality. However, this is clearly a local effect and its phonological status seems unclear. The vowels in question are sometimes described as having a "harsh" voice quality; Noske (1996:91–92) treats them as being phonologically [+ATR] due to (local) assimilation with the preceding glide, but describes that process as "sporadic".

[15] Dimmendaal (1983: 25–26) treats the intervening [j] in cases like [akitemjɛt] 'attempt' as being epenthetic rather than underlying; whatever its status, it is clear that the glide prevents [-ATR] harmony from the suffix (or, rather, overrides it by triggering [+ATR] harmony).

Laal (Lionnet 2017). Certain morphological contexts display a regressive rounding harmony that is parasitic on both height and backness: /ɨ…u/ → [u…u] and /ə…o/ → [o…o]. However, this harmony only applies if the target vowel (/ɨ/ or /ə/) also happens to be adjacent (or nearly adjacent) to one of the labial consonants /p, b, ɓ, m͡b, m, w/ (7a). When this is not the case, the vowels remain disharmonic (7b). Strikingly, the facilitating labial consonant need not intervene between the trigger and target vowels, as shown by cases like /ɓɨ̀r-ú/ → [ɓùrú] or /wə̀ːr-ó/ → [wòːró]. The issue is thus not one of selective transparency by labials, nor is it the case that spreading of [+round] from vowel to vowel somehow depends on the presence of an intervening labial as intermediary stepping-stone. Note that labial consonants on their own do not trigger rounding (7c).

(7) Laal: (parasitic) rounding harmony only if labial C present (Lionnet 2017)

a.	/dɨ̀l<u>m</u>-ú/	dùlmú	‘type of house-PL’	
	/<u>ɓ</u>ɨ̀r-ú/	ɓùrú	‘fish hook-PL’	
	/tə̀<u>b</u>-ó/	tòbó	‘fish species-PL’	
	/<u>m</u>ə̂l<u>m</u>-ó/	môlmó	‘Koranic teacher-PL’	
	/<u>w</u>ə̀ːr-ó/	wòːró	‘genet-PL’	
b.	/gɨ́n-ù/	gɨ́nù	‘net-PL’	(not *[gúnù])
	/sə̀g-ó/	sə̀gó	‘tree species-PL’	(not *[sògó])
c.	/<u>p</u>ɨ́r<u>m</u>ɨ́n/	pɨ́rmɨ́n	‘dust’	(not *[púrmɨ́n])
	/<u>b</u>ə̀<u>b</u>rə̀/	bə̀brə̀	‘lizard species’	(not *[bòbrə̀])
	/<u>m</u>ə̀ː<u>m</u>-ə̀r/	mə̀ːmə̀r	‘my grandmother’	(not *[mòːmə̀r])

As Lionnet (2016) notes, the triggering of harmony as a cumulative effect of a [+round] vowel and a [labial] consonant can easily be captured in a theory with weighted constraints, such as Harmonic Grammar (Legendre et al. 1990, Pater 2009). A constraint against disharmonic [ɨ…u] and [ə…o] sequences and a constraint against unrounded [ɨ, ə] in the vicinity of a labial consonant can “gang up” and jointly trigger unfaithfulness to the input (/ɨ, ə/ → [u, o]), even if neither constraint is able to cause any such rounding on its own. Lionnet (2016, 2017) rejects this solution in favour of a more phonetically grounded analysis, in which categorical harmony is the cumulative result of smaller co-articulatory (sub-phonemic) effects, which can be independently observed. Thus, for instance, /ə/ has markedly lower F2 in contexts like [s<u>ə̀</u>gó] or [b<u>ə</u>brə̀] than when no rounded vowel or labial consonant is nearby. When these gradient, sub-phonemic effects add up, Lionnet argues, their combination amounts to a (phonological) category shift from [-round] [ə] to [+round] [o].

In the Laal case, the consonantal context of a vowel in target position determines whether it undergoes vowel harmony or not. An analogous situation obtains in Kaska (Dene Zā́gé’; Hansson & Moore 2011, 2014), but here the vowels in question alternate between undergoing harmony and being neutral and *transparent* to it, depending on the consonantal context. Hansson & Moore (2011) analyze the regressive (root-to-prefix) vowel harmony in Kaska as involving the feature [+back], triggered by any of the non-high vowels /a, aː, o, oː/ (but not high /uː/) and targeting only the [+low] vowel [æː] (→ [aː]). The latter may either involve underlying /æː/ or a contraction of /e+e/, which obligatorily lowers to [æː] in all contexts (8a).[16] High /iː, uː/ ([iː, ʉː]) are transparent to the harmony, and so is short /e/ ([ɛ]), other things being equal (8b); other vowel qualities happen not to occur in the relevant positions.[17]

(8) Kaska [+back] harmony: /e/ transparent or undergoer, depending on consonantal context

a.	/ke-te-e-t’éɬ/	kɛtæːt’ɛ́ɬ	‘they(PL) will walk/go’
	/ké-ke-te-e-ʔóːɬ/	kɛ́kɛtaːʔóːɬ	‘they(PL) will paddle around’
	/æː-s-h-t’úːtʰ/	æːst’úːtʰ	‘I sucked’
	/æː-t-k’as/	aːk’as	‘s/he ate quickly’
b.	/me-kʰ<u>ǽː</u>-ke-te-iː-k’<u>áː</u>n/	mɛkʰ<u>áː</u>kɛtiːk’<u>áː</u>n	‘they burned him/her up’
	/n<u>ǽː</u>-ke-z<u>o</u>j/	n<u>áː</u>kɛ́z<u>o</u>j	‘they are all scraping (hide)’
c.	/se-h-ʦʰúːʦʰ/	sɛhʦʰúːʦʰ	‘s/he put (fabric) there’
	/se-h-tʰáːn/	sahtʰáːn	‘s/he put (long object) there’
	/se-tʰáːn/	sɛtʰáːn	‘(long object) is there’
	/neh-jeke/	nɛhjɛkɛ	‘under you(DU/PL)’

[16] Hansson & Moore (2011) transcribe the phonetic qualities of the non-high back rounded vowels /o, oː/ (orthogr. *o*, *ō*) as [ʊ, oː], while here they are rendered as [o, ɔː]. The corresponding front unrounded vowels (orthogr. *e, ē*) are transcribed as [ɛ, æː], reflecting the fact that each is phonetically lower than its back rounded counterpart. I represent them phonemically (underlyingly) as /e, æː/ here, rather than /e, eː/ (or /ɛ, ɛː/ as in Hansson & Moore 2014), since the latter vowel is consistently low and alternates with the [+low] vowel [aː].

[17] The underlying representations in (8) are simplified in that zero morphs are omitted and no distinctions are made between different types of morpheme boundaries, e.g. among “conjunct” and “disjunct” prefixes (Rice 2000).

/ne̲h-jé-n-uː-kʰã̲́ː̲/ na̲hjɛ́nuːkʰã̲́ː̲ ‘s/he will give you(DU/PL) back (contained liquid)’

As the examples in (8c) show, however, when short /e/ is immediately followed by a tautosyllabic (coda) /h/, it is not transparent but instead undergoes backness harmony, surfacing as (low) [a]. Just as in the Laal case, this can be related to subtle phonetic (allophonic) effects that are observable in non-harmony contexts. As Hansson & Moore (2011, 2014) show, short /e/ in the environment __h]$_\sigma$ has a markedly lower (and more retracted) phonetic realization than elsewhere: [ɛ̞], even bordering on [æ], instead of the usual [ɛ]; e.g. /eh-t-ʦʰeʦ/ → [ɛ̞h.ʦʰɛʦ] ‘you(DU/PL) eat’ vs. /e-t-ʦʰeʦ/ → [ɛ.ʦʰɛʦ] ‘s/he eats’. On the assumption that this local V-C interaction with a coda /h/ renders short /e/ phonologically [+low], and that [+back] harmony targets only [+low] vowels (with [-low] vowels being transparent), the shift of /e/ from neutral/transparent to undergoer can be straightforwardly viewed as a feeding interaction.

In sum, in Kaska just as in Laal, a local allophonic (i.e. “subphonemic”) effect of a consonant on a vowel causes the latter to become subject to harmony. However, in Kaska that allophonic effect involves (mainly) a phonetic dimension *different* from that of the harmony itself (height, as opposed to backness), whereas in Laal the two involve the same phonetic parameter (rounding). Therefore the Kaska case does not necessitate the sort of scalar, “subfeatural” representations advocated by Lionnet (2017) for Laal.

2.6 Consonants as neutral segments

As noted at the outset of this chapter, the default state of affairs is for consonants to be completely inert and transparent to vowel harmony. In some situations, this non-participation is itself a notable fact. This is particularly the case when glides like [j] or [w] are neutral and transparent while their high vowel counterparts [i, u] are active participants (e.g. in backness harmony, rounding harmony or tongue-root harmony). Since the glide vs. vowel distinction is often represented in terms of syllable structure rather than featural content (e.g. Levin 1985, Harris & Kaisse 1999; though see Padgett 2008), this may have significant implications for how the vowel harmony relation is analyzed in the languages in question.

We encountered a case of this in Turkish (§2.3.1), where the glide /j/ is neutral and transparent to front/back harmony, in contrast to the palatalized lateral /lʲ/, which seems to block back harmony and trigger a front-harmonic span in its own right. One approach to this type of unexpected transparency is by representational stipulation; for instance, Levi (2004) proposes that [j] in Turkish is a true coronal consonant, lacking the Vocalic and V-Place nodes that characterize both vowels and secondary-articulated consonants like [lʲ]. Similarly, in Pulaar (Paradis 1992), the glides [j, w] neither trigger nor block [+ATR] harmony, whereas their vocalic counterparts [i, u] do (even when epenthetic). Levi (2004) suggests that the neutrality of the consonants [j, w] be captured by assuming that they differ from the vowels [i, u] in lacking the relevant representational node (either the feature [+ATR] specifically or an entire Vocalic node, depending on which feature geometry one adopts).

While such representational stipulations can work for individual cases, they are unlikely to be viable as an all-purpose approach to this problem. Analogous situations can arise with harmonies that involve other features which more often cross the vowel/consonant divide. Thus, for instance, regressive nasal harmony between vowels in the Mọ̀bà dialect of Yorùbá is neither triggered nor blocked by nasal consonants (Ajíbóyè & Pulleyblank 2018). It is hardly plausible to assume that segments like [m] or [n] lack the feature [+nasal] outright, nor that nasality in vowels involves some feature other than [+nasal], especially since other sound patterns in the same dialect do restrict the co-occurrence of oral vowels and nasal consonants. A more attractive approach is one which takes the vowel-to-vowel harmony relation to be stated as a feature-agreement requirement on vowels specifically (e.g. successive moras, as in Ajíbóyè & Pulleyblank's analysis, or syllable nuclei). Such agreement in the output representation can be achieved either by means of feature copying/insertion, effectively skipping any intervening consonants, or potentially by (strictly local) feature spreading that affects intervening segments as well (on such "agreement by spreading", see Hansson 2010b).

In section §2.3 we encountered many cases of *selective blocking*, where a certain subset of consonants interrupt vowel harmony while others are neutral and transparent to it. Some cases of this kind may be better viewed as a matter of *selective transparency*, especially when the set of blockers is large and diverse while the non-blockers form a coherent natural class. The liquid transparency in certain Italian dialects discussed in §2.3.3 is an example of this state of affairs. Other well-known types of cases are ones involving transparency of coronal sonorants in general—or occasionally of all coronals—as well as that of "guttural" consonants, especially laryngeals (Paradis & Prunet 1989, McCarthy 1994, Rose 1996, Gafos & Lombardi 1999). With very few exceptions, attested cases of such trans-coronal and/or trans-guttural vowel harmony all involve total assimilation (vowel copy), rather than harmony in one specific feature.

With respect to the transparency of gutturals, Sylak-Glassman (2014) argues that this phenomenon should be separated into *non-lingual transparency* on the one hand, whereby vowel assimilation applies across laryngeal and pharyngeal consonants, and *dorsal transparency* on the other, in which uvulars (and possibly also velars) are transparent. While non-lingual transparency is very well attested, dorsal transparency is quite rare and appears to be most common with assimilation in rounding. In Iraqw, for instance, progressive total vowel assimilation across laryngeals and pharyngeals is triggered by any of /i, u, a/, e.g. /buːʔ-iːm/ → [buʔuːm] 'harvest pay (DUR)', /waʔalah-iːm/ → [waʔalahaːm] 'exchange (DUR)', while harmony across uvulars and velars appears to be limited to /u/, e.g. /ɬuːq-iːm/ → [ɬuquːm] 'kill big animal or man (DUR)' (Mous 1993, Rose 1996, Sylak-Glassman 2014). Similarly, Yamane-Tanaka (2006) finds that in Gitksan, older generations of speakers had progressive vowel harmony from all of [ɛ, a, ɔ] across an intervening laryngeal, but across uvulars only from rounded [ɔ].[18] An interesting additional case is Loniu (see chapter 76, section §3.2), in which regressive rounding harmony applies across velars as well as glottals, nasals, and the [+round] consonants /w, p^w/.

Based on cross-linguistic evidence, Walker & Rose (2015) view the crucial distinction as being between "supra-laryngeal gutturals" (uvulars, pharyngeals) on the one hand and laryngeals on the other, and observe that transparency of the former implies transparency of latter but not vice versa. Furthermore, this appears to be independent of whether or not these two classes of consonants pattern together with respect to other sound patterns in the language, e.g. local processes of vowel lowering or retraction.

Since the advent of feature geometry and underspecification theory in the mid-1980s, patterns involving selective transparency have often been used as evidence that the class of transparent consonants in question is representationally impoverished in some manner, either universally or on a language-specific basis. Thus trans-laryngeal vowel harmony supports the idea that laryngeal consonants lack a Supralaryngeal or C-Place node altogether (Steriade 1987a), and coronal transparency provided arguments for radical (i.e. markedness-based) underspecification of [coronal] place (Paradis & Prunet 1989). The aforementioned feature-

[18] Younger Gitksan speakers appear to have generalized the dorsal transparency to [ɛ, a] contexts as well, with some speakers even extending it to the (front) velar fricative [x^j].

geometric analyses of glide transparency in Turkish and Pulaar by Levi (2004) also fall in the same category. The full range of attested patterns of selective transparency (and indeed selective blocking, too) seems too complex and nuanced for such approaches, however.

Many recent analyses instead seek to motivate the division into transparent vs. non-transparent consonants in overtly articulatory (gestural) terms, based on the default assumption that all vowel-to-vowel assimilation involves extension of a single articulatory gesture, other things being equal (e.g. Ní Chiosáin & Padgett 2001; see chapter 32). Since intervening consonants would thus be contained within the span of this extended gesture—that is, they are *undergoers* of the harmony in some sense (§2.2)—their own articulatory properties can conflict with the harmony gesture, potentially resulting in blocking. Such conflict may involve contradictory demands on an articulator, e.g. in terms of constriction location, as in most cases of antagonistic blocking (§2.3.1). Alternatively, it may be a matter of gestural uniformity, usually involving differences in constriction degree, as is presumably the cause for most patterns of sympathetic blocking (§2.3.2). There is thus no difference in kind between selective blocking and selective transparency; the latter is merely a subtype of the former in which the compatibility demands on consonants within the gestural span are unusually stringent.

2.7 Vowel harmony and consonant harmony

Although *consonant harmony* as a phenomenon falls outside the scope of this handbook, I will end this chapter by briefly considering the relationship between vowel harmony and consonant harmony. Do these two phenomena differ significantly in their cross-linguistic typological profiles? If so, does this suggest that the two might involve distinct grammatical mechanisms (e.g. types of constraints/processes, representational considerations)? Do some types of vowel harmony resemble consonant harmony more than others? How permeable is the border between consonant and vowel harmony? Do we find cases where one type of pattern has developed into the other, or cases where such a shift might be underway? These types of questions are addressed below. For an overview of consonant harmony with references to current research, the reader is directed to Hansson (2020).

2.7.1 Similarities and differences

In the heyday of autosegmental (and metrical) approaches to harmony processes (late 1970s to mid-1990s), consonant and vowel harmony were standardly assumed to involve the exact same types of processes and grammar-internal mechanisms. The neutrality and transparency of intervening segments—of vowels and other consonants in the case of consonant harmony, and of consonants and (in some languages) a designated subset of vowels in the case of vowel harmony—was taken to reflect the same general notion of *relativized locality*, typically attributed to *non-specification* for the harmonic feature (e.g. underspecification based on irrelevance, redundancy or unmarked/default status). For instance, Steriade (1987b) draws on examples of both vowel-vowel and consonant-consonant interactions to illustrate certain proposed locality restrictions on assimilatory (as well as dissimilatory) processes.

From the mid-1990s, the proposal that all feature spreading should be construed as *strictly local*—a blanket rejection of the gapped representations typical of autosegmental analyses of harmony systems with one or more transparent segments—gained increasing support (e.g. Archangeli & Pulleyblank 1994; Pulleyblank 1996; Ní Chiosáin & Padgett 1997, 2001; Gafos 1998, 1999 [1996]; Gafos & Lombardi 1999; Walker 2000b [1998]; see §2.2 and §2.6). Arguments in support of this view were adduced from both consonant and vowel harmony, as well as from vowel-consonant harmony processes like nasal harmony (chapter 3). Thus Gafos (1999 [1996]; see also chapter 40) argues that the prevalence of coronal (esp. sibilant) harmony among consonant harmony systems is due to the fact that coronal-specific contrasts like [s] vs. [ʃ] or [ʂ] involve precisely the kinds of articulatory gestures that can be maintained through intervening vowels and non-coronal consonants without interfering with their articulation or crucial acoustic-perceptual cues. As for vowel harmony, phonetic evidence has been used to call into question the alleged transparency of intervening consonants (e.g. Ní Chiosáin & Padgett 2001; see §2.2) and also of neutral vowels, e.g. for front/back harmony in Finnish (Gordon 1999; Välimaa-Blum 1999) and Hungarian (Benus 2005, Benus & Gafos 2007) and for ATR harmony in Kinande (Gick et al. 2006) and Halh Mongolian (Rialland & Djamouri 1984; Svantesson et al. 2005; see chapter 60). For related discussion, see also chapters 32 and 40.

Starting around 2000, more systematic cross-linguistic surveys of consonant harmony came to emphasize salient differences between its typological profile and that of vowel harmony or other feature-spreading phenomena (Rose & Walker 2000, 2004; Walker 2000a, 2000c, 2001;

Hansson 2001, 2010a). One particularly salient characteristic of long-distance consonant assimilations is the role of *similarity* in defining the set of trigger-target pairs that are subject to assimilation (for a variety of manifestations of such similarity effects, see Hansson 2020). Another empirical generalization—considered at the time to be exceptionless, but see below—is the consistently inert and *transparent* behaviour of all segments that intervene between the consonants in question. These considerations were a key motivation for formal analyses of consonant harmony as being driven by constraints demanding featural *agreement* rather than feature spreading, in particular the theory of Agreement by Correspondence (ABC; Walker 2000a, 2000c; Rose & Walker 2004; Hansson 2001, 2010a; Bennett 2015; see chapter 30, section §30.2.3). In the ABC approach, the set of interacting segments is determined by constraints that require a correspondence relation to hold between co-occurring segments that exceed some similarity threshold (i.e. share a certain set of features). That correspondence relation in turn functions as a conduit for assimilation, by way of featural-identity constraints that require agreement in some feature [F] (the harmony feature) between correspondent segments.

Similarity effects are of course attested in vowel harmony as well: harmony may be *parasitic* (e.g. Archangeli 1985; Cole & Trigo 1988; Wayment 2009; Jurgec 2013), such that a pair of vowels will only be subject to harmony in feature [F] if they also have matching values for some other feature [G]. A common variant of parasitic vowel harmony is rounding harmony between vowels that match in [±high] and/or [±low] (Kaun 1995, 2004), as in the Laal example in §2.5 (see chapter 5 for other cases). Those vowel harmony systems that display not only this type of trigger-target similarity restriction, but also *transparency* of intervening vowels (ones not meeting the criterion), are most analogous to prototypical consonant harmony systems. Indeed, some have proposed analyzing such vowel harmony systems with formal mechanisms developed for consonant harmony, such as the aforementioned ABC model (e.g. Sasa 2009; Walker 2009, 2015, 2018; Rhodes 2012; Bowman & Lokshin 2014; McCollum & Essegbey 2018). Other approaches exist in which relative similarity (a set of shared features) serves to define the *tier* on which featural agreement is assessed; these are likewise equally amenable to consonant harmony and many vowel harmony systems. One example is the Agreement by Projection (ABP) approach, proposed in Hansson (2014) for consonant harmony but applied to other types of harmony and dissimilation in various recent work (e.g. Walker 2015; Jurgec 2016; Lionnet 2017; Sande 2019).[19]

Recent empirical advances in the study of consonant harmony have cast some doubt on the idea that consonant harmony is fundamentally different in kind from (most) other harmony phenomena. For instance, a number of cases have come to light in which intervening segments are not uniformly inert and transparent. One example is sibilant harmony in Slovenian (Jurgec 2011), which is blocked if any non-sibilant coronal obstruent intervenes, whereas it is free to apply across coronal sonorants and all non-coronal consonants. Other reported cases of blocking in consonant harmony are discussed in Hansson (2010a:166–175) and Hansson (2020). Furthermore, a few consonant harmony systems exist in which relative trigger-target similarity appears to play little or no role (for one such case, Karaim palatalization harmony, see §2.7.2). The apparent typological asymmetries between consonant harmony and vowel harmony may well turn out to be largely accidental (statistical) gaps in attestation, resulting in part from the fact that consonant harmony is less frequent overall than is vowel harmony and in part from general differences in distribution and inventory structure between consonants and vowels (Hansson 2008).

Finally, the supposedly fundamental distinction between agreement and spreading turns out to be more nuanced than usually acknowledged. In a constraint-based framework, strictly local feature spreading (affecting all intervening segments) can emerge as a means to satisfy a demand for long-distance agreement between a pair of segments (Hansson 2010b). Phonetic evidence that intervening segments are permeated by the assimilating property, and thus carry the harmonic feature in the phonological output representation (see §2.2 for discussion), does not entail that those segments are necessarily *targets* of harmony in the strict sense. Rather, they may instead be what might be called *collateral undergoers*, affected if and only if they happen to intervene between a harmony trigger and a (proper) harmony target. As discussed in Hansson (2010b), this appears to be the case for intervening non-coronal consonants and vowels in Kinyarwanda sibilant harmony, judging by the articulatory findings of Walker et al. (2008). To the best of my knowledge, phonetic studies that claim to find allophonic harmony effects on

[19] Agreement by Projection (Hansson 2014) draws on an earlier proposal by Pulleyblank (2002), which was explicitly intended to cover vowel-vowel and consonant-consonant interactions alike. For an explicit comparison of ABP and ABC as regards their typological predictions, see DelBusso & Bennett (2019).

neutral vowels in vowel harmony (such as those cited earlier in this section) have not systematically controlled for this possibility. In sum, much remains unclear regarding the role of (potentially long-distance) agreement relations in vowel harmony, and the conditioning factors (such as relative similarity) on which such agreement requirements may be based. This makes it difficult to determine to what extent vowel harmony and consonant harmony are different in kind.

2.7.2 Shifts between harmony types

There seem to be no attested cases of consonant harmony systems in which vowels play a role, the way we have seen consonants do in vowel harmony, e.g. with certain vowels acting as blockers, triggers or facilitators (cf. §2.3, §2.4 and §2.5, respectively). However, some consonant harmony systems appear to have developed historically out of what was previously a vowel harmony system. In other words, the locus of the harmonic feature, and the assimilatory dependency relation between segments, has become *transphonologized* from vowels onto surrounding consonants.

The best known case of this kind is (Western) Karaim, a Turkic language spoken in a few small ethnic and religious enclaves in modern-day Lithuania, Poland and Western Ukraine. In the Northwest dialect of Karaim (spoken in Lithuania), the inherited front/back vowel harmony has morphed into a *consonant palatalization harmony* (Nevins & Vaux 2004; Hansson 2007; Németh 2014). Consonants became strongly palatalized in the vicinity of historically front vowels, and the historically front rounded vowels [œ, y] have subsequently become phonetically back (or central) in most environments—at least optionally, and especially for younger speakers—and front unrounded [ɛ] also merged with its back counterpart [ɑ] in non-initial syllables. As a result, in a front-harmonic word such as [kʰʲɔtʲ-ʉɾʲ-ʉlʲ-ʉgʲunʲ] 'lift yourself up' (as retranscribed by Nevins & Vaux 2004 from recordings in Csató & Nathan 2002), it seems clear that the harmony has come to be entirely carried by the consonants rather than the vowels; cf. the Turkish cognate [gøtyr-yl-] 'be carried away' (or, in narrower transcription, [gʲøtʲyɾʲ-ylʲ-]). Viewed as a consonant harmony system, Karaim is typologically anomalous in several respects. In particular, trigger–target similarity appears to play no role (cf. §2.7.1): all consonants participate in the harmony, not some subset (natural class) with many features in common. The synchronic anomaly is understandable, given the diachronic origins, but it does nonetheless have implications for theories of what constitutes a possible harmony system (Hansson 2007).

Certain other harmony systems may be in the process of undergoing the same sort of shift from vowel harmony to consonant harmony. In her phonetic study of tongue root harmony in two Even dialects, Aralova (2015) found that speakers of the Bystraia dialect rely mainly on acoustic cues in consonants (in particular the dorsal stop /k/ and the liquids /l, r/) for categorizing words into harmonic sets. Though the same was not true for the Sebian-Küöl dialect, both dialects display a strong tendency to neutralize the harmonic distinction in high vowels, merging the ATR/RTR pairs [i, iˤ] and [u, uˤ], respectively; in the Bystraia dialect, the same tendency is present for non-high vowels as well.

All of the historical changes developments described above for Northwest Karaim are almost certainly due to prolonged contact with the surrounding Baltic and Slavic languages, in particular Lithuanian and Polish (Andersson et al. 2017). Contact-induced change may perhaps have been a contributing factor in the the Even case as well, in particular as "[t]he restructured phonological system of Bystraia Even […] resembles the phonological system of Russian in several ways" (Aralova 2015:202). Nevertheless, Aralova adduces several arguments against the hypothesis that Russian influence played any significant role. Whatever the contributing role of language contact in these specific cases, the kind of transphonologization they illustrate clearly hinges on the sorts of allophonic effects on consonants that were described in §2.2. Even if they start out as mere phonetic coarticulation, such effects may become phonologized as (stable, categorical) properties on the consonants in question, thus paving the way for the kind of reanalysis that has occurred in Northwest Karaim, and may be in progress in Bystraia Even.

A final case worth mentioning is that of Sibe (Li 1996; Nevins 2010; see chapter 61), in which a non-high vowel will trigger long-distance uvularization of a dorsal consonant later in the word, across any intervening high vowels and non-dorsal consonants. Thus we see [ɨrsu(n)-kun] 'ugly-DIM' but [dʑalu-qun] 'full-DIM', and [gɨnɨ-xɨ] 'go-PAST' but [fɔndʐi-χɨ] 'ask-PAST' and [tykɛ-χɨ] 'watch-PAST'. Nevins (2010) views both the vowel height distinction and the velar/uvular distinction as involving the feature [±low], and analyzes the dependency as long-distance assimilation in [+low], with all intervening [-low] segments being transparent. As Nevins notes, uvularization immediately adjacent to a [+low] (or [-high]) vowel is well attested in the region, e.g. in Sanjiazi Manchu (Li 1996; see chapter 61, section §2.6.2.2) and Sakha

(Krueger 1962; see chapter 59, section §59.6.4). What is special about Sibe is the *long-distance* nature of this dependency. Interestingly, Nevins (2010) mentions the observation by Zhang (1996) that Sibe has, with very few exceptions, raised /a, ɔ/ to /ɨ, u/ in non-initial syllables (including all suffixes); e.g. [ana-] > [anɨ-] ‘push’, [bɔdɔ-] > [bɔdu-] ‘think’. If we conjecture that uvularization predated this merger, this means that a modern-day Sibe form like [anɨ-χɨ] ‘push-PAST’, in which the vocalic trigger is now quite distant from the consonantal target, goes back to earlier *[ana-χɨ] or even *[ana-χa] (cf. Classical Manchu *ana-ha*). In other words, the uvularization most likely originated as a local V-C assimilation, but subsequent historical changes—specifically, vowel mergers in non-initial syllables—have caused the pattern to become reanalyzed as a long-distance dependency.[20]

While the Sibe case is certainly different in kind from those of Karaim and Even in terms of its synchronic characteristics, it further illustrates how easily the surface patterns of harmony systems can become disrupted through the effects of other, independent changes in the phonological system, and how easily such disruptions can cause a fundamental shift in the basis for harmony.

2.8 Concluding remarks

This chapter has surveyed the ways in which consonants may be implicated in vowel harmony. As we have seen, consonants may sometimes act as blockers (§2.3), triggers (§2.4) or facilitators (§2.5) of assimilatory sound patterns that are otherwise manifested as a vowel-to-vowel interaction.

The question whether intervening consonants are ever genuinely transparent to vowel harmony, or are themselves always undergoers of the harmony (§2.2)—in which case alleged “transparency” amounts to nothing more than the absence of blocking (§2.6)—remains a challenging and highly theory-dependent problem. This is due to a number of analytical ambiguities that are inherent in any model that separates the *phonological grammar* (mapping between two symbolic representations, input and output) from a language-specific module of *phonetic implementation* (translating the phonological output representation into concrete

[20] Becker (2016) argues that a similar long-distance dependency between vowels and dorsal consonants holds in Uyghur, but involving the feature [±back] rather than [±low]. The Uyghur case seems likely to also be the result of historical mergers affecting intervening vowels.

articulatory/acoustic realities; Zsiga 2021). When an intervening consonant is demonstrably affected (articulatorily, and perhaps also acoustically) by the harmony context, the possibility must be ruled out that this effect on consonants arises in the phonology-phonetics mapping (e.g. as coarticulation) and is thus not encoded as such in the phonological output representation. (See chapter 41 on the analogous problem of distinguishing between phonetic vowel-to-vowel coarticulation and phonological vowel harmony.) Secondly, even if the consonant is an undergoer, in the sense of carrying/sharing the harmony feature in the phonological output representation, this does not mean that it is a *target* in the same sense as the vowels are. As discussed in §2.7.1, it is entirely possible that intervening (non-blocker) consonants are nonetheless "transparent" in the very real sense of being *ignored* (irrelevant, invisible) by the phonological constraints (rules, operations, relations) that drive harmony, and that they "undergo" harmony only by virtue of happening to intervene between a bona fide trigger-target pair of vowels (cf. Hansson 2010b).

Similar ambiguities of analysis also make it difficult to address the question whether all harmony processes are essentially alike, or whether there are fundamental differences in kind, e.g. between (most or all) sound patterns labelled "consonant harmony" and (most or all) sound patterns of "vowel harmony" (§2.7.1; see also chapter 40). Empirical research continues to increase our knowledge base, identifying new cases and contributing descriptive details (phonetic, phonological and morphological) on familiar ones. This, combined with advances in our understanding and modelling of the phonology-phonetics interface, will no doubt lead to new and improved theories of harmony phenomena.

References

Abakah, Emmanuel Nicholas. 2012. Some assimilatory processes in Akan. *Journal of West African Languages* 39(2): 47–82.

Ajíbóyè, Ọládiípọ̀ and Douglas Pulleyblank. 2018. Mọ̀bà nasal harmony. *Revealing structure: papers in honor of Larry M. Hyman*, ed. by Eugene Buckley, Thera Crane and Jeff Good, pp. 19–34. Stanford, CA: CSLI Publications.

Amoako, Wendy. 2020. Assessing phonological development among Akan-speaking children. Master's thesis, University of British Columbia.

Andersson, Samuel, Oliver Sayeed and Bert Vaux. 2017. The phonology of language contact. *Oxford Handbooks Online*. https://doi.org/10.1093/oxfordhb/9780199935345.013.55

Aralova, Natalia. 2015. *Vowel harmony in two Even dialects: production and perception*. Utrecht: LOT Publications.

Archangeli, Diana. 1985. Evidence for coplanar representation in nonlinear phonology. *Linguistic Inquiry* 16(3): 335–372.

Archangeli, Diana and Douglas Pulleyblank. 1994. *Grounded phonology*. Cambridge, MA: MIT Press.

Archangeli, Diana and Douglas Pulleyblank. 2007. Harmony. *The Cambridge handbook of phonology*, ed. by Paul de Lacy, pp. 353–378. Cambridge: Cambridge University Press.

Archangeli, Diana and Jonathan Yip. 2019. Assamese vowels and vowel harmony. *Journal of South Asian Languages and Linguistics* 6(2): 151–183.

Ariste, Paul. 1968. *A grammar of the Votic language*. Bloomington, IN: Indiana University Press.

Ballard, Lee W. 2010. Akan vowel harmony in Optimality Theory. Master's thesis, University of Florida.

Becker, Laura. 2016. Vowel-consonant harmony in Uyghur. Ms. Leipzig University. https://laurabecker.gitlab.io/papers/VowelConsHarmonyUyghur.pdf

Beddor, Patrice Speeter, James D. Harnsberger and Stephanie Lindemann. 2002. Language-specific patterns of vowel-to-vowel coarticulation: acoustic structures and their perceptual correlates. *Journal of Phonetics* 30(4): 591–627.

Benus, Stefan. 2005. Dynamics and transparency in vowel harmony. Doctoral dissertation, New York University.

Benus, Stefan and Adamantios I. Gafos. 2007. Articulatory characteristics of Hungarian ‘transparent’ vowels. *Journal of Phonetics* 35(3): 271–300.

Berkson, Kelly H., Matthew C. Carter and Christopher M. Robbins. 2016. An acoustic analysis of the vowels and stop consonants of Bashkir. *Journal of the Acoustical Society of America* 139: 2215.

Berta, Árpád. 1998. Tatar and Bashkir. *The Turkic languages*, ed. by Lars Johanson and Éva Á. Csató, pp. 283–300. New York: Routledge.

Blumenfeld, Lev and Ida Toivonen. 2016. A featural paradox in Votic harmony. *Natural Language and Linguistic Theory* 34(4): 1167–1180.

Bowman, Samuel R. and Benjamin Lokshin. 2014. Idiosyncratically transparent vowels in Kazakh. *Proceedings of the 2013 Annual Meeting on Phonology*, ed. by John Kingston, Claire Moore-Cantwell, Joe Pater and Robert Staubs. Washington, DC: Linguistic Society of America. https://doi.org/10.3765/amp.v1i1.24

Boyce, Suzanne E. 1990. Coarticulatory organization for lip rounding in Turkish and English. *Journal of the Acoustical Society of America* 88: 2584–2595.

Canalis, Stefano. 2009. Post-tonic vowel harmony in some dialects of central Italy: the role of prosodic structure, contrast and consonants. *Phonetics and phonology: interactions and interrelations*, ed. by Marina Vigário, Sónia Frota and M. João Freitas, pp. 247–266. Amsterdam: John Benjamins.

Casali, Roderic F. 1990. Contextual labialization in Nawuri. *Studies in African Linguistics* 21(3): 319–346.

Casali, Roderic F. 1995. Labial opacity and roundness harmony in Nawuri. *Natural Language and Linguistic Theory* 13(4): 649–663.

Clements, George N. 1980. *Vowel harmony in nonlinear generative phonology: an autosegmental model (1976 version)*. Bloomington, IN: Indiana University Linguistics Club.

Clements, George N. 1984. Vowel harmony in Akan: a consideration of Stewart’s word structure conditions. *Studies in African Linguistics* 15(3): 321–337.

Clements, George N. 1985. Akan vowel harmony: a nonlinear analysis. *African linguistics: essays in memory of M. W. K. Semikenke*, ed. by Didier L. Goyvaerts, pp. 55–98. Amsterdam: John Benjamins.

Clements, G. N. and Elizabeth V. Hume. 1995. The internal organization of speech sounds. *The handbook of phonological theory*, ed. by John A. Goldsmith, pp. 245–306. Oxford: Blackwell.

Clements, George N. and Engin Sezer. 1982. Vowel and consonant disharmony in Turkish. *The structure of phonological representations*, ed. by Harry van der Hulst and Norval Smith, vol. 2, pp. 213–255. Dordrecht: Foris.

Cole, Jennifer and Loren Trigo. 1988. Parasitic harmony. *Features, segmental structure and harmony processes*, ed. by Harry van der Hulst and Norval Smith, vol. 2, pp. 19–38. Dordrecht: Foris.

Conklin, Jenna T. 2015. The interaction of gradient and categorical processes of long-distance vowel-to-vowel assimilation in Kazan Tatar. Master's thesis, Purdue University.

Cook, Eung-Do. 1993. Chilcotin flattening and autosegmental phonology. *Lingua* 91(2–3): 149–174.

Csató, Éva Á. 1999. Syllablic harmony in Turkic: the evidence of code-copying. *Language encounters across time and space: studies in language contact,* ed. by Bernt Brendemoen, Elizabeth Lanza and Else Ryen, pp. 341–352. Oslo: Novus Press.

Csató, Éva Á. and David Nathan. 2002. *Spoken Karaim*. CD-ROM. Tokyo: Tokyo University of Foreign Studies.

DelBusso, Natalie and William G. Bennett. 2019. ABP and ABC: agreement with/out correspondence. *Phonological Data and Analysis*, 1(3): 1–25.

Dimmendaal, Gerrit. 1983. *The Turkana language*. Dordrecht: Foris.

Elmedlaoui, Mohamed. 1995. *Aspects des représentations phonologiques dans certains langues chamito-sémitiques*. Rabat: Faculté des Lettres et des Sciences Humaines, Université Mohammed V.

Faust, Noam. 2017. Get that into your head: Tigre vowel harmonies as templatic. *Glossa: a journal of general linguistics* 2(1): 95.

Fitzgerald, Colleen M. 2002. Vowel harmony in Buchan Scots English. *English Language and Linguistics* 6(1): 61–79.

Frajzyngier, Zygmunt and Eric Johnston. 2005. *A grammar of Mina*. Berlin: Mouton de Gruyter.

Gafos, Diamandis. 1996. Eliminating long-distance consonantal spreading. *Natural Language and Linguistic Theory* 16(2): 223–278.

Gafos, Adamantios I. 1999. *The articulatory basis of locality in phonology*. New York: Garland. [Doctoral dissertation, Johns Hopkins University, 1996.]

Gafos, Adamantios and Linda Lombardi. 1999. Consonant transparency and vowel echo. *Proceedings of the North East Linguistic Society* 29, Vol. 2, pp. 81–95. Amherst, MA: GLSA Publications.

Gambarage, Joash J. and Douglas Pulleyblank. 2017. Tongue root harmony in Nata: an allomorphy-based account. *Africa's endangered languages: documentary and theoretical approaches*, ed. by Jason Kandybowicz and Harold Torrence, pp. 57–85. Oxford: Oxford University Press.

Gick, Bryan, Douglas Pulleyblank, Fiona Campbell, and Ngessimo Mutaka. 2006. Low vowels and transparency in Kinande vowel harmony. *Phonology* 23(1): 1–20.

Gordon, Matthew. 1999. The "neutral" vowels of Finnish: How neutral are they? *Linguistica Uralica* 35(1): 17–21.

Hall, Daniel Currie. 2018. Locality, neutrality, and contrast: a new resolution to the Votic paradox. *NELS 48: Proceedings of the 48th meeting of the North East Linguistic Society*, ed. by Sherry Hucklebridge and Max Nelson, vol. 2, 1–14. Amherst, MA: GLSA.

Hall, Nancy. 2006. Cross-linguistic patterns of vowel intrusion. *Phonology* 23(3): 387–429.

Halle, Morris. 1995. Feature geometry and feature spreading. *Linguistic Inquiry* 26(1): 1–46.

Halle, Morris, Bert Vaux, and Andrew Wolfe. 2000. On feature spreading and the representation of place of articulation. *Linguistic Inquiry* 31(3): 387–444.

Hansson, Gunnar Ólafur. 2001. Theoretical and typological issues in consonant harmony. Doctoral dissertation, University of California, Berkeley.

Hansson, Gunnar Ólafur. 2007. On the evolution of consonant harmony: the case of secondary-articulation agreement. *Phonology* 24(1): 77–120.

Hansson, Gunnar Ólafur. 2008. Effects of contrast recoverability on the typology of harmony systems. *Contrast in phonology: theory, perception, acquisition*, ed. by Peter Avery, B. Elan Dresher and Keren Rice, pp. 115–141. Berlin: Mouton de Gruyter.

Hansson, Gunnar Ólafur. 2010a. *Consonant harmony: long-distance interaction in phonology.* Berkeley, CA: University of California Press. [Revised version of Hansson (2001).]

Hansson, Gunnar Ólafur. 2010b. Long-distance voicing assimilation in Berber: spreading and/or agreement? *Actes du congrès de l'ACL 2010 / 2010 CLA conference proceedings*, ed. by

Melinda Heijl. Canadian Linguistic Association. http://homes.chass.utoronto.ca/~cla-acl/actes2010/actes2010.html

Hansson, Gunnar Ólafur. 2014. (Dis)agreement by (non)correspondence: inspecting the foundations. Paper presented at the ABC↔Conference, Berkeley, May 2014.

Hansson, Gunnar Ólafur. 2020. Consonant harmony. *Oxford research encyclopedia of linguistics*, ed. by Mark Aronoff. Oxford: Oxford University Press. https://oxfordre.com/linguistics/

Hansson, Gunnar Ólafur and Patrick J. Moore. 2011. The phonetics of transparency in Kaska vowel harmony. *Proceedings of the 2010 Dene/Athabaskan Languages Conference*, ed. by Siri G. Tuttle and Olga Lovick, pp. 122–138. Fairbanks, AK: Alaska Native Language Center.

Hansson, Gunnar Ólafur and Patrick J. Moore. 2014. Transparency and subphonemic effects in Kaska vowel harmony. Poster presented at the 2014 Annual Meeting on Phonology, Massachusetts Institute of Phonology, September 2014.

Harris, James W. and Ellen M. Kaisse. 1999. Palatal vowels, glides and obstruents in Argentinian Spanish. *Phonology* 16(2): 117–190.

Harvey, Mark and Brett Baker. 2005. Vowel harmony, directionality and morpheme structure constraints in Warlpiri. *Lingua* 115: 1457–1474.

Hayes, Bruce and Zsuzsa Londe. 2006. Stochastic phonological knowledge: the case of Hungarian vowel harmony. *Phonology* 23(1): 59–104.

Hayes, Bruce, Kie Zuraw, Péter Siptár and Zsuzsa Londe. 2009. Natural and unnatural constraints in Hungarian vowel harmony. *Language* 85(4): 822–863.

Heath, Jeffrey. 2005. *A grammar of Tamashek (Tuareg of Mali)*. Berlin: Mouton de Gruyter.

Higgins, Holly Ann. 2012. *Ikoma vowel harmony: phonetics and phonology*. Dallas, TX: SIL International.

Hoberman, Robert D. 1988. Emphasis harmony in a Modern Aramaic dialect. *Language* 64(1): 1–26.

Hoole, Philip and Marianne Pouplier. 2015. Interarticulatory coordination. *The handbook of speech production*, ed. by Melissa A. Redford, pp. 131–157. Oxford: Wiley.

Hudu, Fusheini. 2013. Dagbani tongue-root harmony: triggers, targets and blockers. *Journal of African Languages and Linguistics* 34(1): 47–73.

Ito, Junko. 1984. Melodic dissimilation in Ainu. *Linguistic Inquiry* 15(3): 505–513.

Johansson, Lars. 1991. On syllabic frontness oppositions in Turkic. *Varia Eurasiatica: Festschrift für Professor András Róna-Tas*, pp. 77–94. Szeged: Attila József University.

Jurgec, Peter. 2011. Feature spreading 2.0: a unified theory of assimilation. Doctoral dissertation, University of Tromsø.

Jurgec, Peter. 2013. Two types of parasitic assimilation. *Nordlyd* 39(2): 1–28.

Jurgec, Peter. 2016. Velar palatalization in Slovenian: local and long-distance interactions in a derived environment effect. *Glossa: a journal of general linguistics* 1(1): 24.

Kabak, Bariş. 2011. Turkish vowel harmony. *The Blackwell companion to phonology*, ed. by Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume and Keren Rice, vol. 5, pp. 2831–2854. Oxford: Wiley-Blackwell.

Kaun, Abigail R. 1995. The typology of rounding harmony: an optimality theoretic approach. Doctoral dissertation, University of California, Los Angeles.

Kaun, Abigail R. 2004. The typology of rounding harmony. *Phonetically based phonology*, ed. by Bruce Hayes, Robert Kirchner and Donca Steriade, pp. 87–116. Cambridge: Cambridge University Press.

Kimper, Wendell. 2011. Competing triggers: transparency and opacity in vowel harmony. Doctoral dissertation, University of Massachusetts, Amherst.

Kiparsky, Paul. 1985. Some consequences of lexical phonology. *Phonology Yearbook* 2: 85–138.

Kochetov, Alexei. 2006. Syllable position effects and gestural organization: evidence from Russian. *Laboratory Phonology 8*, ed. by Louis Goldstein, D. H. Whalen and Catherine T. Best, pp. 565–588. Berlin: Mouton de Gruyter.

Krämer, Martin. 2001. Yucatec Maya vowel alternations: harmony as syntagmatic identity. *Zeitschrift für Sprachwissenschaft* 20: 175–217.

Krueger, John R. *Yakut manual*. The Hague: Mouton.

Levi, Susannah V. 2004. The representation of underlying glides: a cross-linguistic study. Doctoral dissertation, University of Washington.

Levin, Juliette. 1985. A metrical theory of syllabicity. Doctoral dissertation, Massachusetts Institute of Technology.

Legendre, Géraldine, Yoshiro Miyata and Paul Smolensky. 1990. Harmonic Grammar: a formal multi-level connectionist theory of linguistic well-formedness: an application. *Proceedings* *of the 12th annual conference of the Cognitive Science Society*, pp. 884–891. Cambridge, MA: Lawrence Erlbaum.

Li, Bing. 1996. *Tungusic vowel harmony: description and analysis*. The Hague: Holland Academic Graphics.

Lionnet, Florian. 2016. Subphonemic teamwork: a typology and theory of cumulative coarticulatory effects in phonology. Doctoral dissertation, University of California, Berkeley.

Lionnet, Florian. 2017. A theory of subfeatural representations: the case of rounding harmony in Laal. *Phonology* 34(3): 523–564.

Mahanta, Shakuntala. 2007. *Directionality and locality in vowel harmony*. Utrecht: LOT Publications.

McCarthy, John J. 1994. The phonetics and phonology of Semitic pharyngeals. *Papers in Laboratory Phonology III: Phonological structure and phonetic Form*, ed. by Patricia Keating, pp. 191–233. Cambridge: Cambridge University Press.

McCollum, Adam G. 2015. Labial harmonic shift in Kazakh: mapping the pathways and motivations for change. *Proceedings of the 41st annual meeting of the Berkeley Linguistics Society*, ed. by Anna E. Jurgensen, Hannah Sande, Spencer Lamoureux, Kenny Baclawski and Alison Zerbe, pp. 329–352. Berkeley, CA: Berkeley Linguistics Society.

McCollum, Adam G. 2018. Vowel dispersion and Kazakh labial harmony. *Phonology* 35(2): 287–326.

McCollum, Adam G. and James Essegbey. 2018. Unbounded harmony is not always myopic: evidence from Tutrugbu. *Proceedings of the 35th West Coast Conference on Formal Linguistics*, ed. by Wm. G. Bennett, Lindsay Hracs,and Dennis Ryan Storoshenko, pp. 251–258. Somerville, MA: Cascadilla Proceedings Project.

McCollum, Adam G. and Darya Kavitskaya. 2018. Non-iterative vowel harmony in Crimean Tatar. *Proceedings of the 35th West Coast Conference on Formal Linguistics*, ed. by Wm. G. Bennett, Lindsay Hracs and Dennis Ryan Storoshenko, pp. 259–268. Somerville, MA: Cascadilla Proceedings Project.

Morén, Bruce. 2003. The parallel structures model of feature geometry. *Working Papers of the Cornell Phonetics Laboratory* 15: 194–270.

Morén, Bruce. 2006. Consonant–vowel interactions in Serbian: Features, representations and constraint interactions. *Lingua* 116(8): 1198–1244.

Mous, Maarten. 1993. *A grammar of Iraqw*. Hamburg: Helmut Buske.

Nash, David. 1986. *Topics in Warlpiri grammar*. New York: Garland.

Németh, Michał. 2015. A historical phonology of Western Karaim: the process of its diversification into dialects. *Studia Linguistica Universitatis Iagellonicae Cracoviensis* 132(3): 167–185.

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

Nevins, Andrew and Bert Vaux. 2004. Consonant harmony in Karaim. *MIT Working Papers in Linguistics* 46: 171–194.

Ní Chiosáin, Máire, and Jaye Padgett. 1997. Markedness, segment realization, and locality in spreading. Report LRC-97-01, Linguistics Research Center, Univ. of California, Santa Cruz.

Ní Chiosáin, Máire and Jaye Padgett. 2001. Markedness, segment realization and locality in spreading. *Segmental phonology in Optimality Theory*, ed. by Linda Lombardi, pp. 118–156. Cambridge: Cambridge University Press.

Noonan, Michael. 1992. *A grammar of Lango*. Berlin: Mouton de Gruyter.

Noske, Manuela. 1996. [ATR] harmony in Turkana. *Studies in African Linguistics* 25(1): 61–99.

Okello, Jenny. 1975. Some phonological and morphological processes in Lango. Doctoral dissertation, Indiana University.

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

Padgett, Jaye. 2008. Glides, vowels and features. *Lingua* 118(12): 1937–1955.

Paradis, Carole. 1992. *Lexical phonology and morphology: the nominal classes in Fula.* New York: Garland.

Paradis, Carole and Jean-François Prunet. 1989. On coronal transparency. *Phonology* 6(2): 317–348.

Paster, Mary. 2004. Vowel height harmony and blocking in Buchan Scots. *Phonology* 21(3): 359–407.

Pater, Joe. 2009. Weighted constraints in generative linguistics. *Cognitive Science* 33: 999–1035.

Poppe, Nicholas. 1964. *Baskhir manual: descriptive grammar and texts with a Bashkir-English glossary*. Bloomington, IN: Indiana University Press.

Pulleyblank, Douglas. 1996. Neutral vowels in optimality theory: a comparison of Yoruba and Wolof. *Canadian Journal of Linguistics* 41: 295–347.

Pulleyblank, Douglas. 2002. Harmony drivers: no disagreement allowed. *Proceedings of the 28th annual meeting of the Berkeley Linguistics Society*, ed. by Julie Larson and Mary Paster, pp. 249–267. Berkeley, CA: Berkeley Linguistics Society.

Rhodes, Russel. 2012. Vowel harmony as agreement by correspondence. *UC Berkeley PhonLab Annual Report*, vol. 8, pp. 138–168. https://escholarship.org/uc/item/9ns2k90j

Rialland, Annie and Rédouane Djamouri. 1984. Harmonie vocalique, consonantique et structures de dépendance dans le mot en mongol khalkha. *Bulletin de la Société de Linguistique de Paris* 79: 333–383.

Rice, Keren. 2000. *Morpheme order and semantic scope: word formation in the Athapaskan verb*. Cambridge: Cambridge University Press.

Ringen, Catherine and Miklós Kontra. 1989. Hungarian neutral vowels. *Lingua* 78(2–3): 181–191.

Rose, Sharon. 1996. Variable laryngeals and vowel lowering. *Phonology* 13, 73–117.

Rose, Sharon and Rachel Walker. 2000. Consonant agreement at a distance. Paper presented at the 31st meeting of the North Eastern Linguistic Society, Georgetown University, October 2000.

Rose, Sharon and Rachel Walker. 2004. A typology of consonant agreement as correspondence. *Language* 80(3): 475–531.

Rose, Sharon and Rachel Walker. 2011. Harmony systems. *Handbook of phonological theory (2nd edition)*, ed. by John Goldsmith, Jason Riggle, and Alan C. L. Yu, pp. 240–290. Oxford: Wiley-Blackwell.

Sande, Hannah. 2019. A unified account of conditioned phonological alternations: evidence from Guébie. *Language* 95(3): 456–497.

Sasa, Tomomasa. 2009. Treatments of vowel harmony in optimality theory. Doctoral dissertation, University of Iowa.

Shahin, Kimary N. 2002. *Postvelar harmony*. Amsterdam: John Benjamins.

Steriade, Donca. 1987a. Locality conditions and feature geometry. *Proceedings of the 17th meeting of the North Eastern Linguistic Society*, ed. by Joyce McDonough and Bernadette Plunkett, pp. 595–617. Amherst, MA: GLSA Publications.

Steriade, Donca. 1987b. Redundant values. *CLS 23: Papers from the parasession on autosegmental and metrical phonology*, ed. by Anna Bosch, Barbara Need, and Eric Schiller, pp. 339–362. Chicago, IL: Chicago Linguistic Society.

Stewart, John M. 1967. Tongue root position in Akan vowel harmony. *Phonetica* 16: 185–204.

Stewart, John M. 1983. Akan vowel harmony: the word structure conditions and the floating vowels. *Studies in African Linguistics* 14: 111–139.

Svantesson, Jan-Olof, Anna Tsendina, Anastasia Karlsson and Vivan Franzén. 2005. *The phonology of Mongolian*. Oxford: Oxford University Press.

Sylak-Glassman, John. 2014. Deriving natural classes: the phonology and typology of post-velar consonants. Doctoral dissertation, University of California, Berkeley.

Uffmann, Christian. 2006. Epenthetic vowel quality in loanwords: empirical and formal issues. *Lingua* 116(7): 1079–1111.

Usmanova, M. G. 2006. *Grammatika bashkirskogo jazyka dlja izuchajushchikh jazyk kak gosudarstvennyj*. Ufa: Kitap.

Välimaa-Blum, Riitta. 1999. A feature geometric description of Finnish vowel harmony covering both loans and native words. *Lingua* 108(4): 247–268.

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

van der Hulst, Harry and Jeroen van de Weijer. 1995. Vowel harmony. *The handbook of phonological theory*, ed. by John A. Goldsmith, pp. 495–534. Oxford: Blackwell.

Walker, Rachel. 2000a. Long-distance consonantal identity effects. *Proceedings of the 19th West Coast Conference on Formal Linguistics*, ed. by Roger Billerey and Brook Danielle Lillehaugen, pp. 532–545. Somerville, MA: Cascadilla Press.

Walker, Rachel. 2000b. *Nasalization, neutral segments, and opacity effects*. New York: Garland. [Doctoral dissertation, University of California, Santa Cruz, 1998.]

Walker, Rachel. 2000c. Yaka nasal harmony: spreading or segmental correspondence? *Proceedings of the 26th annual meeting of the Berkeley Linguistics Society*, ed. by Lisa

Conathan, Jeff Good, Darya Kavitskaya, Alyssa Wulf, and Alan C. L. Yu, pp. 321–332. Berkeley, CA: Berkeley Linguistics Society.

Walker, Rachel. 2001. Consonantal correspondence. *Proceedings of the Workshop on the Lexicon in Phonetics and Phonology (Papers in Experimental and Theoretical Linguistics 6)*, ed. by Robert Kirchner, Joe Pater, and Wolf Wikeley, pp. 73–84. Edmonton: Department of Linguistics, University of Alberta.

Walker, Rachel. 2009. Similarity-sensitive blocking and transparency in Menominee. Paper presented at the 83rd Annual Meeting of the Linguistic Society of America, San Francisco, January 2009.

Walker, Rachel. 2015. Surface correspondence and discrete harmony triggers. *Proceedings of the 2014 Annual Meeting on Phonology*, ed. by Adam Albright and Michelle A. Fullwood. Washington, DC: Linguistic Society of America. https://doi.org/10.3765/amp.v2i0.3744

Walker, Rachel. 2016. Positional prominence and consonantal interactions in metaphony and post-tonic harmony. *Approaches to metaphony in the languages of Italy*, ed. by Francesc Torres-Tamarit, Kathrin Linke and Marc van Oostendorp, pp. 301–331. Berlin: De Gruyter Mouton.

Walker, Rachel. 2018. Feature Identity and icy targets in Menominee vowel harmony. *Hana-bana (花々): a Festschrift for Junko Ito and Armin Mester*, ed. by Ryan Bennett, Andrew Angeles, Adrian Brasoveanu, Dhyana Buckley, Nick Kalivoda, Shigeto Kawahara, Grant McGuire and Jaye Padgett. https://escholarship.org/uc/item/3xv2s3sm

Walker, Rachel, Dani Byrd, and Fidèle Mpiranya. 2008. An articulatory view of Kinyarwanda coronal harmony. *Phonology* 25(3): 499–535.

Walker, Rachel and Geoffrey K. Pullum. 1999. Possible and impossible segments. *Language* 75: 764–780.

Walker, Rachel and Sharon Rose. 2015. Guttural semi-transparency. Paper presented at the 2015 Annual Meeting on Phonology, Vancouver, October 2015.

Watson Janet C. E. 2002. *The phonology and morphology of Arabic*. Oxford: Oxford University Press.

Wayment, Adam. 2009. Assimilation as attraction: computing distance, similarity, and locality in phonology. Doctoral dissertation, Johns Hopkins University.

Whalen D. H. 1990. Coarticulation is largely planned. *Journal of Phonetics* 18: 3–35.

Wölck, Wolfgang. 1965. *Phonematische Analyse der Sprache von Buchan*. Heidelberg: Carl Winter.

Woock, Edith Bavin and Michael Noonan. 1979. Vowel harmony in Lango. *Papers from the 15th annual regional meeting of the Chicago Linguistic Society*, ed. by Paul R. Clyne, William F. Hanks and Carol L. Hofbauer, pp. 20–29. Chicago: Chicago Linguistic Society.

Yamane-Tanaka, Noriko 2006. Transguttural harmony in Gitksan: its development and typological implications. *Proceedings of the 21st Northwest Linguistics Conference*, ed. by Seok Koon Chin and Atsushi Fujimori, pp. 136–152. Vancouver: Dept. of Linguistics, Univ. of British Columbia.

Youssef, Islam. 2010. Laryngeal assimilation in Buchan Scots. *English Language and Linguistics* 14(3): 321–345.

Zhang, Xi. 1996. Vowel systems of the Manchu-Tungus languages of China. Doctoral dissertation, University of Toronto.

Zsiga, Elizabeth C. 2021. *The phonology/phonetics interface*. Cambridge, MA: MIT Press.

Zymet, Jesse. 2015. Distance-based decay in long-distance phonological processes. *Proceedings of the 32nd West Coast Conference on Formal Linguistics*, ed. by Ulrike Steindl, Thomas Borer, Huilin Fang, Alfredo García Pardo, Peter Guekguezian, Brian Hsu, Charlie O'Hara, and Iris Chuoying Ouyang, pp. 72–81. Somerville, MA: Cascadilla Proceedings Project.