# A Correspondence Approach to Vowel Harmony and Disharmony*

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**Abstract**

In the paper, it will be argued that both harmony and dissimilatory OCP effects on vowels are best analyzed as correspondence relations between output segments within certain domains, rather than as featural alignment as proposed in the literature for analyses of harmony. The presented approach allows for a unitary treatment of harmony and disharmony effects and predicts that disharmony is to be found more rarely. Furthermore, it will be shown that the prosodic domains mora and syllable play a crucial role for harmony. Under this assumption, the fact that consonants can block vowel harmony will be explained straightforwardly. Following Inkelas' (1994) theory of underspecification, the approach allows a division of harmony systems into structure changing (i.e., all overriding) and structure filling (i.e., morpheme-specific) harmony types. My argumentation is based mainly on data from Ainu, Turkish, and Yucatec Maya.

## 1 Introduction

Assimilation and dissimilation phenomena are generally considered in isolation in the phonological literature. Recently, this has lead to a striking asymmetry in their respective analyses. In the present paper, I will argue that both phenomena call for a parallel treatment and that this can be accomplished within Correspondence Theory (McCarthy & Prince 1995, McCarthy 1996). I will argue against the alignment approach of feature spreading (Kirchner 1993, Cole & Kisseberth 1994, Pulleyblank, Jiang-King, Leitch & Ola 1995, Ringen & Vago 1995, Pulleyblank 1996, among others), which treats feature spreading as a special case of Generalized Alignment (McCarthy & Prince 1993). Moreover, I will argue against the approach that regards dissimilation as a local conjunction of markedness constraints (Alderete 1997), or simply takes over the OCP as it was originally formulated by Leben (1973), Goldsmith (1976), and McCarthy (1986) (McCarthy & Prince 1995, Pulleyblank 1996, Myers 1997). The feature alignment approach provides no insights into disharmonic patterns. When the latter phenomena are analysed in the local conjunction approach, they appear as completely unrelated to harmonic phenomena. Both approaches taken together do not reflect the striking parallels and interactions between harmonic and disharmonic patterns.

One of the main results of this paper will be that spreading as such does not exist at all. Assimilation of features is to be regarded as a case of correspondence. To be more precise, I will assume a constraint schema, that establishes a 'surface-to-surface' correspondence relation between segments of one sound string. In an output representation, segmental features obey constraints that demand correspondence with 'neighboring' elements. The definition of neighborhood or locality will be subject to

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language-specific 'parametrization'. This parametrization crucially involves prosodic domains. Disharmonic patterns constitute violations of the constraints responsible for harmonic patterns. Under the assumption that it is generally more desirable to satisfy constraints than to violate them systematically, this leads to the prediction that dissimilation is more marked than assimilation. The nature of 'neighborhood' as it will be observed in the Yucatec data, will contradict the assumption of strict locality and coproduction implied by the alignment approach to feature spreading. Ní Chiosáin & Padgett (1997) explicitly argue for strict locality and coproduction of spreading features on all intervening segments. The Yucatec data, in turn, support a relativized locality postulate as advocated in the autosegmental literature in general.

The concept of assimilation as correspondence also requires a rethinking of the notions of 'blocker' or 'opaque segment'. These are elements that intervene between the spreading element and its target, or, in the spirit of this paper, between the segments which potentially correspond to each other with respect to the relevant feature.

The paper is structured as follows: In section 2, the basic assimilation phenomena as well as current approaches to harmonic and disharmonic behavior of features are introduced by Turkish examples. In section 3, morpheme-specific vowel harmonies and disharmonies are investigated, with particular focus on Yucatec Mayan and Ainu. In section 4, I will develop the basic theoretical ideas and formalizations, which will be applied to Turkish in section 5. Section 6 provides an analysis of the alternations observed in Ainu and Yucatec. In this section, the analysis will be extended to principled dissimilatory phenomena, i.e., OCP effects. Section 7 summarizes and concludes the discussion.

## 2 Current treatments of assimilation and dissimilation

My proposal, like most other approaches discussed in this paper, is couched within Optimality Theory (Prince & Smolensky 1993) and/or Correspondence Theory (McCarthy & Prince 1995). For this reason, some basic remarks about these frameworks are in order.

The nature of Optimality Theory is declarative rather than processual, hence there cannot be any intermediate steps of derivation (i.e. levels) as, e.g., in Lexical Phonology (Kiparsky 1982, 1985).

Within Optimality Theory (henceforth OT) it is assumed that grammar consists of the following ingredients: First, underlying forms (the input), and surface forms (the output), are distinguished. The function GEN generates a theoretically infinite set of candidate output forms of a given input. There is a fixed set of constraints, which are ordered hierarchically, in a language-specific ranking. These constraints are violable. The function EVAL evaluates on the basis of the ranking which candidate form is the optimal output for a particular grammar. The candidate form which conforms most to the constraints that rank high wins, and is chosen as the optimal output.

The main characteristic of Correspondence Theory (henceforth CT) is that there is a special relation between input and output forms. The importance of this relation is warranted by particular correspondence constraints. An underlying form should be as faithful as possible to its output form and vice versa. The crucial point is that input-output correspondences are assumed for features, segments, or other grammatical structure between underlying material and surface forms.[1]

## 2.1 OT Approaches to harmony

The literature on harmony and disharmony is enormous and I will restrict myself to a brief summary of the most recent approaches.

Under the alignment approaches, spreading is generally analysed as a special extension of the generalized alignment schema (McCarthy & Prince 1993), as cited in (1).

(1) Generalized Alignment (McCarthy & Prince 1993:80):

Align (Cat1, Edge1, Cat2, Edge2) $=_{def}$

$\forall$Cat1 $\exists$Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide.

Where

Cat1, Cat2 $\in$ PCat $\cup$ GCat

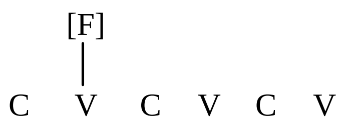
Edge1, Edge2 $\in$ {Right, Left}

Paraphrased in non-technical language, this means that for all members of a certain prosodic or grammatical category there is a member of another prosodic or grammatical category, and the right (or left) edge of the former category falls together with the right (or left) edge of the latter category. Kirchner's (1993) formulation of harmony in alignment terms is given in (2).

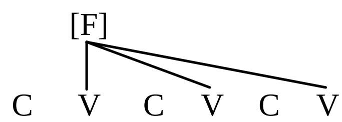
(2) Align (F, R, morphological word, R): For any parsed feature F in morphological category MCat (= root, word), the right edge of F is associated to the rightmost syllable of MCat.

For a language like Turkish this means that any feature [round] or [back] should be realized on the rightmost vowel (or syllable) of a morphological word. Together with the assumption that features are lexically anchored on underlying segments this yields 'stretching' of the feature to the denoted edge. If rounding occurs in a word, it should end when the word ends (Align Right), or it should begin when the word begins (Align left). Suppose the structures in (3) were morphological words. The structure in (3a) would get two violation marks, because there are two vowels between the right edge of the form and the vowel with the feature F, that do not bear this feature. In contrast, the structure in (3b) gets no violation mark, because the right edge of the feature F coincides with the right edge of the whole form.

(3) a.




b.




[1] Several phenomena like reduplication and opacity effects gave rise to different types of correspondence relations, for instance base-reduplicant or base-output correspondence. This is only interesting to see that the kind of correspondence to be established in this paper is not the only type of relation that extends the standard input-output correspondence modell.

I will demonstrate featural instantiations of this kind of alignment with the example of Turkish harmony in the following. Turkish has the front vowels *i, ü, e, ö,* and the back vowels *a, o, u, ɨ,*. All vowels in a word agree in backness and high vowels additionally agree in roundness, as exemplified in (4).

| | | | | |
|---|---|---|---|---|
| (4) | *hüviyet* | 'identity' | *kɨmɨltɨ* | 'movement' |
| | *küsülü* | 'annoyed' | *oyuncak* | 'play-thing' |
| | *netice* | 'result' | *sogukca* | 'coldish' |

[van der Hulst & van de Weijer 1991:40][2]

Turkish is an agglutinative suffixing language. Vowels in affixes show alternating backness and roundness specifications, according to the demands of harmony (see Clements & Sezer 1982, Goldsmith 1990, van der Hulst & van de Weijer 1991, Kirchner 1993). This is shown by the examples in (5).

| (5) | nom.sg. | nom.pl. | gen.sg. | gen.pl. |
|---|---|---|---|---|
| 'rope' | *ip* | *ip-lʲer* | *ip-in* | *ip-lʲer-in* |
| 'girl' | *kɨz* | *kɨz-lar* | *kɨz-ɨn* | *kɨz-lar-ɨn* |
| 'face' | *yüz* | *yüz-lʲer* | *yüz-ün* | *yüz-lʲer-in* |
| 'stamp' | *pul* | *pul-lar* | *pul-un* | *pul-lar-ɨn* |
| 'hand' | *elʲ* | *elʲ-lʲer* | *elʲ-in* | *elʲ-lʲer-in* |
| 'stalk' | *sap* | *sap-lar* | *sap-ɨn* | *sap-lar-ɨn* |
| 'village' | *kʲöy* | *kʲöy-lʲer* | *kʲöy-ün* | *kʲöy-lʲer-in* |
| 'end' | *son* | *son-lar* | *son-un* | *son-lar-ɨn* |

[Clements & Sezer 1982:216]

In (5) the suffix *-lV*$^{[-high]}$*r*[3] surfaces as [*-ler*] or [*-lar*] depending on the backness value of the preceding vowel. *-V*$^{[+high]}$*n* surfaces as [*-in, -ɨn, -un, -ün*] depending on the backness and roundness value of the preceding vowel. Therefore, it is generally assumed that the features for backness and roundness spread from left to right, according to the schema given in (2) above.

Word-initial epenthetic vowels harmonize with the following root vowel (e.g., the English loan 'group' becomes *g**u**rup*, in accordance with roundness (labial) and backness (palatal) harmony, or, in the loans ***ɨ**spanak* 'spinach' and ***i**skelet* 'skeleton' word-initial epenthesis respects backness harmony). This leads to an analogous formulation of leftward alignment, which is ranked below the constraint in (2). To avoid that these constraints simply move a feature realization from one edge of a word to another edge, some additional assumptions have to be made: Features must be lexically anchored to a segmental position, and they must be 'stretchable'. The common point of view is that an articulation span of a feature is extended (thus the EXTEND[rd] constraint for rounding harmony proposed by Kaun 1994). This implies that spreading features are coarticulated on intervening segments that normally do not bear such features, like consonants (see also the discussion in Ní Choisáin & Padgett 1997).

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[2] Van der Hulst & van de Weijer use data from Clements & Sezer (1982), Harris (1987 UCL class notes), Kardeştuncer (1982), Lewis (1967) and Steuerwald (1972).

[3] Capital 'V' symbolizes an underspecified vowel.

Why non-high vowels do not participate in roundness harmony in Turkish even though they potentially could (and in fact do so in a number of languages; see Kaun 1994) can be explained by 'grounded conditions' (following Pulleyblank 1996) or feature co-occurrence constraints and their specific ranking in the hierarchy; compare Kirchner (1993) or Kaun (1994) for more details on this point.

Every analysis has to cope with exceptions. Turkish exhibits a number of nonharmonic roots and affixes which must be dealt with. Some examples are given in (6).

(6)

| | | | | | | |
|---|---|---|---|---|---|---|
| a. | *hamsi* | 'anchovies' | *biɫɫur* | 'crystal' | *sifon* | 'toilet flush' |
| | *anne* | 'mother' | *kudret* | 'power' | *peron* | 'railway platform' |
| | *bobin* | 'spool' | *fiat* | 'price' | *muzip* | 'mischieveous' |
| | *rozet* | 'collar pin' | *mezat* | 'auction' | *nemrut* | 'unsociable' |

[Clements & Sezer 1982:222; Kirchner 1993:2]

| | | | | |
|---|---|---|---|---|
| b. | */-istan/* | | */-va:ri/* | |
| | *mo:l-istan-ɨ́* | 'Mongolia' | *asker-va:ri* | 'soldier-like' |
| | *arab-istan-ɨ́* | 'Arabia' | | |
| | *ermen-istan-ɨ́* | 'Armenia' | | |

[Clements & Sezer 1982:231; Kirchner 1993:3]

In (6a) vowels with different backness values occur in one root, e.g. [+back] *a* precedes [-back] *i* in *hamsi* or [-back] *e* comes before [+back] *u* in *nemrut*. In (6b) the affixes always surface with the same features, and do not undergo harmony with the stem vowels. Furthermore, they are inherently disharmonic, containing back *a* and front *i*. All these forms violate the alignment constraint in (2).

Ranking the alignment constraints above featural faithfulness constraints yields all-overriding harmony. The inverse ranking leads to a total absence of harmony. But neither is desired for Turkish. At this point, underlying representations come to play a central role. In standard OT, full underlying specification has to be assumed, even of epenthetic material, in order to avoid FILL or DEP violations. FILL and DEP constraints demand the presence of surface features in underlying forms, that means feature insertion is a violation of these constraints. This lead Kirchner (1993) to the conclusion that the alternating features [round] and [back] are of a privative nature, not binary as [high] and [low] are analysed in his theory. Privativity of at least some features has been argued for by other scholars as well (see, e.g., Steriade 1995 for an argumentation that all features should be privative). Obviously, Kirchner (1993) wants to restrict underspecification to (the absence of) privative features. Thus, he can analyse disharmonic roots only by assuming morpheme-specific constraint rerankings ("PARSE(f) / IDENT(f) >> {ALIGN(f,L), ALIGN(f,R)}") that are linked to lexical entries and override the regular Turkish Grammar ("{ALIGN(f,L), ALIGN(f,R)} >> PARSE(f) / IDENT(f)").

Beckman (1997), proposes to deal with harmony in terms of positional faithfulness constraints for particular features, instead of feature alignment. These positional faithfulness constraints rank above the markedness constraints dealing with the same features. This approach works under the assumption that a multi-segmental linking of one feature is less expensive than violations of markedness constraints for individual features for each segment. In Shona, the language examined by Beckman, all vowels of a word harmonize in height with the initial vowel, if no opaque vowels intervene. The role of the latter is handled by feature cooccurrence constraints and by ranking certain

Identity feature constraints high. However, morpheme-specific exceptions to harmony, as observed in Turkish, are not easy to handle in such an analysis. Furthermore, this approach gives no explanation why in most languages, which exhibit harmony, the assimilation pattern is restricted to single words (instead of phrases or larger units) or even smaller domains.

In the next section, I will turn to analyses of the apparent opposite of spreading, i.e., dissimilation.

## 2.2 How to deal with dissimilatory OCP effects in a constraint-based framework

Assimilation is the state of affairs where a segment surfaces with the same specification for a certain feature as another segment within the same prosodic or morphological domain. Dissimilation mirrors this situation: A segment surfaces with the opposite value for a feature that is realized by a certain segment nearby. To account for this similarity, a generalized alignment account is inappropriate, since it is difficult to imagine how to handle dissimilation with alignment. Alderete (1997) proposes to treat dissimilation as the result of a local conjunction of markedness constraints. The idea is the following: A markedness constraint bans the emergence of a feature value, e.g. [+F]. In a local conjunction of markedness constraints, the second appearance of [+F] within a defined local domain (e.g. 'stem') is twice as bad as the first, and thus has to be avoided.

The alternative, worked out by Pulleyblank (1996:330ff), is simply to regard the Obligatory Contour Principle (Leben 1973, Goldsmith 1976, McCarthy 1986) as a constraint, which forces dissimilation.

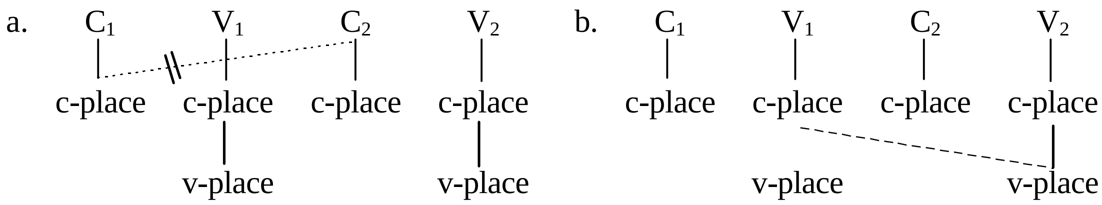
(7) Obligatory Contour Principle (Pulleyblank 1996:330):
A sequence of identical elements within a tier is prohibited.

In OT/CT sound strings are regarded as concatenations of segments, which means that structure is assumed to be nonhierarchical in general. No consonant and vowel tiers or tiers for single features are available yet. So among other things, the question remains which role tiers and other concepts from feature geometry can play in OT/CT.

## 2.3 Locality

It is generally assumed that phonological phenomena are locally constrained, this means that elements involved in or affected by phonological phenomena should be adjacent. For example, effects of word-initial elements on word-final elements (within one word) are not expected in natural language. There are several views of how strictly the notion of locality should be taken (for a discussion see Ní Chiosáin & Padgett 1997). Under feature geometrical considerations, locality is seen as 'relative' with effects from one feature node to another, which are located within a hierarchy, and not as affecting adjacent segments. Certain nodes are located under other nodes which explains why some features spread long distance (like vowel features, voice, nasality) and others do not (like consonantal place). This is illustrated in (8).

(8) Locality in feature geometry:




As can be seen in the diagram, c-place spreading (indicated by the dotted line from c-place to c-root in (8a)) has to cross the association line of segments that should not be involved; hence consonantal place spreading is ruled out by a prohibition against line-crossing (see for instance Odden 1994). In contrast, v-place features are lower in the hierarchy, and, when they spread (as indicated by the dashed line in (8b)) there are no lines to cross, hence v-place feature spreading is possible.

Ní Chiosáin & Padgett (1997) reject feature geometry and postulate strict locality. In OT/CT, sound chains are seen as strictly string-adjacent, i.e. CVCVCV... sequences. This means that, e.g., vowel place features are not direct neighbours with respect to their place in a feature tree – vowel place features of different segments are in most cases separated from each other by consonants and their features. Ní Chiosáin & Padgett claim that since in the case of spreading vowel place features, these features are coarticulated on intervening consonants, all spreading must be totally local, going from one segment to the next. Consonantal place features cannot spread over vowels because they cannot be coarticulated on vowels without turning them into consonants, yielding extra-long consonants [C:::] from /CVCV/, which is impossible to pronounce. This effect, which changes a segment of one basic type into another by the spreading of a c-place feature, is labelled the 'bottleneck effect'. Phonetic experiments (Boyce 1990 and references cited there) have shown that the activity of the muscles responsible for lip rounding decreases while test persons pronounce a nonlabial consonant which is situated between two rounded vowels.[4] This fact poses a severe problem for the strict locality postulate. Just imagine labial harmony between two vowels with a consonant between them, which by definition cannot bear the feature labial (e.g. a glottal stop). No coarticulation can take place, and locality will be violated.

Odden (1994) (working in feature geometry) argues that target and trigger of feature interaction should be in adjacent syllables. He thus distinguishes two types of locality: adjacent root nodes and adjacent syllables. This is in contrast to the strict locality assumption of Ní Chiosáin & Padgett. The position taken by Piggott (1996) is an extension of this. Examining nasal harmony patterns in Lamba and Kikongo, he concludes that in the former language, nasal harmony is best analyzed as agreement between syllables, but in the latter, as agreement between feet. In this paper, I will show support for the point of view that prosodic units other than the syllable are relevant for vowel harmony. More precisely, I will give evidence for the mora as a domain of featural agreement.

[4] To be more precise, in the experiment carried out by Boyce, Turkish showed continuing lip rounding over consonant clusters between rounded vowels, while English showed significant loosening of lip rounding. Boyce concludes from this that the two languages employ different strategies of articulation, one supporting relativized locality, the other strict locality. As she claims, both theories mentioned (relativized as well as strict locality) seem insufficient to capture the data presented by her.

I will first present the relevant data and return to the theoretical discussion of locality in section 4.

## 3 Harmonic and disharmonic patterns in Ainu and Yucatec

Clements & Sezer (1982) concluded that harmony is no longer active in Turkish roots. Disharmony in this case simply arises from a lack of harmonic behavior, not from principled disharmonic alternations. Recall from section 2.1 that consequently, in his OT analysis, Kirchner (1993) has to assume constraint reranking for nonharmonic lexical items. In contrast, in this section, I will investigate morpheme-specific harmonies and *principled* (morpheme-specific) disharmonies, i.e., disharmonies that are governed by the regular dissimilation of certain features, which occur both in the same language.

### 3.1 Yucatec Maya

Yucatec is a Mayan language, spoken by aproximately 500,000 people in south-eastern Mexico, Belize, and northern Guatemala (Lehmann 1990). In this language, suffixes which completely copy the vowel of the stem can be found, while another suffix displays a disharmonic pattern surfacing always as [+high], while disharmonizing with regard to backness; whereas most other suffixes do not exhibit assimilatory or dissimilatory patterns at all.

In (9a), the harmonizing suffixes for imperfective and subjunctive are shown, preceded by all five vowels of the Yucatec inventory.[5] In contrast, the imperfective suffix for transitive verbs and the perfective suffix never alternate in vowel quality regardless of the stem vowel, as illustrated in (9b).

(9) Yucatec Maya[6]:

| | i. Imperfective | | ii. Subjunctive |
|---|---|---|---|
| a. | *ʔah-al* | wake.up-IMPF | *ʔah-ak* |
| | *ʔok-ol* | enter-IMPF | *ʔok-ok* |
| | *lub'-ul* | fall-IMPF | *lub'-uk* |
| | *wen-el* | sleep-IMPF | *wen-ek* |
| | *kíim-il* | die-IMPF | *kíim-ik* |

| | | | | | | |
|---|---|---|---|---|---|---|
| b. | i. | *yil-ik* | see-IMPF | ii. | *yil-ah* | see.PERF |
| | | *tsol-ik* | explain-IMPF | | *putʃ-ah* | hit-PERF |

One may conclude that in this language (where harmony is not broadly active) some lexemes are fully specified whereas others are underspecified, as indicated in (10).

[5] Yucatec has the vowels *i,e,a,o,u*, and furthermore distinguishes between long and short vowels, and among the long vowels, between high toned and low toned ones.

[6] The Yucatec data are taken from Ayres & Pfeiler (1997) and from Bricker & Yah (1981).

(10) a. Fully specified morphemes: /-*ik*/; /-*ah*/

b. Underspecified morphemes: /-*Vl*/; /-*Vk*/

In Yucatec, harmony is blocked if more than one consonant is located between the two potentially involved vowels. (11) illustrates this with the subjunctive suffix, which normally echoes the root vowel (cf. 9a.ii). In (11), the vowel of the subjunctive suffix surfaces as [*a*].

| | | | |
|---|---|---|---|
| (11) | *tùukul-n-**a**k* | think-N-SUBJ | * *túukuln**u**k* |
| | *hèek'-n-**a**k* | break-N-SUBJ | * *hèek'n**e**k* |
| | *ts'íib'-n-**a**k* | write-N-SUBJ | * *ts'íib'n**i**k* |

The same holds for the other harmonizing suffix in (9). The blocking effect is illustrated in (12).

(12) a. *t'otʃ-b'-**a**l* 'to harden (glue)' instead of * *t'otʃ-b'-**o**l*
harden-PASS-IMPF

b. *míis-t-áʔal* 'being swept' instead of * *míistíʔil*
sweep-TRANS-PASS.IMPF or * *míʔistil*

In (12b) the facts are somewhat obscured by the subsegmental passive morpheme [+glottal], which otherwise is realized on the stem, as can be seen in comparing the forms in (13a) and (13b).[7]

(13) a. *ts'on* b. *k=in* *ts'oʔon* *-ol*
shoot (tr) AUX=1 shoot.PASS IMPF
'I am (being) shot.'

A consonantal barrier, consisting of more than one consonant, thus bans the 'transfer' of the vowel features from the stem to the affix. This blocking behaviour is also observed with roots with a final consonant cluster (although they are rare). This shows that this is not a morphematic restriction. This means that the possibility is excluded that adjacency (or locality) of harmonizing or otherwise interacting elements is defined over morphemes, with intervening morphemes instead of phonological units as blockers.

For vowel dissimilation, the locality restrictions are less strict, as can be seen below. Vowel disharmony is observed with only one suffix, a stem-forming derivational suffix on denominal and deadjectival verbs. The vowel of the suffix /-*kV:*$^{[+high]}$*n*/ surfaces as [*u*] after front vowels and as [*i*] after back vowels, illustrated with stems containing the vowels *u*, *a* (*a* is a front vowel in Yucatec), and *i* in (14).

[7] Clitics are separated from their host by an equals sign, affixes by a hyphen.

(14) Yucatec: *-kV:$^{[+high]}$n-*

a. ***u**ts-k**ii**n-t-ik* 'enhance/repair sthg.'
good-D-TR-IMPF

b. *h**a**w-k**uu**n-t-ah* 'lay sthg. down face up'
lie.down.face.up-D-TR-PERF

c. *sáas**i**l-k**uu**n-s le k'oʔob'en-oʔ!* 'Light up the/that kitchen!'
light.up-D-CAUS DET kitchen-DEM

The whole pattern can be described as in the following table.

(15) Yucatec disharmony-pattern:

| stem | affix |
|---|---|
| C*i*C | |
| C*e*C | *-kuun* |
| C*a*C | |

| stem | affix |
|---|---|
| C*u*C | |
| C*o*C | *-kiin* |

Yucatec stems always end in a consonant. As this affix has an initial consonant, the result is an intervening consonant cluster in all cases. Vowel disharmony takes place in this context (where, as we saw earlier, harmony would be blocked).

### 3.2 Ainu

A similar pattern can be observed in Ainu. The language's genetic affiliation is not clear; it is spoken on the island of Hokkaido (Japan), Sachalin and on the Kurile Islands (Russia) by about 16,000 speakers (numbers from Patrie 1982). Ainu has five vowels, *i,e,a,o,u*. On some verbal stems, the transitivizing suffix completely echoes the root vowel; see (16).

(16) Harmony in Ainu:

| | | | | |
|---|---|---|---|---|
| *mak-a* | 'to open' | *tas-a* | 'to cross' | |
| *ker-e* | 'to touch' | *per-e* | 'to tear' | |
| *pis-i* | 'to ask' | *nik-i* | 'to fold' | |
| *pop-o* | 'to boil' | *tom-o* | 'to concentrate' | |
| *tus-u* | 'to shake' | *yup-u* | 'to tighten' | [Itô 1984:506] |

Itô (1984) analyzed the transitivizing suffix as a completely underspecified vowel, or as merely [+syllabic].

On some stems, the same suffix always surfaces as [+high] and with a backness specification that is the opposite of that of the vowel in the stem.

(17) Backness disharmony in Ainu:

| | | | | | |
|---|---|---|---|---|---|
| a. | *hum-i* | 'to chop up' | *mus-i* | 'to choke' | |
| | *pok-i* | 'to lower' | *hop-i* | 'to leave' | |
| b. | *pir-u* | 'to wipe' | *kir-u* | 'to alter' | |
| | *ket-u* | 'to rub' | *rek-u* | 'to ring' | [Itô 1984:506] |

Itô proposes that, in these cases, a floating autosegment [+high] may belong to the stem. The autosegment gets associated to the empty suffix, and triggers a Melodic Dissimilation Rule (MDR), which forces the vowel in the suffix to have the opposite backness specification than that of the stem vowel.

A more plausible reason why feature dissimilation applies instead of vowel harmony in these cases can be found in the assumption that when the floating feature of the stem is realized on the suffix, this suffix is interpreted as belonging to the root, because it contains material from the root. Within roots dissimilation is required, while between roots and affixes assimilation is the dominant requirement.

Now consider a third pattern:

(18) Height disharmony in Ainu:

| | | | | | |
|---|---|---|---|---|---|
| a. | *an-i* | 'to have' | *car-i* | 'to rotate' | |
| b. | *ram-u* | 'to think' | *rap-u* | 'to flutter' | |
| | *pat-u* | 'spray' | *yak-u* | 'destroy' | [Dettmer 1989:479f.] |

In (18) the suffix always appears as [+high] as in (17), but on some stems as front and on others as back. In contrast to (17), all these examples have an *a* in the stem. Itô speculates that Ainu historically had a front and a back /a/ which merged to one unspecified /a/. Frontness of this suffix is not predictable synchronically. According to Itô, the backness value of the floating autosegment is prespecified.

On stems ending in a glide both harmony and disharmony are blocked. The suffix (still the same transitivizer) surfaces as [*e*], as exemplified in (19).

(19) Lack of (dis-)harmony in Ainu:

| | | | | |
|---|---|---|---|---|
| *ray-e* | 'to kill' | *say-e* | 'to wind' | |
| *chaw-e* | 'to solve' | *taw-e* | 'to pull with force' | |
| *hew-e* | 'to slant' | *rew-e* | 'to bend' | |
| *piw-e* | 'to cause to run' | *chiw-e* | 'to sting' | |
| *poy-e* | 'to mix' | *moy-e* | 'to move' | |
| *huy-e* | 'to observe' | *tuy-e* | 'to cut' | [Itô 1984:506] |

Itô generalizes that the diphthongs (consisting of vowel + glide) are subject to MDR here. The off-glide always bears the opposite backness value of the preceding vowel. The blocking of harmony is attributed to a constraint which bans the sequences [*yi*] and [*wu*] in Ainu, as proposed by Kindaichi & Chiri (1936; cited from Itô 1984). If one assumes that the glide is syllabified into the onset position of the syllable bearing the suffix, harmony should apply between the root vowel and the suffix (not semi-vowels). Unfortunately, this does not happen. According to the MDR (suppose there is a floating [high] feature, and consider the glide again as participating in feature interaction of vowels), the suffix would have to surface as [*u*] after [*y*] and as [*i*] after [*w*], yielding e.g. **piwi* or **huyu*, not **piwu* or **huyi*, while only the latter would be banned by the *[*yi*, *wu*] constraint. A more promising approach would be to regard the glides in the diphthongs as blockers. This proposal will be worked out in more detail in sections 4 and 6.

What is observed in Ainu is that assimilation as well as dissimilation takes place in nearly the same environment on the same suffix, with largely the same features involved.[8] My proposal is to analyse this as dissimilation holding within roots and assimilation holding within words or any other larger unit. This proposal will be discussed more in sections 4 and 6.

This completes the data section. With these patterns in mind, I will now turn to the theoretical problems related to these data and provide my proposal for their solution. Before going into the details of the analysis in sections 5 and 6, I will introduce my basic ideas in the following section.

## 4 The new proposal

So far, similar morpheme-specific patterns of vowel harmony and disharmony have been observed in three unrelated languages. Turkish is insofar similar to Ainu and Yucatec as in the former language many forms occur which do not undergo harmony, even though the proportion of nonharmonic items is clearly higher in the latter.

In Ainu and Yucatec, harmony is total, involving all relevant features of the vowel system, while disharmony is restricted to backness. One of the disharmonizing elements is always prespecified for height. In Ainu, height is prespecified on the root, and realized on the suffix; in Yucatec the suffix itself has to be regarded as prespecified for [+high]. Both languages exhibit a five vowel system, with roundness or ATR/RTR playing no role. When height is specified on involved vowels, they can only dissimilate in backness. The roundness value will fall out automatically by co-occurrence restrictions.

### 4.1 The role of morphological domains

Besides the similarities, some differences in the two languages can be extrapolated. In Ainu, disharmony is restricted to the root: When the last feature associated to the root is realized on a derivational suffix,[9] this is interpreted as belonging to the root and thus undergoes dissimilation. If the root has no unassociated vowel feature to be realized, the attached underspecified suffix is free from material belonging to the root, and is interpreted as belonging to the stem or word; in this case, it is subject to harmony. In contrast to this, disharmony occurs within the (derived) stem in Yucatec, and the concept 'root' plays no role at all. In this language, the stem-forming affix -$kV^{[+high]}n$ always displays backness disharmony, while inflectional affixes display harmony.

### 4.2 Consonants and moras

The role of semi-vowels in Ainu still remains obscure. Recall that in this regard, the observations in Yucatec may provide some insight. It has been shown that more than one consonant builds a barrier for featural interactions of vowels. I will argue in the

[8] It might be noted that the same patterns are observed for the suffix -*VhV* which marks possessed forms of nouns. Confer the discussion of the possessive construction in Dettmer (1989:107ff.)

[9] For an argument in favour of the derivational status of transitivizing operations as opposed to inflectional status see Krämer (1997).

remainder of this paper that harmony proceeds from mora to mora, not from syllable to syllable in Yucatec, while disharmony proceeds from syllable to syllable. Consider the possibility that consonants in coda position acquire moraic weight by this position. If a mora is occupied by a consonant, assimilation of the following vowel is banned in Yucatec. If one assumes further that the vowel 'looks' to the previous mora, in order to acquire its features, there are no features available to copy, when this mora is a consonantal coda. If the vowel would copy consonantal features it would have to change into a consonant. Ainu diphthongs consist of a vowel-glide sequence. The glide or semi-vowel is subject to root-internal disharmony, but the following suffixed vowel undergoes neither assimilation nor dissimilation if preceded by a semi-vowel. Semi-vowels are half consonants and half vowels by nature. It is thus expected that, within some language, they behave like vowels as part of a diphthong, but like consonants in the role of a segment in coda position. As coda elements they behave exactly like consonants in coda position in Yucatec: There is no featural interaction with the adjacent vowel(s). So, one can say that the blocking of assimilation and dissimilation in Ainu is caused by the interaction of the restriction of these phenomena as going from mora to mora, and the consonantal nature of semi-vowels. Thus, the off-glides must be ambisyllabic in the affixed forms in Ainu, as illustrated in (20).

(20) a. Behavior of glides in Yucatec b. Behavior of glides in Ainu


I will elaborate on the technical details and consequences of the language-specific behavior of glides and consonants with regard to moraic weight and syllabification in section 6.2.

### 4.3 Arguments for analysing harmony as correspondence

At first sight the assumption that the mora and the syllable are crucially involved into harmonic behaviour is technically incompatible with the basic idea of featural alignment. It would be a curious instantiation of the generalized alignment schema, which aligns a feature to the right or left edge of the next mora in a string. The usual alignment involving moras or syllables, as in Align(feature x, R, syllable, R) would align the right edge of every feature x with the right edge of a syllable, yielding no effect at all, except a coarticulation of vowel feature x on coda consonants, or the eventual elimination of all diphthongs in a language. A possibility would be to add the prosodic category which is relevant for harmony in a language as a third argument of the alignment schema, as was indicated already by Kirchner's (1993) formulation of feature alignment (see (2)). Even if one considers this possibility, the interaction of harmony and disharmony in the two languages is hardly to handle. Establishing a correspondence relation between moras or syllables likewise, however, is theoretically unproblematic in comparison to this. Furthermore, the theoretical possibility of a negative correspondence constraint exists, that means *Correspondence is a grammatical means, leading directly to disharmonic patterns.

Moreover, what we have observed about the role of the domains 'root' and 'stem' or 'word' in Ainu and Yucatec would lead to a treatment in terms of levels of representation and their ordering to account for the fact that harmony and disharmony are observed in the same language. For instance, on a stem-forming level or in the lexicon disharmony applies, and at a later stage of the derivation, a harmony rule applies. Within the OT framework no intermediate levels exist between underlying form (input) and surface representation (output). The introduction of intermediate levels can be avoided in these cases by restricting the scope of constraints to such domains. Restricting constraints on disharmony to a domain smaller (root or stem) than those constraints responsible for harmonic patterns (morph./phon. word) yields the emergence of both in a single grammar.

There is another argument against treating harmony as alignment. The term ‘spreading’ implies that a feature spans over more than one segment within a domain. Ní Chiosáin & Padgett (1997) claim that vowel features (for place and roundness) can be coarticulated on intervening consonants, whereas major consonantal features would change a vowel into a consonant if imposed on it. This is not the whole story, as can be seen from the simple fact that not only place and roundness features but also height features participate in assimilatory phenomena. Height harmonies are observed in several languages (see Goad 1993, Beckman 1997 and many others), and total harmonies are attested in Ainu and Yucatec. Even though rounding might be coarticulated on consonants, it is doubtful whether this is of any phonological relevance. For height features, it may be physically impossible to let the tongue remain in a certain position while articulating the intervening consonant (if it is not accidentally one which is articulated without tongue involvement, e.g., labial or glottal stops). Another point is that the number of intervening consonants is not irrelevant, as has been shown above. In Turkish, however, the number of intervening consonants plays no role for the behavior of vowels. Compare example (21), where all vowels display harmonic behavior, even though separated by consonant clusters, which, furthermore, contain different types of consonants (liquids, nasals, stops, and fricatives, and the latter voiced and voiceless).

(21) Turkish

| | | |
|---|---|---|
| *yorgun-luk* | ‘tiredness’ | |
| tired -NOM | | |
| *yabancɨ* | ‘strange(r)’ | |
| *yüz -dür -mek* | ‘to skin an animal’ | |
| surface-be-INF | | |
| *zayɨf -la -mak* | ‘to get thinner’ | |
| weak-VERB-INF | | [Wendt 1976] |

In Yucatec, two consonants constitute too large a distance for vowel assimilation to proceed, whereas for dissimilation they are no obstacles. In Ainu, assimilation and dissimilation are blocked already by intervening semi-vowels. These data suggest that assimilation goes from one prosodic category to the next and not – as spreading in the sense of Ní Chiosáin & Padgett – from one segment to the next. For Turkish harmony, the relevant category indeed seems to be the syllable.[10] The participation of consonants in backness harmony, as is observed in Turkish, is no argument for segment-to-segment spreading (or correspondence) of vowel harmony either. In Turkish, the consonants /k,g,l/ have a velar and a palatal allophone. The velar variant surfaces in the neighborhood of back vowels, while the palatal allophone surfaces with front vowels. As Clements & Sezer (1982:233f) state, these consonants harmonize with the vowel to the left in some words with disharmonic vowels, too; and they exhibit disharmonic behavior in some words where the vowels are harmonic. Thus, consonant backness harmony in Turkish cannot be regarded as evidence for vowel harmony going from segment to segment. The consonant pattern must be treated as a separate phenomenon and is no biproduct of vowel harmony.

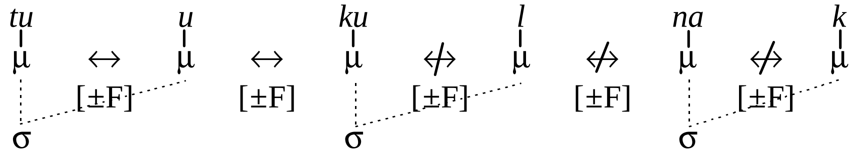
In Yucatec and Ainu, the relevant category has been identified above as the mora. Consider in this respect the Turkish word *yüzdürmek* 'to skin an animal' and the Yucatec word *tuukulnak* 'might think' in (22) and (23). As indicated in (22), assimilation (symbolized by ↔) proceeds from syllable to syllable in Turkish and is not interrupted by coda consonants. In Yucatec, as shown in (23), assimilation goes from mora to mora, and the coda consonant [*l*], constituting a mora, is a blocker. Although vowel features may be coarticulated on consonants, they may not be anchored there in the same way as they are on vowels. Since the mora left-adjacent of the rightmost underspecified vowel (of the suffix -*Vk*) in (23) has no vowel features to be copied, this vowel is left alone and has to be filled according to the language's ranking of V-place constraints. Thus, it turns out as *a*, the least marked vowel in the Yucatec system. The same holds for Ainu, with *e* as the least marked vowel.

(22) Turkish: *yüzdürmek* 'to skin an animal'

| *yüz* | | *dür* | | *mek* |
|---|---|---|---|---|
| σ | ↔ | σ | ↔ | σ |
| | [±back], [±round] | | [±back] | |

[10] An alternative analysis would be that coda consonants in Turkish do not project a mora. This leads to the possibility of describing the three languages as equally applying harmony from mora to mora, with the difference in the language-specific definition of moras (i.e. Turkish coda consonants do not project a mora, but Yucatec coda consonants give additional moraic weight to a syllable). In Turkish place-names (called 'Sezer stems' by Inkelas 1998), however, stress assignment seems to be quantity sensitive (that is, coda consonants count as moraic), whereas in the 'regular' stress pattern the mora plays no role at all (cf. Inkelas 1998 and references cited there), The moraic weight of coda consonants in Turkish place names has no impact on the (non-)harmonic behavior of the vowels of these words. Furthermore, the feet detected as domains of nasal harmony in Kikongo by Piggott (1996) are different from the feet which are relevant for stress assignment in that language. Thus, moraic or syllabic vowel harmony must not be accompanied by the respective quantity-sensitive or -insensitive stress system.

(23) Yucatec: *tuukulnak* 'think' (subjunctive form)




In (22) and (23), the assimilation relation is represented by a bidirectional arrow because at the moment we do not know whether it is spreading, copying or harmony that happens there.

What one observes in natural languages is that one segment corresponds in (certain) feature specifications to another. So there exists a featural correspondence like the one between inputs and outputs, i.e., between underlying representations and surface forms. On the basis of the formulation of the general schema of the IDENT(F) constraint family by McCarthy & Prince (1995:264), cited in (24), I will formalize this kind of correspondence.

(24) The IDENT(F) Constraint Family

*General Schema*

IDENT(F)

Let α be a segment in $S_1$ and β be any correspondent of α in $S_2$.

If α is [γF] then β is [γF].

(Correspondent segments are identical in feature F.)

The concept of featural identity implies that there are segments in underlying forms. The mapping of these segments from the input to the output is provided for by MAX-IO, which demands faithfulness of underlying segments to surface segments. If an underlying segment appears on the surface, MAX-IO is satisfied. But satisfaction of MAX-IO does not involve the mapping of feature values. This is done by the Identity constraints. For a hypothetical segment C, IDENTITY(coronal) (to name c-place) is satisfied if both segments are [αcoronal] for example. IDENTITY(coronal) or IDENTITY(c-place) is violated if one them is [αcoronal] and the other is [βcoronal]. But if MAX-IO is violated for this segment, i.e., when there is no output, then IDENTITY(c-place) can neither be regarded as violated nor as satisfied, because there are no two features to compare. This is illustrated by the tableau in (25).

(25)

| input: C[+lab, +plos, +voice]<br>output candidates: | MAX-IO | IDENT (labial) | IDENT (high) | IDENT (plosive) | IDENT (voice) |
|---|---|---|---|---|---|
| ☞ C[+lab,+plos,+voice] | | | | | |
| C[-lab,+plos,+voice] | | * | | | |
| C[+lab,-plos,+voice] | | | | * | |
| C[+lab,+plos,-voice] | | | | | * |
| ∅ ('null-parse') | * | | | | |

Ident(labial) for example is violated in tableau (25) when the feature specifications of input segment and output candidate are not the same; Ident[high] is never violated, because there is no height feature in the input, and, thus, no identity relation. In case of the null-parse, no Identity violations can be detected, bacause there are no features in the output which should be identical to the input feature specifications.

Featural identity of vowels which are moraically or syllabically adjacent in an output string can be formulated as in (26).

(26) SURFACE-IDENTITY(F) (S-IDENT, general schema): [11]
Let $\alpha$ be a vowel in *syllable/mora* 1 and $\beta$ be any correspondent of $\alpha$ in *syllable/mora* 2.
If $\alpha$ is [$\gamma$F] then $\beta$ is [$\gamma$F].
('A vowel has to have the same value for a feature F as the vowel in the adjacent syllable or mora.')

This constraint enables the feature specifications of vowel *x* in syllable/mora 1 to license the same features borne by vowel *y* in syllable/mora 2. If the feature specifications of a vowel are underlyingly unspecified, the surface candidate which has the same feature values as a neighboring vowel will not have the respective DEP-feature violations, because the vowel's feature specifications are licensed by a correspondence relation, and thus it is better than a vowel without feature specifications licensed in this way. For this purpose, the DEP constraint schema has to be defined less strictly than it was originally by McCarthy & Prince (1995:264) with its restriction on input-output relations. I will use it in the way stated in (27).

(27) DEP-X: Every x in the output has to be licensed by a correspondence relation.

In languages which allow sonorant consonants in syllable peaks or those which project a mora on coda consonants, there may be a segment in a syllable or mora next to a hypothetical vowel with the feature F, which does not bear this vocalic feature F. If this happens, the constraint is vacuous, because there cannot be any correspondence regarding the value of F if only one segment bears F. Neither can there be any surface correspondence when both segments are underspecified for F. In this case both will turn out with the unmarked value for F. Tableau (28a) illustrates the argument given above by showing that the constraint is violated whenever two segments in the right surface structure (i.e., neighboring moras in this case) have a feature in common but not the same value for it, and that the constraint is satisfied under this circumstances when both segments agree in feature specification. (28b) illustrates that it is vacuous whenever two elements in the right environment do not both have a feature F.

[11] In the remainder of this paper, constraints of this kind (Surface-Identity) will be abbreviated as S-IDENT$_{\sigma/\mu[\text{feature}]}$, where the subscript $\sigma$ or $\mu$ indicates whether the particular correspondence relation holds for syllables or moras. Within the square brackets, the feature is given which is affected by the correspondence relation.

(28) a.

| /$V_{[\alpha F]}$...$V_{[\beta F]}$/ | S-IDENTμ(F) |
|---|---|
| μ μ <br> $V_{[\alpha F]}$ ... $V_{[\beta F]}$ | * |
| μ μ <br> $V_{[\alpha F]}$ ... $V_{[\alpha F]}$ | |
| μ μ <br> $V_{[\beta F]}$ ... $V_{[\alpha F]}$ | * |
| μ μ <br> $V_{[\beta F]}$ ... $V_{[\beta F]}$ | |

b.

| /$C_{[\alpha P]}$...$V_{[\beta F]}$/ | S-IDENTμ(F) |
|---|---|
| μ μ <br> $C_{[\alpha P]}$ ... $V_{[\beta F]}$ | |
| μ μ <br> $C_{[\alpha P]}$ ... $V_{[\alpha F]}$ | |
| μ μ <br> $C_{[\beta P]}$ ... $V_{[\alpha F]}$ | |
| μ μ <br> $C_{[\beta P]}$ ... $V_{[\beta F]}$ | |

There are two possibilities to violate this constraint, first, if an underlyingly specified feature surfaces with its underlying specification instead of the one required by S-Ident (I would call this 'accidental' violation), secondly if the feature surfaces with the opposite value (i.e. always α instead of β). The intuitively most straightforward way is the latter option, i.e. to let features not agree. This yields disharmonic patterns. The feature in question is 'copied' with the opposite value. *S-IDENT has to be formulated as in (29).[12]

(29) *SURFACE-IDENTITY (preliminary general schema):

Let α be a vowel in *mora/syllable* 1 and β be any correspondent of α in *mora/syllable* 2.

If α is [γF] then β is ***not*** [γF].

Highly ranked, this constraint produces sequences of, e.g., high-nonhigh-high-nonhigh vowels if [±high] is the feature referred to by F.

(30) $CV_{[+F]}CV_{[-F]}CV_{[+F]}CV_{[-F]}CV_{[+F]}$

Unfortunately, this would override any kind of harmony.

Here, some basic remarks about the notions 'root', 'stem', 'morphological word' etc. are necessary. I assume the morphological hierarchy in (31). McCarthy & Prince (1993) assume a slightly more simplified hierarchy, where no difference is made between derivational and inflectional affixation. This would ignore obvious differences in the phonological behavior of derived/composed stems and inflected forms, which can be covered by the hierarchy in (31). The parentheses indicate optionality.

(31) Morphological hierarchy:

Mword = stem (+ inflectional affix(es))
stem = root (+ derivational affix(es))
root = basic lexeme of major lexical category

With this hierarchy as background, one can surmise that there are phenomena or conditions which hold only for roots, or for stems, or for the whole morphological word.

[12] To regard the principled violation of constraints as a possibility or tool of grammar has been proposed by McCarthy (1996) in his analysis of Rotuman phase marking.

The idea that the scope of constraints is not unlimited, but restricted to well-defined domains has been developed by Buckley (1996a,b), in order to account for stress phenomena in Kashaya, which have otherwise been explained by assuming different lexical levels. Following Buckley's ideas, I propose to restrain the S-IDENTITY constraints to a certain morphological domain. Outside of this domain, violations of the constraint are not incurred.

(32) *S-IDENTITY (general schema):
Let α be a vowel in *mora/syllable* 1 and β be any correspondent of α in *mora/syllable* 2.
If α is [γF] then β is ***not*** [γF].
Domain: M-Cat.

Where M-Cat is any morphological category, like root, stem, or morphological word.

To avoid that harmony and disharmony block each other, languages have the choice to restrict the scope of such constraints over the morphological domains, given above. If S-Ident and *S-Ident are restricted to different domains in a language, reflexes of both are expected to be observed, as is the case in Ainu and Yucatec.

Universally undominated LOCALITY requires that only segments in *adjacent* syllables stand in a correspondence relation. This prevents unattested patterns as, for instance, harmony between the first and the third vowel of a word.

(33) LOCALITY: Domains, referred to in correspondence relations, are adjacent.

To analyse adequately the cases in which harmony is blocked in Ainu and Yucatec, and those where an epenthetic vowel is involved in Turkish, a technique is necessary, which chooses the right featural profile of epenthetic or underspecified vowels for which no featural correspondence can be established. I will turn to this last prerequisite of an analysis of harmony and disharmony in the next section.

### 4.4 Remarks on featural epenthesis

To be prepared for the analysis, I will outline some provisional assumptions on the right choice of epenthetic vowels in general and in the three languages which are examined in this paper in particular. The reasons for vowel epenthesis as such will not be considered here. I assume that epenthetic material is chosen according to the language-particular ranking of DEP-F constraints. The reader should keep in mind that the DEP schema has been defined in section 4 without reference to the type of correspondence relation, that may license a feature (i.e., base-reduplicant, input-output or surface correspondence). DEP constraints on vowel features, which are relevant for the choice of the least marked vowel in the examined languages are given in (34).

(34) DEP[F] constraints for vowel features:

| | | |
|---|---|---|
| a. | DEP[+high] | Specification of [+high] in an output has to be licensed by a correspondence relation. |
| b. | DEP[+low] | Specification of [+low] in an output has to be licensed by a correspondence relation. |

c. DEP[+back] Specification of [+back] in an output has to be licensed by a correspondence relation.
d. DEP[+round] Specification of [+round] in an output has to be licensed by a correspondence relation.
e. DEP[mid] Local conjunction of DEP[-high] & DEP[-low]: Specification of [-high, -low] within one segment must be licensed by a correspondence relation.

All DEP(F) constraints are actually a pair of constraints, one for the positive, one for the negative feature specification, which always have to be ranked according to Paninian Ranking (cf. Prince & Smolensky 1993) (i.e. DEP[+F] >> DEP[-F]). Only DEP[mid] has no counterpart, because it is no constraint on a phonological primitive. It is rather a local conjunction of two independent DEP constraints.[13] Local conjunction is understood by Smolensky (1993, 1995) as a constraint which is violated only if all of its conjunct constraints are violated within a certain domain. Here, the domain is the segment. This constraint plays a role in Yucatec and Turkish, because the former exhibits an [*a*] as the vowel with epenthesised features, the latter a high vowel (which alternates in backness and roundness, see section 5). (Recall that in Ainu an [*e*] surfaces when harmony and disharmony are blocked.) The DEP(F) constraints on roundness play no crucial role in Ainu and Yucatec, since they are predictable in these languages. Turkish has [± round] as an active feature, so it has to be considered for this language. The rankings in (35) determine the choice of the epenthetic vowel in the three languages under examination.

(35) Ranking for the investigated languages:
a. Ainu: DEP[+back], DEP[+high], DEP[+low] >> DEP[-high], DEP[-low], DEP[-back], (DEP[mid])
b. Yucatec: DEP[+back], DEP[+high], DEP[mid] >> DEP[-back], DEP[-high], DEP[+low], DEP[-low]
c. Turkish: DEP[+back], DEP[+low], DEP[mid] >> DEP[-back], DEP[-low], DEP[+high], DEP[-high],

In the tableaux in (36), (37) and (38), the evaluation is illustrated.

(36) Evaluating the least marked vowel for Ainu:

| | DEP[+back] | DEP[+high] | DEP[+low] | DEP[-high] | DEP[-low] |
|---|---|---|---|---|---|
| *o* | *! | | | * | * |
| *u* | *! | * | | | * |
| *i* | | *! | | | * |
| *a* | (*?) | | *! | * | (*?) |
| ☞ *e* | | | | * | * |

---

[13] The same effect might either result from positing a primitive cooccurrence constraint *[-high, -low], which prohibits the negative specification of the two features within a segment. Both strategies have the advantage, that no primitive feature [±mid] has to be assumed, and that antipaninian ranking is avoided.

Whether the vowel *a* in tableau (36) violates DEP[+back] or DEP[-back] is unclear because, in Ainu, the vowel behaves sometimes as front, and sometimes as back (see section 3).

(37) Evaluating the least marked vowel for Yucatec:

| | DEP [+back] | DEP [+high] | DEP [mid] | DEP [-back] | DEP [-high] | DEP [+low] | DEP [-low] |
|---|---|---|---|---|---|---|---|
| *o* | *! | | * | | * | | * |
| *u* | *! | *! | | | | | * |
| *i* | | *! | | * | | | * |
| *e* | | | *! | * | * | | * |
| ☞ *a* | | | | * | * | * | |

(38) Evaluating the least marked vowel for Turkish:

| | DEP [+ro] | DEP [+back] | DEP [+low] | DEP [mid] | DEP [-ro] | DEP [-back] | DEP [-low] | DEP [+high] | DEP [-high] |
|---|---|---|---|---|---|---|---|---|---|
| *o* | *! | * | | * | | | * | | * |
| *ö* | *! | | | * | | * | * | | * |
| *u* | *! | * | | | | | * | * | |
| *ü* | *! | | | | | * | * | * | |
| *a* | | *! | * | | * | | | | * |
| *ɨ* | | *! | | | * | | * | * | |
| *e* | | | | *! | * | * | * | | * |
| ☞ *i* | | | | | * | * | * | * | |

In the next sections, I will illustrate the ideas outlined in section 3 by concretely applying them, first to Turkish, then to Ainu and Yucatec, discussing technical problems and details which emerge in the respective language.

## 5 Vowel harmony and disharmony in Turkish

Having provided the theoretical background for the treatment of vowel harmony, I will now return to the Turkish data, to exemplify the proposed constraint schema. The constraints relevant for labial and palatal harmony can be formulated as in (39).

(39) S-IDENTITY for backness:
Let α be a vowel in *syllable* 1 and β be any correspondent of α in *syllable* 2.
If α is [γback] then β is [γback].
('A vowel has to have the same backness specification as the vowel in the adjacent syllable.')

(40) S-IDENTITY for roundness:
Let α be a vowel in *syllable* 1 and β be any correspondent of α in *syllable* 2.
If α is [γround] then β is [γround].
(A vowel has to have the same roundness specification as the vowel in the adjacent syllable.)

In tableau (42), the regular case of Turkish vowel harmony is shown, involving only backness harmony in this particular example. To avoid roundness harmony affecting nonhigh vowels, I assume a feature co-occurrence constraint which bans segments that are [-high] and [+round] (*LORO), and which has to be ranked above the S-Ident constraints that license harmony. This is largely the same as feature cooccurrence restrictions like *[-high, +round] as proposed by Kirchner (1993) and many others.

(41) *LORO: Don't produce segments that contain [-high] and [+round].
(Local conjunction:[14] *[-high] & *[+round])

This constraint has to rank below Identity feature constraints, because Turkish has the vowels *o* and *ö*.[15] Identity feature rules out the candidates which are not faithful to the input with regard to the height of the vowel in the affix (a), and the one which is not faithful with regard to the height and roundness of the vowel of the root (d). The latter candidate would be optimal if the S-Identity constraints ranked above the other constraints considered.

(42) Turkish *yüzler* 'faces'

| | *\/yüz+lV$^{[-high]}$r/* | IDENT(F) | *LORO | S-IDENT σ[back] | S-IDENT σ[round] |
|---|---|---|---|---|---|
| | a. *yüzlür* | *! | | | |
| | b. *yüzlar* | | | *! | * |
| | c. *yüzlör* | | *! | | |
| | d. *yezler* | *!* | | | |
| ☞ | e. *yüzler* | | | | * |

In tableau (43), a slightly more complex case is exemplified. Here, it can be seen that harmonic features do not spread from the root to affixes. Locality crucially rules out candidate (c) in which the vowel of the second affix surfaces with the same backness and roundness specifications as the vowel of the root. [+round] harmony skips the medial vowel in this candidate and proceeds beyond it.

---

[14] On the notion of constraint conjunction, see section 4.4.

[15] Obviously, this treatment is not quite appropriate, since the vowels /o/ and /ö/ only surface in initial syllables in the native vocabulary. The exclusion of nonhigh vowels from labial harmony and this limited occurrence of *o* and *ö* might be caused by wellformedness constraints on higher prosodic structures. For the purpose of this paper, the stipulated co-occurrence constraint suffices to capture the data.

(43) Turkish *yüzlerin* 'faces'(genitive)

| /*yüz+lV*$^{[-high]}$*r+Vn*/[16] | LOCALITY | IDENT(F) | *LORO | S-IDENT σ[back] | S-IDENT σ[round] |
|---|---|---|---|---|---|
| a. *yüzlürün* | | *! | | | |
| b. *yüzlörün* | | | *! | | |
| c. *yüzlerün* | *! | | | | ** |
| ☞ d. *yüzlerin* | | | | | ** |

The Identity feature constraints involved so far, which have to be ranked above the S-Identity constraints, are constraints on height, banning the nonhigh vowels from participating in roundness harmony.

The ranking of constraints that is necessary to account for the Turkish data so far is given in (44).

(44) LOCALITY, IDENT[high] >> *LORO >> S-IDENT$_{σ[back]}$, S-IDENT$_{σ[round]}$

As there are various words and affixes in Turkish with vowels which do not participate in labial and palatal harmony, we have to assume that harmony only operates on underspecified vowels, and that the Identity constraints for the features which are active in vowel harmony rank above the S-Ident constraints.[17] Vowels of most loanwords are analyzed by speakers of Turkish as fully specified, and, in some instances undergo reanalysis to underspecification. In the latter case, they participate in harmony, but not always to the full extent (compare (45)). With the assumptions 1) that IDENT(F) constraints are ranked above S-IDENTITY, and 2) that roundness and backness specifications may be reanalyzed from specified to unspecified, one can explain the alternations in pronunciation in (45). The disharmonic forms in the left column are Standard Turkish; the forms in the second column are dialectal variations.

(45) ‘Regularized’ disharmonic loans

| | | |
|---|---|---|
| *komünizim* | *kominizim* | ‘communism’ |
| *mersörize* | *merserize* | ‘merserize’ |
| *külot* | *kilot* | ‘panties’ |
| *bisküvit* | *büsküvüt* | ‘biscuit’ |
| *püro* | *puro* | ‘cigar’ |
| *nüzul* | *nüzül* | ‘paralysis’ |
| *nüfus* | *nufus* | ‘population’ |
| *kupür* | *küpür* | ‘denomination, clipping’ |

[16] Suffixes with alternating high vowels are usually symbolised as capital I or U in the turkological literature. Since in this approach (see section 4.4) the height of underspecified vowels falls out by the ranking of DEP(F) constraints, only alternating vowels which occur as nonhigh (standardly symbolized as E) must be prespecified for [-high]. The others can be reduced underlyingly to empty V.

[17] This reflects to a certain degree the position of Clements & Sezer (1982), who state that harmony is synchronically no longer active in Turkish roots.

| | | | |
|---|---|---|---|
| *motör* | *motor* | 'engine, motorboat' | |
| *şoför* | *şöför* | 'driver' | |
| *sövalye* | *sovalye* | 'knight' | [Clements & Sezer 1982; Kirchner 1993:2] |

Disharmony occurs not only in loans and some affixes. Native Turkish roots show disharmonic vowels as well (see (6) above and the lists in Clements & Sezer (1982), van der Hulst & van de Weijer (1991)).

In the preceding paragraphs, I have proposed to analyse Turkish harmony as structure-filling, not structure-changing. General considerations on vowel systems predict that the two features [back] and [round] are good candidates for underspecification, since in the classical five vowel system (as in Ainu and Yucatec, or e.g. Spanish) front vowels are never round and all back vowels (except /a/) are round. If one leaves such a system entirely unspecified for either roundness or for backness, one gets the right surface values by feature co-occurrence constraints. I will not go into the technical details here. For the present analysis, it is not relevant whether nonhigh vowels are excluded from participation in labial harmony by (redundant) prespecification of their roundness value, or by general feature co-occurrence constraints like *LORO (as in Kaun 1994 for example).[18] The case is different for vowels in the suffixes *-Vyor* and *-Vstan*, which do not participate in palatal (backness) harmony. Here, the nonalternating vowels *o* and *a*, respectively, have to be fully specified, because they do not undergo harmony.

The affix *-Vyor* also constitutes evidence for relative directionality of feature interaction. Why should the first vowel of this affix not agree with its second vowel instead of with the one to its left (i.e., the root vowel)? That faithfulness to underlying root material ranks higher than faithfulness to the lexical specification of affixes, as proposed by McCarthy & Prince (1995) in discussion of another topic, seems to play no role here, since, in Turkish, some stem-final consonants assimilate to the following vowel in backness (see van der Hulst & van de Weijer (1991) for examples and discussion). One might speculate that harmony is not an issue of simple surface-surface correspondence, but of 'stem-affix correspondence'. But this view would fail to explain why in many languages roots are harmonic internally, too, or why in Turkish *gel-iyor-um* 'I am coming', for instance, the last affix corresponds in roundness and backness to the adjacent affix, and not to the root.

In order to capture the tendency of Turkish vowels to harmonize from left to right, an additional device has to be invoked. This device is found in anchoring (McCarthy & Prince 1995, 1996). The relevant anchoring constraint is stated by me informally below.

(46) $\text{ANCHOR}_L$ (feature, segment, left):
The leftmost output correspondent of an underlying feature F is associated to the segment to which the feature is associated underlyingly.

This constraint ensures that all surface correspondents of a feature are located to the right of or on the segment to which the feature is linked underlyingly. I assume a parallel $\text{ANCHOR}_R$ constraint for all features. Ranked highly, both constraints together conspire

[18] For an argumentation for underspecification of roundness, or better anything but height in these vowels see below in the discussion of epenthesis and footnote 16.

against any harmonic behavior. (This is quite similar to the assumption that Cole & Kisseberth (1994:103) express by their notion of basic alignment.) Tableau (47) below illustrates the effect of the proposed ANCHOR$_L$ constraint. In tableau (47), the S-IDENT constraints are not decisive. The decision between candidates (a-d) is made by the anchor constraint, which rules out right-to-left assimilation in favor of left-to-right assimilation. The last candidate, (e), is the most harmonic form (but not with regard to constraint satisfaction), in which all vowels harmonize with the first vowel, satisfying ANCHOR$_L$ and S-IDENT. It violates featural identity, and this candidate is excluded by the ranking of IDENT(F) for [back] and [round] above S-IDENT. Changing underlying /o/ from [+back, +round] to [-back, -round] for the sake of harmony and directionality, violates the Identity constraints for these features. Thus, the /o/ remains unchanged. (The ranking of IDENT(F) with regard to the other constraints involved, like ANCHOR$_L$ and DEP-F is not possible with the data available.) What is clear is that full specification blocks harmony, and left anchoring of features determines the direction of harmony.

(47) Turkish *geliyorum* 'I am coming'[19]

| */gel-Vyor-Vm/* | IDENT[round] | IDENT[back] | ANCHOR$_L$ | S-IDENT$_{σ[bck]}$, S-IDENT$_{σ[ro]}$ |
|---|---|---|---|---|
| a. *gel-**u**yor-um* | | | *! | ** |
| b. *gel-**ɨ**yor-um* | | | *! | ** |
| c. *gel-**ü**yor-um* | | | *! | ** |
| ☞ d. *gel-**i**yor-um* | | | | ** |
| e. *gel-**iye**r-**i**m* | *! | *! | | |

Next, I will proceed to leftward harmony, which occurs in Turkish when a vowel position has to be epenthesized left of the initial underlying vowel.

A vowel that is inserted as the leftmost vowel in a word, copies backness and roundness features from its neighbor to the right. In any other position, if features are available from the left, epenthetic vowels prefer these. These patterns may result from the need to avoid DEP(F) violations. Moreover, it can be seen from epenthesis that the active SURFACE-IDENTITY constraints solely affect the features [round] and [back] in Turkish, and not height, because the epenthetic vowel is always high.

(48) Turkish epenthesis:

| | | | |
|---|---|---|---|
| a. *grup* | b. *gurup* | 'group' | |
| *kral* | *kɨral* | 'king' | |
| *prens* | *pirens* | 'prince' | |
| *smok'in* | *sɨmok'in ~ simok'in* | 'dinner jacket' | |
| *kres* | *kɨres* | 'creche' | [Clements & Sezer 1982:247] |

The forms in column (a) in (48) are pronounced in careful speech, while the forms in (48b) are judged as colloquial. The tableau in (49) illustrates the high ranking of DEP[round] and DEP[back] even above ANCHOR$_L$. If one assumes further that DEP[high] is ranked rather low (with DEP[+high] >> DEP[-high]), as outlined in 4.4, the height of

[19] In this and all following tableaux, I will omit LOCALITY and mark only S-Ident violations of vowels in adjacent syllables or moras.

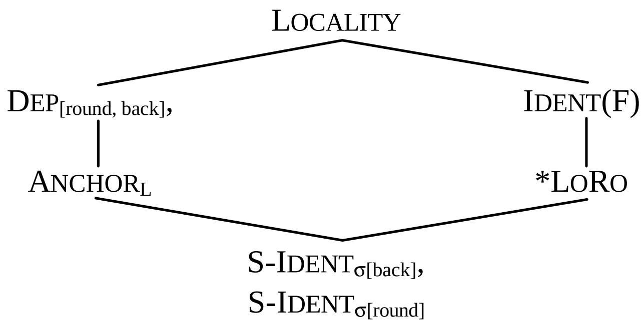
the epenthetic vowel and of many harmonic vowels (like the first one in the suffix -*Vyor* above) falls out automatically. Thus, vowels participating in backness and roundness harmony in Turkish can be analysed as completely underspecified, whereas those only participating in backness harmony must be regarded as prespecified for [-high]. Returning to tableau (49), in the optimal candidate, the requirement to avoid DEP[round, back] violations is solved by licensing [+round] and [+back] specifications through S-IDENT in violation of $\text{ANCHOR}_L$. The result is right-to-left assimilation, which is otherwise banned.

(49) Turkish *gurup* 'group'

| /*grup*/ | DEP [+round], [+back] | DEP [-round], [-back] | $\text{ANCHOR}_L$ | S-$\text{IDENT}_{\sigma[bck]}$ | S-$\text{IDENT}_{\sigma[ro]}$ | DEP [+high] |
|---|---|---|---|---|---|---|
| ☞ a. *gurup* | | | * | | | * |
| b. *gɨrup* | *! | * | * | | * | * |
| c. *gürup* | *! | * | * | * | | * |
| d. *girup* | | *!* | | * | * | * |

The diagram in (50) reflects the ranking of Turkish. IDENT(F) is not ranked crucially with respect to $\text{DEP}_{[\text{round, back}]}$ and $\text{ANCHOR}_L$, but they all are ranked above the given S-IDENT constraints.

(50) Turkish Ranking:




The assumed constraints and their ranking provide an adequate analysis of the Turkish facts. I have shown that that featural IDENTITY constraints are ranked above S-IDENTITY constraints in Turkish. The analysis works under the premise that nothing but alternating structure is underspecified and other structures are fully specified in underlying forms, as proposed by Inkelas (1994). With these insights into the analysis of harmony in mind, I will now turn to Ainu and Yucatec to show differences in the language-particular ranking of the proposed constraints.

## 6 An analysis of Ainu and Yucatec

In this section, I will give a detailed account of the patterns found in Ainu and Yucatec. First, in subsection 6.1, I will explore the analysis of harmony in these languages, in subsection 6.2 I will be concerned with the absence of harmony (i.e. conditions on blocking) and finally, in 6.3, I will give an account of the disharmonic patterns.

### 6.1 Generating harmony in Ainu and Yucatec

As I exemplified in section 3, Ainu and Yucatec both display affixes which contain a vowel that surfaces with the feature specification of the root vowel. This pattern can be blocked by consonants in coda position in Yucatec and by diphthongs in Ainu. Furthermore, both languages have disharmony. In Ainu, disharmony occurs when the stem has an unassociated height feature, in Yucatec it occurs with a stem-forming affix.

The Yucatec and Ainu harmony facts can be accounted for mostly by the same constraints as those proposed for Turkish. The relevant adjacent domains are moras, instead of syllables, as mentioned in sections 3 and 4. An indication for the relevance of the mora in Yucatec may be seen in the fact that the language distinguishes between short and long vowels. Unfortunately, Yucatec stress patterns have not been examined yet. Tozzer (1921/1977:27f) wrote that accent is in part dependent on the length of the vowel, but also that "the rythm is very irregular and it is impossible to ascertain the general scheme of long and short syllables" (p. 28). Roots are normally CVC in shape, and affixes VC. This yields an overall pattern of open syllables, and an obligatory consonantal coda (yielding a closed syllable) at the right edge of words (provided for by *h* or *ʔ* epenthesis if necessary). Ainu historically had phonemic vowel-length, but lost it. For accentuation, a vowel in open syllables, i.e., light V or CV, gets lengthened; in closed syllables, i.e. (C)VC or (C)VG (G=glide) syllables, lengthening does not occur (Dettmer 1989:43f). This is a clear hint on the moraic status of codas in Ainu.

In Turkish, only the features [round] and [back] were subject to harmony. In Ainu and Yucatec, at first sight *all* features are involved, since harmony consists of total correspondence. From the vowel inventory we know that roundness or ATR play no role in these languages. Roundness is predictable. So the remaining features which are relevant for harmony are [±high], [±low] and [±back]. Underspecification of the affected vowels has to affect only these three features as well, because in the case of blocking of harmony, the relevant vowel surfaces as the default one in the particular language. Furthermore, the underspecified/harmonizing vowels do not alternate in length in Yucatec, which is distinctive there. The S-IDENTITY constraint can be formulated as follows.

(51) Moraic SURFACE-IDENTITY (S-IDENT$_{\mu[b,h,l]}$):
Let α be a vowel in *mora* 1 and β be any correspondent of α in *mora* 2.
If α is [γback], [δhigh], [εlow] then β is [γback], [δhigh], [εlow].

In Ainu and Yucatec, harmonic patterning is restricted to a handful of affixes. Consequently, S-IDENTITY has to be ranked below the relevant IDENT(F) constraints, as was the case for Turkish; see (52). Lexical entries have to be fully specified, except for alternating structure.

(52) IDENT(F) >> S-IDENT$_{\mu[b,h,l]}$

Harmony or, in case of its blocking, featural epenthesis is triggered by the need to parse a segment of the input, forced by the constraint MAX-IO, (McCarthy & Prince 1995:264) which is ranked above DEP(F) constraints (I will give a more detailed analsysis of epenthesis below in the discussion of blocking). Furthermore, satisfying S-IDENT avoids DEP(F) violations, because every feature that is specified in correspondence to another output segment counts as licensed on grounds of the definitions given in section 4.

(53) MAX-IO: Any segment in the input has a correspondent in the output.

The effect of the proposed constraints is shown in the tableaux below for Yucatec. (For Ainu, the analysis is similar.)

(54) (Under-)specification and harmony in Yucatec:

| i. */lub'-Vl/* | IDENT(F) | S-IDENT$_{\mu[F]}$ | MAX-IO |
|---|---|---|---|
| a. *lub'al* | | *! | |
| b. *lub'el* | | *! | |
| c. *lub'ol* | | *! | |
| d. *lub'il* | | *! | |
| e. *lub'l* | | | *! |
| f. ☞ *lub'ul* | | | |

| ii. */tsol-ik/* | IDENT(F) | S-IDENT$_{\mu[F]}$ | MAX-IO |
|---|---|---|---|
| a. *tsolok* | *! | | |
| ☞ b. *tsolik* | | * | |
| c. *tsolak* | *! | * | |

The candidate *lub'ul* in (54), which is chosen as optimal, has no DEP[F] violation at all, since a correspondence relation between all vowels in adjacent moras is established in satisfaction of S-IDENT. Hence, the *u* of the suffix corresponds to the *u* of the stem, and DEP[F] violations result only from features that are filled in without being subject to a correspondence relation.

In (54ii), IDENT(F) rules out the candidate form that overrides underlying feature specifications. This is crucial for fully specified elements, because in order to satisfy IDENT(F), S-IDENTITY, which demands that a vowel should look like the one in the next mora, has to be violated. MAX-IO prohibits skipping the featureless segment in the output (form (e)), which would leave all other constraints unviolated. The ranking of MAX-IO is not relevant. It is crucial that it is located above any kind of DEP constraint. For Ainu harmony, the ranking is the same. The candidates in(54i.a) and (54ii.c) contain the epenthetic vowel. In (54ii), it is trivially ruled out because its feature specifications violate IDENT(F). In (54i), the epenthetic candidate is odd, because it violates S-IDENT. Its features do not correspond to those of the vowel in the neighboring mora.

I turn to the evaluation of harmony blocking now.

## 6.2 Blocking and directionality

In this section, I will provide an analysis for the cases in which harmony does not have a surface reflex. Furthermore, I will explore the case where correspondence with the vowel to the left is blocked, but a correspondent is available to the right. In this case, no featural correspondence is observed either.

One necessary ingredient for the difference between Ainu and Yucatec has to be the analysis of the correct vowel for the underspecified suffixes when harmony is blocked. An important part of this task has been done already in section 4.4, where an analysis of the choice of the right epenthetic vowels in the three languages examined in this paper was given.

As pointed out in section 4, S-IDENTITY is satisfied vacuously when one of the moras (or syllable peaks) in question is occupied by a consonant because, in this case, there are no features to correspond. In tableau (55), S-IDENTITY indeed plays no role at all, because it refers to *vowel features* in the mora adjacent to a vowel. In the case of the underspecified vowel in *tuukulnVk*, there are no such features because the mora in question is occupied by a consonant, namely *l*. This consonant gets its moraic weight by being parsed in coda position (see below for a discussion of this point). Being faithful to the features of *l* would transform the underlying empty vowel into a surface consonant, causing problems of syllabification (as the sequence *nlk* of the hypothetical output *tuukulnlk*, with copied *l* features is not a good syllable in Yucatec and in most other languages). MAX-IO prohibits underparsing of the segment in question. For the candidates that realize the segment, ranking and violations of DEP(F) are crucial in (55). Candidate (b) violates DEP[+high] and DEP[+back] by filling in the features of [u] in the suffix vowel, while candidate (c) (note that both, (b) and (c) contain a *u* in the suffix) disregards the limit of S-IDENTITY by corresponding to features located beyond its prosodic scope, i.e., the features of the last *u* of the stem. Actually, this should be registrated as a violation of LOCALITY, which I omitted here.

(55) Evaluating vowel harmony when there is none in Yucatec:

| */tuukul+n+**V**k/* | IDENT (F) | S-IDENT$_{\mu[F]}$ | MAX-IO | DEP [+back] | DEP [+high] | DEP [mid] | DEP [+low] |
|---|---|---|---|---|---|---|---|
| a. *tuukuln**o**k* | | | | *! | | * | |
| b. $tuuku_1ln\mathbf{u}_2k$ | | | | *! | * | | |
| c. $tuuku_1ln\mathbf{u}_1k$ | | *! | | | | | |
| d. *tuukulnk* | | | *! | | | | |
| e. *tuukuln**i**k* | | | | | *! | | |
| f. *tuukuln**e**k* | | | | | | *! | |
| g. ☞ *tuukuln**a**k* | | | | | | | * |

In the case when a vowel-initial suffix is attached to a stem ending in a diphthong or a glide, respectively, the semivowel is syllabified as a consonantal onset. In this position, it does not bear a mora, and is thus no obstacle for assimilation of the suffix vowel, as illustrated in (56). When another consonant intervenes between the glide and a suffix vowel, assimilation is blocked; see the example in (57).

(56) Yucatec participle formation of positionals with affix *-Vkb'al*[20]

| | |
|---|---|
| *tʃuy-ukb'al* | 'hanging' |
| *hay-akb'al-en* | 'I am stretched out' |
| *k'eb'-ekb'al-en* | 'I am leaning' |
| *tʃil-ikb'al-en* | 'I am lying down' |
| *ʃol-okb'al-en* | 'I am kneeling' |
| *kul-ukb'al-en* | 'I am sitting' |

(57) Blocking of harmony in Yucatec

a. *káʔah* *tʃu**y**-**l**-**a**k-en*
occur hang-POS-SUBJ-1.SG
'I might hang.'

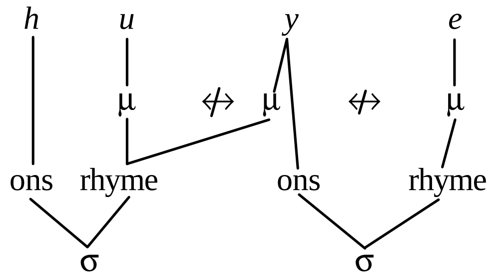
One can state that even though consonant epenthesis occurs under pressure of ONSET in Yucatec (realized as a glottal stop), it is avoided when possible, i.e. when a potential onset is available. I assume that in Yucatec codas are parsed into moraic structure (see section 6.1). This is accounted for by ranking CodaMoraicity (Davis 1998) or WEIGHT-BY-POSITION (Baker 1997, following Hayes 1989) over DEP-μ. I follow Baker (1997), who states that vowels are assigned moras universally by GEN, while consonants get moraic weight by the above ranking. ONSET ensures syllabification of root- or affix-final consonants into the syllable of the following vowel-initial suffix. Thus, real diphthongs do not exist in Yucatec. No mora is assigned to the glide, with the result that the vowel of the root (the 'ex-diphthong') and the suffix (the underspecified vowel), are parsed into adjacent moras, and, as a consequence of this, yield vowel harmony. In (57), the glide is in coda position, while the following consonant *l* is parsed as onset of the underspecified suffix. Since the glide's features must be assumed to be consonantal by nature, harmony is blocked. In this pattern of syllabification and mora-assignment, one crucial difference between Yucatec and Ainu emerges. In Ainu, diphthongs must be assumed to be bimoraic underlyingly, while in Yucatec vowel-glide sequence get their second mora in the way described above. This is the reason why in Ainu (dis)harmony is blocked.

As was shown in section 3, after a vowel-glide sequence, both harmony and disharmony are blocked in Ainu. Unfortunately, the Ainu patterns of syllabification are not treated extensively in the literature available. Onset epenthesis is observed in syllables bearing stress and between vowels, i.e., to avoid hiatus. On the other hand, resyllabification between consonant-final roots or words and vowel-initial affixes or words is observed, but not consistently. According to Dettmer (1989), younger speakers tend to avoid onset epenthesis, which is interpreted as an influence from Japanese. All in all, the sources cited by Dettmer are somewhat inconsistent on where exactly epenthesis occurs. This is most intriguing where diphthongs are concerned. On the one hand, the authors cited in Dettmer do not agree whether the latter part of the falling diphthongs consists of a vowel or a glide (this results in different transcriptions, e.g., *ui* vs. *uy*). In kana transcription, a sequence like *sey* 'mussel'+*o* 'plenty of it inside' plus *pet* 'river' (*seyo pet* 'river plentiful of mussels') is transcribed as *se-yo* (Dettmer 1989:38). This may be

[20] The status and the function of the affix *-Vkb'al* may be controversial, because it is not clear whether it is derivational or inflectional in nature. For the sake of the current argument, I will treat it as an inflectional affix.

due to the nature of kana as a syllabic writing system without signs for heavy syllables, or it may be a hint on syllabification. However, for the reasons oulined so far, it would be expected that the diphthong is kept. There are several possibilities to achieve this: A glottal stop could be inserted before the vocalic affix; or the syllable containing the affix could be onsetless. The most plausible alternative is that the glide is in fact ambisyllabic. This means that diphthongs are underlyingly bimoraic in Ainu (in contrast to Yucatec, where they get their second mora in order to satisfy requirements of the constraint component CON), and that the second mora has to be kept. This leads to the required bimoraic syllable ending in a consonantal segment (the glide, which is in coda and onset position likewise, and which has to be a consonant to fill the onset appropriately), which prevents the following vowel from (dis)corresponding in features with the root vowel. The analysis of diphthongs and syllabification is illustrated in (58). See also (20) in section 4.2 for a comparison of Ainu and Yucatec on this behalf.

(58) Ainu: *huye* 'to observe something.'




With this syllabification, the analysis as given for Yucatec holds for these data too, with the additional difference in the ranking of DEP(F) constraints in Ainu as proposed in (35a) and (36) which yields *e* as the default vowel.

Directionality has played no role in the analysis so far, as the underspecified elements have been in word-final affixes. But for Yucatec, directionality is crucial. Affixes marking person and number potentially follow the subjunctive marker -*Vk*, as can be seen in (59a,b).

(59) Blocking and directionality of harmony in Yucatec

a. *káʔah tʃuy-l-ak-en*
occur hang-POS-SUBJ-1.SG
'I might hang.'

b. *káʔah tʃuy-l-ak-óʔob'*
occur hang-POS-SUBJ-PL
'They might hang.'

When harmony is blocked by a preceeding consonant cluster (as in (59a,b)), the vowel of the subjunctive affix should copy the features of the following vowel, if harmony were not restricted in directionality. But it does not, as shown in example (59). Here, a similar scenario can be observed as above in the discussion of Turkish, where, e.g., the unspecified vowel in the suffix -*Vyor* is prevented from copying features from the right-adjacent *o*. It must be concluded that the pattern in (59) is a surface effect of the $\text{ANCHOR}_{L}$ constraint in Yucatec, which was proposed in the discussion of Turkish above. From this pattern it can be concluded that $\text{ANCHOR}_{L}$ is ranked above all DEP(F) constraints in Yucatec, in contrast to Turkish, where it is ranked below DEP[round] and DEP[back].

(60)

| | /*tʃuy+l+Vk+en*/ | IDENT(F) | ANCHOR$_L$ | S-IDENT$_{\mu[F]}$ | DEP[back], DEP[high], DEP[mid] | DEP[low] |
|---|---|---|---|---|---|---|
| | a. *tʃu*$_1$*yl***u**$_1$*ken* | | | *!* | | |
| | b. *tʃu*$_1$*yl***u**$_2$*ken* | | | * | *!* | |
| | c. *tʃuyl***e**$_1$*ke*$_1$*n* | | *! | | | |
| | d. *tʃuyl***e**$_1$*ke*$_2$*n* | | | * | *! | |
| | e. *tʃuyl**u**k**u**n* | *! | | | | |
| | f. *tʃuyl**a**k**a**n* | *! | | | | * |
| ☞ | g. *tʃuylaken* | | | * | | * |

One crucial aspect of the tableau in (60) is that ANCHOR$_L$ ranks above S-IDENT, which prevents candidate (c) from winning. Candidates (e) and (f) are ruled out because the underlying feature specifications of the /e/ are not identical to those of the output candidate. Candidate (a) has two violations of S-IDENT, one for establishing a correspondence relation with a vowel that is not in an adjacent mora (the *u* of the stem),[21] and one for not fulfilling correspondence of the underspecified vowel and the vowel *e* in the following mora. The latter constraint violation is also observed in candidate (b), which up to this point, is equally good as the actual winning candidate (g). But in candidate (b), the features [+back] and [+high], which make the underspecified vowel surface as [u] are not licensed by any correspondence relation; they are arbitrarily filled in, causing fatal DEP(F) violations. Candidate (d) is also no possible analysis. The *e* as a surface form of the underspecified vowel is not licensed, yielding a DEP[mid] violation which is fatal.

I will now advance to the next section, where the analysis proposed so far will be extended to disharmony.

### 6.3 Generating disharmony

The basic idea for analyzing the disharmonic patterns described in section 3 is to regard them as principled violations of the S-IDENTITY constraints, as formally proposed in section 4. This constraint schema is repeated in (61).

(61) S-IDENTITY (general schema):
Let α be a vowel in *mora/syllable* 1 and β be any correspondent of α in *mora/syllable* 2.
If α is [γF] then β is [γF].
Domain: M-Cat.

In section 3, it was pointed out that the disharmonic affixes in both languages were stem forming, i.e. derivational. In Yucatec, the only stem formant containing a vowel, -*kV*$^{[+high]}$*n*-, is subject to backness disharmony, whereas inflectional affixes with

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[21] This may actually be counted likewise as a violation of undominated LOCALITY. In any case, the candidate loses.

underspecified vowels, *-Vl*, *-Vk*, are subject to complete harmony. In Ainu, the situation is slightly different: The underspecified transitivizer, being by nature a derivational stem-forming affix, was subject to harmony. Only when the root to which it was attached had a nonassociated vowel feature at its right edge (to be realized on the suffix), did the transitivizer surface disharmonically. I suggest that a root edge (or, generally, the edge of any category) is set where the last feature belonging to the root (or to any category in question) is located. Thus, the affix is 'incorporated' into the stem and has to obey the constraints relevant within that domain. This generalization would be problematic in an alignment account where features are stretched out beyond the edges of their underlying domain (e.g., a feature of a vowel in a root is aligned with the edge of a prosodic word), leading to undesired contradictions and complications.[22] In Ainu, *S-IDENTITY holds for roots, in Yucatec for stems. This is expressed in (62) and (63).

(62) *S-IDENTITY (with surface reflexes in Ainu):
Let α be a vowel in ***mora*** 1 and β be any correspondent of α in ***mora*** 2.
If α is [γback] then β is ***not*** [γback].
Domain: **root**.

(63) *S-IDENTITY (with surface reflexes in Yucatec):
Let α be a vowel in ***syllable*** 1 and β be any correspondent of α in ***syllable*** 2. If α is [γback] then β is ***not*** [γback].
Domain: **stem**.

In both languages, these constraints are dominated by Identity feature constraints. The ranking of *S-IDENT with regard to S-IDENT is indetectable in Yucatec, since underspecification is rare and both constraints hold over different prosodic categories and different domains (*S-IDENTσ,stem; S-IDENTμ,Wd). The wide-spread occurrence of long vowels and the complete absence of real diphthongs in the language suggest the extremely low ranking (or absence) of a *S-IDENTμ constraint in this grammar. In Ainu, *S-IDENTμ must dominate the relevant constraints which demand harmony, because both establish correspondence between moras. So satisfaction of S-IDENT in the word would exclude satisfaction of *S-IDENT in the root. However, since the scope of the latter is larger (for Yucatec, Turkish and Ainu the domain of S-IDENT must be the word (morphological or phonological))[23], harmony can be observed on affixes. (A potential *S-IDENTσ must be ranked extremely low in Ainu, showing no effect at all.)

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[22] Suppose, ALIGN (root, R, $F_{root}$, R) exists and is ranked high as proposed here for Ainu. Suppose further, a local conjunction of markedness constraints, which is restricted to roots (*[F]&*[F]$_{root}$). This yields disharmony in roots. When now ALIGN([F],R Wd, R) forces harmony, the whole thing collapses, since what is aligned to the right edge of the word is a root feature. If the right edge of the root feature is located at this edge, there must also be the right edge of the stem. Unfortunately, in the stem the local conjunction holds. Satisfying the local conjunction leads to Locality violations and so forth.

[23] It might well be that in Ainu and Yucatec S-Ident is not restricted to any domain. At least for Turkish it is known that harmony does not extend over word boundaries.

(64) Evaluation of vowel disharmony for Yucatec /*kV*$^{[+high]}$*nt*/:

| | | /*uts+kV*$^{[+high]}$*nt*/ | IDENT[back] | IDENT[high] | *S-IDENT$_{stem}$ | S-IDENT$_{\mu F\ Wd}$ |
|---|---|---|---|---|---|---|
| | a. | ***i**ts-k**u**nt]$_{stem}$* | *! | | | |
| | b. | ***i**ts-k**i**nt]$_{stem}$* | *! | | * | |
| | c. | *uts-k**a**nt]$_{stem}$* | | *! | | |
| | d. | *uts-k**e**nt]$_{stem}$* | | *! | | |
| | e. | *uts-k**u**nt]$_{stem}$* | | | *! | |
| ☞ | f. | *uts-k**i**nt]$_{stem}$* | | | | |

In (64), the first two candidates (a,b) are trivially ruled out because the stem vowel is underlyingly specified for its feature values. The emergence of the vowel *a* in the stem forming suffix (64c) is ruled out, because the suffix vowel underlyingly contains the feature [+high] that has to be identical to the surface form in satisfaction of IDENT[high]. This feature specification is contradictory to the feature profile of the Yucatec unmarked vowel. The same holds for candidate (d); IDENT[high] is violated by this form. The form with identical vowels in (e) is out because both have the same backness value, which violates *S-IDENT. Identity feature constraints have to be ranked higher than *S-IDENT in order to prevent polysyllabic stems and compounds in Yucatec from undergoing disharmony. S-IDENT, the constraint responsible for harmony, has to be ranked below *S-IDENT, to prevent stems from undergoing harmony, and it has to be defined over a larger domain than *S-IDENT, i.e., the whole (morphological or phonological) word, to account for the harmony facts at all. That we do not find any harmonic interaction between the last two vowels in outputs like *utskintah* 'someone improved sthg.' is captured by the analysis for blocking and directionality of harmony given in subsection 6.2.

For Ainu, a similar picture emerges. Here, the disharmony constraint holds only over the root, while the harmony constraint has a larger scope, i.e., the word. Recall that I adopted Itô's proposal, that the disharmonic forms are analysed as underlyingly having an unassociated vowel feature [+high]. This feature belongs to the lexical root. Thus, the root domain, and with it the domain of disharmony, ends with the end of the floating feature. This means that the transitivizing suffix, on which the feature is realized, is treated as phonologically belonging to the root, and by this, it is subject to *S-IDENT. If there is no floating feature, the suffix cannot be interpreted as belonging to the root, and S-IDENT has to be satisfied.

(65) Evaluation of vowel-disharmony for Ainu

| i. | | /*hum*$^{[+high]}$*+V*/ | MAX-IO | IDENT[high] | *S-IDENT$_{root}$ | S-IDENT$_{\mu[F]}$ |
|---|---|---|---|---|---|---|
| | a. | *hum* | *! | | | |
| | b. | *huma* | | *! | * | * |
| | c. | *hume* | | *! | | * |
| | d. | *humo* | | *! | * | * |
| | e. | *humu* | | | *! | |
| ☞ | f. | *humi* | | | | * |

| ii. | | /*ket*[+high]+V/ | MAX-IO | IDENT[high] | *S-IDENT$_{root}$ | S-IDENT$_{\mu[F]}$ |
|---|---|---|---|---|---|---|
| | a. | *ket* | *! | | | |
| | b. | *keta* | | *! | (*) | * |
| | c. | *kete* | | *! | * | |
| | d. | *keto* | | *! | * | * |
| | e. | *keti* | | | *! | * |
| ☞ | f. | *ketu* | | | | * |

Instead of MAX-IO in the tableaux (65i,ii), any morphological constraint could be proposed which forces a surface reflex of a given morpheme or the spell-out of underlying features (e.g., transitivity). These are violated if the transitivizing morpheme shows no surface realisation at all. With the given underlying form, all output forms (b-e) in both tableaux which disregard the identity of the floating feature are ruled out. As assumed above, with this floating feature, the edge of the root is supposed to be at the end of the [+high] feature span. As this coincides with the right edge of the suffixed vowel on which the floating feature is parasitically realized, the suffix is in fact incorporated into the root and is thus subject to the constraints holding there, in this case *S-IDENT, which demands dissimilation of [back]. The violation mark for *S-IDENT for candidate (b) is given in parentheses, reminiscent of the fact that the backness value of *a* in Ainu is undecided. Thus, it cannot be evaluated whether *a* is disharmonic to *e* or not.

Finally, the question may arise why the Ainu roots with this unassociated feature do not show umlaut in suffixless forms of these verbs, in order to show a surface reflex of this underlying segmentless feature. For instance, *ket*[+high] should be subject to umlaut or raising, resulting in the output *[kit]*. Since this is not the case, I suggest that LINEARITY (as formulated in McCarthy & Prince 1995, McCarthy 1996) is ranked highly in Ainu, which prohibits metathesis as a strategy to keep the stem-final feature. The same effect (not realizing the segmentless feature on the stem vowel) may be caused by highly ranked UNIFORMITY (McCarthy & Prince 1995), which prohibits realization of multiple independent features on one segment.

These assumptions complete the analysis of vowel feature interaction in Yucatec and Ainu.

## 7 Conclusion

In this paper I have provided arguments for rejecting the treatment of vocalic feature spreading as an extension of Generalized Alignment or as crucially involving feature nodes. The proposal put forth instead is to treat assimilation as well as dissimilation as satisfying or violating surface-to-surface correspondence constraints. The advantages are, first, that the two phenomena which seem to be the opposite of each other can be treated theoretically alike, which was not possible in other approaches. Second, the restriction of faithfulness constraints to certain phonological or morphological domains makes an interaction of both phenomena in one language or in one word possible.[24] In this way, some theoretical drawbacks have been avoided: It is not necessary to assume intermediate levels of derivation to account for the data. In the OT/CT framework, co-phonologies or morpheme-specific constraint reranking would be inevitable, but not with the devices proposed here. Third, instances of opacity or blocking can be explained quite straightforwardly by the proposal made in this paper, if one defines locality for feature correspondences in terms of prosodic categories (moras or syllables in the cases discussed). No other account can explain, why a consonant cluster should stop vowel harmony, since in segmentalist approaches, consonants are either not affected at all by vowel harmony, because they lack v-feature nodes (feature geometry), or vowel features are believed to be coarticulated on all consonants (feature alignment) without exception. The variation of some consonants with regard to backness, as it is observed in Turkish has already been identified by Clements & Sezer (1982) as a phenomenon independent of vowel harmony.

There might be a deeper motivation for the constraint schema proposed, for surface-to-surface correspondence, and for its limitation to domains: One effect of vowel harmony can be said to be the organization of sound strings into units. In the ideal case, all syllables or moras which belong to a certain word or root or other unit agree in one or more feature specifications. For instance, in one word, all vowels may be [+round], while in the next they might be all [-round]. Similar effects of organization can be reached by disharmonic patterns. It might thus be concluded that there should be a grammatical means for this purpose. And, finally, individual languages should be able to choose which units (domains) and which features they use for organizational purposes.

The principled limitation of the scope of certain constraints to phonological or morphological domains will probably bear a more convenient possibility to deal with other phenomena as well, for which co-phonologies had to be assumed (cf. for instance Inkelas 1998, Itô & Mester 1995).

SURFACE-IDENTITY may be subject to the reproach that any M-Cat or P-Cat may be taken as an argument for one of its variables. And with the right constraint instantiation, even consonantal place features might be expected to show long distance effects. The combinatorial possibilities of this constraint schema may not have empirical consequences in the languages of the world, and, thus, should be treated with caution as should be done with the unlimited combinatorial possibilities of Generalized Alignment. It has been argued here that, for the latter, the extension to vowel features is not appropriate in the sense that featural alignment is at least not responsible for vowel

[24] Cf. The interaction of obstruent voicing and devoicing (Rendaku and Lyman's Law) in Japanese compounds (Itô, Mester & Padgett 1995; Alderete 1997)

harmony, even though that theoretical possibility lies at hand and is used extensively in the literature.

A side effect of the investigation made in this paper are arguments for archephonemic underspecification (Inkelas 1994). As argued by Inkelas, alternating structure is taken to be underspecified, and nonalternating structure as specified in underlying forms. Without this premise, the morpheme-specific harmonies explored here cannot be explained. Thus, one has to distinguish between structure-filling harmony systems like Ainu and Yucatec, and structure-changing harmony systems, for which Shona (cf. Beckman 1997) might be a candidate.

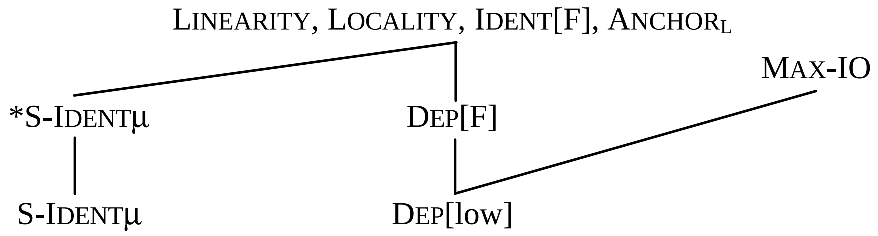
(66) a. structure filling harmony: IDENT[F] >> S-IDENT[F]
b. structure changing harmony: S-IDENT[F] >> IDENT[F]

Turkish has to be regarded as belonging to the structure filling type (66a), with an assumed diachronic reranking from type (b) to (a). Otherwise, the large number of disharmonic words and affixes cannot be analyzed appropriately. Certainly, a Turkish word like *Türkiye* 'Turkey' must have the *i* underlyingly specified for [-round]. A privative [round] (as proposed, for instance, by Kirchner 1993 and several publications of Steriade) would yield **Türküye*. Thus, I follow Inkelas in assuming binary feature values, with underspecification as the third possibility (i.e., [+F], [-F], [∅F]; cf. Clements 1976). There is an interesting regularity of featural underspecification, which turns out in the comparison of the three languages: A vowel is either completely underspecified (that means with regard to the specification of all features relevant in the particular language), or it is completely specified, or it is only specified for the opposite specification of the feature which is the least marked in the vowel system of the language. In Turkish, epenthetic vowels appear always as [+high] (but do not have to be specified for that feature value in some underlying representation), while the only feature that is necessarily specified for vowels participating in Turkish harmony is [-high]. In Ainu and Yucatec Maya, the epenthetic vowel is a non-high vowel, while the only feature specification that is needed to describe the disharmonic phenomena in these two languages is [+high]. These principled feature specifications might lead to deeper insights into the connection between (language-specific) markedness, phonological activity, and the structure of lexical representations.

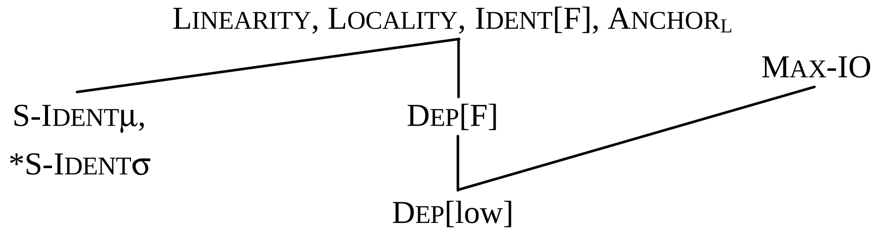
Apart from the assumed diachronic shift in Turkish, the 'harmony grammars' of the languages discussed in this paper are largely the same. There is still one difference, namely in the ranking of DEP[F] constraints with regard to $\text{ANCHOR}_L$. In Turkish, the DEP[F] constraints rank higher than $\text{ANCHOR}_L$ (except for DEP[low]), resulting in leftward harmony when features of epenthesized vowels have to be specified, while in Yucatec, they are ranked the other way round, resulting in the emergence of the least marked vowel in that system when harmony with (correspondence to) the vowel to the left is blocked. In Ainu and Yucatec, we find grammatical variation in the parametrization of domains for the *S-IDENT constraints (in Ainu the mora and the root are crucial categories, while in Yucatec the syllable and the stem are relevant), and a difference in the assignment of moras to diphthongs.

In summary, I give the rankings of the three languages discussed in this paper.

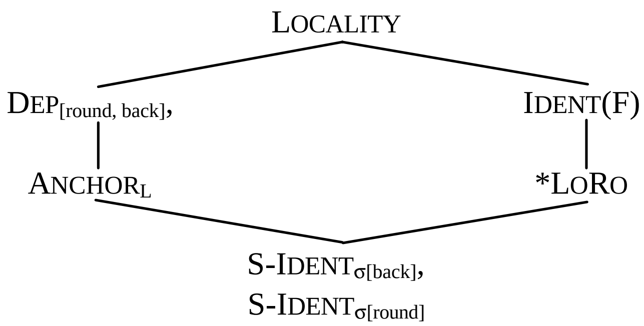
(67) Ranking in Ainu:




(68) Ranking in Yucatec:




(69) Ranking in Turkish:




Finally, some questions remain with regard to underspecification. It is in no way clear which features in which positions tend to be underspecified, and which do not. In this paper, the impression might have emerged that affixes tend to be more underspecified than stems. Even though this is a rather rough generalization, it can be seen as an effect of the ranking of faithfulness constraints to stems above faithfulness to affixes (as proposed by McCarthy & Prince 1995) Intelligibility demands that lexical items should be somehow recoverable ('recoverability of the base'), while this is not so decisive for functional items. Unfortunately, this does not explain the fine-grained decisions that have to be made by Turkish speakers, when reanalyzing the features of the vowels of disharmonic stems from specified to unspecified.

Another remaining question touches on the observation that backness disharmony co-occurs with total harmony, i.e., that the patterns in Ainu and Yucatec are strikingly similar, even though these two languages are not related to each other. Itô (1984) briefly mentions other languages where harmony and disharmony interfere in a similar way. For example in Ngbaka a height disharmony co-occurring with total harmony is observed. Which features can be active in interacting harmony and disharmony systems, and why these patterns co-occur in the described way, remains open for further research.

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