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Some Questions concerning the Analysis of Vowel Harmony*

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1. Introduction

One of the main topics for phonologists has been the problem of vowel harmony. They have shown that the standard theory of generative phonology cannot offer any fullfledged analysis of vowel harmony. It was realized by Clements (1980) that the autosegmental approach was applicable to vowel harmony. Ringen (1980) suggests that some of the problems can be removed by adopting the assumption that phonological representations need not be fully specified. Underspecification theory, proposed by Kiparsky, incorporates both of these proposals. Radical underspecification theory, developed in the recent work of Archangeli and Pulleyblank, suggests that vowel harmony should be analysed by exclusion of redundant features in underlying representation, parametric linking of unassociated autosegmental features and the feature geometry. In this paper, I will discuss some of the proposals for handling the problems of vowels that are transparent to vowel harmony in that they fail to undergo it, so-called "neutral vowels". Within the theory of autosegmental phonology, McCarthy (1984) has analysed vowel harmony phenomena in the Pasiego Montañes dialect of Spanish and Vago also has described it within underspecification theory. Spencer (1986) presents the alternatives to McCarthy's rule system that rules defined only over autosegmental tiers are interpreted as well-formedness conditions. Ringen (1986) shows how Hungarian vowel harmony can be analysed within the underspecification theory. Within the radical underspecification theory, Archangeli and Pulleyblank (1989) have discussed Yoruba vowel harmony. The purpose of this paper is not to give alternate analyses to these proposals, but

consider both theoretical and emperical questions found in the analyses of vowel harmony.

2. 1 Pasiego vowel harmony analysis by McCarthy

McCarthy recognises two types of harmony process in Pasiego, one described as a feature-specifying rule, the other as a feature changing rule. The feature-specifying harmony admits transparent segments which may be analysed as participating in the harmony process during the course of derivation. The feature-changing type, on the other hand, involes neutral vowels which play no role in the harmony. They are removed from the class of harmonic vowels.

Pasiego has five vowels in lexical representations /i, e, a, o, u/. Of these, /i, a, o, u/ may have lax counterparts in surface forms, expressed as /I, A, O, U/. /e/ has no lax counterpart and behaves as a tense vowel. Pasiego exhibits two vowel harmony processes, Tense (ATR) Harmony and [high] Harmony. In general, lax vocalism is morphologically conditioned and tense harmony is triggered by the masculine singular count suffix /−U/ in the word-final position, though this is not a sufficient condition for lax vocalism. The tense harmony is illustrated by the following examples[1]:

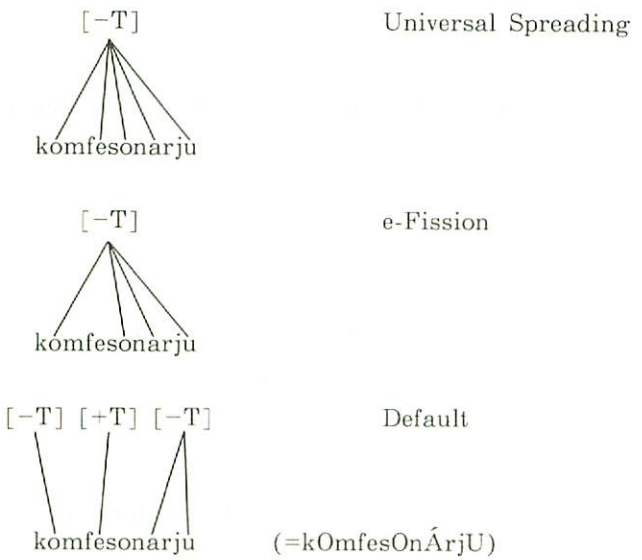
(1)	Tense		Lax	
(a)	soldáus	'soldiers'	sOldÁU	'soldier'
	málu	'evil'	mÁlU	'evil'
	komfesonárjus	'confessionals'	KOmfesOnÁrjU	'confessional'

Both McCarthy and Vago assume that in lexical representations the [−T] autosegment is preattached only to final syllable. In other words, vowels are unspecified for the feature [T] ([ATR]) at the underlying level. Then [−T] spreads leftward to all other vowels by universal spreading convention early in the derivation.

The vowel /e/ is transparent with respect to tense harmony so that it never surfaces as a lax vowel. McCarthy account for the transparency of the vowel /e/ by means of e-Fission and [T] specification by the later default rules. Underlying tense /e/ laxes in laxing contexts and the connection between the /e/ and

[−T] autosegmental feature is broke down by a context-free rule. Later the /e/ becomes specified for [+T] ([+ATR]) by default, as it does not have a specification for this feature. The sample derivation of this process is shown as follows:

(2)



[high] harmony in Pasiego applies to nonfinal vowels[2] and is controlled by the stressed syllable: all non-low vowels must agree with the stressed vowel of the word on the feature [high]. The low vowels are transparent and can coocur with any vowels. Vago points out that high glides in the onset of a stressed syllable trigger [high] harmony and determine high vocalism to the left. However, from this fact, the rightward spreading of the autosegment must be prohibited so that the correct forms can be derived in the words with the high glides.

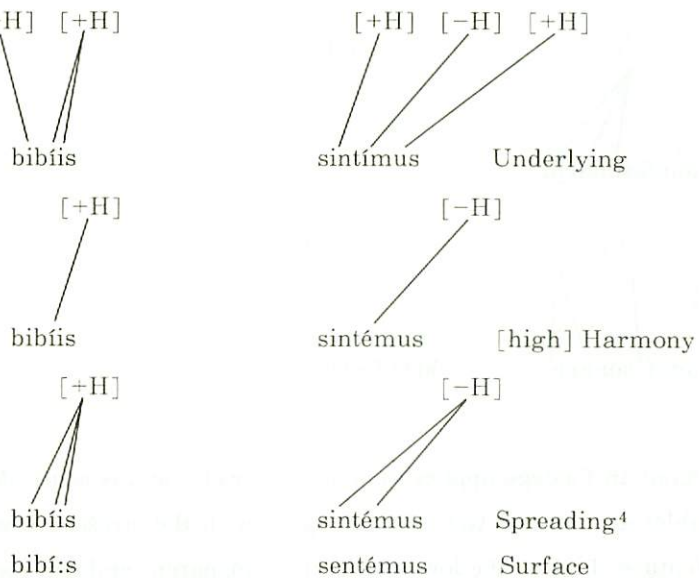
McCarthy accounts for height harmony through a context-sensitive process divided into several steps. First the feature [high] of an unstressed vowel is deleted from the autosegmental tier in the context of a stressed vowel specified for [high]. Then the [high] feature associated to the stressed syllable spreads to an unstressed vowel automatically by convention. Height harmony appears in the following examples:[3]

(3)

(a)	lubúkus	'young wolves'		kUntÍntU	'happy'(count)
	mInnÚdU	'small'(count)		belórta	'hay-rake'
(b)	sintír	'to feel' (inf.)	bebér	'to drink'	(inf.)
	sentémus	(1pl. pr. ind.)	bebámus	(1pl. pr. sub.)	
	sintáis	(2pl. pr. sub.)	bibí:s	(2pl. pr. ind.)	

McCarthy's derivation is roughily illustrated with slight modification in (4).

(4)



The low vowel /a, A/ is transparent with respect to the height harmony, it does not block the harmony and it does not trigger [high] harmony. McCarthy explains the transparency of low vowels by excluding them from the set of P-bearers that can be associated with the autosegment [high]. This means that non-low vowels must have underlying height specifications,since spreading cannot give them height specifications in spite of the appearence of both high and mid vowels in the context of a stressed low vowel, as is shown in (3b). /a, A/,on the other hand, is specified [−high] by a redundancy rule.

2．2 Reanalyses by Spencer (1986) and Vago (1988)

There have been three different proposals adopted in the analysis of neutral vowels in the history of autosegmental phonogical theory. In the earliest version, neutral vowels alternated at the earliest stages of derivation and were subject to a late neutralization rule. In later developments of the theory, neutral vowels are excluded from the set of harmonic segments and the vowel harmony rule applies to them vacuously. In this analysis, they are specified for the harmonic feature by the late default rules, or underlyingly on the segmental level or a tier which is independent of the harmonic autosegmental tier. McCarthy's account of neutral /e/ belongs to the version of neutralization, and his explanation of /a/ falls within the default category.

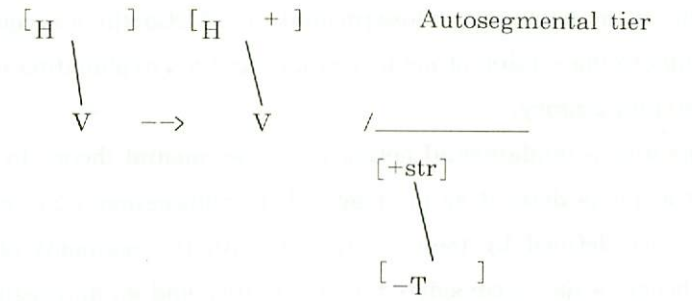
Spencer modifies a fundamental notion in autosegmental theory by reversing the idea that a tier is defined as the place where autosegments are settled and autosegments are defined by their interaction with the segments of CV tier. Within this theory, a tier is considered as a primitive and an autosegmental tier is defined by a feature set. All the autosegmental values on the tier can be changed by a rule and the elements of the segmental tier are linked to the tier at every stage. In this system, Height harmony is analysed as an operation on the autosegmental tier with [high]. This may be called the duplicate analysis of vowel harmony, along with Vago (1988).

Spencer's analysis of a neutral vowel /a/ falls within the duplicate category. This analysis accounts for the transparency of /a/ with respect to [high] harmony by linking it to the segmental tier but not to the [high] tier. Height harmony is a rule operating over the autosegmental tier, so that /a/ on the segmental tier is unaffected by height harmony and any other process which refers only to [high] tier. Consequently, /a/ is redundantly specified for the [high] feature on the CV tier by universal convention. On the other hand, /a/ is linked to the autosegmental [tense] tier.

A similar line of analysis seems to be applied to the account of the transparency of neutral /e/ concerning [tense] harmony. /e/ is linked to the [high] tier but is not specified for that feature on the segmental tier. In the same way as the explanation of the neutrality of /a/, /e/ is not associated with the [tense] tier and is prelinked to that feature on the segmental tier. This time, however, it

brings about another difficulty. According to McCarthy, the mid vowels are raised to high under stress in words only with lax vowels and unstressed vowels harmonize with derived [+high] vowels just as they are an eligible target for height harmony by underlying ones. The stressed vowel /e/ raises to /I/ in lax words. Like McCarthy's analysis, Spencer proposes the Raising that attaches a stressed vowels to a [+H] autosegment within a [−T] domain. This means that /e/ must be linked to [tense] on the autosegmental tier. Spencer proposes the following raising rule:

(5)



This rule refers to the [−T] domain and not to the segment marked [−tense] on the segmental tier. Just as the segment /a/ is ignored by height harmony, the vowel /e/ can be subjected to the rule (5) even though it is specified for the feature [+tense] on the segmental tier. The specification of the vowel /e/ for [+tense] may reflect the neutrality with respect to [tense] harmony.

Vago (1988) tries to describe the vowel harmony of Pasiego within a recent advanced underspecification theory incorporating hierarchical fearure geometry. The basic assumption of the underspecification theory is that only one value of every feature is specified in underlying representation. In addition. Vago cites the constraint that all feature spreading must be local. This constraint is called Locality Condition:

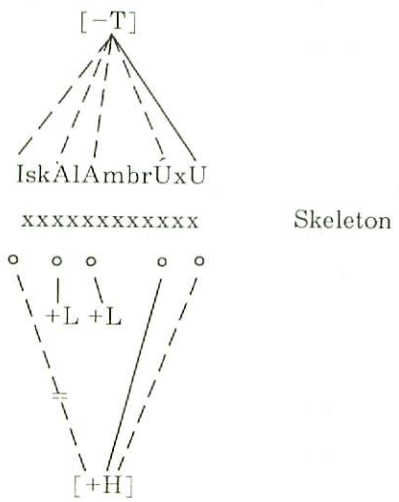
(6) Locality Condition

A rule can apply only if a special target is adjacent to a specified trigger.

Ringen (1988) notes that "if features are organized hierarchically, and if a rule whose target is node or feature α scans the highest level of syllabic structure

providing access to α (maximal scansion), then, in general, consonants will be transparent to rules affecting vowels, but vowels will block rules applying to consonants. In the case of minimal scansion, a rule whose target is node or feature α scans the tier containing α." If this condition can be justified and is adopted, it is possible to prevent an autosegment from spreading to the target segment through an intervening segment. Although /a/ is specified for [+low] ([−high]) on the segmental level, it neither triggers nor blocks the spread of the feature [H] in McCarthy's as well as Spencer's analysis. However, this position cannot be defended in underspecification theory. Since features [back], [high], [low] are all terminal ones dominated by Dorsal node and higher Place node in general feature geometry[5], /a/ is not eligible for spreading. To see this, consider the folowing examples:

(7)



As is shown in (7), spreading the aurosegment [+H] from the stressed vowel through /A/ to the vowel /I/ violates the Locality Condition, since the trigger and target nodes are not adjacent on the tier that is scanned for rule application. Consequently, the intervening vowel prelinked to the feature segmentally on the same feature tier as that of the autosegment will block the propagation of harmonic feature. The effect of the condition is to account for the opacity of neutral vowels to vowel harmony[6]. In Pasiego, there are two possible ways of avoiding

the violation of the condition: the low vowel that is transparent to [high] harmony is never associated with the feature dominated by the dorsal tier before the application of spreading of the feature [H], or the low vowel is specified for some other feature that is not dominated by the dorsal tier. The former soulution requires maximal underspecification for the low vowel and the default rule to apply to /a/ as late as possible, and the latter forces neutral vowels to be represented on the tier above the place tier or on the skeletel tier with an empty node, if Vago's proposal is accepted. Vago suggests that the propsal that /a/ might be specified only for [−round] should be rejected in Pasiego, as that feature is not distinctive for the language.

Vago assumes that Pasiego vowel should be accounted for by the −H Default Hypothesis. This hypothesis is based on the idea that +H is specified lexically and −H is derived by a default rule applying after the [high] harmony rule. Through the investigation of raising context and lowering context, Vago indicates that there is a lot of evidence for the raising of mid vowels in height harmony. This supports the spreading of the autosegment [+H] and only this feature is specified on the autosegmental tier underlyingly. As a result of the adoption of −H default hypothesis, the height harmony of Pasiego is not analysed as a feature changing process. Vago assumes that the class of high vocalic morphemes contains an unassociated or floating +H feature on the [high] tier, and the mid vocalic morphemes or disharmonic morphemes contain specified vowels that are opaque to [high] harmony. The +H feature is attached to the stressed high vowel by H−Linking rule. Then,the mirror image H-Spread rule spreads the +H feature to the unstressed vowels within the harmonic domain. Therefore, high vowels in disharmonic roots and morphemes in which a low vowel is stressed are attached to +H on the underlying level. Some version of the Strict Cycle Condition prevents H-spread from applying within disharmonic roots, since H-Spread is assumed to be cyclic. In order to see the explanation of vowel harmony within the underspecification theory, it seems appropriate to outline Ringen's analysis of Hungarian vowel harmony,which is another intriguing application of underspecification theory.

2．3 Ringen's (1988) Analysis of Hungarian Vowel Harmony

According to Ringen, the vowels of the standard dialect of Hungarian are given in (8):

(8)

	Front				Back		
	Short	Long	Short	Long	Long	Short	Long
High	i	í	ü	û		u	ú
Mid		é	ö	ô		o	ó
Low	e				á	a	
	Unrounded		Round		Unrounded		Round

Ringen's discussion focuses on [back] harmony and no attention is paid to [round] harmony. In general, front and back vowels do not cooccur in words. /i, í, é/ are transparent to [back] harmony. The transparent (neutral) vowels can occur with both front and back vowels. Non-neutral suffix vowels harmonize with root vowels in the quality of backness. However, many complicated examples are found. This is illustrated by the following forms:

(9)

(a) város 'city' város-nak dat. ûr 'gap' ûr-nek dat.
(b) radír-nak 'eraser' tányér-nak 'plate'
(c) fillér-nek 'penny' víz-nek 'water'
(d) híd-nak 'bridge' cél-nak 'goal'
(e) büró-nak 'bureau' sofôr-nek 'chauffeur'

Following Vago, one value of each feature is single-valued in underlying representation. Thus the underspecification theory requires us to decide which value should be specified for the feature [back] underlyingly. Ringen considers both possibilities and concludes that underlying specification of [−back] can explain Hungarian vowel harmony in the most appropriate fashion. Fundamentally the feature [−back] functions as a floating autosegment that is linked to unassociate vowels by universal convention from left to right, one to one. Vowel

Harmony is stated as a rule that spreads the feature [back] rightward. Unlike Vago's analysis, Ringen does not adopt feature geometry.

Of Ringen's arguments the treatment of the transparent vowels is most interesting, since they seem to control the vowel quality of harmonic suffix. I cannot clearly understand why Ringen advocates underlying specification of [−back] , even though it is of some advantage to account for the alternation of harmonic suffixes in mixed vowel roots with sequence of neutral vowels[7]. Aside from this argument, we see a sketch of how the transparency of neutral vowels is dealt with. Ringen's sample derivations of relevant words are shown as follows:

(10) a. [−back]

V V r + n V k (ûrnek)

[+low]

b. [−back]

v V V z + n V k (víznek)

[+low]

c.

r V b V V r + n V k → r V b V V r + n V k

[+low] [−round] [−low]

[+back][−back] [+back]

[+low, +round, −high] [+round, +high, −low] [+high, +low, −round]

(radírnak)

d. [−back]

b V r V V + n V k (bürónak)

[−high] [+low]

Back vowel roots like *ház* are not lexically specified with a floating autosegment, while roots cited (10a) contains a lexically specified segment. The redundancy rules supply the feature [+back] to the root vowels and harmonic suffix vowels in the former. In (10c), the root have no [−back] autosegment and by the redundancy rules the second root vowel can be derived as the front vowel *í*. However, the transparent vowels /i, í, é/ must not be specified [−back] by the

redundancy rule before the application of the vowel harmony rule. Otherwise the vowel harmony rule would generate incorrect harmonic suffix vowels following mixed vowel roots like (10c) if the Redundancy Rule Ordering Constraint is adopted[8]. Roots with only neutral vowels like (10b) are assumed to have a free [−back] autosegment. On the other hand, roots as cited in (9d), which require back vowels in suffixes, are assumed to contain no autosegment, though they are formed only with neutral vowels. In (10d) the spreading of the feature [−back] to the second root vowel is blocked by the Strict Cycle Condition and its association with the suffix vowel violates the Locality Condition[9].

Ringen insists that front suffix vowels are used for most mixed vowel roots ending in multiple neutral vowels. To describe this phenomena, Ringen formulates a rule that inserts a [−back] autosegment into a morpheme ending with multiple transparent vowels. This rule puts the feature [−back] into the last root vowel but one. In this analysis, it can be seen that there is more than one source for transparent vowels. The adequacy of these sources for the neutral vowels should be discussed from theoretical as well as phonological viewpoints. As far as I can understand it, Ringen's argument does not seems to give positive support to multiple sources for the transparent vowels in Hungarian.

3.0 Discussion

It is clear that vowel harmony is one of the principles in a vowel system and has language-specific characteristics. Vowel harmony makes some feature values predictable in that the rule of vowel harmony can be insert the absent values. Harmonic values are morphemic in that the assignment of harmonic values to particular vowels constitutes a predictable form derived by the effect of universal convention on linking and language-specific rules. Fundamentally radical underspecification theory, developed by Archangeli and Pulleyblank, is considered to be on the right track in the assumption that a feature is the most basic unit. However, it raises emperical and theoretical questions in the analysis of vowel harmony. In this sense, the questions should be considered that have been raised by the analysis sketched in the section 2.

In McCarthy's analysis, neutralization is assumed to derive a tense vowel /e/ from /E/ that does not fail to appear in the course or derivation, since /E/ can-

not occur on the surface level. Recent phonological theory strongly requires us to abandon any neutralization rules as a tool of explanation. Even if /e/ is specified [+tense] in underluying representaion, [T] Spreading will alternate the feature value to [−tense] in autosegmental analysis such as Spencer's rule that generates the [−T] aurosegmental tier. Underspecification theory does not allow us to specify both values underlyingly, and if possible, Locality Condition blocks the spreading of [−T] and incorrect forms surface. In this case, the most reasonable solution may be reached by positing the [T] Coocurrence Constraint as formulated in Archangeli and Pulleyblank (1989)[10]. Spencer's analysis of the vowel /e/ raises the same problem as that of McCarthy's in that non-surface /E/ appears in the course of derivation. Further, the neutral /e/ is specified as [−tense] on the autosegmental tier and as [+tense] on the segmental tier during the derivation. Is this account tenable theoretically? As far as I understand, Spencer's system appears not to be so simple, as there are two kind of rules; one refers to a segmental tier, the other to an autosegmental domain.

Concerning the transparent vowel /a/, the default analysis appears to be a reasonable explanation. However, as Vago has shown, McCarthy's analysis is made untenable by underspecification theory, since he permits both +H and −H autosegments on underlying representation. The same argument can apply to Spencer's analysis. Moreover, the [−high] specification on /a/ on the CV tier may block the feature change on the autosegmental tier that happens on the right of the transparent vowel /a/, since it violates Locality condition. However, rules with reference to autosegmental features can have their application prevented only by other autosegmental tiers, and any features specified on a segmental tier cannot block the application unless they are not linked to the autosegmental tier. Spencer's theory cannot represent the directionality of vowel harmony, althouth the opacity of disharmonic vowels can be explained by means of a representational format. In this sense, the existence of the autosegmental tier depends on a set of features. Does this definition of a tier invoke a serious theoretical problems in autosegmental phonology?

Within the underspecification and feature geometry, transparent vowels are accounted for by the association of a floating autosegment, non-occurrence of a autosegment in a root with only neutral vowels, having no feature node relevant to the structural description of the rule and total underspecification. The former

two are adopted for the neutral vowels which take part in vowel harmony. The latter two are given to the transparent vowels that are skipped by vowel harmony. These allow for one neutral vowel as found in Pasiego, but not for neutral vowels affecting harmony as done in Hungarian. According to Archangeli and Pulleyblank (1989), vowel harmony can be considered as generation of an appropriate node structure between a triggering autosegmental feature specification and the tageted feature node within the feature hierarchy. This means that vowel harmony is a process of giving an autosegment to a feature node. If this is the case, why can only [−ATR] specification generate the node structure in vowel harmony? Underspecification theory accounts for vowel harmony by a spreading rule and default rules. Thus, this theory claims that vowel harmony consists of two different phonological processes. The principle that all predictable feature values are supplied by default rules may be logically justifiable, but in vowel harmony, both values ('+' or '−') of a harmonic autosegment dominate each harmonic domain. Is it possible for default feature specification to represent the spreading nature of harmonic autosegments satisfactorily?

The rest of this section will be devoted to a consideration of Korean vowel harmony within the underspecification theory. According to Aoyama (1955), Korean still has vowel harmony especially in roots of verbs and adjectives[11]. Some of the suffix vowels alternate depending on the harmonic quality of root vowels. Here consider two domain patterns in verbs and adjectives. Korean has the following surface vowel inventory:

(11)

	Front	Back	
High	i	ɨ	u
Mid	e	ə	o
Low	ɛ	a	
	Unrounded	Unrounded	Round

Aoyama's research shows that Korean has the following cooccurrence restrictions on vowels:

(12) a. If /i, ɨ, e, ə, u/ appears in the first domain (as the first vowel of a root), /a, o, ɛ / never occurs in the second domain (as the second vowel of a

root).

b. If /a, o, ɛ / appears as the first vowel of a root, /ə, e/ never occurs as the second vowel.

c. /i, u, ɨ/ can be contained in the second domain freely.

High vowels /i, u, ɨ/ function as transparent vowels, since they are not subject to restriction. Within the present feature system there seems to be no possibility that only one feature can be picked up to characterize this vowel harmony, since one group of vowels cannot be separated from the other. However the vowels /a, o, ɛ / might be characterized by [−ATR][12]. If this assumption is adopted, the feature values that distinguish the vowels are shown (13a), (13b) giving the underspecified representation that I assume underlyingly.

(13) a.

	i	e	ɛ	a	o	ə	ɨ	u
[high]	+	−	−	−	−	−	+	+
[low]	−	−	+	+	−	−	−	−
[back]	−	−	−	+	+	+	+	+
[round]	−	−	−	−	+	−	−	+
[ATR]	+	+	−	−	−	+	+	+

b.

	i	e	ɛ	a	o	ə	ɨ	u
[high]	−				−	−		
[low]		+	+					
[back]				+	+	+	+	+
[round]				+				+
[ATR]				−				

To complete the fully specified representation in (13a) from the partially specified ones in (13b), the following default rules are required:

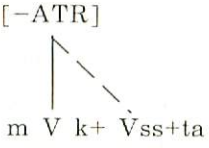
(14) a. [+low] ---> [−high]
b. [ ] ---> [+high]
c. [ ] ---> [−low]
d. [ ] ---> [−back]
e. [ ] ---> [−round]
f. [+low] ---> [−ATR]
g. [ ] ---> [+ATR]

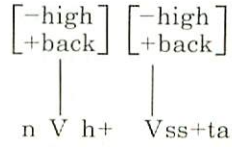
Further investigation of Korean phonology may allow us to dismiss the redundancy rule (14g) if no independent motivation is found with reference to other rules. Pulleyblank (1988) calls the rule (14g) a complement rule that is language-specific. The analyses of [ATR] harmony in many language suggest that [−ATR] is an unmarked specification for [ATR], inserted by the default rule, with [+ATR] specified underlyingly (see Archangeli and Pulleyblank (1989)). In this case, Korean harmony system is necessary to be described as a marked one, like that of Yoruba, which is a Kwa language spoken primarily in Nigeria. The free [−ATR] specification is linked by universal convention to unassociated vowels from left to right, one to one. The harmony rule is directional, applying from left to right. Since Korean does not have [−ATR, +high] vowels, the [−ATR] specification can be linked only to [−high] vowels. Vowel Harmony can be formulated as a rule that spread [−ATR] rightward:

(15) *Vowel Harmony*

Now consider some of the derivations to see how VH rule works. The lexical entry for makassta 'block (past)' will have a free autosegment and the vowel will specified as [+low], while *nəhəssta* 'put in (past)' has no [ATR] autosegment underlyingly.

(16)





Underlying

Surface

c. [−ATR]

tt A r(ɨ)+ Ass+ta

Other rules
and Default

[ttaratta] 'follow(past)'

[−ATR]

t A t^h U+ Ass+ta

Other rule and
Default

[tat^hwətta] 'dispute(past)

In (16c) the autosegment could spread to the past tense suffix only if the intervening transparent vowel /ɨ/ is deleted by a rule before Vowel Harmony applies. Thus, the rule of ɨ-Deletion, which is well-motivated in Korean phonology, must be ordered before the Vowel Harmony rule. Unless /ɨ/ deletes in this environment, it will block the spreading of the autosegment. In (16d) Vowel Harmony would not spread to the suffix vowel, since [−ATR] must associate only to [−high] vowels throughout derivation. High vowels are opaque and block the harmony process. In this analysis, there are no examples that need to be explained by Locality Condition and SSC. In modern Korean, Vowel Harmony is a minor rule which can cover only a small amount of vocabulary. A thorough research will surely raise many problems with this analysis.

4. Conclusion

I have shown that three insightful analyses which account for vowel harmony in two languages present some challenging phenomena to the theory of phonology. In Spencer's version of autosegmental theory, languages with autosegmental tiers must strictly distinguish ones without them. In addition, it is necessary to equip two different kinds of autosegmental tier for transarent vowels of different qualities. The deletion of autosegments is superfluous and neutralization should be abandoned in McCarthy's proposal. The description of Hungarian vowel harmony by Ringen in the underspcification theory suggest the possibility that indeterminacy occurs when one value of every feature to be specified underlyingly is determined. The account of vowel harmony by the default rules does not reflect the directionality of harmony. Following Ringen, I doubt whether multiple sources for transparent vowels need to be allowed.

I have shown that the analysis of Korean vowel harmony in terms of underspecification theory is possible only if the specification of /o/ for [−ATR] is not falsified. Vowel harmony as found in modern Korean may offer serious problems to the theory of underspecification.

Notes

* I thank Marc Weedon-Newstead who kindly read over the authors first draft and corrected his English phrasings.

1. The pasiego dialect is spoken in the Cantabrian mountains, located in the south-central area of the province of Santandar in north-central Spain. McCarthy presents an insightful inverstigation of quite complex data from Pasiego.

Unreferenced Pasiego forms used in this paper are cited in McCarthy's article, and unreferened Hungarian ones here in Ringen's article.

2. Vago (1986) points out that unstressed vowels in the final syllable are limited to the /e, u, U, a/. This means that on the surface they may violate the principles of [high] harmony. He notes that "he assumes, along with McCarthy, the operation of late reduction processes (that also supply phonetic detail)". For this reason, they can leave the violation of height harmony in unstressed final vowels out of consideration.

3. Lax mid vowel are systematically excluded from appearing in stressed syllables on the surface. This forces McCarthty to formulate raising rule in the rule system.

4. McCarthy seems not to allow H feature to spread to the final syllable. Pasiego has the words "bjéspora", "rIkÍtIkO" and so on that require the rightward spreading of autosegment H. If The feature H can spread from right to left, a rule of neutralisation might be necessary to derive a correct form "sentémus" from /sentémos/ that is generated by spreading. The spreading of the feature H to the final syllable may be prevented by prelinking the feature H to the final vowel.

5. Discussions for hierarchical feature geometry are advanced in such works as Clements (1985), and Archangeli and Pulleyblank (1989). Their proposals are slightly differnt each other. In Archangeli and Pulleyblank, [ATR] is excluded from the dorsal node and dominated by Tongue Root node. I do not see the

necessity for a node which dominates [tense] in this organisation.

6. According to Vago, Kikuria has height harmony and the low vowel blocks the spreading of [+high] . This opacity of the low vowel is appropriately characterized by the Locality Condition.

7. The autosegment [+back] is assumed to be specified underlyingly and [−back] is filled in by a redundancy rule. In this situation, a constraint that [+back] may only link with vowels that are [+low] or [+round] may be incorporated into the analysis. However, roots with only neutral vowels like *híd* have unassociated autosegment which can spread the feature to suffix vowels. This explanation is more desiarable than an alternative in which [−back] is postuated, I think.

8. Redundancy Rule Ordering Constraint is given in the form: A redundancy rule assigning [αF] , where 'α' is '+' or '−', is automatically assigned to the first component in which there is a rule which refers to [αF] . Ringen says that this is a recent version of the constraint.

9. Within hierchical feature geometry, the fact that disharmonic vowels block the spreading of the autosegment can explain explicitly by feature tiers. If the disharmonic vowels are specified on the same feature tier as the autosegment, they cannot be skipped by vowel harmony.

10. Archangeli and Pulleyblank insist that there is a good motivation of ATR Coocurrence Constraint for ATR harmony in Yoruba. They claim that the fact that [−ATR] is restricted to nonhigh vowels must be captured by a constraint on feature combinations. Along this line, they define the constraint: a [−ATR] specification can linked to a vowel that is [−high] . This constraint played the role of defining the structure to be preserved through application of rules and conventions. For Pasiego Tense vowel harmony, such a constraint might be stated in the following:

"A [−T] specification cannot be linked to a vowel that is [αF] ."

11. Korean includes many Sino-Korean vocabulary which violate vowel harmony. Among original Korean words, nouns loosely observed vowel harmony. Recently, /ə/ takes place of /a/ in harmonic suffix vowels even after [−ATR] stem vowels.

12. The acronym "ATR" refers to the feature" advanced tongue root" or"expanded pharynx." Although I don't know whether [ATR] can be fully justifia-

ble from a Korean phonetic viewpoint, the description of Korean vowel harmony with [ATR] is on the right track. The same situation is found in the analysis proposed by Archangeli and Pulleyblank (1989).

13. The phonetic symbol [tt] represents a glottal stop.

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