Effects of contrast recoverability
on the typology of harmony systems

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1. Introduction

Harmony, like all other types of assimilation, can be viewed as an instance of contextual neutralization: in a given environment one member of a [+F] : [−F] opposition is allowed, while the other is prohibited (see, e.g., Steriade 2001).\(^1\) This straightforward fact is summarized schematically in (1).\(^2\)

(1) Harmony as neutralization (example with root-to-affix directionality)

a. If root contains [+F], then…
   affix segments are neutralized to [+F] (that is, [−F] is “not licensed”)

b. If root contains [−F], then…
   affix segments are neutralized to [−F] (that is, [+F] is “not licensed”)

In the literature on phonological harmony systems it has often been assumed that the elimination of a [+F] : [−F] contrast in the targeted positons—and the ensuing predictability of [±F] values in those position—is the very “goal”, or main function, that underlies harmony itself. This interpretation has typically been motivated with respect to speech perception (Suomi 1983; Kaun 1995) or general processing/parsing considerations (Kaye 1989; the idea goes back to Trubetzkoj 1939).
Relating harmony to neutralization in this manner brings up an important question which, somewhat surprisingly, is rarely asked in the literature on harmony systems and their formal analysis. To what extent does harmony result in true neutralization in the narrowest possible sense: the obliteration of existing lexical contrasts? In this context it is useful to make a terminological distinction between what I will henceforth refer to as actual and virtual neutralization, respectively, shown schematically in (2). (Note that my choice of representing the disfavoured feature value in the neutralization environment as “[−F]”, rather than “[+F]”, is entirely arbitrary and not in any way significant.)

(2)  

a. Actual neutralization (eliminates attested lexical contrast):

UR: /…+F…/ /…−F…/

\[ \downarrow \checkmark \]

SR: [...+F...] *[…−F…]

b. Virtual neutralization (no attested lexical contrast to eliminate)

UR: /…+F…/ (*/…−F…/)

\[ \downarrow \]

SR: [...+F...] *[…−F…]

As an example of actual neutralization, (2a), consider the suspension of the /m/ : /n/ contrast in word-final position in Finnish. For example, the two NOM.SG forms [avain] ‘key’ and [jæsen] ‘member’ both have word-final [n]. Labials like [m] simply do not occur in this position in Finnish words, though they are allowed in other positions (cf. [ma:] ‘land’, [silma:] ‘eye’). Crucially, we can see how the neutralization obliterates an existing lexical /m/ : /n/ contrast by looking at other word forms that are morphologically related to [avain] and [jæsen], such as the NOM.PL forms [avaimet] ‘keys’, [jæsenet] ‘members’.
Compare this to a similar neutralization of the /m/ : /n/ contrast in final position in Mandarin Chinese. Here again, just as in Finnish, we find only word-final [n] in surface forms ([sān] ‘three’, [hān] ‘very’), even though [m] does occur in other environments ([mōn] ‘door’). But as pervasive and systematic as this neutralization pattern may be, it cannot be shown to result in the obliteration of any actual lexical contrasts. There simply do not exist any individual words or morphemes which could be argued to contain final /m/ in their lexical representation. Hence this is a case of virtual neutralization, as in (2b).

It should be noted at this point that in Optimality Theory (Kager 1999; McCarthy 2002, 2003; Prince and Smolensky [1993] 2004), virtual and actual neutralization are in effect equated, by way of the Richness of the Base tenet (see McCarthy 2002: 68–82). In a virtual-neutralization environment like (2b), [−F] is consistently absent from output strings. The very systematicity of this gap entails that the phonological grammar of the language in question must have the capacity to repair any potential input representations which contain [−F] in that environment—no matter how hypothetical these may be—by rendering them unfaithfully in the output. In Optimality Theory, all conceivable inputs, real and hypothetical alike, must map onto well-formed outputs, and all neutralization is therefore “actual” in the sense of (2a). From this perspective, what gives Mandarin the appearance of being different from Finnish is simply a consequence of the morphological structure of the former. If a morpheme-final segment never alternates between word-final (coda) and word-medial (onset) position, for example as a consequence of morpheme concatenation, a hypothetical morpheme-final /m/ gets no chance to show its true colours in any surface forms containing the morpheme in question. Consequently, a learner of Mandarin will never see a reason to posit a final /m/ in that morpheme in the first place. Similarly, if all Finnish [n]-final words happened to behave like [jäsen] (with [n] in all related forms), thus making Finnish a case of virtual rather than actual neutralization,
then this would not reflect any difference in the phonology of Finnish as such. Instead, the lack of existing lexical entries with stem-final /m/ would have to be an accidental gap in the lexicon, of no particular significance for the phonological analysis of the language.\footnote{\textsuperscript{4}}

Positional neutralization phenomena in the world’s languages are usually of the Finnish type, where alternations among morphologically related forms provide evidence of lexical contrasts which the neutralization is (partially) obliterating. It should be noted that the locus of such contrasts need not be in root morphemes, as in the Finnish example, but may be in affixes. For example, the underlying value for [±voice] in the English 
-th and -s suffixes, though neutralized after voiceless obstruents (eighth [eItT] vs. eights [etts]), emerges intact after sonorants (ninth [nainT] vs. nines [nainz]).

If harmony is merely a particular instantiation of contextual neutralization, our expectation is that it should pattern in ways similar to other types of neutralization. In particular, we ought to expect to see cases where actual neutralization results from the assimilation processes of harmony, especially in light of the fact that from an Optimality Theory perspective, all neutralization is strictly speaking “actual”, as explained above. The central goal of this paper is to demonstrate that things are not quite so simple. In its purest form, actually-neutralizing assimilation is robustly attested only for consonant harmony, while it is conspicuously absent from the typology of vowel harmony system. This curious asymmetry among harmony systems, which thus far appears to have gone unnoticed, needs to be explained in some principled way.

I propose an explanation in terms of the relative recoverability of the lexical contrasts in question: their “discoverability” on the basis of available surface evidence (see Kaye 1974). I argue that in positions targeted by harmony, lexical contrasts are far more easily recoverable — and hence more easily and securely acquired — under consonant harmony than under vowel harmony. The ultimate source of the bias is a trivial yet
substantial asymmetry between consonants and vowels with respect to inventory size, inventory structure, and general phonotactic distribution. Finally, I briefly address how the crucial type of actually-neutralizing harmony, which is attested among consonant harmony systems but not in vowel harmony, has important implications for the analysis of directionality effects in output-oriented frameworks like Optimality Theory.

2. Neutralization patterns in harmony systems

In any harmony system, the segmental inventory of the language in question can be partitioned into three classes of segments with respect to their participation, or lack thereof, in the harmony pattern. (Note that this classification is intended as purely taxonomic, with no particular implications as regards theoretical assumptions.)

(3) Classes of segments in a given harmony system:

a. all non-neutral [+F] segments
b. all non-neutral [−F] segments
c. all neutral segments (may be an empty set)

For example, in a typical ATR harmony system like that of Akan, (3a) consists of [+ATR] /i, u, e, o/, (3b) of [−ATR] /i, u, e, o/, and (3c) of the low vowel /a/. In Turkish palatal harmony, (3c) is an empty set, as there are no neutral vowels, whereas (3a) consists of [+back] /u, u, a, o/, and (3b) of [−back] /i, y, e, o/.

Individual morphemes in the lexicon may of course be similarly classified with respect to the kinds of segments they contain, just as the English suffixes -th and -s can be classified as containing an underlyingly [−voi] and [+voi] obstruent, respectively. This yields the following typology of harmony processes, based on whether or not the
harmony gives rise to actual neutralization, and if so, under what circumstances such neutralization takes place. My decision to represent the non-harmony-triggering feature value in (4c) as [−F], rather than [+F], is entirely arbitrary. The idea is simply that in the (4c) case, one of the two [F]-values is inert, failing to trigger assimilation; for a particular feature in a particular language, that value might well be [+F] rather than [−F].

(4) Four-way typology with respect to (actual) neutralization in affixes:
   a. lexical [±F] contrast not maintained with any root (contrast unrecoverable)
   b. lexical [±F] contrast maintained with neutral roots only
   c. lexical [±F] contrast maintained with [−F] roots or neutral roots
   d. lexical [±F] contrast maintained with [+F], [−F] or neutral roots (no harmony)

Type (4d) can obviously be ignored, as it consists of languages which do not exhibit any harmony whatsoever. The remaining three are attested cross-linguistically to varying degrees. Type (4a) is by far the most common, and seems to be equally well attested for vowel harmony and consonant harmony. As for type (4c), it is well attested for consonant harmony, but perhaps somewhat less so for vowel harmony. The most interesting type by far is (4b) which, though robustly attested among consonant harmony systems, appears to be entirely unattested for other kinds of harmony.

The following sections illustrate this typology ranging over (4a-c), not only with real examples but also, in the case of typological gaps, with made-up examples, so as to show what such a system would look like if it did exist. As vowel harmony is a more widespread phenomenon than consonant harmony, it will provide our point of departure, in §2.1, followed by a corresponding survey of consonant harmony in §2.2. Each is divided into subsections corresponding to the three neutralization patterns in (4a-c).
2.1. Neutralization patterns in vowel harmony

2.1.1. Vowel harmony with complete neutralization

In the typical case, corresponding to (4a), harmony is manifested solely as “virtual” neutralization, in that there is no evidence of an underlying lexical contrast in affixes which is being obliterated by the harmony. In systems of this kind, the surface \[\pm F\] value in the affix is completely predictable given the root. That is, a hypothetical \[\pm F\] contrast among affixes, were it to exist, would get no chance to surface intact. An example is Finnish palatal harmony, illustrated in (5); /i, e/ are neutral vowels.

(5) Finnish \[\pm\text{back}\] harmony (adessive suffix /-llA/):

a. /katu-llA/  [kadulla] ‘on the street’ ([+back] root)
c. /vete-llA/ [vedellæ] ‘on the water’ (neutral root)

Since a lexical \[\pm\text{back}\] specification for the suffix vowel cannot be determined conclusively, that vowel is here represented archiphonemically as /A/ for convenience. Finnish does not have contrasting pairs of affixes with inherently back vs. front vowels, such as a pair /-lla/ vs. /-llæ/ (or even, say, /-lla/ vs. /-tæ/) with separate meanings or functions. Such a contrast would be perfectly conceivable in principle, and would presumably surface intact after a neutral vowel. After all, this is precisely what happens root-internally, as shown in (6).
(6) Root-internal [±back] contrast after neutral vowels in Finnish:

a. /nenæ/ \[nenæ\] ‘nose’

b. /mela/ \[mela\] ‘oar, paddle’

Another example of a vowel harmony system of this type is tongue root harmony in Akan (Archangeli and Pulleyblank 1994), which affects prefixes and suffixes alike. Here /a/ is neutral, cooccurring with both vowel sets (/bisa/ ‘to ask’, /pira/ ‘to sweep’).

(7) Akan [±ATR] harmony in prefixes and suffixes:

a. /O-susu-I/ \[O-susu-i\] ‘s/he measured (it)’ ([+ATR] root)

b. /O-furu-I/ \[O-furu-ʃ\] ‘s/he went up’ ([-ATR] root)

c. /O-kasa-I/ \[O-kasa-j\] ‘s/he spoke’ (neutral root)

Just as in the Finnish case, Akan affix vowels do not show any evidence of contrasting lexically for the harmonizing feature. Instead, their surface [±F] specification is completely predictable from context.

2.1.2. Vowel harmony with asymmetric neutralization

In a number of cases, only one [F]-value appears to be active (or “dominant”), inducing harmony on nearby vowels. For example, [+ATR] might spread but not [-ATR], [+round] but not [-round], and so forth. Most cases of harmony processes which target vowels and consonants alike fall in this category as well. For example, nasal harmony typically involves nasalization only, to the exclusion of denasalization (see Walker 2000a for a typology). As a result, in the pattern corresponding to (4b), lexical contrasts will be neutralized only in the vicinity of a segment with the active value
(represented here as [+F], regardless of what the actual + or – designations might be in practice). Segments with the inactive value (here [−F]) do not trigger harmony, and thus do not condition neutralization; nor do neutral segments, to the extent that the system in question contains any. Taking an example from nasal harmony, a contrast like /n/ : /l/ in suffixes might be neutralized (to [n]) after [+nasal] roots while remaining intact after [−nasal] roots.

Having only one feature value be active is the essential ingredient in so-called dominant-recessive vowel harmony. The prototypical system of this kind also involves bidirectional spreading (affix-to-root as well as root-to-affix; e.g., in Kalenjin, Turkana, Nez Perce, etc.), which creates additional complications. However, this is not always the case, as unidirectional dominant-recessive harmony also exists (pace Baković 2000). An example of this is tongue root harmony in Karajá, a Macro-Jê language of Brazil (Ribeiro 2001, 2002). Just as in most dominant-recessive tongue root systems, [+ATR] is the dominant value, triggering assimilation in nearby [−ATR] vowels. With regard to directionality, the harmony is strictly regressive/anticipatory: recessive vowels which follow a dominant one are unaffected, as shown in (8).

(8) Right-to-left [+ATR] harmony in Karajá

a. Permitted vowel sequences:

   [+ATR]…[+ATR]

   [−ATR]…[−ATR]

   [+ATR]…[−ATR]   (no progressive harmony)

b. Prohibited vowel sequence:

   *[−ATR]…[+ATR]   (→ [+ATR]…[+ATR] by regressive harmony)
As shown below, vowel harmony in Karajá holds both morpheme-internally (9a) and between morphemes (9b). Vowels whose surface [±ATR] value is entirely determined by harmony are underlined in the examples. These are in a position of neutralization, namely preceding a [+ATR] vowel, where any and all [+ATR] : [−ATR] contrasts are neutralized to [+ATR].

(9) Examples of Karajá tongue-root harmony (data from Ribeiro 2001, 2002)

a. Root-internally:

/kube/  [kube] ‘palm’ ([+ATR]…[+ATR])
/dɔre/  [dɔre] ‘parrot’ ([−ATR]…[−ATR])
/tʃuʃɔ/  [tʃuʃɔ] ‘quati’ ([+ATR]…[−ATR])

b. Between morphemes:

/r-ɾ-o=ɾ-e/  [ɾidɔɾe] ‘s/he ate (it)’
/r-ɾ-tʃuɔ=ɾɛɾi/  [ɾotʃuhɔɾɛɾi] ‘he is cursing’
/r-ɾ-tʃuɔ=ɾ-e/  [ɾotʃuhɔɾe] ‘he cursed’

To make a more direct comparison with Finnish or Akan, it is important to note that unlike in the latter two systems, a lexical [±ATR] contrast is attested in suffixes and clitics in Karajá. On the one hand, there are underlyingly [+ATR] clitics (such as /=le/ EMPHATIC), which always surface with their [ATR] specification intact. On the other hand, there are also underlyingly [−ATR] clitics (such as /=ke/ POTENTIAL), the vowels of which are realized as [−ATR] or [+ATR] depending on context, as shown in (10).
Harmony alternation in enclitic /=kɛ/ (Ribeiro 2002):

\[
\begin{align*}
\text{relekɛ} & \quad \text{relekɛ} \\
\text{/r-ɛle}=kɛ & \quad \text{r-ɛle}=kɛ=le/
\end{align*}
\]

CTFG-become=POT \quad CTFG-become=POT=EMPH

‘He was in the process of becoming [a dolphin’)

In sum, Karajá vowel harmony does neutralize actual [+ATR] : [−ATR] contrasts in clitics and affixes (e.g., /=le/ vs. /=kɛ/), but only before vowels with the dominant feature value, [+ATR]. Elsewhere the underlying contrast is upheld.

Other examples of vowel harmony systems with these properties are surprisingly hard to come by, though they most certainly do exist. Even Karajá is far from being an ideal case; for example, lexical [±ATR] contrasts are conspicuously absent from prefixes. It is also worth noting that Karajá involves tongue-root harmony, as do all reported cases of bidirectional dominant-recessive harmony (Baković 2000); the reasons for this typological limitation are not known. Another case of tongue-root harmony with the same kind of asymmetric neutralization pattern is the Môba dialect of Yoruba (Perkins 2005). Here proclitics with mid vowels contrast lexically in [±ATR], but harmony neutralizes this contrast before vowels with the dominant feature value, [−ATR] (or, alternatively, privative [RTR]): in that context, all mid-vowel proclitics surface as [−ATR], even ones which are underlingly [+ATR].

In the realm of height harmony, a case of asymmetrically neutralizing harmony involving vowel height does appear to be found in C’Lela (Dettweiler 2000; Pulleyblank 2002), where harmony is triggered only by [−high] vowels, including /a/. A lexical [±high] contrast in suffixes and clitics (e.g., 2.SG /vu/ vs. 2.PL /no/) is neutralized after [−high] roots (11a), but emerges intact after [+high] roots (11b).
Asymmetrically neutralizing height harmony in C’Lela (Pulleyblank 2002)

a. Neutralization after [-high] roots:

/batk vu/ → [batk³ vo] ‘released you-SG’
/batk no/ → [batk³ no] ‘released you-PL’

b. Contrast after [+high] roots:

/buzk vu/ → [buz³k³ vu] ‘chased you-SG’
/buzk no/ → [buz³k³ no] ‘chased you-PL’

In sum, relatively few vowel harmony systems with the property of asymmetric neutralization appear to be attested. For example, I have yet to find any solid cases involving rounding (despite the fact that [+round] is typically “dominant” in rounding harmony systems) or the back/front dimension. The interim conclusion is that this type of partially neutralizing vowel harmony is fairly rare.7

2.1.3. Vowel harmony with symmetric neutralization

This brings us to the last pattern, corresponding to (4c), which appears to be entirely unattested in the cross-linguistic typology of vowel harmony systems. In this case, neutralization is symmetric in feature-value terms. That is, affixal vowels are neutralized toward [+F] or [−F] depending on the root, just as they are in the Finnish and Akan cases in (5)–(7) above. What is crucial about this (nonexistent) type, however, is that an underlying lexical contrast does emerge intact when no harmony trigger is present—that is, when the root happens to contain only neutral vowels.

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Since vowel harmony systems of this kind do not appear to be attested, a hypothetical example will have to suffice as illustration. The one shown in (12) is modelled on Finnish palatal harmony, as laid out in (5) above.

(12) Pseudo-Finnish: [±back] harmony with marginal contrast preservation

a. Lexical [±back] contrast in (certain) suffixes:

/-llæ/ aDESSIVE (‘on X; with X’)  
/-ssa/ INESSIVE (‘in X’)  

b. Neutralization to [+back] after non-neutral [+back] roots:

/katu-llæ/ [kadu-llæ] ‘on the street’  
/katu-ssa/ [kadu-ssa] ‘in the street’  

c. Neutralization to [−back] after non-neutral [−back] roots:

/pøytæ-llæ/ [pøydæ-llæ] ‘on the table’  
/pøytæ-ssa/ [pøydæ-ssa] ‘in the table’  

d. Contrast preserved after neutral roots:

/vete-llæ/ [vede-llæ] ‘on the water’  
/vete-ssa/ [vede-ssa] ‘in the water’

The way in which Pseudo-Finnish differs from real Finnish is twofold. Firstly, vowels of individual suffixes carry their own contrastive [±back] specification. Secondly, this specification comes to light whenever there is no harmony trigger in the root, as in (12d). In real Finnish the relevant forms in (12d) both have [æ]: [vede-llæ, vede-ssa]. That (12d) is perfectly conceivable in principle is evident from real Finnish forms such as the ones in (13), where a [+back] vowel may occasionally be found after a neutral root:
Genuine Finnish: spurious “contrast” in affixes after neutral roots

a. /vete-llA/ [vede-llæ] ‘on/with water’
b. /vere-llA/ [vere-llå] ‘on/with blood’

However, what is happening in (13) is rather a matter of lexical contrast among roots (typically analyzed in terms of absence vs. presence of a floating [+back] autosegment), which simply happens to be realized on the affix vowel in the surface representation.

2.2. Consonant harmony

Turning now to consonant harmony and its cross-linguistic typology, a few fundamental differences are worth noting which sometimes render direct comparison with vowel harmony difficult. Generally, consonant harmony only operates between segments that are highly similar to one another (Walker 2000b; Hansson 2001; Rose and Walker 2004). It is typically also limited to segments which are contrastively specified for the feature in question. That feature may well be redundant or irrelevant for most segments in the inventory (e.g., a coronal-specific feature such as [±distributed] in the case of vowels and non-coronals, and perhaps some coronals as well). As a result, the class of neutral segments is generally much larger in consonant harmony systems. In a sibilant harmony system, for example, all non-sibilant consonants (as well as all vowels) can be considered neutral, a point to which I shall return in §3. Most of the individual systems illustrated below are discussed at greater length in Hansson (2001).

2.2.1. Consonant harmony with complete neutralization

The pattern corresponding to (4a), so ubiquitous in vowel harmony, is not extremely common among consonant harmony systems, though it is nevertheless fairly
well attested. As an example, consider the sibilant harmony found in several Omotic languages of Ethiopia, such as Koyra (Hayward 1982), shown in (14). Here affix sibilants agree with root sibilants in [±anterior] (or its analogue in alternative feature systems).

(14) Sibilant harmony in Koyra (Hayward 1982)

a. Neutralization to [−ant] after root with [−ant] sibilant
   /goːʧ]-uS-/ \[goːʧ]-uʃ-\ ‘cause to pull’
   /paʧ]-uS-\ / \[paʧ]-uʃ-\ ‘cause to cover up’

b. Neutralization to [+ant] after root with [+ant] sibilant
   /kes]-uS-\ / \[kes]-us-\ ‘cause to go out’
   /suːz]-uS-\ / \[suːz]-us-\ ‘cause to bless’

c. Neutralization to [+ant] after neutral (sibilant-free) root
   /tup]-uS-\ / \[tup]-us-\ ‘cause to tie’
   /ʔuːʔ]-uS-\ / \[ʔuːʔ]-us-\ ‘cause to sip’

This is completely parallel to the Finnish case in (5) above. In Koyra, an affixal sibilant is realized as [−anterior] after roots containing an [−anterior] sibilant, otherwise as [+anterior]. In Finnish, an affixal vowel is realized as [+back] after roots containing a [+back] vowel, otherwise as [−back].

2.2.2. Consonant harmony with asymmetric neutralization

This pattern, corresponding to (4b), is even more robustly attested for consonant harmony than the complete-neutralization pattern just presented, and seems far more common than what we saw for vowel harmony in §2.1.2. An example of a system with these properties is the long-distance [±nasal] agreement found in many Bantu languages.
For example, in Yaka (Hyman 1995), a nasal anywhere in the word forces all subsequent voiced consonants to surface as nasals as well. Thus sequences like *[m…d] or *[n…b] are prohibited, and are repaired to *[m…n], etc., whenever they arise through morpheme concatenation (within the appropriate morphological domain). Only [+nasal] is active, not [−nasal]: affix segments can be nasalized through harmony but never denasalized. The examples in (15) are drawn from Hyman (1995), and also directly from Ruttenberg (1968) via the on-line CBOLD database (http://www.cbold.ddl.ish-lyon.cnrs.fr/).8

(15) Neutralization patterns in Yaka nasal consonant harmony:

a. Lexical [±nasal] contrast among suffixes:

/-idi/ PERFECTIVE
/-an-/ RECIPROCAL

b. Neutralization after roots with [+nasal] voiced C:

/-tsúm-idi/ [−tsúm-iŋi] ‘sewed’
/-tsúm-an-/ [−tsúm-an-] ‘sew each other’ (contrived form)

c. Contrast preserved after roots with [−nasal] voiced C:

/-kúd-idi/ [−kúd-iŋi] ‘chased’
/-kúd-an-/ [−kúl-an-] ‘chase each other’

d. Contrast preserved after neutral roots (no voiced C):

/-kík-idi/ [−kík-iŋi] ‘connected’
/-kík-an-/ [−kík-an-] ‘connect each other’

Just as in the Karajá and C’Lela vowel harmony systems discussed in §2.1.2, affix segments which contain the active/dominant [F]-value (here [+nasal]) surface intact
regardless of context. Affix segments containing the inert/recessive value [−nasal], on the other hand, alternate depending on the harmonic context.

2.2.3. Consonant harmony with symmetric neutralization

We are now left with the neutralization pattern which appeared to be missing from the typology of vowel harmony systems, namely (4c), wherein a lexical contrast in affixes emerges only with neutral roots. Despite the fact that consonant harmony is comparatively much rarer than vowel harmony, there is no corresponding gap in the typology of consonant harmony. On the contrary, the symmetric-neutralization pattern in (4c) is robustly attested for consonant harmony. A case in point is the sibilant harmony found in Navajo, as well as in many other Athabaskan languages, illustrated in (16).

(16) Sibilant harmony in Navajo (data from Sapir and Hoijer 1967)

a. Lexical contrast in prefixes:
   /si-/ ASPECT (usually perfective, though not in these examples)
   /fi-/ 1.SG (possessive)

b. Neutralization to [−ant] before roots with [−ant] sibilant:
   /si-yiʃ/   [fi-yiʃ] ‘it is bent, curved’
   /fi-tʃ’i?/ [fi-tʃ’i?] ‘my intestines’

c. Neutralization to [+ant] before roots with [+ant] sibilant:
   /si-si/   [si-zi] ‘it (long object) lies’
   /fi-tʃe?/ [si-tʃe?] ‘my rock’

d. Contrast preserved before neutral (sibilant-free) roots:
   /si-ʃa/   [si-ʃa] ‘it (round object) lies’
   /fi-tʃa?/ [fi-tʃa?] ‘my father’
Another well-known case is the sibilant harmony found in many Chumashan languages, such as Ineseño (Applegate 1972; Poser 1982; Lieber 1987: 145–150), which has prefixal contrasts like 3.SUBJ /s-/ vs. DU.SUBJ /ʃ-/'. Each surfaces intact before a neutral root, preserving the underlying /s/: /ʃ/ contrast. Before a root containing /s/, /ts/, etc., both prefixes surface with [s]; before a root with /ʃ/, /tʃ/, etc., both surface with [ʃ].

The neutralization patterns displayed by the sibilant harmony systems of such languages as Navajo and Ineseño Chumash are entirely analogous to those of the hypothetical Pseudo-Finnish vowel harmony system outlined in (12) earlier. In all three, affix segments are contrastively specified for [+F] vs. [−F], and this underlying contrast emerges only in contexts where the affixes in question attach to neutral roots, whereas it is neutralized in all other circumstances, to [+F] or to [−F] depending on the root.

3. Explaining the typological gap: the role of recoverability

The brief survey in the preceding section raises an important question. Given the fact that vowel harmony is such a common phenomenon, in contrast to the comparative rarity of consonant harmony, why is it that actual neutralization—the obliteration of real lexical contrasts—is attested in the typology of consonant harmony systems but not (or only marginally so) in that of vowel harmony systems?

To my knowledge, the only work which comes close to addressing this problem is Lieber (1987: 145–150). To be exact, the question she raises is a slightly different but closely related one: why is feature-changing harmony so remarkably rare? (See §4 for discussion of the feature-changing vs. feature-filling distinction in this context.) In fact, the only case of feature-changing harmony of which Lieber is aware is the Chumash sibilant harmony system just mentioned. Her suggested explanation for the rarity of such
harmonies invokes the relative markedness of different rule types. In her analysis of Chumash sibilant harmony, sibilant harmony is decomposed into an ordered sequence of two rules (following Poser 1982). First, an unbounded delinking rule removes contrastive $[\pm\text{distributed}]$ (or perhaps $[\pm\text{anterior}]$) specifications from sibilants whenever these are followed by another sibilant somewhere later in the word. Next, a feature-filling rule spreads $[\pm\text{distr}]$ (or $[\pm\text{ant}]$) specifications to these same sibilants. From this Lieber conjectures that “if […] feature-changing harmonies require unbounded Delinking rules […] and if this sort of rule is highly marked and therefore very costly to a grammar, then we would expect feature-changing harmonies to be rare, perhaps virtually nonexistent” (Lieber 1987: 149).

The most obvious problem with this explanation is that it is utterly circular. From the observed rarity of unbounded delinking rules we infer that these must be “costly” elements of grammar (never mind the vagueness of the “cost” notion itself), and because feature-changing harmony employs a costly kind of operation, it is consequently rare. Why not stipulate instead that it is simply feature-changing harmony as such which is “highly marked and therefore very costly” (especially considering the fact that the very notion of unbounded delinking operations is only needed as a component of such harmonies in the first place)? Secondly, the interpretation of feature-changing harmony as delinking plus spreading rests entirely on a serialist conception of phonological grammars, and becomes utterly meaningless in a parallelist constraint-based perspective such as that of Optimality Theory. Finally, even if we were to accept Lieber’s explanation for the rarity of feature-changing (and thus actually-neutralizing) harmony, we are still left with a bigger conundrum: why is it only attested in consonant harmony, not vowel harmony? Given that the latter kind of harmony is so vastly more common in the world’s languages, we ought to expect the exact opposite to be the case.
I suggest that the answer to the question instead ultimately lies in the relative recoverability of lexical contrasts under these different kinds of harmony: vowel harmony on the one hand and consonant harmony on the other. The term “recoverability” here refers simply to the relative amount of surface evidence available to a language learner, on the basis of which she can establish whether such a lexical contrast exists in the first place (cf. Kaye 1974).⁹

In order for a lexical contrast to exist in affix vowels (or consonants), it must of course be learnable. That is to say, generations of learners need to be able to reliably discover the existence of that contrast from surface evidence available in the ambient stimulus data. In order for this to be possible, there need to exist at least some contexts in which the contrast is manifested as such on the surface rather than neutralized. Consider now the fact that every root typically contains at least one vowel and at least one consonant. In order for an affix contrast to surface intact—such that a learner might be expected to notice its existence—the nearest relevant root vowel (in vowel harmony) or consonant (in consonant harmony) must not be a harmony trigger, but rather a neutral or non-harmony-inducing segment of some kind. What needs to be determined, then, is the following: what are the odds that this will indeed be the case, and are these odds any different in vowel harmony than in consonant harmony?

There are several fundamental asymmetries between vowels and consonants that bear on this matter, most of them deriving from some rather mundane facts of life. Firstly, there is a striking difference in the nature of the vowel space and the “consonant space”, which is in turn directly reflected in inventory structure. The features which form the basis of vowel harmony systems tend to cross-cut the entire vowel space: every vowel is either front or back, either rounded or unrounded, and so forth. The features involved in consonant harmony, on the other hand, tend to be relevant only for segments
occupying small subregions of the consonant space. For example, it is only dorsals that can be either velar or uvular (the basis of harmony in a small handful of languages; see Hansson 2001); similarly, only coronal segments can be either [+anterior] or [−anterior], [+distributed] or [−distributed], and so forth (at least in most versions of distinctive feature theory). For this reason, a great number of segments in any given consonant harmony system are ones for which the [+F] vs. [−F] categorization simply does not apply, and which are therefore, by definition, neutral segments.

Secondly, as mentioned earlier, a definitive hallmark of consonant harmony processes is that relative trigger/target similarity plays an extremely important role (Walker 2000b; Hansson 2001; Rose and Walker 2004), which further shrinks the set of segments participating in the harmony. For example, non-sibilant coronals like /t/ or /n/ appear to be neutral in all sibilant harmony systems, laryngeal harmony is frequently limited to obstruents which are homorganic, and so forth. In effect, then, consonant harmony is nearly always parasitic on features other than the harmonizing one, whereas this seems somewhat less typical of vowel harmony systems.10 (This is perhaps in part an illusion; it might be that pairs vowels which are highly distinct, like [y] vs. [a], should nevertheless count as being far more similar to one another than a consonant pair like, say, [kʰ] vs. [r], merely by virtue of both being vowels.)

Finally, neutral vowels, when they are present at all in a system, tend to be the odd man out: the lone exception among all the vowels. Common examples are /a/ in height harmony or tongue root harmony, and /i/ in palatal or rounding harmony. Compare this with consonant harmony where, for the reasons just mentioned, neutral consonants (those which neither trigger nor undergo assimilation) are usually in an overwhelming majority in the inventory, greatly outnumbering their non-neutral counterparts.
Recall that the missing vowel harmony type is one where an underlying \([\pm F]\) contrast in suffixes does exist, but is maintained only in forms containing a neutral-vowel root. Furthermore, those forms constitute the sole potential source of evidence available to the learner that such a lexical contrast exists in the first place. As it turns out, the consonant/vowel asymmetries just outlined lead to a severe reduction in the extent to which such crucial evidence is readily available in vowel harmony systems as compared to consonant harmony systems. To see why this is so, I ask the reader to consider, as a thought experiment, a hypothetical language displaying both \([\pm ATR]\) vowel harmony and \([\pm anterior]\) sibilant harmony, where the facts in (17) hold true.

(17) Contrast recoverability under harmony: a thought experiment

a. The segment inventory of language L consists of 7 vowels and 28 consonants.
b. 6 of the 7 vowels form three \([\pm ATR]\) pairs (e.g., /u/ : /u/); unpaired /a/ is neutral and cooccurs freely with either kind of vowel.
c. 4 of the 28 consonants are sibilant coronals, forming two \([\pm anterior]\) pairs (e.g., /s/ : /ʃ/); the rest are neutral (non-coronals and non-sibilant coronals) and cooccur freely with either kind of sibilant.
d. All vowels have the exact same frequency of occurrence, as do all consonants; each root is a CV syllable (exactly one C and one V).

Given these facts (admittedly somewhat unrealistic in their simplicity), the probability that a given affix will find itself in a *neutralizing environment*—that is, cooccurring with a non-neutral root—is 6 to 1 (86%) for the ATR harmony, whereas it is only 1 to 6 (4 to 24, i.e. 14%) for the sibilant harmony. In other words, an affixal \([\pm ATR]\) vowel contrast will manifest itself as such only very rarely in surface forms (14% of the
time, to be precise), whereas an affixal [±ant] sibilant contrast will surface intact in the vast majority of surface forms (86% of the time). Even if we make assumption (17d) much less artificial and drastically expand the template of possible root shapes to \(C(C)V((C)C)\)—such that any one of up to four consonants could potentially be a harmony-inducing sibilant—it is still the case that around 50% of all conceivable roots will be neutral (sibilant-free). In other words, an affix sibilant would still find itself in a non-neutralizing environment about half the time, whereas for affix vowels the same is true only about 14% of the time.

Lexical contrasts in vowel harmony systems are thus far less easily recovered, and hence harder for successive generations of learners to discover and internalize, than are corresponding contrasts in consonant harmony systems. Due to the paucity of surface evidence that some affix vowels are underlingly [+F] whereas others are [−F], one would expect such contrasts to show a very strong tendency to disappear over time. In consonant harmony systems with the same properties, lexical contrasts in affix segments will be much more easily recoverable (and learnable), and these are therefore predicted to be far less vulnerable to loss over time. In sum, a vowel harmony system of the relevant type, (4c), were it to exist, would be expected to be diachronically unstable, showing a strong tendency to shift toward the ubiquitous (4a) type.

From this I suggest the following conjecture. The observed (synchronic) asymmetry in the cross-linguistic typology of harmony systems is nothing more than a reflection of this *diachronic* asymmetry between consonant and vowel harmony. The explanation for the absence of vowel harmony systems of the relevant type should thus not be sought in the synchronic design principles of grammar, for example by modifying our theory of Universal Grammar so as to circumscribe the range of possible languages to exclude systems of this kind. Instead, the typological gap is better seen as a product of the
diachronic trajectories of language change. These trajectories are in turn defined and shaped by the (admittedly synchronic) learnability factors which influence language transmission across generations—or, rather, which influence individual learners’ success in replicating the grammars of the speakers providing the ambient input data.

4. The importance of the missing neutralization type

The typological asymmetry discussed in §2 and §3 may seem like a rather trivial issue of no particular consequence for the phonological analysis of harmony. As it turns out, however, the “missing” harmony type, which is attested for consonant harmony systems but not for vowel harmony, has serious implications for questions of considerable theoretical importance.

First of all, it should be re-emphasized that in systems like those described for Navajo and Ineseño Chumash in §2.2.3 (as well as the non-existing Pseudo-Finnish system laid out in §2.1.3), harmony must be viewed as a genuinely feature-changing process. In Navajo, for example, the affixal sibilants which are targeted by harmony demonstrably contrast underlingly for [±anterior]. It is therefore absolutely clear that the harmony has the power to change not only input [+ant] to output [−ant] but also to change input [−ant] to output [+ant] (cf. Navajo /si- yiʃ/ → [ʃi- yiʃ] ‘it is bent, curved’ and /ʃi-tseʔ/ → [ʃi-tseʔ] ‘my rock’). Note that this fact is entirely independent of how one chooses to construe the /s/ : /ʃ/ contrast representationally. For the sake of the argument, let us assume that rather than binary [−ant] vs. [+ant], we instead view /ʃ/ as being distinguished from /s/ by the presence of some monovalent feature [F] (e.g., [posterior]). Navajo sibilant harmony must then have the power not only to add (or spread) this feature [F] to the sibilant of the possessive /si-/ prefix (whenever the following root contains an [F]-carrying sibilant), but also to remove that same feature from the sibilant
of the /ți-/ aspect prefix (whenever the following root contains a sibilant not carrying [F]). The same reasoning applies if /ʃ/ and /s/ are considered to be distinguished by two monovalent and mutually incompatible features [F] and [G] (roughly corresponding to [−ant] vs. [+ant], similar to the common use of privative [ATR] and [RTR] in the analysis of tongue-root vowel harmony systems). Before roots containing sibilants specified as [F], harmony has the effect of removing [G] from (and adding/spreading [F] to) the sibilant of the /si-/ prefix. And before roots containing sibilants specified as [G], harmony must likewise be capable of removing [F] from (and adding/spreading [G] to) the sibilant of the /ți-/ prefix. Before roots containing no sibilant at all, the underlying featural specifications of the prefix sibilants, be they [+F]/[−F], [F]/Ø or [F]/[G], surface intact and unchanged.

For this reason, it is absolutely impossible in principle to recast the type of harmony found in Navajo and Chumash as being in any way strictly feature-filling, as has frequently been done in autosegmental analyses of vowel harmony. By contrast, the sibilant harmony in Koyra (see §2.2.1), just like the analogous and ubiquitous vowel harmony systems described in §2.1.1, can easily be interpreted in feature-filling terms. Since there is no evidence for an underlying /ʃ/ : /s/ contrast among affix sibilants in Koyra, it is quite possible to view these as being underlingly unspecified for the relevant feature(s). Koyra sibilant harmony might then be interpreted as involving only [−ant] (or “[F]” in either of the alternative privative analyses outlined in the previous paragraph). In other words, after roots containing a [−ant] sibilant, an suffix sibilant in Koyra takes on the [−ant] (or [F]) specification of this root sibilant. In all other contexts, including when following roots which happen to contain a [+ant] sibilant, that same suffix sibilant simply gets specified by default as [+ant] (or [G], or simply left unspecified for privative [F]).
The inherently feature-changing character of the consonant harmony systems of languages like Navajo, Tahltan (Shaw 1991) and the Chumashan languages has profound and devastating consequences for unification-based approaches like Declarative Phonology (Scobbie 1991; Russell 1993; Bird 1995; Coleman 1998). In such models, phonology is construed as *monotonic*, such that any kind of destructive effects that remove or alter lexically specified information are disallowed in principle. Not surprisingly, proponents of declarative approaches to phonology have attempted to explain away Chumash sibilant harmony as a mere “phonetic process” outside the realm of the phonological grammar (Russell 1993; Bird 1995). See Poser (2004) for a host of counterarguments against such an interpretation, most of which apply at least as strongly to Navajo and Tahltan as well.

A second and more subtle problem concerns absolute directionality and its analysis in output-oriented constraint-based frameworks like Optimality Theory. As it turns out, a subset of the languages with actually-neutralizing consonant harmony also obey fixed regressive directionality (see Hansson 2001 for a survey of directionality patterns in consonant harmony systems). For example, sibilant harmony in Ineseño Chumash (Applegate 1972; Poser 1982; Lieber 1987: 145–150) proceeds from right to left, with no regard whatsoever for morphological constituency or prosodic structure. The sibilant which happens to be the rightmost one in the word simply determines the [±ant] value of any and all preceding sibilants, as illustrated in (18).

(18) Right-to-left sibilant harmony in Inenseño (Applegate 1972)

a. /s-apitʃʰ-o-it/ [ʃapitʃʰolit] ‘I have a stroke of good luck’

b. /s-apitʃʰ-o-us/ [sapitsʰulus] ‘he has a stroke of good luck’

c. /s-apitʃʰ-o-us-waf/ [ʃapitʃʰuluʃwaf] ‘he had a stroke of good luck’
Note that here, just as in Navajo, harmony is symmetrically feature-changing (triggering both [+ant] → [−ant] and [−ant] → [+ant] as unfaithful input-output mappings), as well as being actually-neutralizing. As I demonstrate elsewhere (Hansson 2001, in prep.), the specific combination of symmetric neutralization with absolute directionality of assimilation creates severe and unexpected problems for output-oriented approaches to phonology, and is in fact impossible to handle in standard versions of Optimality Theory.

For reasons of space this complex issue can only be touched on briefly here. The core of the problem is that the kinds of output well-formedness constraints which are ultimately responsible for driving harmony—whether these be construed as AGREE[F], ALIGN[F], SPREAD[F], or something else entirely—cannot in and of themselves guarantee that the manner in which harmony is achieved will adhere to a particular directionality of assimilation. This is illustrated by the tableau in (19). Here the intended derivation is /Ce-CuC/ → [Ce-CuC], with regressive [+ATR] harmony (similar to the Karajá pattern in §2.1.2); in the constraint labels, ‘[+A]’ stands for [+ATR] (or, equivalently, privative [ATR]). A constraint like ALIGN-L[+ATR], for example, is defined as requiring that any [+ATR] autosegment occurring in the output be aligned with the left edge of the word.

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<tr>
<td>b.</td>
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– 27 –
Note that even though a right-to-left orientation has essentially been built into the Align-$L$[+ATR] and Spread-$L$[+ATR] constraints, this does nothing to help rule out the left-to-right spreading alternative in (19c). That candidate satisfies such constraints vacuously, by not containing any output [+ATR] element at all. The responsibility for preferring (19b) over (19c) must obviously fall to other constraints. Baković (2000) suggests that these may be of two kinds, each giving rise to its own distinctive pattern. Output-output correspondence to the stem of affixation (e.g., Ident[±ATR]-SA), when ranked sufficiently high, will result in stem control or “cyclic” harmony, an extremely common pattern (see Ringen and Vago 1998 for a variation on this idea, using positional input-output faithfulness to root vowels). Alternatively, a Markedness or Faithfulness constraint favouring one [F]-value over the other (*[–ATR] or Ident[+ATR]-IO, or a local conjunction of the two) will guarantee that the directionality goes from vowels with the favoured value to vowels with the disfavoured one. The resulting pattern is a typical dominant-recessive harmony. Either strategy would suffice to select (19b) over (19c), assuming for simplicity that, in our hypothetical example, /CuC/ is the stem and /Ce-/ a prefix.

However, both strategies break down when combined simultaneously with both (i) absolute directionality and (ii) actually-neutralizing harmony. This is exactly what we find in the sibilant harmony of Ineseño Chumash in (18) above. Here we need to ensure not only that /...s...ʃ.../ → [...ʃ...ʃ...], but also that /...ʃ...s.../ → [...s...s...]. Stem
control can obviously not be appealed to, since harmony may go from an affix (suffix) sibilant to a root sibilant just as easily as from a root sibilant to an affix (prefix) sibilant. However, a dominant-recessive analysis fails as well, since harmony alternately favours [+ant] over [−ant] and [−ant] over [+ant], depending simply on which type of sibilant happens to follow the other in the linear sequence. Neither feature value can be designated as the dominant or “active” one in the operation of this harmony system.

In fact, the problem of enforcing absolute directionality of this kind appears to be intractable in standard Optimality Theory. I have argued elsewhere (Hansson 2001, in prep.) that the only viable solution within an Optimality Theory architecture appears to be to formalize the harmony-driving constraint as a targeted constraint (Wilson 2001). Such constraints differ from conventional Markedness constraints in that they circumscribe the range of possible repairs for the offending structure. Most importantly, a targeted constraint of the type *[-αF] / __ [αF], while seemingly equivalent to a standard agreement constraint like *[-αF][αF] or AGREE[F], differs from the latter in that it favours only those candidates which have repaired the targeted marked element as such (here, the [-αF] segment on the left), not ones which involve modification of the surrounding context (here, the [αF] segment on the right). In other words, such a constraint will prefer the regressive-assimilation candidate [αF][αF] over unassimilated *[-αF][αF], without simultaneously (and equally) preferring the progressive-assimilation alternative [−αF][−αF] as a conventional (non-targeted) agreement constraint would. Directionality ties like that shown in (19) are thus broken in a consistent manner that is independent of the feature values involved, the morphological or prosodic affiliation of the interacting segments, or any other conceivable factors beyond the linear precedence relation itself. In the above example, regressive assimilation will be ensured both for
cases of the \([-\alpha F]...[\alpha F]\) type (\(\rightarrow [\alpha F]...[\alpha F]\)) and for ones of the \([\alpha F]...[-\alpha F]\) type (\(\rightarrow [-\alpha F]...[-\alpha F]\)).

This is shown in tableaux (20)–(21), which render schematically the regressive [±anterior] sibilant harmony observed in Inseseño Chumash. Because targeted constraints do not impose a total ordering on the entire candidate set, but rather a partial ordering—involving only those candidate pairs which differ in terms of the specified repair to the targeted marked structure—the format of tableaux is necessarily slightly unorthodox. In place of asterisks, each tableau cell lists which (other) candidates, if any, a constraint deems to be more harmonic than the candidate under consideration. Parentheses indicate harmonic orderings of this kind (i.e. preferences) which are cancelled out by conflicting harmonic orderings assigned by higher-ranked constraint. The bottom row displays how a total ordering over the full candidate set is gradually built up, going from higher-ranked to lower-ranked constraints, until one candidate emerges as most harmonic. Note in particular that no individual constraint directly prefers the regressive-assimilation candidate over its progressive-assimilation competitor. Rather, that preference emerges by transitivity: regressive assimilation (20b)/(21c) beats no assimilation (20a)/(21a) on *[−αant] / _[−αant], the targeted constraint, whereas the latter beats progressive assimilation (20c)/(21b) on simple Faithfulness to input [±ant] values.

\[
\begin{array}{|c|c|c|}
\hline
(20) & /f...s/ & *[−αant] / _[−αant] & IDENT[±ant]-IO \\
\hline
\text{a.} & \text{ʃ}...s & s...s \supset \text{ʃ}...s! & \\
\hline
\text{b.} & s...s & (\text{ʃ}...s \supset s...s) & \\
\hline
\text{c.} & \text{ʃ}...ʃ & \text{ʃ}...s \supset \text{ʃ}...ʃ! & \\
\hline
\text{cumulative ordering} & s...s \supset \text{ʃ}...s & \text{ʃ}...s \supset \text{ʃ}...s \supset \text{ʃ}...ʃ & \\
\hline
\end{array}
\]
That the fundamental problem of accounting for absolute directionality in output-oriented frameworks has not previously been noted is hardly surprising. The problem can arise only when the harmony system in question displays precisely the kind of marginal contrast preservation (symmetric neutralization) defined in (4c). As we have seen, harmony of this type is entirely unattested among vowel harmony systems. The specific combination of marginal contrast preservation with absolute directionality of assimilation is found only in a small subset of consonant harmony systems.

5. Summary

We have seen how a close examination of certain aspects of the cross-linguistic typology of harmony systems reveals an asymmetry with respect to the neutralization patterns caused by harmony. Neutralization of actual lexical contrasts (in affixes) appears to be unattested in vowel harmony systems—or at least in those systems where both feature values are active in the harmony—whereas that same kind of neutralization does occur in a number of consonant harmony systems.

The central claim made here has been that this asymmetry falls out from considerations of contrast recoverability. It was demonstrated how the surface evidence
needed for reliably establishing the existence of lexical contrasts (in positions targeted by harmony) is necessarily quite limited in a typical vowel harmony system, far more so than in a typical consonant harmony system. Owing to these learnability factors, such contrasts therefore have a very high likelihood of disappearing over time in vowel harmony systems, while that likelihood is much smaller for consonant harmony systems.

Finally, the existence of actually-neutralizing harmony of this kind, attested in consonant but not vowel harmony, was shown to have profound implications for the analysis of harmony within output-oriented models like Optimality Theory, as well as for unification-based approaches to phonology.

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2 Here and throughout, all featural contrasts will be rendered formally as binary [+F] : [−F] oppositions, rather than as the presence vs. absence of a privative feature, [F] : Ø, or as mutually incompatible privative features, [F] : [G] (e.g., [ATR] vs. [RTR]). This is solely for simplicity of exposition, and questions of feature valency, and of the formal representation of specific featural contrasts, are entirely orthogonal to the discussion and argumentation throughout this work (see §4 for elaboration on this point).

3 The morphological abbreviations occurring in glosses this paper are as follows: NOM = nominative; SG = singular; DU = dual; PL = plural; POT = potential; EMPH = emphatic; CTFG = centrifugal; 1, 2, 3 = first, second, third person.

4 This is a slight oversimplification, albeit one which is of no consequence for the ensuing discussion. It would in fact be perfectly possible to force neutralization to [n] to extend to
related forms as well (where the nasal is non-final), by invoking some mechanism ensuring paradigmatic identity, such as Uniform Exponence (Kenstowicz 1997), Output-Output Correspondence (Benua 2000), Paradigm Uniformity (Steriade 2000), or Optimal Paradigms (McCarthy 2005).

5 The following discussion is restricted to lexical contrasts in affixes, ignoring roots as harmony undergoers (e.g., in dominant-recessive harmony, umlaut, metaphony, etc.). Surface evidence for lexical [+F] : [−F] contrasts is usually much more readily available for root morphemes, for the following reasons: (i) unlike affixes, a root may frequently occur on its own as an independent word; (ii) a root forms the central “hub” of an entire paradigm of morphologically related forms, in ways that an affix does not; and (iii) relevant information about a root’s lexical representation may be distributed across several forms in that paradigm. In very rare cases, affixes may themselves act as independent roots in certain constructions, in which case their underlying contrastive [+F] value may become apparent. This appears to be the case in Hungarian, which is otherwise much like Finnish in the relevant respects (see Ringen and Vago 1998).

6 For this reason, the prefixes in (9b) should perhaps preferably be rendered as /I-/, /O-/ rather than /I-/ /σ-/. If such a prefix contrast did exist, underlyingly [+ATR] prefixes would be expected to surface consistently as [+ATR], whereas [−ATR] ones would alternate between [+ATR] and [−ATR], just as the /=ke/ clitic does in (10).

7 It is important not to confuse the pattern in (11) with another phenomenon, quite commonplace in vowel harmony systems, whereby certain individual morphemes fail to undergo harmony (though the two phenomena are sometimes hard to distinguish in practice). In such cases, the disharmonic behavior of an affix vowel is idiosyncratic, not an automatic consequence of it being specified lexically as [+F] rather than [−F] (or vice
versa). Indeed, one typically finds that disharmonic affixes with both [F]-values exist in a given language. In Turkish palatal harmony, for example, the [−back] suffix /-gen/ ‘(poly)-gon’ and the [+back] suffix /-(i)jor/ PRESENT are equally disharmonic in their own idiosyncratic way (cf. [altuğun] ‘hexagon’, [gelijör] ‘s/he is coming’).

8 Note that [d] and [l] are allophones in complementary distribution in Yaka, [d] occurring before [i], and [l] occurring elsewhere; the phoneme is referred to here as /d/.

9 Note that this is a sense of the term “recoverability” which is different from that used in works concerned with perceptual cues and their role in phonology (e.g., Silverman 1997).

10 Strictly speaking, the proper comparison should therefore be between consonant harmony and parasitic vowel harmony in particular. Obviously, the cross-linguistic absence of the neutralization pattern in §2.1.3 holds true a fortiori for that particular subset of vowel harmony systems, and one may ask why this should be so. This might suggest that it is the general applicability of [±F], rather than its redundancy, that is the crucial factor. Neutral /i, e/ in Finnish palatal vowel harmony are phonetically [−back], and do require a [−back] suffix vowel as in (5c), while in a sibilant harmony system, neutral non-coronals such as /k/ or /m/ are simply neither [+anterior] ([or [+distributed]]) nor [−anterior] (or [−distributed]) and hence cannot impose either feature value on other segments.

11 As noted above, Poser (1982) and Lieber (1987: 145–150) capture the feature-changing character of sibilant harmony processes like those of Chumash and Navajo by decomposing them into a delinking rule and a (feature-filling) harmony rule. Avery and Rice (1989: 194), who represent [±anterior] contrasts with privative [posterior], view Chumash sibilant harmony as fusion of [coronal] nodes, where “fusion is right-headed, so the features of the rightmost sibilant remain”. However, their claim that on this analysis
“sibilant harmony is not feature-changing” is puzzling (perhaps reflecting an excessively narrow sense of the term “feature-changing”). In sequences like /ʃ…s/ → [s…s], the (right-headed) fusion operation must somehow involve delinking or deletion of the first sibilant’s [posterior] specification. In their more detailed treatment of Ponapean velarization agreement along the same lines, Avery and Rice are more explicit in suggesting that deletion/delinking is indeed implicated: “[t]he result of the fusion is that only secondary features of the righthand segment, the head, are maintained [emphasis added]” (Avery and Rice 1989: 182). For this reason, it is hard to see how the term “feature-changing” is any less descriptive of their node-fusion analysis of sibilant harmony in Chumash (or Navajo) than it is of the delinking-plus-feature-filling analyses proposed by Poser (1982) and Lieber (1987).

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