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On the Description of a Diagonal Vowel Harmony Process: A Particle Analysis

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1. Introduction

Modern Korean does not have a strict and regular vowel harmony process, like that of Turkish or Mongolian, but rather has a very rare type which is often called "diagonal" because the line dividing the harmonic classes runs diagonally (Aoki 1968; Kim 1978). Therefore, most earlier approaches had to describe the vowel harmony process either by reconstructing an abstract vowel system (Moon 1974; McCarthy 1983) or by appealing to semantic features replacing the standard phonological features (Kim-Renaud 1976). In order to solve these problems, Ahn (1986) proposes a special feature [±L] indicating relative (not absolute) heights of the two vowel groups. This third alternative, however, still has a serious problem as it appeals to the notorious "phonological use of diacritic features". Due to these problems, it has been realized that the standard feature theory cannot provide any satisfactory device to describe the diagonal vowel harmony without appealing to an abstract vowel system or a nonphonological (diacritic or semantic) feature. A careful look, however, would reveal that vowel harmony in Korean shows two different aspects, depending on whether a target vowel is located syllable initially or not. therefore, instead of appealing to an abstract vowel system or a nonphonological features, I will propose a fourth alternative reanalyzing the diagonal vowel harmony process, by employing the theory of Particle Phonology proposed by Schane (1984a, b). Moreover, I will modify my earlier claim on the diagonality of vowel harmony in Modern Korean by describing two aspects, "trigger" and "undergoer" of harmony processes.

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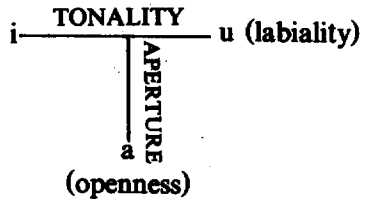
2. Representation of Vowels and Diphthongs

2.1. Particle Phonology (henceforth PP) is a theory about segmental entities of vowels, and it is a radically different framework of describing vowels and diphthongs. The primitive phonological elements of PP are drastically different from traditional distinctive features, and they are of two types: "elementary particles" and "punctuators". There are three elementary particles: *a*, *i*, and *u*. Particles do not exactly represent segments or features. Rather they share both of these entities. Thus, in isolation, they correspond to the vowels [a], [i], and [u], while, in combination, they represent phonological characteristics: aperture or openness for *a*, palaltality or frontness for *i*, and labiality or rounding for *u*. The following figure (1) illustrates the segment-like and feature-like aspects of the elementary particles.

(1)



Vowels other than [a], [i], and [u], as well as diphthongs, are represented as combinations of the elementary particles. Here we note that, in Schane (1984a, b), traditional phonetic symbols appear in square brackets, whereas particle representations are unbracketed. Therefore, the front vowels [e] and [ɛ] will be represented as *ai* and *aai* respectively. In this paper, however, particle representation will appear in curly brackets since they represent phonetic segments by forming sets. In other words, [e] will be presented as a set {ai} since [e] is the combination of two elementary particles *a* and *i* indicating aperture (or openness) and palatality (or frontness) respectively. Here {ai} is in fact representing {a, i} in a mathematical formula but the comma separating the particles will be omitted just for convenience.

According to Schane (1984b: 131), there are three punctuators, in addition to the elementary particles. A "+" sign between particles signifies that the particle sets on each side of the "+" represent vowels belonging to separate syllables (i.e., [+syllabic] in SPE). A space between particles specifies length (i.e., [+long]).

A half-moon "‿" beneath particles indicates nonsyllabicity (i.e., [-syllabic]).

Now recall Schane (1984a:39) noting that the complex particles, in their role as monophthongal vowels, constitute unordered sets. Therefore, he lists particles in alphabetical order for convenience. In this paper, however, I will take an ordered representation of particles for several reasons. In other words, there are good reasons to list particles in the order of {u}, {a}, and {i}.

First, umlaut in (2a) is viewed as a particle analogue of assimilation in PP as shown in (2b) or (2c).

(2) a. a → e / ___ i
ə → e / ___ i
o → ö / ___ i
u → ü / ___ i

b. aa → aa͡i / ___ i
a → a͡i / ___ i
ua → ua͡i / ___ i
u → u͡i / ___ i

c. aa → i͡aa / ___ i
a → i͡a / ___ i
ua → i͡ua / ___ i
u → i͡u / ___ i

In (2b) and (2c) where the palatality particle is ordered to a (left or right) peripheral place, umlaut can be easily seen as addition of the (underlined) palatality particle {i}. According to Schane's representation in (3), however, it would not be easy to capture this process as addition of a palatality particle.

(3) aa → aa͡i / ___ i
a → a͡i / ___ i
au → a͡iu / ___ i
u → i͡u / ___ i

Therefore, we figure that the palatality particle is better located in the (left or right) peripheral location in a particle set.

Second, Korean syllable structure does not allow **wu*, **wo*, **wu*, and **wo*, and this constraint can be generalized as the constraint on *{u͡}+{u} clash.

(4) *{u͡u}, *{u͡ua}, *{u͡ui}, *{u͡uai}

In other words, by placing {u} before other particles, we can show the syllabic constraint more easily.

Third, the front round vowels [ü] and [ö] alternate with the diphthongs [wi]

and [we] respectively in most dialects of Korean. According to Schane's alphabetical array of particles, these alternations cannot be derived in an explanatory way in (5a), while the ordered representation, where {u} precedes other particles, can easily capture the generalized picture of this alternation.

(5) a. {iu} – {u̯i} ([ü]–[wi]) b. {ui} – {u̯i}
{aiu} – {u̯ai} ([ö]–[we]) {uai} – {u̯ai}

In other words, (5b) clearly shows that the monophthong vs. diphthong alternation is the result of the syllabic vs. nonsyllabic variation of the labiality particle. Moreover, we have to see that diphthongs containing {u̯} may show alternation with monophthongs, while those diphthongs containing {i̯} never show any alternation: e.g., {i̯ua}–*{iua} Therefore, we figure that the labiality particle precedes other particles. Now, as we saw in (3) where the palatality particle is better located in either a left or a right peripheral position, there is no problem to locate {i} at the right peripheral position in a particle set. We thus order the three elementary particles as {u}, {a}, and {i}.

However, one may raise a possible problem on the ordered location of {i} since both {i̯} (i.e., *y*) and {u̯} (i.e., *w*) should precede a vowel in order to form an on-glide diphthong. In other words, if a diphthong begins with an {i̯}, the nonsyllabic particle should precede other (but syllabic) particles {u} and {a}. This possible problem, however, can easily be solved by distinguishing nonsyllabic particles from syllabic particles and by placing nonsyllabic particles {i̯} and {u̯} before syllabic particles for diphthongs. And, there is no conflict between {i̯} and {u̯} since they cannot occur together.[1] Based on these observations, I will use the particle representation of ordered array replacing Schane's unordered array, although this suggestion for ordered representation might have to be reformulated with more evidence.

On the other hand, Schane (1984b:153) briefly suggests that a two dimensional array would provide an even more iconic representation of some phonological processes such as fusion or umlaut, but he did not adopt this mode of notation for typographical reasons. (In the next section, however, it will be shown that this sort of two-dimensional array is very revealing in explaining au-

1) The only off-glide *-iy* does not nullify this hypothesis due to its unique particle representation {i̯}.

tosegmental aspects such as vowel harmony.)

(6) $\{a\} \rightarrow \begin{Bmatrix} a \\ i \end{Bmatrix}$

Here the horizontal sequence to the left correlated directly to a temporal ordering of separately occurring particles, whereas the vertical array on the right portrays a simultaneous occurrence.

2.2. With the observations so far as well as the basic framework of PP and the 10 vowel system of B.-G. Lee (1976), I will present the particle representation of Korean vowels in table (7).

(7) Korean vowels: [i] →{i} [ü]→{ui} [ɨ]→{ } [u]→{u}
[e]→{ai} [ö]→{uai} [ə]→{a} [o]→{ua}
[ɛ]→{aai} [a]→{aa}

From table (7), we can see how complex particles define the different vowels. All front vowels contain the particle {i}, all rounded vowels {u}, and all nonhigh vowels {a}. Moreover, we also note that [a] is represented as {aa}, instead of {a}, since a single occurrence of the aperture particle indicates [a] in those languages with only one central vowel [Schane 1984b:132). In other words, the interpretation of particles is system-dependent for those languages with both [a] and [ə] (or [ʌ]; it is the latter that is represented by one occurrence of the aperture particle, while the former takes two. On the other hand, the vowel [i] is without any elementary particle since it lacks both tonality and aperture.[2] (Note also that neither the palatality particle nor the labiality particle can occur more than once in a monophthong, while the aperture particle can occur twice.)

Unlike the representation of vowels, the particle sets of the halves of a diphthong occur in their proper sequence in Schane (1984a,b). The diphthongs in Korean are presented in (8), where the half-moon symbol denotes that the particle sets are ordered as listed, and it also specifies the nonsyllabic component.

2) In the underspecification theory of Archangeli (1984), this vowel [ɨ] is regarded as a default vowel which does not have any specified feature in the underlying representation (Sohn 1987).

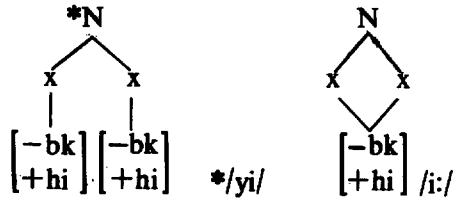
(Moreover, diphthongs counting as more than one mora will contain the "space" as part of their representations.)

(8) a. Off-glide: [ɨy]→{ i͡}
b. on-glides:

[-bk, -rnd]	[-bk, +rnd]	[+bk, -rnd]	[+bk, +rnd]
*[yi] → {i͡i}	*[yü] → {i͡ui}	*[yɨ] → {i͡ }	[yu] → {i͡u}
[ye] → {i͡ai}	*[yö] → {i͡uai}	[yə] → {i͡a}	[yo] → {i͡ua}
[yɛ]] → {i͡aai}		[ya] → {i͡aa}	
[wi] → {u͡i}	*[wü] → {u͡ui}	*[wɨ] → {u͡ }	*[wu] → {u͡u}
[we] → {u͡ai}	*[wö] → {u͡uai}	[wə] → {u͡a}	*[wo] → {u͡ua}
[wɛ] → {u͡aai}		[wa] → {u͡aa}	

This table exhausts all the possible combinations for diphthongs in Korean, assuming a 10 vowel system. As noted in Ahn (1988), there are several constraints on diphthongs. First, Korean does not allow any off-glides except for *ɨy*. Second, on-glides are produced after undergoing the following negative conditions: (i) As the variants *wi* and *we*, replacing *ü* and *ö*, frequently occur, there is no diphthong containing [−bk, +rnd] vowels such as **yü*, **yö*, **wü*, and **wö*. (ii) *ɨ* cannot be preceded by a glide as in **yɨ* and **wɨ*. (Depending on dialects, [yɨ] and [wi] are often used for [yə] and [u].). (iii) [−bk, +hi) *y* cannot form a diphthong with another [−bk, +hi] segment, which is explained by the obligatory contour principle, as shown in (9).

(9) a.



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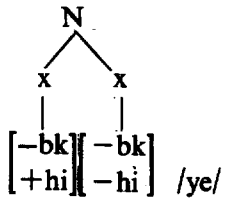
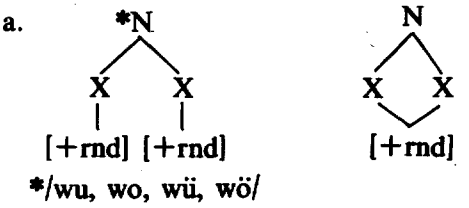
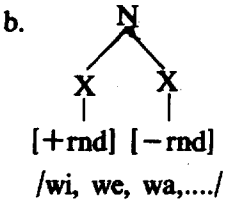
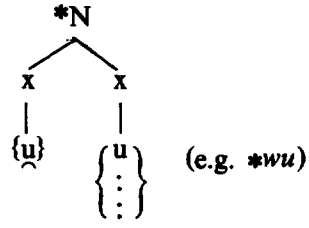


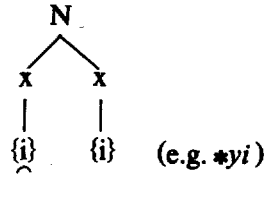
(iv) [+rnd] glide *w* cannot take [+rnd] vowels by the same reason.

(10) a. 

b. 

Now, within the framework of PP, these constraints can be reanalyzed as follows: (i) As the variant {u͡i} and {u͡ai}, replacing {ui} and {uai}, frequently occur, there is no diphthong containing both the labial particle and the palatality particle (i.e., {ui}) such as *{u͡ui}, *{i͡uai}, *{u͡ui}, and *{u͡uai}. (ii) As there can be no diphthong formed only with the nonsyllabic {i} or {u}, *yi* and *wi* are prohibited. (iii) There will be no {i͡}+{i} or {u͡}+{u} clash by the law of diphthongal differentiation (Schane 1984b, 138). Thus *{i͡i}, *{u͡u}, *{u͡ua}, *{u͡ui}, and *{u͡uai} will be prohibited.

(11) a 

b. 

3. Treatment of diagonal vowel harmony

3.1. Vowel harmony processes (henceforth VH) are divided into two major types: horizontal harmony and vertical harmony. The vertical type is often called palatal vowel harmony and is characterized by the dichotomy of harmonic vowel classes into front and back (i.e., palatal vs. velar). In Turkish, for example, four front vowels [u, o] harmonize together against four back vowels.[3)]

3) Turkish has both vertical (or palatal) and rounding (or labial) harmonies as Aoki (1968:143) notes that a rounding harmony frequently occurs secondarily with other type of harmony.

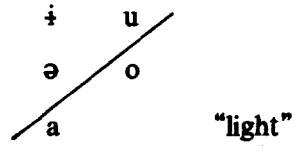
(12)

preceding V:	[i]	[ü]	[ɨ]	[u]
	[e]	[ö]	[a]	[o]
following V:	[i]	[ü]	[ɨ]	[u]

On the other hand, the harmonic classes in horizontal harmony are grouped in terms of vowel height: high vs. low, raised vs. lowered, or tense vs. lax.

VH in Korean, however, belongs to a rare third type which is called "diagonal" because the line dividing the harmonic classes runs diagonally in the vowel chart. The following chart from Kim (1978) shows the diagonal pattern in which the upper vowels are "dark" and the lower ones are "light": it has been interpreted that "light" vowels express "small", "bright", "light", or "shallow", while "dark" vowels express "big", "dark", "heavy", or "deep". (Choi 1937; Huh 196; Kim-Renaud 1976; McCarthy 1983).

(13)



Historically speaking, Middle Korean, like many languages in the Altaic family to which Korean belongs, had a very regular vertical (or palatal) VH (Lee 1972). However, this strict VH has gradually decayed due in part to a vowel shift, monophthongization, and massive borrowing from Chinese which does not have VH (Lee 1972; Kim-Renaud 1976; Kim 1978). The result is that VH is regularly kept in only two areas of Korean morphology; between the final vowel of the verb stem and the following *ə*-initial suffix and in the words of phonetic symbolism.

3.2. The earliest generative account of VH in Korean is given in Kim (1973). Reasoning that VH, to the extent that it remains in modern Korean, still operates on the pre-vowel shift Middle Korean vowel system, he restores it by way of an adjustment rule of the form:

(14) $u \rightarrow ɨ$

This is of course the reverse direction of the actual vowel shift but it enables the VH rule to refer to natureal classes [−back] (i.e., *ɨ, ə*) vs. [+back] (i.e., *o, a*)[4] But the actual pronunciation of *ɨ* is *u*, thus one needs a readjustment rule to change *ɨ* back to *u*, in order to undo the effect of the adjustment rule. The following derivation shows the sequence of derivation of two verbal forms, "light" and "dark". (Here we may use the underspecified *A*, instead of the traditional *ə*, to represent the suffix initial vowel which has the *ə/a* alternation by VH.)

(15)	sok−A	'to deceive'	suk − A	'to lower'
	-------		sɨk − A	: Adjustment : *u* → *ɨ*
	sok−a		sɨk − ə	: VH
	-------		suk − ə	: Readjustment : *ɨ* → *u*

While this sort of treatment of VH in Korean looks "reasonable and even logical" (Kim 1973: 138), it is nonetheless unsatisfactory for several reasons: (i) it is quite arbitrary to invoke an adjustment rule, (ii) it requires a readjustment rule which is an instance of absolute neutralization (Kiparsky 1973), (iii) as only the *i*'s which adjusted from *u*'s undergo a readjustment, but not the underlying *i*'s, there is a dependency relation between the adjustment, and readjustment rules which must be diacritically marked, (iv) phonology becomes too unconstrained and powerful if adjustment of this sort is allowed in phonology, for there is nothing one cannot do if one is permitted to alter the underlying representation by way of adjustment rules.

Being aware of the problem and recognizing that the VH should be specifiable with a single distinctive feature, Moon (1974) proposed to reconstruct the Korean vowels in a symmetric way by adopting the feature system proposed by Wang (1968).

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4) In order to account for the historical vowel shift, Kim (1978:228) reconstructs the early Korean vowel system as below.

Modern Korean	i	ɨ	u	o	a	ə	ɸ
*Early Korean	i	a	ɨ	u	o	a	o

From this data, he reconstructs the Early Korean vowel system as below.
(The modern reflexes of the reconstructed vowels are given in parentheses.)

i	ɨ (u)	u (o)
	ə (ɨ)	o (o)
	a (ə)	ɔ (a)

(16)

	−bk		+bk	
−mid	i	ɨ	u	+hi
		ə		
+mid		ɐ	o	−hi
−mid		a		
	−rnd		+rnd	

Here [+mid] ɐ is paired with ɨ in Middle Korean but is now extinct. In this vowel system, VH operates neatly [+hi] vs. [−hi] and a diagonal aspect is replaced by an elegant symmetric pattern. Evidence available from textual analyses, however, has shown that in the early Middle Korean or Old Korean period when the regular VH was fully operative, the vowel system was quite different from the late Middle Korean system which is similar to that of Modern Korean (Kim 1978:225). In particular, ɐ should be placed below *o* (i.e., low back) rather than as a mid central unrounded vowel as presented in (16) (Lee 1972:111).

Moreover, neither Kim's (1973) nor Moon's (1974) account describes only the suffixal VH of (17a), and either approach cannot cover VH in phonetic symbolism (or ideophone) of (17b) because, unlike in *a/ə*-initial suffixes, ɐ and *o* as well as *a* and *o* function as "light" vowels in sound symbolic words.[5]

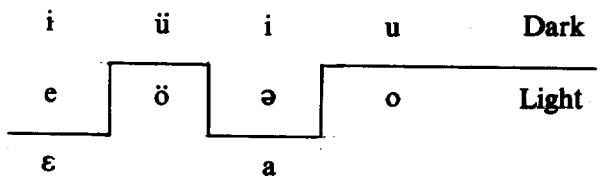
(17) a. Light: *po-ala* 'look', *kal-ala* 'Change'
Dark: *cip-əla* 'Pick up', *se-əla* 'Count',
mɛ-əla 'Tie', *cü-əla* 'Hold',
cö-əla 'Tighten', *kɨ-əla* 'Draw',
cu-əla 'Give'

b. Dark: *p'əlkəh* Light: *p'alkah* −'red'
sukun *sokon* 'whispering'
k'üciüciü *k'öcöcö* 'shabby'
kelkel *kɛlkɛl* 'exhausted'
pipi *pɛpɛ* 'twisting'
tɨlsək *tals'ak* 'lifting'

5) This phenomenon shows that VH survived in monophthongization which is described as: a+i>ɛ, ə+i>e, u+i>ü, o+i>ö. This case of fusion is also better explained in PP as: {aa}+{i}>{aai}, {a}+{i}>{ai}, {u}+{i}>{ui}, {ua}+{i}>{uai}.

For this reason, we may divide the Korean surface vowels in the following way (McCarthy 1983):

(18)



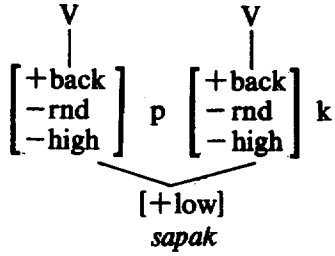
It should be noted here that there is no universal phonetic feature which will distinguish the two groups: the dark and the light vowel sets are not natural classes in any distinctive feature framework. Thus Kim-Renaud (1976) adopts the semantic features [±dark] and [±light] by arguing that, although these diacritic features are phonologically ad hoc, they are semantically well motivated in Korean phonology. McCarthy (1983), however, does not agree with this nonphonological analysis. Instead, he proposes an abstract version of the Korean vowel system with the dark/light distinction corresponding to the values of [±low] in the following way.

(19)

i	ü	ɨ	u	
e		ə		dark=[−low]
æ	œ	a	ɔ	light=[+low]

It can be seen that this system permits a neat formulation of the VH process in Korean. An example from McCarthy is given below.

(20) a.



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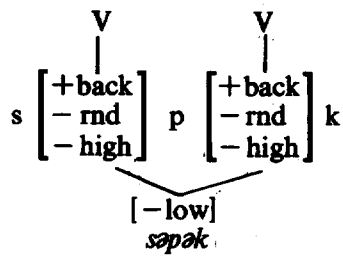
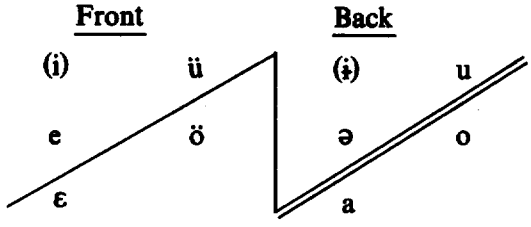


It is, however, still not satisfactory for several reasons (Ahn 1986:31). First, it does not reveal the unequivocal fact that VH in Korean is "diagonal"; namely, the fact that Korean does not have regular VH, but rather a disrupted harmonic

process. Second, McCarthy's claim indicates that VH of Korean is a horizontal type which has a [+low] vs. [−low] distinction. However, as all other languages in the Altaic family to which Korean belongs still retain vertical VH, we should assume the present system was historically derived from a regular vertical VH of an earlier period. Third, this system cannot show the neutrality of *i* and *ɨ*; these two vowels are neutral when they are not syllable initial, e.g., *posilak, pusilək* 'rustling', *posisi, pusisi* 'rising gently'. Finally, œ and ɔ are abstract vowels arbitrarily motivated with no phonetic import. Consequently, in my earlier paper (Ahn 1986:32), I proposed the following categorization of Korean vowels with two diagonal lines, one each in front and back. (The meaning of the double line is explained below.)

(21)

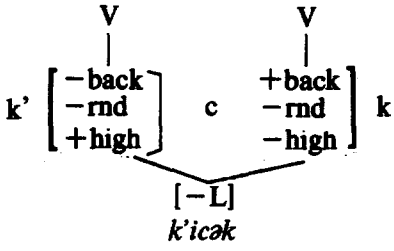


In Ahn (1986), it was claimed that this system has several advantages over McCarthy's. First of all, it gives a true picture of the diagonal shape of Korean VH, where a glance reveals the disrupted and shifted pattern of vowel harmony. Second, we can explain the neutrality of *i* and *ɨ* by saying that they are located in the extreme peripheral region farthest from the dividing lines so that they are less sensitive to the VH process. Third, an arbitrary or abstract representation of the vowels is not needed. Finally, it can clearly be shown that the the suffixal VH takes the division drawn by the double line, while the sound symbolic VH takes the division drawn by both lines.

I realized, of course, that there was still the problem of dividing the two harmonic groups into two natural classes with a distinctive feature in a universal phonetic feature system. Therefore, I discarded McCarthy's abstract vowel system, although I adopted his idea of using [±low] for the relative, not the absolute, height of vowels. Moreover, I did not accept Kim-Renaud's terms just because it is motivated semantically, not phonologically. I thus replaced [±low] of McCarthy and [light]/[dark] of Kim-Renaud with [±L]which indicates the rela-

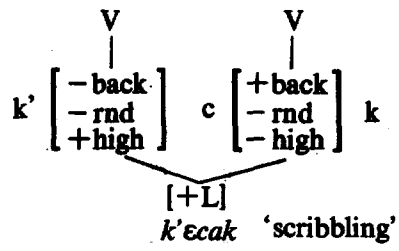
tive, not absolute, heights of the two vowel groups, and this [+L] constitutes another harmonic tier in addition to the already existing syllable, CV, and segmental tiers. An example from Ahn (1986) is given below.

(22) a. Dark



k'icək

b. Light



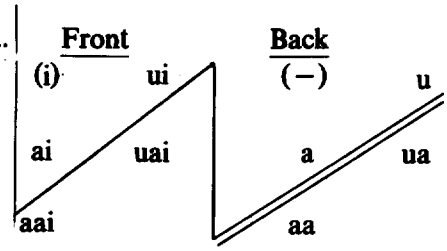
k'ɛcak 'scribbling'

In (22a), the first vowel is realized as *i*, not *e*, because of the feature [+high]. In (22b), however, there occurs a conflict between the segmental feature [+high] and the harmonic feature [+L]. In this case, the light form has the vowel *ɛ* because the autosegmental harmony featrure [+L] takes precedence over the segmental [+high].

As I have already mentioned above, however, this alternative description is still not a satisfactory solution as it appeals to the diacritic feature [±L]. Moreover, I used a very awkward (or even arbitrary) mechanism in (19), stating that where there occurs a conflict between the segmental feature [+high] and the harmonic feature [+L], the autosegmental harmonic feature takes precedence. For these problems, we now realize that, in the standard feature theory, there is no adequate solution to the description of this diagonal VH without appealing to non-phonological features, phonological abstractness, or multi-valued representation as shown in Chomsky & Halle (1968) or in Chen (1973). We thus need to look for a radically different way of description in another theoretical framework, and that framework is PP.

3.3. In order to show the diagonal aspect of the VH, we may redescribe the vowel chart (21) as (23) in light of PP. (In (23b), the particles are unordered just for convenience.)

(23) a.



b.

dark	ai	ui	a	u
light	aai	aui	aa	au

Both descriptions in (23) clearly show that the diagonal shape of VH in Modern Korean is controlled by the aperture particle in each pair. Moreover, {i} and { } (i.e., [i] and [ɨ]) are shown as neutral because their would-be "light" counterpart {ai} and {a} (i.e., [e] and [ə]) are already functioning as "dark" counterparts of {aai} and {aa} (i.e., [ɛ] and [a]).

At this point, however, we have to consider Kim-Renaud (p.c. in 1989) who argues that *i* and *ɨ* (i.e., {i} and { } in PP) are not genuine neutral vowels since they behave as dark vowels syllable-initially. She also argues that affixal VH in Modern Korean is not in fact a diagonal type since the only distinction figured out by VH is the *ə/a* (i.e. {a}/{aa} in PP) alternation as shown in (17). She thus retains her affixal VH rule formulated earlier (Kim-Renaud 1976), which works horizontally in (25).

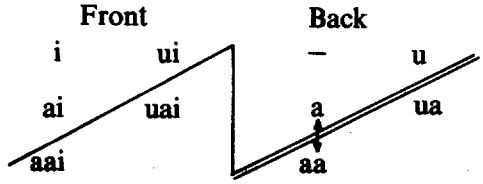
(24) Affixal VH

$$\begin{bmatrix}+\text{back}\\-\text{high}\end{bmatrix} \rightarrow [+\text{light}] \,/\, [2 \leq \text{light}]\ [-\text{syll}]\ \&\ \_\_\_\_$$

Cond: Optional if [2≤light]=[2 light] and [−syll]=[+cons]

(*ə* becomes *a* after a verb stem whose final vowel is *o* or *a*.
The rule is optional if *ə* is preceded by *a* plus one or more consonants.)

(25)

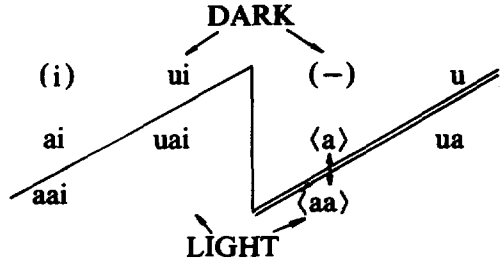


In light of this criticism, we now have to reexamine the fundamental nature of VH in Korean in order to provide a better analysis. For this purpose, I will refer to Mohanan (1989) who distinguishes two (opposite) notions, "undergoer"

and "trigger" in phonological change: Phonological change is the pairing of "undergoer" of change and output of change, where the undergoer is the phonological unit that undergoes the change, the output is the phonological unit that the undergoer changes into, and the environment or context of change is defined in terms of metrical or prosodic edge, "trigger", and temporal order.

When we employ the notion of "trigger", we can solve both problems Kim-Renaud raised. First, even though affixal VH shows the *a/ə* alternation only, this alternation is still triggered by those vowels divided by both lines. Second, in (23), if we assume that the parentheses are ignored in the "trigger" VH, {i} and { } (i.e., *i* and *ɨ*) are specified as dark vowels rather than neutral ones since they are in a triggering (i.e., syllable-initial) position. Therefore, the vowel chart (23) describing VH is still valid with respect to the notion of "trigger". Moreover, even in terms of "undergoer", the ideophonic VH is also straightforward: as the parentheses are applied in this case, *i* and *ɨ* remain as neutral. As pointed out by Kim-Renaud, however, we have to provide a different description on the affixal VH of "undergoer", which leads to the modification of (23) as (26).

(26)



(Note:
i) Affixal VH of undergoers applies to ⟨ ⟩ only.
ii) Neutrality applies to an undergoer with ( ).)

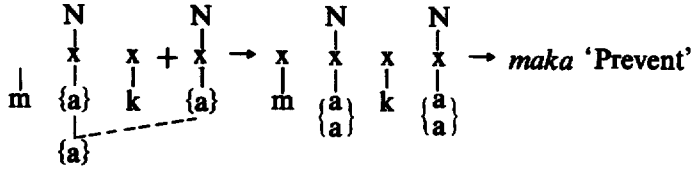
With this modified version of VH model, we can show the two aspects of VH in a more explanatory way. Moreover, we can still maintain the earlier claim for the diagonality of VH in Modern Korean as the diagonality holds for the "trigger" VH of ideophones as well as affixes.[6] Furthermore, we can also retain the

6) We have seen that the VH process in Korean is best described in terms of aperture. From this generalization, however, we may still doubt that VH in Modern Korean is in fact a horizontal type because the VH is controlled by the addition or non-addition of the aperture particle, which may be interpreted as [+low] in the standard feature notion. As mentioned in Lee (1972:131) and Kim (1978:227), however, all other languages in the Altaic family to which Korean belongs show fairly regular palatal (vertical) VH. If the vertical VH is regarded as a common feature in the Altaic family, Korean would

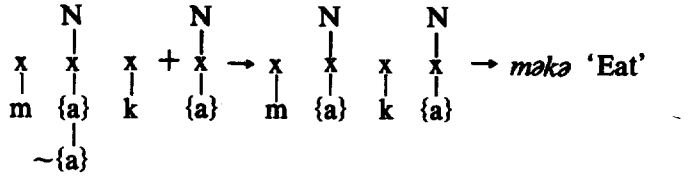
claim on the neutrality of {i} and { } as undergoers.

Based on this modification and the theory of PP, I will now reanalyze harmonic processes as follows, by employing the multi-tiered representation of syllable by Levin (1985).

(27) a.



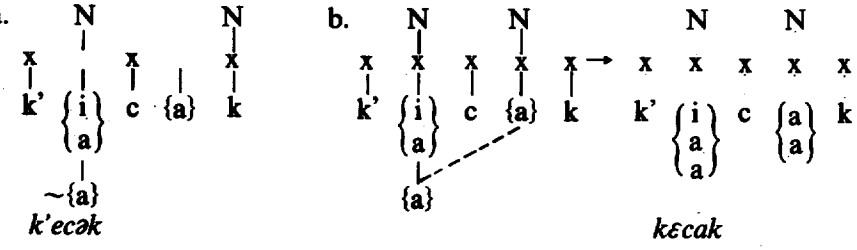
b.



As we can see here, the representation of the two-dimensional vertical array is very useful in this kind of autosegmental analysis. Moreover, I used {a} and ~{a} to represent the addition and non-addition of the aperture particle. ("~" indicates a negative value.)

Now it will be shown that we can discard the arbitrary analysis of (22) as shown in the following derivation, where I will show the *k'ecək / kɛcak* alternation.

(28) a. b.



Here, as we have to consider the neutrality of ideophonic undergoers {i} and {}, the earlier version of VH rule (29) should be revised as (30).

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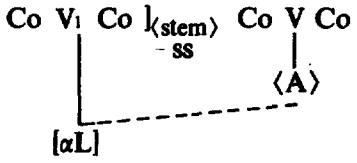
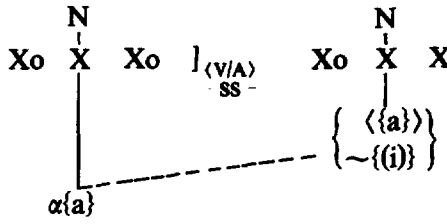
also have had the same feature in an earlier period and the VH in Modern Korean could be the result of a "decay" of an ideal system of the earlier period. And there are several indications implying some kind of historical vowel shifts in Korean. First, all the pairs of vowel participation in VH do not show the same height or the same backness, and this might be the result of historical vowel shifts. Second, historical texts reveal that VH was much more regular in Modern Korean, while it operates only between verbal roots and *a*-initial suffixes as well as in ideophones. Third, the harmonic counterparts of *i* and *ɨ* are missing in Modern Korean. (See Lee (1972) for details.)

(29) VH (earlier version)



(stem=stem of verb or adjective
ss=sound symbolic morpheme)
(The suffix vowel *A* occures as *a* or *ə* depending on VH.)

(30) VH (new version)



(a=either a positive or a negative (~) value
{(i)}={i} or { })

The new version (30) indicates that when the aperture particle gets a positive value, it is spread to the undergoing vowel under two conditions: First, if the trigger is a verb/adjective stem, the undergoer must be an {a}-initial affix. Second, if the undergoer is either {i} or { }, there is no spreading.[7]

Now we note that the new VH rule (30) and the particle-based description of VH in (26) have several advantages over the earlier approaches proposed so far (Kim-Renaud 1976; McCarthy 1983; Ahn 1986).

First, as shown in (26), by categorizing two aspects of VH as "undergoer" and "trigger", we can provide a more accurate description of VH in Modern Korean. Thus we can still hold the claim for the diagonality of VH as it holds for the trigger VH of affixal as well as ideophonic cases. Consequently, as the particle based representation (26) shows the true picture of VH, we do not need an arbitrary or abstract representation of vowels.

Second, in my earlier rule formulation (26), I used the underspecified *A* to show the a/*ə* alternation in an affix-initial position. In PP, however, as all the harmonic alternation in (23) can be captured as a uniform process, the presence or absence of the additional aperture particle, we do not need the underspecified segment in our rule formulation.

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7) The question comes up whether we have to generate a nonexisting vowel by this rule. For example, we may think that if the undergoer is {aai}, we have to generate a nonexisting vowel *{aaai}. This ill-formed output, however, will be filtered out by the vowel system of Korean.

Third, the neutrality of the ideophonic undergoers i and ɨ can be predicted by the new rule formulation (30).

Fourth, Ahn (1986:32) already explained the neutrality of *i* and *ɨ* as undergoers, by saying that they are located in the extreme peripheral region farthest from the dividing lines so that they are less sensitive to the VH process. Within the framework of PP, we can also add that {i} and { } remain neutral because their would-be "light" counterparts {ai} and {a} are already functioning as the "dark" counterparts of the light {aai} and {aa}.[8]

Finally, by employing the particle representation replacing the standard feature representation, we can now state that vowels harmonize for aperture. In standard notation, the use of two binary features [high] and [low] would handle VH awkwardly where vowels of differing height move up or down the height scale and hence would have to require complex variables. (For example, Wang (1968) used a single rule with multiple variables. However, as some of his outputs are found to be incorrect, he needs an additional rule to cure this problem. See Schane (1984b) for additional arguments against the standard feature notation.) This problem makes us turn to the question of "mirroring": how accurately the notational system is able to track the nature of events it describes. And it is shown that particle notation could be closer to this goal than the standard notation.

4. Excursus

Before I finish up this paper, I would like to raise one more issue, the explanatory nature of elementary particles in Particle Phonology. I will now show that the explanatory nature of the elementary particles is not only acoustically but also phychologically real. First, from the point of articulatory phonetics, *i, a,* and *u* are the most probable vowels in a 3-vowel system (Rass 1984), which are maximally dispersed in our articulatory organ. We have called this aspect "the principle of maximum differentiation". In other words, just as we use three kinds

8) According to Lee (1972:137), the neutrality of two vowels *i* and *ɨ* were caused by the merger with other vowels, which was partially responsible for the decay of VH. Just as the Mongolian *i* became neutral due to the merger of the front *i* and the back ɨ so the Middle Korean *i* became neutral for the same reason. For instance, the fact that the honorific morpheme *-si-* took the suffix *a* instead of *ə* in Middle Korean indicates the origin of the vowel in *-si-* as a back vowel (Lee 1972:115). Moreover, *nic-* 'forget' could take each suffixal form *-ɔni* or *-ini* due to this reason (Lee 1972:137).

of colors for traffic lights, green, yellow, and red since they are most distinctive from each other, so a language with only 3 vowels would take the maximally differentiated *i, a,* and *u* as its vowels. Suppose we used other colors, such as red, purple, and orange for traffic lights, then most drivers as well as pedestrians would find it very difficult or confusing to read traffic orders. Similarly, if a 3-vowel system language has *i, e,* and *ɛ*, communication would not be as easy as using *i, a, u*. Therefore, just as the three vowels, *i, a,* and *u,* are the basic elements universally, so they are qualified as the elementary particles in PP. Moreover, if we suppose a 5-vowel system, the basic vowels would appear as *i, e, a, o,* and *u* (Lass 1984), where *e* and *o* have the combined nature of *i* and *a* and that of *u* and *a* respectively, in terms of their articulatory locations and the distinctive features. Similarly, in PP, *e* and *o* (i.e., {ai} and {ua}) are presented as the combination of {i} + {a} and {u} + {a} respectively.

Second, from the acoustic point of view, *i, a,* and *u* are the basic vowels as the distributional shapes of their formants (especially the first and the second formanfs, F_1 and F_2 are maximally distinctive from those of other vowels. According to Ladefoged (1982:176), a given vowel is the rapid repetition (corresponding to the vibrations of the vocal cords) of its peculiar notes (corresponding to its formants). Moreover, as in PP, the formants of other vowels can be derived from those of the basic vowels.[9] For example, in the following table (31), the F_1 and F_2 values of *ɛ* (i.e., {aai}) are represented as 550Hz and 1770 Hz respectively and their scalar locations are between 280 Hz of *i* and 710 Hz of *a* for F_1, while 2250 Hz of *i* and 1100 Hz of *a* for F_2.

(31)

F_2	2250	1770			
			1100	.....	870
		550	710		
F_1	280			.....	310
		[ɛ]	[a]	[ɔ]	[u]

(Ladefoged 1982:176)

9) According to Schane (1984b:153), the particle notation for fusion (e.g., *a* + *i* > *ai*) is reminiscent of the notation of chemistry, where the input of elements determines the composition of a compound (e.g., Na + Cl = NaCl). The phonological notation [a] + [i] > [e] would be analogous to the chemical statement: Sodium + [i]rine=Salt.

Here we can see that the scalar values of F_1 and F_2 in [ɔ] are also represented in between those values of [a] and [u]. Furthermore, we can test the validity of this kind of arithmetic by hypothesizing that the formant values of [ae] should be located in between those of [ɛ] and [a], and they really appear as such (i.e., 690 Hz and 1660 Hz) in Ladefoged (1982: 176).

Third, language specifically, particle representation of vowels is psychologically real in Korean. As Schane (1984b:153) states that the particle notation for fusion is reminiscent of the notation of chemistry, the particle notations of vowels reflect the orthographical representation of the vowels and the diphthongs in Korean, as shown in (32).

(32)

IPA	particle notation	orthographic representation
[i]	{i}	ㅣ
[u]	{u}	ㅜ
[a]	{aa}	ㅏ
[ə]	{a}	ㅓ
[e]	{a} + {i} = {ai}	ㅓ + ㅣ = ㅔ
[ɛ]	{aa} + {i} = {aai}	ㅏ + ㅣ = ㅐ
[u]	{u} + {i} = {ui}	ㅜ + ㅣ = ㅟ
[we]	{u} + {ai} = {uai}	ㅜ + ㅔ = ㅞ
⋮	⋮	⋮

As we have seen so far, the particle representation of vowels are not only phonetically (i.e., articulatorily as well as acoustically) but also psychologically real. Moreover, the theory of PP can show its adequacies in describing other vocalic processes such as umlaut, vowel coalescence, and *i* deletion (Kim-Rranud 1974; Ahn 1985), etc. Furthermore, we may try to annex this theory with the theory of feature geometry by Clements (1985) for better description of vowels.

Nevertheless, there exist several problems to solve for the development of PP. First, The theory of PP can only cover vowels and vowel-related phonological processes. In order to be a universally acceptable theory, it should be developed so that it can fully describe consonants or consonantal processes as well. Moreover, this theory is not adequate in terms of markedness values. According to Schane (1984a, b), the particle notation of vowels can represent the markedness value of a vowel by the number of elementary particle present in its representation. Thus, according to Schane, [i] or [u] (i.e., {i} or {u}) is less marked than [e] or [o] (i.e., {ai} or {ua}). However, as language specific [a] has to be rep-

resented as {aa} if [ə] or [ʌ] (i.e., {a}) is present, we have to wonder whether [a] (i.e., {aa}) is more marked than [ə] (i.e., {a}). Furthermore, Schane (1984b:153) notes that the vowel [ɨ] is considered more marked than other vowels and attributes this status to its lack of elementary particles. According to the underspecification theory (Archangeli 1984), however, [ɨ] in Korean should be the least marked vowel since it can be inserted in many cases (Sohn 1987). As the markedness status of [ɨ] conflicts between the theories of PP and underspecification, we have to decide which may is the right direction to take. I leave these questions as residual problems for the time being.

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