KOREAN VOWEL HARMONY - AN OPTIMALITY ACCOUNT

by

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ABSTRACT

This thesis examines two aspects of Korean vowel harmony: the identification of the correct harmonizing feature and neutrality in the harmony system.

In this study, I investigate the hypothesis that Korean vowel harmony can be described as tongue root harmony and that the neutrality in the harmony system can be accounted for through the interaction of various constraints within the framework of Optimality Theory; the Theory of Constraint Interaction (Prince and Smolensky 1993, McCarthy and Prince 1993).

In Chapter One, the basic phenomena and the problems of Korean vowel harmony are presented. Chapter Two discusses the theoretical background of Optimality Theory. The basic claims and motivation for the theory are dealt with in the first section. In the following section, I consider major studies applying this theory, including: syllable theory (Prince and Smolensky 1993); prosodic morphology (McCarthy and Prince 1993, Prince and Smolensky 1993); and vowel harmony (Pulleyblank 1993). In Chapter Three, the Optimality account of Present-Day Korean and Later Middle Korean is presented. I further discuss Optimality Theory's treatment of diachronic change in harmony systems. Concluding remarks and areas for further research are given in Chapter Four.

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CHAPTER 1

INTRODUCTION

Vowel harmony is a well known phonological phenomenon found in numerous languages. Until now, it has been generally assumed that palatal (front-back) harmony is found typically in Uralic and Altaic languages, while tongue root harmony occurs mainly in language families in Africa (Vago 1980). But recent studies (Svantesson 1985, Song 1990) show that tongue root harmony is also found in some of the Altaic languages such as Korean and Mongolian.

The vowel harmony of Korean has been a controversial topic not only due to the difficulty in finding a correct harmonizing feature but also due to problems in explaining the identification and properties of neutral vowels in harmony. The neutrality of high unrounded vowels in the Korean harmony system has hitherto been treated merely as an exception to the harmony in most studies.

In this study, the hypothesis that Korean vowel harmony can be described as tongue root harmony and that the neutrality in the harmony system can be accounted for as resulting from the interaction of various constraints will be investigated within the framework of *Optimality Theory; the Theory of Constraint Interaction* (Prince & Smolensky 1993, McCarthy & Prince 1993a,b).

1.1. A Summary Introduction of Korean Vowel Harmony Phenomena

In Present-Day Korean (henceforth; PDK) the vowel harmony phenomenon can be found in sound symbolic words and so called 'A-initial suffixes' (C.W.Kim 1978, Kim-Renaud 1986, etc.). In PDK, there are 10 monophthongs which result historically from the loss of [ʌ] and the monophthongization of diphthongs (əy->e, ay->ɛ, oy->ö, uy->ü) after Later Middle Korean (henceforth; LMK). The vowel systems of LMK and PDK are shown in (1) and (2) respectively.

(1) Later Middle Korean

i	ɨ	u
	ə	o
	a	ʌ

(2) Present-Day Korean

i	ü	ɨ	u
e	ö	ə	o
ɛ		a	

In the sound symbolic words of PDK, vowels are divided into two sets. The vowels [i,e,ü,ɨ,ə,u] form a harmonic group traditionally called 'dark' vowels, and the vowels [ɛ,ö,a,o] form the other set called 'light' vowels. Within a sound symbolic word, vowels must be either all dark or all light. The only exceptions for this are the vowels [i] and [ɨ] which are neutral in non-initial syllables and therefore may cooccur with either dark or light vowels. Some examples of sound symbolic words are given in (3).

(3)	Dark	Light	
	cik'əl	cɛk'al	'chattering'
	səpək	sapak	'crunching'
	tɨls'ək	tals'ak	'lifting'
	p'yulutuŋ	p'yolotoŋ	'pouting'
	pisil	pɛsil	'staggering'
	sinkɨl	sɛnkɨl	'smiling'

The last two examples 'staggering' and 'smiling' show the neutrality of the high unrounded vowels in the second syllables. Vowel harmony in sound symbolic words has been difficult to describe because the vowels of each harmonic class do not clearly constitute a natural class. Traditionally, it has been treated as palatal harmony of the type common in Altaic languages including Turkish and Classical Mongolian. However, since each harmonic group includes both back and nonback vowels, it cannot simply be treated as strictly palatal harmony. McCarthy (1983) described vowel harmony in sound symbolic words as a height harmony arguing that [low] is the feature that distinguishes each harmonic set. This analysis is not very plausible since he had to include an ad hoc context-free rule ([+round]-> [-low]) for the nonlow rounded vowels (o,ö). Kim-Renaud (1986) described vowel harmony in sound symbolic words by semantic features like [dark] and [light], which does not seem to have strong phonological motivation. In other

studies, the harmony was considered as exceptional like Nez Perce, since the harmony was not considered to be characterized by any single distinctive feature (Tohsaku,1983). I will adhere to the arguments presented in Song (1990) in stating that [ATR] is the feature which distinguishes the dark vowels from the light ones in PDK.

1.2. Optimality Theory and Application thereof in Vowel Harmony

Optimality Theory, which is a theory of constraint interaction, offers a principled account for the problem of neutral vowels in Korean vowel harmony, using the mechanism of ranking a set of conflicting constraints that play a crucial role in the language.

Since Chomsky and Halle (1968), it has been standard procedure to derive output forms from input structure by applying a set of rules. However, the Optimality concept suggests a rather different method. Instead of taking the underlying form (an input) and transforming it into its associated output in a step-by-step manner, Optimality Theory allows the generation of a large set of candidate outputs and evaluates them by the mechanism of well-formedness constraints. The constraints are part of Universal Grammar, and each language has a different ranking of the constraints constituting the individual grammar. By giving an appropriate ranking for Korean, therefore, we can

solve the problem of neutral vowels within the framework of Optimality Theory. The neutral vowels in the harmony system of Korean result simply from the interaction between the grounded condition RTR/LO (Archangeli & Pulleyblank, in press) and right and left edge constraints on alignment:

(4) Constraints

ALIGN-α-L/R: The left/right edge defined by feature α aligns with the left/right edge of Domain D.

RTR/LO: If [-ATR] then [+low]; if [-ATR] then not [-low].

The ALIGN constraint links the feature to the left/right edge of each domain. For example, if [-ATR] fails to link to the first mora of the word then it violates ALIGN-L. Likewise, a violation of ALIGN-R will occur if the feature is not aligned to the right edge of a morpheme. The grounded condition RTR/LO prevents the [-ATR] feature from linking to nonlow vowels.

To illustrate this, let us discuss the difference between 'crunching' (**sapak**) and 'staggering' (**pɛsil**) from the examples in (3). I assume that [-ATR] is the harmonizing feature in harmony and that the light sound symbolic words have an underlying [-ATR] specification while dark sound symbolic words do not. The properties of the neutral vowels are explained by the relative order of the constraints

RTR/LO and ALIGN-R (RTR/LO>> ALIGN-R); the basic hypothesis is that harmony is interrupted by the effect of the grounded condition RTR/LO whereas the constraints on alignment encourage it. ALIGN-L ensures that the feature [-ATR] aligns to the left-edge of the words. ALIGN-R causes this [-ATR] feature to spread to the following vowels. Thus, ALIGN-L and ALIGN-R together derive the harmony effect. However, the RTR/LO condition which prevents [-ATR] from linking to nonlow vowels blocks this harmony when the non-initial vowels are not low. As a result, the non-initial moras of each word surface as [+ATR] (i,ɨ) in such cases. In other words, the feature [-ATR] aligns to the right vowel of **sapak** without incurring any violation. If [-ATR] is not aligned to the right, then the form violates ALIGN-R; as it is, harmony proceeds to the right in normal cases. However, in the case of high unrounded vowels, harmony cannot proceed as such because it will incur an RTR/LO violation. The candidate form **pɛsil** will be the optimal form even though it violates ALIGN-R because it is more important to obey the higher ranked constraint RTR/LO. [i] and [ɨ] are neutral only in non-initial syllables because ALIGN-L is ranked higher than RTR/LO. To sum up, the ranking with respect to these three constraints is: ALIGN-L>> RTR/LO>> ALIGN-R.

The basic analysis of the most crucial type of case in our investigation has been outlined here and will be discussed in detail in Chapter Three. A more profound

analysis, however, will require a complete ranking of all the constraints.

We will also examine the diachronic change from Later Middle Korean to Present-Day Korean; this change will be accounted for by reranking some of the constraints for each stage.

1.3. Organization of Content

Chapter Two will discuss the theoretical background of Optimality Theory. The first subsection will deal with the basic claims and the motivation/development of Optimality Theory. In the following section, we will look at the major studies or applications concerning this theory including syllable theory (Prince & Smolensky 1993), prosodic morphology (McCarthy & Prince 1993a, Prince & Smolensky 1993) and vowel harmony (Pulleyblank 1993). In Chapter Three, the main body of the thesis, we will look at the Korean vowel harmony system. The first section will follow the vowel system of Korean through its diachronic changes from Later Middle Korean to Present-Day Korean. Previous accounts of Present-Day Korean vowel harmony will be presented briefly, followed by the Optimality account of the harmony system. In the subsequent section, the Optimality account of Later Middle Korean will be discussed. Optimality Theory's treatment of diachronic change in harmony systems

will also be discussed. The concluding remarks and areas for further research will be given in Chapter Four.

CHAPTER 2

THEORETICAL BACKGROUND

In this chapter, we will discuss the basic characterization of Optimality Theory (henceforth; OT) presented in Prince and Smolensky (1993) and McCarthy and Prince (1993a). In order to derive the hypothesis regarding the harmony system of Korean discussed in the introduction, it is important to lay out some of the properties of Optimality Theory.

Some of the major applications of this theory will also be presented in this chapter. The discussion will help one to understand how OT treats some major areas of phonology. Furthermore, the discussion of syllable theory and prosodic morphology will show that crucial properties of OT are independently motivated --not introduced specifically to account for the harmony phenomenon of Korean, but to explain similar problems in other areas of phonology; the use of constraints other than those directly involved in harmony provides independent motivation for the types of theoretical properties crucial to the account of Korean vowel harmony.

2.1. Optimality Theory

The goal of OT is to develop and explore a theory whereby representational well-formedness determines the assignment of grammatical structure. In the standard theory of generative phonology (since Chomsky and Halle, 1968), the phonological rule aims to encode grammatical generalizations as follows:

(5) A -> B / C _ D

Such a rule examines its input for the pattern CAD and changes element A into B, producing an output that is typically subject to further rules of the same type (Chomsky & Halle 1968, McCarthy & Prince 1993a). Challenges to this derivational approach have recently been observed, as it has been found that linguistic patterning in many areas is actually governed by structural constraints on the *output* level --constraints which furthermore hold generally across forms that would be processed by many distinct rewrite rules. A number of phonologists (Goldsmith 1990,1993, Paradis 1988a, Singh 1987, Coleman 1991, Scobbie 1991,1992, Bird 1990, Myers 1991 and many others) have proposed constraint-based models such as "The Theory of Constraints and Repair Strategies" and "The Persistent Rule Theory" which shift the explanatory burden from the input-driven rewrite rules to output constraints.

Optimality Theory is the outgrowth of a research program first proposed in Smolensky (1988) which seeks to investigate the insights of connectionist and symbolic computation. Smolensky demonstrates that certain connectionist networks can be analyzed as algorithms for maximizing "Harmony", a numerical measure of well-formedness. OT takes this connectionist insight of harmony maximization as a basic cognitive principle and imports it into grammatical theory as optimization. Unlike other connectionist approaches to language, however, OT does not seek to replace symbolic representations and linguistic analyses with low-level numerical computation (Kirchner 1993b, Prince & Smolensky 1993).

The basic idea of OT is that Universal Grammar consists of a set of constraints on representational well-formedness, out of which individual grammars are constructed. Individual grammars are constructed by imposing a ranking on a universal constraint set. According to this theory, language-particular variation is due to differences in the ranking of the constraints. OT shifts the explanatory burden of linguistic theory from input-based rules to output-based constraints. OT allows for the specification of a large set of candidate outputs instead of taking an underlying form and transforming it in a step-by-step manner into its associated output. The candidate set is evaluated by the system of well-formedness constraints, which selects the

actual output (optimal) forms from the candidate set. Therefore, the grammar is configured like this:

(6) Gen (in_i) -> {$cand_1$, $cand_2$, ...}

Eval ({$cand_1$, $cand_2$,... }) = out_{real}

(McCarthy & Prince,1993a)

The grammar defines a pairing of underlying and surface forms ($input_i$,$output_j$) by the function Gen ('generator') which is a fixed part of Universal Grammar. The function Eval determines the relative harmony of the candidates. An optimal output is at the top of the harmonic order on the candidate set, which best satisfies the constraint system. The set of constraints, denoted by '**C**', is provided by Universal Grammar and an individual grammar G_1 is obtained by imposing a strict dominance order, denoted by '>>', on the elements of **C**.

(7) UG = {C_1,C_2,..,C_n} = **C**

G_1 = (**C** ; >>)

(Ito, Mester & Padgett 1993)

OT has the attractive trait of allowing the output form to violate some of the relevant constraints. Prince and Smolensky (1992, 1993) have argued that the goal of developing a restrictive theory of Universal Grammar can be best served by allowing constraints to be violated. The

output, therefore, will typically fail to meet every constraint. For a given input, the candidate that best-satisfies the constraint system will be optimal and is by definition the output that the grammar associates with the input (McCarthy & Prince 1993a).

OT relies on the notion of constraint interaction whereby the satisfaction of one constraint can be designated to take absolute priority over the satisfaction of another. The means that a grammar uses to resolve conflicts is to rank constraints in a "strict dominance hierarchy". Each constraint has absolute priority over all the constraints lower in the hierarchy. That is, lower-ranked constraints can be violated in an optimal output form when such violation secures success in higher-ranked constraints.

The following four principles are hallmark properties of OT presented in McCarthy and Prince (1993a) among others.

(8) Principles of Optimality Theory

a.**Violability;** Constraints are violable, but violation is minimal.

b.**Ranking;** Constraints are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking.

c.**Inclusiveness;** The constraint hierarchy evaluates a set of candidate analyses that are admitted by very general considerations of structural well-

formedness. There are no specific rules or repair strategies.

d. **Parallelism;** Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set. There is no serial derivation.

As mentioned above, ranking and violability are the key characteristics of OT. Let us, then, consider the notions of constraint ranking and constraint violability. Suppose we have a grammar consisting of two constraints, A and B. The grammar functions to pair underlying forms with surface forms: Eval(Gen(in_1))->out_1, Eval(Gen(in_2))->out_2, and so on. Suppose that we have an underlying form /in_k/ which gives rise to a candidate set {k-$cand_1$,k-$cand_2$} through the function Gen (McCarthy & Prince,1993a,b).

The following tableau illustrates how the satisfaction of a constraint hierarchy proceeds.

(9) Constraint Tableau, A>>B

Candidates	A	B
☞k-$cand_1$		*
k-$cand_2$	*!	

(McCarthy & Prince,1993a,b)

Suppose k-cand$_1$ is the actual output form. If both constraints A and B agree that one candidate passes and the other fails, then the optimal candidate is just the one that meets both constraints. No competition is involved in this case. However, if A and B disagree on the candidate set, then we have a constraint conflict, as represented in tableau (9). The candidate k-cand$_1$ meets A and violates B, while k-cand$_2$ meets B but fails A. Since k-cand$_1$ is the actual output form in this case, the constraint A dominates constraint B (A>>B). Therefore, the decision between A and B is made by A alone when A and B disagree on a candidate pair since A takes absolute priority over B in the hierarchy.

It is useful to mention the basic conventions of the tableau at this point following Prince & Smolensky (1993) and McCarthy & Prince (1993a).

•Left-to-right column order mirrors the domination order of the constraints.

•Violation of a constraint is marked by "*" and the fatal violations are also signalled by "!".

•Satisfaction is indicated by a blank cell.

•The symbol ☞ draws attention to the optimal candidate.

•Shading emphasizes the irrelevance of the constraint to the fate of the candidate. A loser's cells are shaded after the fatal violation, the winner's, when there are no more competitors.

An interesting configuration arises when a constraint in the grammar admits multiple (or gradient) violations. We will see in the following chapter that the analysis of Korean vowel harmony involves both single and multiple violations.

Suppose we have a pair of candidates that ties on all constraints higher-ranked than C, and with C itself we have the following.

(10)Multiple Violation

Candidates	...	C
☞$cand_1$	...	*
$cand_2$	...	***

(McCarthy & Prince,1993b)

The principle of Harmonic Ordering (Prince & Smolensky,1993)[1] entails the desirable result that any single constraint will only be violated minimally in an optimal form. In this case, we say that $cand_1$ is the optimal output because its accumulated violations of C are fewer than those of $cand_2$: C is violated minimally.

[1]The notion of Harmonic Ordering defines best-satisfaction in a way that encompasses hierarchical ranking of violation ('violate the lowest-ranked constraint') and nonranking ('violate any single constraint to the least degree possible') (McCarthy & Prince 1993).

Let us conclude the discussion of the theoretical background by looking at three principles that underlie the theory of Gen presented in McCarthy and Prince (1993a).

(i) **Freedom of Analysis;** Any amount of structure may be posited.

(ii) **Containment;** No element may be literally removed from the input form. The input is thus contained in every candidate form.

(iii) **Consistency of Exponence;** No changes in the exponence of phonologically-specified morphemes are permitted.

Freedom of Analysis allows Gen to supply candidate outputs that include any degree of structure, both in terms of autosegmental features and associations and in terms of prosody. It requires no specific rules or repair strategies since the basic principles of representational form supply a range of candidates that are inclusive. The Containment property limits this freedom by requiring the input to be present in any licit candidates. Therefore, if an input form includes a feature specification (i.e. [-ATR]), the correct output form must have this feature. Consistency of Exponence means that the lexical specifications of a morpheme cannot be affected by Gen. Thus, any given morpheme's phonological exponents must be identical in underlying and surface form.

2.2. Major Application

2.2.1. Syllable Theory

One of the major applications of Optimality Theory is to establish a typology of syllable structure systems. The idea is that Universal Grammar provides a set of violable constraints on syllable structure, and that individual grammars fix the relative ranking of these constraints (Prince & Smolensky 1993). Therefore, the typology of possible languages is given by the set of all possible rankings. Prince and Smolensky (1993) derives CV syllable structure typology by using the following constraints and the various rankings of these constraints.

(11) The Basic Syllable Constraints

i) **ONS;** Syllables must have onsets.

ii) **-COD;** Syllables must not have a coda.

iii) **PARSE;** Underlying segments must be parsed into syllable structure.

iv) **FILL;** Syllable positions must be filled with underlying segments.

PARSE and FILL comprise what Prince and Smolensky (1993) calls the "Faithfulness" family of constraints in the sense that well-formed syllable structures are those in which input segments are in one-to-one correspondence with

syllable positions. This faithfulness constraint set is denoted as '**F**' (and a number of it as 'F_i') in the following table.

(12) CV Syllable Structure Typology

(Prince & Smolensky, 1993)

		Onsets	
		ONS>>F_i	**F**>>ONS
Codas	-COD>>F_i	Σ^{CV}	$\Sigma^{(C)V}$
	F>>-COD	$\Sigma^{CV(C)}$	$\Sigma^{(C)V(C)}$

The above typology is consistent with that of Jakobson about syllable structure:

> "There are languages lacking syllables with initial vowels and/or syllables with final consonants, but there are no languages devoid of syllables with initial consonants or of syllables with final vowels."

(Jakobson 1962, Quoted in Prince & Smolensky 1993)

When the Faithfulness constraints dominate both structural constraints (ONS,-COD), respecting the input is more important than obeying ONS and -COD. For example, the string /CVC/ will be parsed as a closed syllable, violating -COD, and the string /V/ will be parsed as an onsetless

syllable, violating ONS. This gives the language $\Sigma^{(C)V(C)}$[2] as the table in (12) shows. On the contrary, a more aggressive parsing of the input will result when a member of the Faithfulness constraints is dominated by either, or both of, the structural constraints. In the case where ONS dominates the Faithfulness constraints, every syllable must have an onset. The string /V/ can either remain unsyllabified, violating PARSE, or be parsed as .□[3]V., violating FILL. This gives the language Σ^{CV} or $\Sigma^{CV(C)}$. The case where -COD dominates a Faithfulness constraint corresponds to languages in which codas are forbidden (Σ^{CV} or $\Sigma^{(C)V}$).

We can extend our explication by showing the interaction of the structural constraints ONS and -COD with the Faithfulness (PARSE, FILL) constraints. Let us discuss the interaction of ONS with Faithfulness first. The following tableaus and explanations are largely from Prince and Smolensky (1993) chapter 6.

Suppose we have an input /V/. If ONS is dominated by both of the Faithfulness constraints, the optimal parse will be .V. as the tableau (13) shows.

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[2]The notation Σ^{xyz} denotes the language whose syllables fit the pattern XYZ (Prince & Smolensky 1993).
[3]□ represents an empty structural position.

(13) Onset Not Required

/V/	FILL	PARSE	ONS
☞.V.			*
<V>		*!	
.□V.	*!		

Notice here that the relative ranking of FILL and PARSE has no effect on the outcome. The violation of PARSE and FILL is fatal because there is a candidate which satisfies both constraints: namely .V., since the syllable does not have to have an onset in this case. The candidates <V> and .□V. can be the optimal parse when we have the following ranking of the constraints.

(14) Enforcement by Overparsing (Epenthesis)

/V/	ONS	PARSE	FILL
.V.	*!		
<V>		*!	
☞.□V.			*

(15) Enforcement by Underparsing (Deletion)

/V/	FILL	ONS	PARSE
.V.		*!	
☞<V>			*
.□V.	*!		

The above cases show that we must have an onset. If FILL is the lowest ranked constraint, a syllable is enforced by overparsing (.□V.). If PARSE is the lowest, then a syllable is enforced by underparsing (<V>). Therefore, we can draw the following conclusion: onsets are optional if PARSE and/or FILL dominates ONS, and mandatory if ONS dominates either PARSE or FILL.

The same line of argument can be presented for Coda cases. The following three rankings determines appropriate outputs for each case.

(16)Coda Not Forbidden

/CVC/	FILL	PARSE	-COD
☞.CVC.			*
.CV<C>.		*!	
.CV.C□.	*!		

(17)Enforcement by Overparsing (Epenthesis)

/CVC/	-COD	PARSE	FILL
.CVC.	*!		
.CV<C>.		*!	
☞.CV.C□.			*

(18)Enforcement by Underparsing (Deletion)

/CVC/	FILL	-COD	PARSE
.CVC.		*!	
☞.CV<C>.			*
.CV.C□.	*!		

Codas are optional in a language if -COD is dominated by both PARSE and FILL as in (16). Codas are forbidden if -COD dominates either PARSE or FILL. If PARSE has the lowest ranking, then the optimal form will be realized by underparsing (phonetic deletion) as in (18). If FILL is the lowest then it is realized by overparsing (epenthesis) as in (17).

The heart of constraint interaction in OT is to build individual phonologies directly from universal principles of structural well-formedness. Universal Grammar provides a set of highly general well-formedness constraints. These often conflicting constraints are all operative in individual languages. Languages differ primarily in the way they rank these universal constraints in a strict dominance hierarchy that determines the circumstances under which constraints are violated. Therefore, a language-particular grammar is a means of resolving the conflicts among universal constraints (Prince & Smolensky 1993).

In this section, we have seen that these changes in the ranking of universal constraints give different types of

syllable typologies. Later, we will see that the changes in ranking can also characterize the different historical stages in a single language as we discuss Korean vowel harmony.

2.2.2. Prosodic Morphology

As we have briefly seen in Chapter One, Optimality Theory's treatment of the harmony system is quite different from the standard approach. In this section, we will observe how Optimality Theory treats prosodic morphology, and the way in which OT's prosodic morphology differs from the standard prosodic morphology based on the arguments presented in McCarthy and Prince (1993a).

The standard theory of prosodic morphology is embodied in the following three core principles.

(19) Principles of Standard Prosodic Morphology
(McCarthy & Prince, 1986)

a. Prosodic Morphology Hypothesis

Templates are defined in terms of the authentic units of prosody: mora(μ), syllable(σ), foot(Ft), prosodic word (PrWd).

b. Templatic Satisfaction Condition

Satisfaction of templatic constraints is obligatory and is determined by the principles

of prosody, both universal and language-specific.

c. Prosodic Circumscription

The domain to which morphological operations apply may be circumscribed by prosodic criteria as well as the more familiar morphological ones.

The essence of the above principles is that templatic and circumscriptional morphology are governed by universal and language-particular constraints on prosodic well-formedness. Optimality Theory (McCarthy & Prince 1993a), however, gives a rather different perspective on these principles. The Template Satisfaction Condition and Prosodic Circumscription can be seen as fixing a dominance relation between the well-formedness constraints of two different domains: namely, prosody(**P**) and morphology(**M**): **P>>M.** Simply put, the constraints on prosodic structure take precedence over the constraints on morphological structure in templatic and circumscriptional morphology (McCarthy & Prince 1993a:102). This is illustrated by showing the Axininca Campa Reduplication case from McCarthy and Prince (1993a) chapter 5.[4] The reduplication process is suffixal in

[4]I this study, we will only discuss the cases which are relevant to show the ranking schema P>>M.

Axininca Campa. The crucial data that we will discuss is given in (20).

(20) Base	Reduplication	
a./osampi/	osampi-sampi	'ask'
b./osaŋkina/	osaŋkina-saŋkina	'write'
c./n-osampi/	n-osampi-sampi	'ask'
d./n-osaŋkina/	n-osaŋkina-saŋkina	'write'
e./n-apii/	n-apii-napii	'repeat'
f./naa/	naa-naa	'chew'

Axininca Campa reduplication involves C-initial roots as well as V-initial roots. We will, however, omit any discussion of the C-initial roots since they are not the case of interest here. The relevant constraints are presented in (21).

(21) Constraints

i) **ONS;** Syllables must have an onset.

ii) **FILL;** Syllable positions must be filled with an underlying segment.

iii) **MAX;** The reduplication is phonologically identical to the Base.

iv) **R≤ROOT;** The Reduplicant (R) contains only the root.

v) **DISYLL;** The Reduplicant is minimally disyllabic.

The ONS constraint, already familiar from the previous section, requires an onset for each syllable. FILL forces the node in the prosodic tree to be filled with a segment. MAX is a familiar feature of reduplicative theory that necessitates that the Reduplicant be an exact copy of its base (Steriade 1988a). R<ROOT characterizes the morphological composition of the source of the Reduplicant, demanding a kind of morphological integrity (Mutaka & Hyman 1990). Finally, DISYLL requires a reduplicant of a certain minimal size (two syllables), a kind of generalized templatic restriction. The last three constraints pertain to morphological structure while ONS and FILL apply to prosodic structure.

Let us, then, look at reduplication with unprefixed V-initial roots ((20)a,b). Since **osampi-sampi** is the optimal form, more harmonic than the total reduplication case, **osampi-osampi**, we can see that ONS dominates MAX.

(22)

Candidates	ONS	MAX
o.sam.pi-o.sam.pi	* *!	
☞o.sam.pi-sam.pi	*	*

The Base **o.sam.pi** must violate ONS, because other options such as <o>.sam.pi or □o.sam.pi are excluded by higher ranking constraints PARSE and FILL. But the Reduplicant should not

violate ONS even at the price of MAX violation. This shows that MAX is crucially dominated by ONS. The prefixed forms of V-initial roots copy neither the prefix nor the root-initial syllable as in (20)c,d. Just as in the above-mentioned case (22), the constraint ONS excludes the total root reduplication candidate, **n-osampi-osampi**. Total Base reduplication (which includes prefix **n-** in this case) is ruled out by R≤ROOT because the Reduplicant must contain only the root according to this constraint. Therefore, the actual output form violates only low-ranking MAX as tableau (23) shows.

(23)

Candidates	ONS	R≤ROOT	MAX
n-osampi-nosampi		*!	
n-osampi-osampi	*!		*
☞n-osampi-sampi			* *

Here, the ranking between ONS and R≤ROOT is not clear while MAX is the lowest ranking constraint for it is violated in the actual output form. The next case ((20)e), however, demonstrates that the morphological constraint R≤ROOT is indeed ranked lower than prosodic constraint, ONS. Consider tableau (24).

(24)

Candidates	ONS	Disyll	R<ROOT	Max
n-apii-pii		*!		*
n-apii.apii	*!			*
☞n-apii-napii			*	

The form that violates R<ROOT can still be optimal since all the other candidates violate highly ranked constraints, namely, ONS and DISYLL.

The next example, (20)f, shows that another prosodic constraint FILL dominates the morphological constraint DISYLL.

(25)

Candidates	FILL	DISYLL
☞naa-naa		*
naa.□□-naa.□□	*!***	

The form naa-naa is optimal even though it violates DISYLL since the other candidate is a violation of the higher constraint, FILL.

The analysis of Axininca Campa shows that the prosodic constraints ONS and FILL crucially dominate reduplicative constraints such as DISYLL, R<ROOT and MAX. That is, the reduplicative constraints can be violated even in an optimal form. Frequently, the Reduplicant is an inexact copy of the

base, violating MAX. Sometimes the Reduplicant contains affixal material, in violation of R<ROOT (**n-apii-napii**). Sometimes, the Reduplicant is monosyllabic, in violation of DISYLL (**naa-naa**).

Certain aspects of OT lead to a very different conception of templates and the Template Satisfaction Condition. Templates are constraints on the prosody/morphology interface (McCarthy & Prince 1993a) and templatic constraints are violable in principle like all other constraints in OT. We will conclude this section by viewing the principles of Prosodic Morphology within OT from McCarthy and Prince (1993a).

(26) Prosodic Morphology within Optimality Theory
(McCarthy & Prince 1993a:103)

a. Prosodic Morphology Hypothesis

Templates are constraints on the prosody /morphology interface, asserting the coincidence of morphological and prosodic constituents.

b. Template Satisfaction Condition

Templatic constraints may be undominated, in which case they are satisfied fully, and they may be dominated, in which case they are violated minimally, in accordance with general principles of Optimality Theory.

c.Ranking Schema

P>>M

The ranking schema (P>>M) is a broad assertion about the nature of prosodic morphology: if some morphological domain is to be prosodically conditioned, then in that domain P must dominate M (McCarthy & Prince 1993a). This development reduces the theory of Prosodic Morphology to the P>>M schema and a set of constraints, all violable in principle.

As mentioned earlier, OT gives a very different perspective and conception regarding Prosodic Morphology. In the following section, we will show that certain aspects of OT lead to a rather different view of harmony systems as well. Furthermore, PDK vowel harmony, which will be presented in the next chapter, contrasts OT's treatment of neutrality in harmony systems with that of conventional derivation-based theory.

2.2.3. Vowel Harmony

In this section, we will examine in greater detail the implications of OT for the treatment of vowel harmony systems. We will begin our analysis of OT's treatment of vowel harmony with a summary of the argument presented in Pulleyblank (1993) regarding tongue root harmony patterns in Standard Yoruba, a Kwa language spoken in Nigeria. The basic hypothesis of his analysis is that formal patterns of

harmony are derived by the alignment constraints of OT (Prince & Smolensky 1993, McCarthy & Prince 1993a,b, Kirchner 1993a) while substantive properties of harmony are derived by Grounding Theory (Archangeli & Pulleyblank, in press). That is, the central properties of harmony systems are derived from the interaction of three types of phonological constraints: faithfulness constraints, alignment constraints and grounded conditions.

Pulleyblank (1993) defines these families of constraints as follows:

(27) Faithfulness Conditions (Pulleyblank 1993)

PARSE: An F-element α must be dominated by an appropriate node in the prosodic tree.

RecF (Recoverability of F-element): An F-element (feature or node) α that is present in an output form is also present in the input.

RecP (Recoverability of Path): For any path between an F-element α and some anchor β, if α is associated to β in the output then α is associated to β in the input.

The faithfulness conditions, as we have already discussed in the previous section, are required to parse features into prosodically well-formed structures with as little modification as possible. For example, the parse

constraint[5] requires a feature (if it is present in the input) to link to an appropriate mora. Recoverability constraints require that material in the output form also be present in the input. The insertion of any feature or association line will be proscribed by these constraints. Rec-F prohibits changes in featural content, and Rec-P prohibits changes in associative paths.

Alignment constraints cause edges of featural domains to coincide with the edges of phonologically, or morphologically, defined domains. This is stated in (28).

(28) Alignment Constraints (Pulleyblank 1993)

ALIGN-L(α,L;D,L): The left-edge of feature α aligns with the left-edge of domain D.

ALIGN-R(α,R;D,L): The right-edge of feature α aligns with the right-edge of domain D.

For example, ALIGN-L (-ATR,L;Word,L) will require the left edge of any [-ATR] specification to be aligned with the left edge of the word.

Finally, the grounded conditions, which are proposed in Archangeli and Pulleyblank (in press), function to increase the phonetic well-formedness of feature combinations. The basic claim is that implicational relations between features

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[5]This constraint is, in essence, the same as (7_{iii}) which deals with prosodic structure.

must be phonetically motivated or grounded. "Such grounded conditions govern properties of segmental inventories, harmonic neutrality (opacity and transparency), rules of redundancy, conditions on the targets and triggers of phonological rules, and so on." (Pulleyblank 1993:8)

The first substantive type of implication advocated by grounded conditions in Archangeli and Pulleyblank (in press) involves the movement of the tongue root implied by a change in tongue height. Consider, for instance, the tongue root with an upward movement of the tongue body (formally [+high]). Raising of the tongue body ([+high]) tends to correlate with tongue root advancement ([+ATR]) because of the physiological fact that tongue is a single volume.[6] On the other hand, the downward movement of the tongue body ([+low]) tends to correlate with tongue root retraction ([-ATR]). These properties can be phonologically expressed as follows:

(29) Grounded Path Condition:α/ATR

(Archangeli & Pulleyblank, in press:148)

a.**HI/ATR** Condition:If [+high] then [+ATR],not[-ATR].

b.**LO/ATR** Condition:If [+low] then [-ATR],not[+ATR].

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[6]See the diagrams in Archangeli & Pulleyblank (in press:147).

The second type[7] involves changes in tongue height implied by a tongue root movement. Movement of the tongue root tends to be accompanied by a sympathetic movement of the tongue body. These dependencies are expressed formally in the following four path conditions.

(30) Grounded Path Conditions: ATR(RTR)/α

(Archangeli & Pulleyblank, in press:150)

a.**ATR/HI** Condition:If[+ATR] then[+high],not[-high].

b.**ATR/LO** Condition:If[+ATR] then[-low], not[+low].

c.**RTR/HI** Condition:If[-ATR] then[-high],not[+high].

d.**RTR/LO** Condition:If[-ATR] then[+low], not[-low].

Archangeli & Pulleyblank (in press) claims that the above conditions (29) and (30) alone reflect the physiologically preferred configurations of tongue body height and tongue root retraction/advancement.

The three types of phonological constraints that we have discussed --namely, faithfulness constraints, alignment constraints and grounding conditions-- will also be the central constraints that derive the Korean harmony system even though each stage of the language has a different ranking of these constraints.

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[7]Even though we only need the above two conditions for the discussion of Yoruba case here, I will include other grounded conditions to give a general picture of Grounding Theory. Moreover, we make use of the RTR/LO condition,(30)d, in the discussion of Korean vowel harmony in Chapter Three.

With the above mentioned constraints in mind, let us consider the case of Yoruba tongue root harmony[8]. Tongue root harmony in Yoruba involves the spreading of the feature [-ATR] (Archangeli & Pulleyblank 1989, 1993, Pulleyblank 1993) as in Korean. Pulleyblank (1993), as in Archangeli & Pulleyblank (1989), assumes that there are two types of morphemes: morphemes with and without the lexical [-ATR] specification.

(31) Mid vowels in Yoruba

a.ègè	'dirge'	b.ègé	'cassava'
èké	'lie'	ɛké	'forked stick'
èse	'cat'	ɛsɛ	'row'

The morphemes in (31)a do not have lexical [-ATR] specification and therefore surface as advanced vowels. Vowels in (31)b appear retracted since they have a lexical [-ATR] specification. Harmony of this type is explained by the interaction of the ALIGN constraint with the Faithfulness constraints (PARSE,RecF,RecP).

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[8]All the data, tableaus and relevant discussions are from Pulleyblank (1993).

(32) Mid vowels, with and without a lexical [-ATR] specification

Yoruba		PARSE	REC-F	ALIGN-R	ALIGN-L	REC-P
a.	ɛgɛ -atr		*!			**
/EgE/	ɛge -atr		*!	*		*
'dirge'	egɛ -atr		*!		*	*
	☞ege					
b.	☞ɛsɛ -atr					**
/EsE/	ɛse -atr			*!		*
[-atr]	esɛ -atr				*!	*
'row'	ese -atr	*!				

RecF prevents the insertion of [-ATR] where it is not present lexically as in (32)a. Therefore, the optimal form will be the one with advanced vowels (ege). However, when there is a lexical [-ATR] specification, as in (32)b, the form in which [-ATR] is linked to both vowels will be the optimal one, even with the two violations of RecP. Other

candidates are worse because they violate higher constraints, ALIGN and PARSE. In this case, the ALIGN constraints play a crucial role; these constraints, however, are not as important when we discuss cases like high vowels (34) and the Later Middle Korean data in Chapter Three.

The high and low vowel cases involve grounded conditions as well as ALIGN and Faithfulness constraints. Let us consider high vowels first. As shown in (33), high vowels can cooccur with both advanced and retracted vowels.

(33) High vowels in Yoruba

a.	èbi	'guilt'	b. ebi	'hunger'
	ɛtiri	'difficult'	èrìgì	'molar tooth'
	idɛ	'brass'	ilé	'house'

The cases in (33)a are problematic if we expect complete harmony without considering any feature cooccurence conditions like HI/ATR. Since the cases in (33)b are straightforward (these morphemes do not have [-ATR] specification, and therefore, surface as all advanced vowels), the following tableau will include the data from (33)a only.

(34)High vowels with a lexical [-ATR] specification

	Yoruba	HI/ATR	PARSE	REC-F	ALIGN-R	ALIGN-L	REC-P
a.	ɛbɪ V -atr	*!					* *
/EbI/	☞ɛbi \ -atr				*		*
[-atr]							
'guilt'	ebɪ / -atr	*!				*	*
	ɛbi -atr		*!				
b.	ɪdɛ V -atr	*!					**
/IdE/	ɪde \ -atr	*!			*		*
[-atr]							
'brass'	☞idɛ / -atr					*	*
	ide -atr		*!				

The second candidate of (34)a is optimal even though it violates ALIGN-R, because the grounded condition HI/ATR is ranked higher. Therefore, any form with a retracted high vowel(ɪ) will be ruled out in the first place. The last candidate of (34)a is a violation of PARSE since the feature [-ATR] does not associate to the appropriate mora. (34)b can be explained in the same manner. The incompatibility of high

vowels with retraction, represented by the highly ranked constraint HI/ATR, causes the general pattern of harmony to be interrupted in the appropriate configuration (Pulleyblank, 1993).

The low vowel cases involve another grounded condition, namely, LO/ATR.

(35) Low vowels in Yoruba

a. àjé	'witch'	b. àfè	'Spotted Grass-mouse'
abébé	'needle'	àwo	'plate'
aʃɔ	'cloth'	àdí	'palm-nut oil'

c. èbà	'food made from *gari*'	*eba
ɛgba	'whip'	*egba
ɛrákpó	'type of plant'	*erapo

The low vowels are systematically retracted. This property is accounted for by ranking the LO/ATR condition higher than recoverability. Consider the following constraint tableau for a form like ɛba, 'food made from *gari*'.

(36) Morphemes with final low vowels, no [-ATR] specification

	Yoruba	LO/ATR	HI/ATR	PARSE	REC-F	ALIGN-R	ALIGN-L	REC-P
/EbA/ 'food'	☞ɛba -atr				*			**
	ɛbæ -atr	*!			*	*		*
	eba -atr				*		*!	*
	ebæ	*!						

The form ɛba (as opposed to ebæ) is optimal even though it requires the insertion of a feature (a RecF violation) since the presence of a low advanced vowel (æ) violates the higher ranked constraint LO/ATR.[9]

The following tableau shows morphemes with initial low vowels ((35) a,b).

[9]Pulleyblank(1993) mentions that the input with lexical [-ATR] specification will also derive an identical surface form (see Pulleyblank 1993:15).

(37)Morphemes with initial low vowels

	Yoruba	LO/ATR	HI/ATR	PARSE	REC-F	ALIGN-R	ALIGN-L	REC-P
a.	☞aje V -atr							**
/AjE/	aje \ -atr					*!		*
[-atr]	æje / -atr	*!					*	*
'witch'	æje -atr	*!		*				
b.	afe V -atr				*			**!
/AfE/	☞afe \ -atr				*			*
'mouse'	æfe / -atr	*!			*		*	*
	æfe	*!						

Pulleyblank (1993) relies, crucially, on the assumption that the ALIGN-R condition is restricted to the domain of the ROOT in this case. In other words, the inserted feature ([-ATR]) is not subject to the ALIGN-R condition as the optimal form in (37)b (afe) shows, since the [-ATR] value in such a case is not a ROOT specification. However, the lexical [-ATR] in (37)a is a ROOT specification and, therefore, is subject to the ALIGN-R condition (i.e. *aje).

The important point emerging from this work is that grounding condition theory (Archangeli & Pulleyblank, in press) can be directly incorporated into the fabric of phonological theory within the Optimality Theory framework.

In the next chapter, we will see that the harmony phenomenon of Korean can also be explained in terms of the interaction of alignment, faithfulness, and grounded conditions, as in Yoruba. Harmony in Korean is intimately tied in to the discussion of Yoruba vowel harmony: not only are the patterns of vowel harmony formally similar, but Korean, like Yoruba, observes tongue root harmony. The grounded conditions have the effect of blocking the effects of harmony in both systems. Differences are also observed in the two harmony systems: grounded conditions override REC-F in Yoruba low vowel cases in (36); we will see, however, that REC-F is still inviolate in the optimal form --REC-F is ranked higher than grounded conditions-- in Korean. Another difference exists in that grounded conditions --as they are ranked higher than ALIGN-R-- define the harmonic edges in Korean, but not in Yoruba. Furthermore, it is interesting to note that the language-particular variation (i.e. Yoruba vs. Korean) is due to the difference in ranking of members of the universal constraint set.

CHAPTER 3

KOREAN VOWEL HARMONY

This chapter will examine the vowel harmony systems in Present-Day Korean and in Later Middle Korean. The focus of this study is to determine how Optimality Theory accounts for the difficulties in the harmony system of this language.

As we have seen in Chapter One, the vowel harmony of Korean has long been a problem for two reasons: it is not clear how to characterize the features that distinguish the harmonizing sets; and the neutrality of front unrounded vowels ([i] and [ɨ]) in the harmony system is yet to be explained, having been treated just as an exception in most analyses proposed for Korean vowel harmony.

In this study, we will investigate the hypothesis that Korean vowel harmony can be described by the feature [ATR] (Song,1990) and that OT can give a principled account of the neutral vowels in the harmony system through an interaction of constraints on alignment and grounded conditions. We will also discuss how OT treats diachronic change in a harmony system by showing the development of vowel harmony through Later Middle Korean to Present-Day Korean. We know that all constraints are present in principle in the OT hypothesis. The diachronic change in the harmony system can be accounted

for by reranking some of the constraints. Certain constraints still play a crucial role after the reranking while some of the constraints are no longer crucial after moving down in the hierarchy. We will see that both types of changes are found in Korean vowel harmony.

3.1. Present-Day Korean

The vowel system is the preliminary basis for the study of vowel harmony in any language. It is, therefore, worthwhile to review the vowel system of Korean in order to discuss vowel harmony. We will look at the development of the vowel system from Later Middle Korean (henceforth; LMK) to Present-Day Korean (henceforth; PDK).[1] LMK (from the fifteenth to the sixteenth century) had seven underlying vowels:

(38)

i	ɨ	u
	ə	o
	a	ʌ

Of these seven vowels [o,ʌ,a] have been called 'light' (yang) vowels and [u,ɨ,ə] 'dark' (yin) vowels; [i] is considered neutral. These two vowel sets, namely 'dark' and

[1]The vowel shift in the previous stage (Old Korean to Middle Korean) is disregarded in this study.

'light', each form a harmonic group as in (39). (The arrow <--> denotes harmonic pairs.)

(39)	neutral	dark		light
	i	u	<-->	o
		ɨ	<-->	ʌ
		ə	<-->	a

In the eighteenth century, the vowel [ʌ] was lost. As a consequence, [a] came into opposition with [ɨ] while it retained the old opposition with [ə]. Then, in the nineteenth century, we encounter two more front vowels [e] and [ɛ] caused by monophthongization (əy --> e, ay --> ɛ). Since the beginning of the twentieth century, Korean has had a flourishing vowel system with two additional front round vowels, [ö] and [ü], brought about through monophthongization (oy --> ö, uy --> ü). This derives the PDK 10 vowel system shown in (40).

(40)				
	i	ü	ɨ	u
	e	ö	ə	o
	ɛ		a	

PDK obtained four additional vowels [e,ɛ,ü,ö] through monophthongization and lost one vowel [ʌ]; and [ɛ] is derived from both [ʌy] and [ay]. In this study, we will devise a phonological 12 vowel system for PDK based on

historical grounds. The vowels [ɛ] and [a] have two different sources due to the loss of [ʌ]. That is, PDK [ɛ] is derived from LMK [ʌy] and [ay], and PDK [a] from LMK [ʌ] and [a]. Therefore, the phonological 12 vowel system will be as follows:

(41)	i	ü (uy)	ɨ	u
	e (əy)	ö (oy)	ə	o
	$ɛ_1$ (ʌy)		a_1 (ʌ)	
	$ɛ_2$ (ay)		a_2	

The vowels in parentheses indicates the LMK vowels from which the PDK vowels are derived. [$ɛ_1$] is distinguished from [$ɛ_2$] in that it is developed from [ʌy] while [$ɛ_2$] is from [ay]. [a_1] indicates the reflex of [ʌ], and [a_2] is the LMK [a]. The following cognates show that the above claims are born out.

(42)	LMK	PDK	
	uy	ü	'up'
	nəy	ne	'you'
	čamoy	čamö	'(yellow) cucumber'
	popʌy	popɛ	'treasure'
	hay	hɛ	'to do'
	pʌlʌm	palam	'wind'
	na	na	'I'

Although V_1 and V_2 do not have any phonetic differences, it will be shown in the following section that they play a phonologically distinctive role in the harmony system. In other words, the neutralization between [a] and [ʌ] (as well as [ay] and [ʌy]) in PDK is realized only at the phonetic level and the distinctions still remain active phonologically. We may assume that the vowels derived from LMK [+low] vowels[2] --namely [ə] and [a], remain as [+low] vowels ([e], [ə], [$ɛ_2$], [a_2]) in PDK phonology. Hence, the following feature specifications for PDK vowels can be drawn.

(43) PDK vowel feature specification[3]

	i	$ɛ_1$	ü	ö	ɨ	a_1	e	$ɛ_2$	u	o	ə	a_2
atr		(-)[4]		(-)		(-)		(-)		(-)		(-)
rnd			+	+					+	+		
bk					+	+			+	+	+	+
low							+	+			+	+

In the above specifications, [e] and [$ɛ_2$] are treated as [+low], whereas [$ɛ_1$] is not [+low] even though it is phonetically lower than [e]. Archangeli and Pulleyblank (in press) argue that a retracted high vowel [ɪ] --which is

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[2]We will discuss LMK vowel feature specifications in a later section.

[3]I assume that values not specified in this table will be assigned by context-free redundancy rules:
[ ]->[+atr], [ ]->[-rnd], [ ]->[-bk], [ ]->[-low].

[4]Parentheses indicate that [-ATR] is not specified segmentally but it is a property of a morpheme.

phonetically "lower" than an advanced mid vowel ([e])-- may occur. That is, even though the vowel [e] is phonetically higher than [ɪ], [ɪ] is phonologically considered [+high], while [e] is not. Similarly, [e] is considered [+low] while [$ɛ_1$] is not, even though the vowel [$ɛ_1$] is phonetically lower than [e] in Korean.

In PDK, the vowel harmony phenomena can only be found in sound symbolic words and in the alternation of the so called, A-initial suffixes[5] following verb or adjective stems (Ahn 1985, C.W.Kim 1978, J.M.Kim 1986, Kim-Renaud 1986 ,etc.).

3.1.1. Sound Symbolic Words

Sound symbolic words (or ideophones) are words denoting sound, smell, taste, color, mood, size, type of movement, or other perceptual experiences (Kim-Renaud, 1986). As in LMK vowels, PDK vowels are divided into two sets in sound symbolic words. The vowels [i,e,ü,ɨ,ə,u] form a harmonic group traditionally called 'dark' vowels which denote darkness, depth, bigness, etc., and the vowels [ɛ,ö,a,o] form the other set called 'light' vowels which gives an impression of lightness, shallowness, smallness, etc. (Kim-Renaud,1986). Within a sound symbolic word, vowels must be either all dark or all light. The only exceptions to this rule are the high

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[5]We will use 'A' to indicate [ə] or [a] as Song (1990) did.

unrounded vowels [i] and [ɨ] which are neutral in non-initial syllables and therefore may cooccur with either dark or light vowels. Some examples of sound symbolic words are given in (44).

(44)		Dark	Light	
	a.	cik'əl	cɛk'al	'chattering'
		kilc'uk	kɛlc'ok	'tall'
	b.	kɛlkɛl	kɛlkɛl	'exhausted'
	c.	tɨls'ək	tals'ak	'lifting'
		kɨlc'ək	kalc'ak	'scratching'
		sɨlc'ək	salc'ak	'stealthy'
		k'ɨt'ək	k'at'ak	'nodding'
	d.	p'əlkən	p'alkan	'red'
		səpək	sapak	'crunching'
		kəntuŋ	kantoŋ	'jumping up and down'
	e.	p'yulutuŋ	p'yolotoŋ	'pouting'
		sukun	sokon	'whispering'
		kulkul	kolkol	'sleeping'
		k'ult'ək	k'olt'ak	'gulping'
	f.	hühü	höhö	'round about'
		kücücü	kökökö	'shabby'
	g.	pisil	pɛsil	'staggering'
		k'ecilək	k'ɛcilak	'half-heartedly'
		pənsil	pansil	'smiling'
		pusisi	posisi	'shining'

	k'umcilək	k'omcilak	'budging'
	k'ukicək	k'okicak	'crumpling'
h.	sinkɨl	senkɨl	'smiling'
	p'intɨl	p'entɨl	'staggering'
	t'eŋkɨləŋ	t'eŋkɨlaŋ	'clanging'
	silkɨm	salaam	'stealthy'
	hintɨl	hantɨl	'rocking'
	kəntɨləŋ	kantɨlaŋ	'wobbling'
	pusɨl	posɨl	'drizzling'
	k'umtɨl	k'omtɨl	'wriggling'

(Kim-Renaud 1986, McCarthy 1983, Sohn 1986, Song 1990)

The data in (44)g and (44)h (the bold faced characters) show the neutrality of high unrounded vowels ([i],[ɨ]) in non-initial syllables. Vowel harmony in sound symbolic words has been difficult to describe because the dark and light vowel sets are not natural classes in the SPE feature system. Hitherto, the neutrality of the high unrounded vowels has been treated merely as an exception to the harmony system. In the following sections, the previous accounts proposed for PDK sound symbolic words and the problems thereof will be discussed. We will then view the Optimality account which gives a better understanding of these problems.

3.1.1.1. Previous Accounts

Semantic Feature Analysis

Kim-Renaud (1986) describes vowel harmony in sound symbolic words by semantic features based on the traditional dichotomy, [dark] and [bright]. According to her, vowel harmony results from velar (nonback/back) harmony in Early Middle Korean. Since all and only the back vowels were bright vowels in that stage in time, the feature [bright] was presumably a redundant feature of the feature [back]. She claims that phonetic symbolism found in various languages proves that certain semantic features are predictable from some phonetic features (Sapir 1911, Poppe 1950, Haas 1970). However, a historic vowel shift in Korean made the phonetic distinction between the two harmonizing groups of vowels opaque, since some nonback vowels became back and vice versa. Therefore, the phonetic feature ([back]) distinguishing the two groups seems to have been replaced by the semantic feature ([bright]). Kim-Renaud (1986) further claims that the case of Korean suggests that semantic features have a role to play in phonological analysis in general. Although her explanation using semantic diacritic features for PDK vowel harmony gives different nuances in sound symbolic words, it lacks an exact mechanism for including the feature [bright] in phonology. Moreover, the direct phonological use of a nonphonetic diacritic feature requires considerable clarification. We may

consequently conclude, therefore, that her analysis is lacking in strong phonological grounding.

Diagonal Analysis

Vowel harmony systems (Aoki,1968) can be divided typologically into two major groups: horizontal (height) harmony and vertical (front/back) harmony. C.W.Kim (1978) suggests a third type, "diagonal", which is found in such languages as Korean or Nez Perce, etc. This particular type of vowel harmony is called "diagonal" because the line dividing the harmonic groups runs diagonally in the vowel chart as in (45);

(45) a.

		u/
	e	/o
	/ a	

Nez Perce

(C.W.Kim,1978:221)

b.

	ɨ	u/
	ə	/o
	/a	

Korean

C.W.Kim (1978) writes that this vowel harmony system is regarded as an unusual phonological phenomenon since no single parameter or distinctive feature of vowels can distinguish the two harmonic classes. He concludes that this diagonal harmony is a transitional phenomenon from a full vowel harmony system in Early Middle and Old Korean , and suggests a sort of adjustment rule to explain the vowel harmony in synchronic grammar. C.W.Kim (1978), however, does

not include front vowels ([i,e,ɛ,ü,ö]) in the inventory; and even a full inventory including the front vowels cannot support the diagonal harmony system. This analysis does little more than recapitulate a historic process; it merely cites diagonal harmony as a result of vowel shift, without offering an in-depth analysis of the phenomenon.

Underlying Vowel Analysis

McCarthy (1983) proposed an abstract version of the Korean vowel system in an attempt to represent the dark/light distinction under the universal feature system, assigning [+low] and [-low] to dark and light vowels, respectively. Vowels are divided into two groups according to the values of the feature [low] as in (46).

(46)	i	ü	ɨ	u	
	e		ə		dark =[-low]
	ɛ	œ	a	ɔ	light=[+low]

The values of the feature [low] constitute morphemes: [-low] is the 'dark' morpheme and [+low] is the 'light' morpheme. The harmony phenomena are the result of spreading the [low] feature. A context free rule, applied subsequently to harmony, then takes all [+round] vowels to [-low] ([œ] changes to [ö] and [ɔ] changes to [o]). Although this system works very well in grouping the harmonizing vowels for the sound symbolic vowel harmony into natural classes, it

arbitrarily sets up low vowels [ɔ] and [œ] as underlying forms of [o] and [ö] respectively, without providing any plausible grounds for doing so (Park,1990). Moreover, McCarthy (1986) is obligated to include an ad hoc context free rule in order to explain the harmony system.

Acoustic Feature Analysis

Y.S.Kim (1984), in an attempt to find an acoustic basis for the harmonic distinction of PDK, suggests the feature [Deep Voice Resonance] to group each harmonic class more naturally, as in (47).

(47)	i	ü	ɨ	u	[-DVR]
	e	ö	ə	o	[+DVR]
	ɛ		a		

His acoustic feature [DVR][6] is a good device for grouping the light vs. dark vowels according to a single feature. However, he neither describes this feature clearly nor gives its source, lacking any acoustic clue to justify its use. Furthermore, the necessity of establishing a new distinctive feature like [±DVR] remains yet to be justified from a universal viewpoint.

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[6]Further study is needed to find a relationship between the feature [ATR] and [DVR].

Tongue Root Feature Analysis

Song (1990) proposes that Korean vowel harmony can be described as tongue root harmony based on the formant analysis of Hwang (1983)[7]. She claims that vowels in sound symbolic words can be divided into two sets by the feature [ATR] as below.

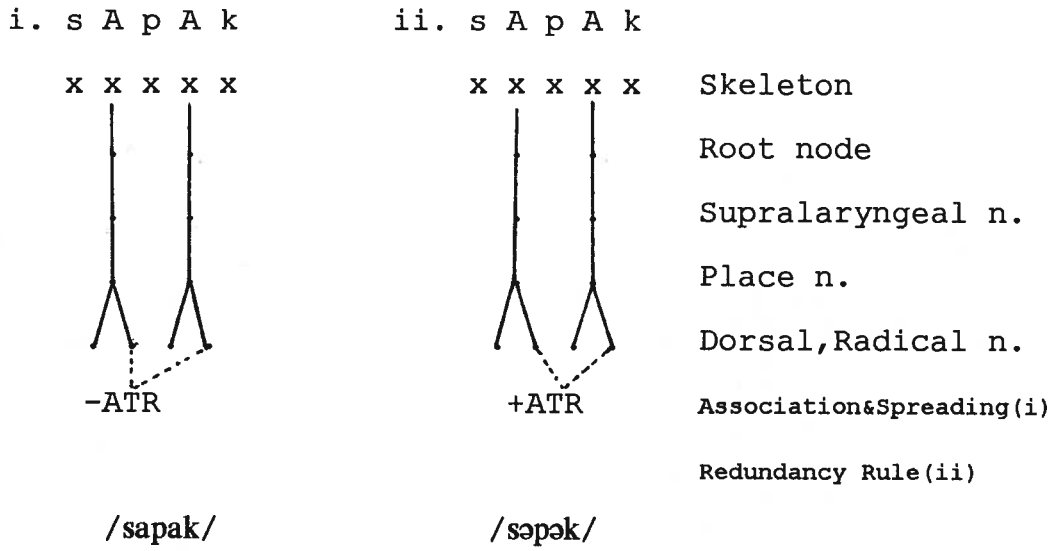
(48)

i	ü	ɨ	u	dark =[+ATR]
e	ö	ə	o	light=[-ATR]
ɛ		a		

Song's (1990) analysis maintains that the harmony system is characterized by spreading of the feature [-ATR]. She claims that a light sound symbolic word has the harmonizing feature [-ATR] and harmony takes place by spreading this feature. A dark sound symbolic word, however, has no harmonizing feature. Therefore, each vowel of a dark sound symbolic word gets [+ATR] by a redundancy rule. The operation of vowel harmony is illustrated in (49) below.

[7]The formant chart and the relevant explanation will be given in the following section.

(49) /sapak/ - /səpək/ 'crunching'



The neutrality of [i] and [ɨ], in her analysis, is accounted for by the Locality Condition[8]. She assumes that the feature structures of [i] and [ɨ] are different, depending on whether these are neutral vowels or harmonic vowels. That is, if the vowels are neutral, they do not have a Radical node (spreading takes place from one radical node to another in her analysis); therefore, these vowels are skipped by the harmonic process as a result of the Locality Condition. The redundant feature [+ATR] is subsequently assigned to these vowels. She also assumes that the harmonizing feature value [-ATR] and the redundant feature value [+ATR] are present on different planes to avoid a violation of the Line Crossing Prohibition (Goldsmith 1976).

[8]See Song (1990:22).

Song's analysis is attractive in that she takes [ATR] as the harmonizing feature. However, her treatment of neutral vowels relies only upon the assumption that vowels have different feature structures depending on whether they are neutral or harmonic vowels; Song (1990) fails to give any independent motivation in defense of her approach.

3.1.1.2. Optimality Account

As we have already seen, researchers have encountered considerable difficulty in finding a single feature that characterizes PDK vowel harmony in sound symbolic words. Song (1990) argues against McCarthy's analysis and proposes the tongue root feature [ATR] as the harmonizing feature to account for vowel harmony systems such as Korean and Nez Perce. In this study, we will basically follow Song (1990) as she takes the feature [ATR] to distinguish dark vowels from light vowels in PDK. She provides acoustic evidence based on Hwang's (1986) formant analysis to argue for the feature [ATR] as the harmonizing feature. The formant chart[9] is given in (50).

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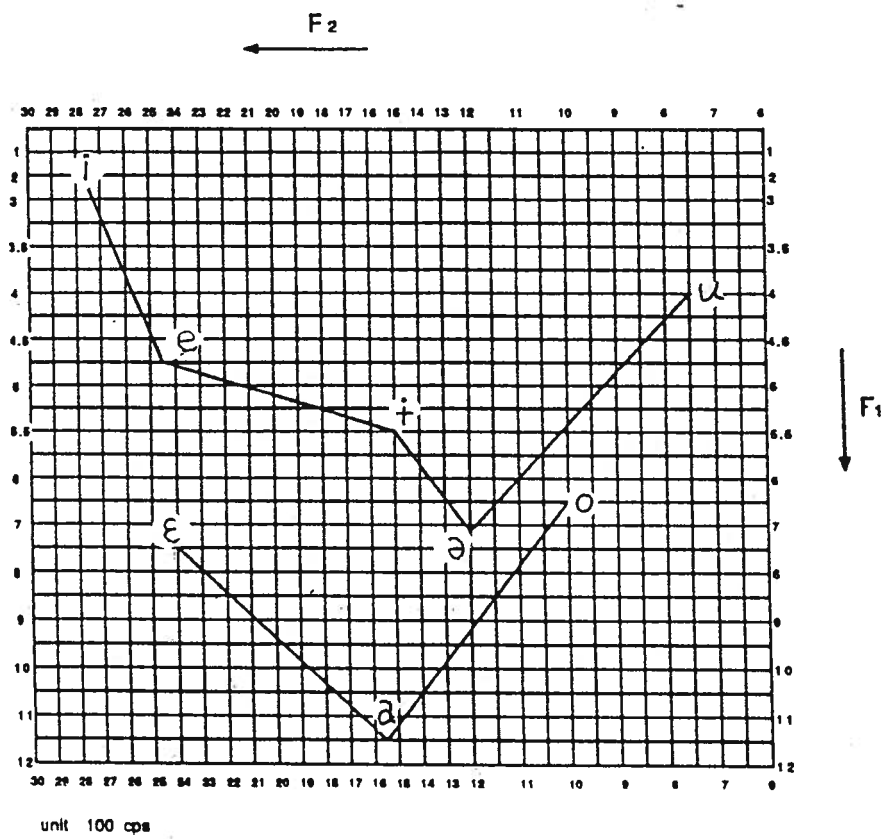
[9]Because Hwang (1986) considered [ü] a diphthong while he considered [ö] a monophthong, he deals with only [ö] but not [ü]. Song (1990), therefore, omits the value of [ö] in the formant chart and deduces the contrast of [ATR] value between [ü] and [ö] from that between [u] and [o].

(50)



Formant Chart

"The major acoustic characteristic of [+ATR] is a lowering of F1 and concomitantly a downward shift of F2 for back vowels and an upward shift of F2 for front vowels. In the formant analysis of present-day Korean the frequencies of F1 for [ɛ,a,o] are higher than those of [i,e,ɨ,ə,u]. The frequencies of F2 for [i] and [e] are higher than that of [ɛ], and the frequencies of F2 for [ɨ],[ə],and [u] are lower than those of [a] and [o], respectively." (Song,1990:40)

Despite the fact that there has been a vowel shift from Later Middle Korean to Present-Day Korean, both systems can be characterized by the same feature. *Hunminjongum* (the

Korean Script of circa 1400 A.D.) describes [o,ʌ.a] as "retracted", [u,ɨ,ə] "somewhat retracted" and [i] "unretracted". Based on this description, C.H.Park (1983) suggests an interesting hypothesis on the six vowel system of Later Middle Korean. He uses [±ATR] instead of "retracted". In his system, [+ATR] includes [i,u,ɨ,ə], the dark vowels, and [-ATR] includes [ʌ,a,o], the light vowels. We will see in the following section that this is consistent with the featural specification of LMK.

In light of these analyses, we may conclude that the vowel harmony in PDK and LMK is characterized by the feature [ATR]. Vowels can be divided into two sets by the feature [ATR] as in (51).

(51)

i	ü	ɨ	u	dark =[+ATR]
e	ö	ə	o	light=[-ATR]
$ε_1$		a_1		
$ε_2$		a_2		

To capture the morphological relation between dark and light sound symbolic words, Song (1990) argues that there is a dependence of light sound symbolic words on dark sound symbolic words. She claims that there are 'dark' sound symbolic words without 'light' counterparts, but there are no 'light' sound symbolic words without 'dark' counterparts. She presents the following examples to back up the claim.

(52)	dark	light	
	mulkəŋ	*molkaŋ	'soft'
	ɨsisi	*asisi	'chilly'

Based on this dependence of light sound symbolic words on dark sound symbolic words, Song (1990) concludes that only [-ATR] can be considered a morpheme since dark sound symbolic words are considered underlying forms. Contrary to her assertions, however, there *are* light sound symbolic words without dark counterparts.

(53)	dark	light	
	*c'əlc'əl	c'alc'al	'busy'
	*səmsəm	samsam	'not too salty'

Therefore, the argument that dark sound symbolic words are underlying forms has no support. McCarthy (1983) argues that the values of the feature [low] constitute morphemes for PDK sound symbolic words: [+low] is the 'light' morpheme, [-low] is the 'dark' morpheme. Our account on the morphology of dark vs. light sound symbolic words is similar to McCarthy's idea in that there is no dependence of light sound symbolic words on dark sound symbolic words. But unlike McCarthy, I just assume that the feature [-ATR] is the morpheme that marks the light class of sound symbolic words, while dark sound symbolic words do not have this morpheme. That is, words that denote light sound symbolism have lexical [-ATR]

specification as a result of morpheme concatenation, while dark sound symbolic words do not have such a specification. Before proceeding with the actual analysis of sound symbolic words, we will discuss some of the constraints that are needed for the task.

As we have already seen in Chapter Two, the basic idea of optimization is to formulate a set of constraints and rank them in a "strict dominance hierarchy" (Prince & Smolensky 1993) instead of having ordered rules. Therefore, there is no notion of step-by-step input-output derivation. What we consider is a set of candidates produced by Gen; then we can evaluate them in relation to the appropriate constraint ranking for the particular language. (54) shows the constraints for the grammar of PDK sound symbolic words. Some of the constraints have already been discussed.

(54) Constraints

PARSE: An F-element must be dominated by an appropriate node in the prosodic tree (Pulleyblank 1993).

REC-F (Recoverability of F-element): An F-element that is present in an output form is also present in the input (Pulleyblank 1993).

ALIGN-α-L/R: The left/right edge defined by feature α aligns with the left/right edge of Domain D (Pulleyblank 1993).

RTR/LO: If [-ATR] then [+LO]; if [-ATR] then not

[-LO] (Archangeli & Pulleyblank 1993).

RD/RTR: If [+RD] then [-ATR]; if [+RD] then not [+ATR].

PARSE forces a feature to be dominated by a prosodic node: if [-ATR] is present in the input, it must be linked to the appropriate mora. Otherwise, it will incur a violation of the constraint as we will see in light sound symbolic words which have the lexical feature [-ATR]. REC-F ensures that no feature can be added freely. When there is no [-ATR] feature in the input, as in dark sound symbolic words, the insertion of [-ATR] will incur the violation of this constraint. The ALIGN constraint has the role of linking a feature to the left/right edge of each domain; if [-ATR] fails to link with the first mora of the word, it will be a violation of ALIGN-L. ALIGN-R will be violated when [-ATR] is not linked to the right edge of a morpheme. The grounded condition RTR/LO prevents the [-ATR] feature from linking with nonlow vowels. Round vowels must be associated to [-ATR] according to RD/RTR condition; the status of the RD/RTR condition, however, is yet to be established. According to Archangeli & Pulleyblank (in press), some languages involve less strongly grounded conditions such as BK/ATR or L-tone/ATR. Manifestations of these conditions appear to be much less frequent. The RD/RTR condition is an example of a weakly grounded condition in

that it does not have a strong phonetic basis and is not found in many languages.

Words with lexical [-ATR] specification; Light Sound Symbolic Words

Let us begin our analysis with the case of light sound symbolic words which have a lexical [-ATR] specification. The symbols in the input forms of tableau (56) and the feature specification of these symbols devoid of [-ATR] are as follows.

(55)

	Ë		Ö		Ä		E		O		A	
	i	ε_1	ü	ö	ɨ	a_1	e	ε_2	u	o	ə	a_2
rnd			+	+					+	+		
bk					+	+			+	+	+	+
low							+	+			+	+

Let us examine the candidate forms for the word 'tall'.

(56)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
kËlc'Ok	kilc'uk -atr	*!			*		
[-atr]	kilc'ok -atr			*!		*	
'tall'	$k\varepsilon_1$lc'uk -atr				*!	*	*
	☞$k\varepsilon_1$lc'ok -atr					* *	

Harmony of this basic type is accounted for by the interaction of Faithfulness constraints (REC-F, PARSE) with constraints on alignment (ALIGN-L, ALIGN-R), as in Yoruba ATR harmony.[10] Since the constraint PARSE is ranked highest in the hierarchy, the optimal form --when there is a lexical [-ATR] specification in the input-- will be the one in which the feature [-ATR] is parsed to vowels. REC-F is irrelevant in this case because the light sound symbolic morphemes have the lexical [-ATR] specification as a result of the specification for "lightness"; REC-F will, however, become relevant when we deal with the cases with no lexical [-ATR] specifications. The first candidate for the word 'tall' is ruled out since it violates PARSE. The next form kilc'ok

[10]The grounded conditions will play a crucial role when we deal with forms including neutral vowels.

violates ALIGN-L ,a fatal flaw since all the rest of the candidates violate only lower ranked constraints; **kilc'ok** also violates the grounded condition RTR/LO because the feature [-ATR] is linked to vowel [o] which is not [+low]. **kε$_1$lc'uk** is ruled out for violating the RD/RTR condition as the round vowel [u] is advanced. Therefore, the form **kε$_1$lc'ok**, since it satisfies all of the higher constraints with the exception of RTR/LO, is the optimal one.

The following is a crucial example showcasing the necessity for distinguishing [ε$_1$] and [ε$_2$].

(57)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
kElkEl	**kelkel** -atr	*!					
[-atr]	**kelkε$_2$l** -atr			*!			
'exhausted'	**kε$_2$lkel** -atr						*!
	☞**kε$_2$lkε$_2$l** -atr						

The optimal form **kε$_2$lkε$_2$l** which does not violate any constraint at all would have violated RTR/LO twice if [ε$_2$] were not considered [+low]. In such cases, the third form would have been the optimal form giving a surface pattern

[...ɛ...i...]. While a possible Korean form (see (60)), this would be incorrect for [kɛlkɛl]. Therefore, it is important to note the phonological distinction regarding the surface vowel [ɛ]: the vowel [$ɛ_2$] is [+low] while [$ɛ_1$] is not.

The following cases as well as (57) demonstrate the need for the ALIGN-R condition.

(58)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
tÄls'Ak [-atr] 'lifting'	tis'ək -atr	*!					
	tis'a_2k -atr			*!			
	ta_1ls'ək -atr					*	*!
	☞ta_1ls'a_2k -atr					*	
sApAk [-atr] 'crunching'	səpək -atr	*!					
	səpa_2k -atr			*!			
	sa_2pək -atr						*!
	☞sa_2pa_2k -atr						

For each example, the third candidate is ruled out because it violates ALIGN-R. The vowel [a_1] violates RTR/LO condition since it is not [+low]. However, [a_2] which is [+low] satisfies this condition.

(59)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
kOlkOl	kulkul -atr	*!			* *		
[-atr]	kulkol / -atr			*!	*	*	
'sleeping'	kolkul \ -atr				*!	*	*
	☞kolkol \/ -atr					* *	

The RD/RTR condition is motivated by the above case (as well as (56)). Without the RD/RTR condition, **kolkul** would have been the optimal form since ALIGN-R is ranked lower than RTR/LO as motivated in (60) below. **kolkol** is the optimal form --even though it violates RTR/LO twice-- since all of the other forms, which have a round advanced vowel [u], violate the higher ranked RD/RTR condition.[11]

[11]The fatal violations of the first and second forms, however, are PARSE and ALIGN-L, respectively.

We can extend the scope of our analysis to the cases with neutral vowels. This neutrality of the front unrounded vowels ([i],[ɨ]) in the harmony system has been treated merely as an exception in most analyses proposed for Korean vowel harmony. In this study, we will see that the problem of neutral vowels can be solved by the interaction between the grounded condition RTR/LO and the alignment constraints. Consider the following tableau.

(60)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
pAnsËl [-atr] 'smiling'	pənsil -atr	*!					
	pənsɛ$_1$l -atr			*!		*	
	☞pa$_2$nsil -atr						*
	pa$_2$nsɛ$_1$l -atr					*!	
pËsËl [-atr] 'staggering'	pisil -atr	*!					
	pisɛ$_1$l -atr			*!		*	
	☞pɛ$_1$sil -atr					*	*
	pɛ$_1$sɛ$_1$l -atr					**!	

As we have already seen, high unrounded vowels in non-initial syllables do not participate in harmony. The neutrality of these vowels in non-initial syllables is the result of ranking grounded conditions (RTR/LO, RD/RTR) lower than ALIGN-L, and higher than ALIGN-R. Simply put, the first vowels must always be parsed given the fact that PARSE and ALIGN-L are higher ranked constraints; however, as ALIGN-R is ranked lower than any other constraints, [-ATR] tends not to be parsed to the second vowel if it incurs a grounded condition violation (namely, an RTR/LO violation).

To illustrate this, let us look at each candidate for the word 'smiling' in tableau (60). The first form, **pənsil**, is a violation of PARSE, the most highly ranked constraint. The second candidate violates ALIGN-L as well as RTR/LO. The third form is optimal even though it violates ALIGN-R; for the form that does satisfy ALIGN-R ($\mathbf{pa_2nsɛ_1l}$) violates RTR/LO which is ranked higher. Similarly, both the third and fourth candidates for 'staggering' violate RTR/LO; however, the form in which [-ATR] is parsed to both moras ($\mathbf{pɛ_1sɛ_1l}$) incurs an additional RTR/LO violation. The optimal form, therefore, is the one with the ALIGN-R violation ($\mathbf{pɛ_1sil}$).

A similar explanation can hold for the neutral vowel [ɨ] as tableau (61) will show.

(61)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
sÄlkÄm	silkim -atr	*!					
[-atr]	silka$_1$m -atr			*!		*	
'stealthy'	☞sa$_1$lkim -atr					*	*
	sa$_1$lka$_1$m -atr					* *!	
sËnkÄl	sinkil -atr	*!					
[-atr]	sinka$_1$l -atr			*!		*	
'smiling'	☞sɛ$_1$nkil -atr					*	*
	sɛ$_1$nka$_1$l -atr					*!	
pOsÄl	pusil -atr	*!			*		
[-atr]	pusa$_1$l -atr			*!	*	*	
'drizzling'	☞posil -atr					*	*
	posa$_1$l -atr					* *!	

The cases in the above tableau demonstrate the necessity for a distinction between [a_1] and [a_2]. If [a_1] were [+low], the candidates in which [-ATR] is linked to the second vowel would not have violated RTR/LO. If this were the case, we could not explain the neutrality of the vowel [ɨ].

The following tableau shows polysyllabic cases with neutral vowels. Here, the graphic representations are given only for the optimal forms.

(62)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
	tenkɨlən	*!					
tEnkÄlAn	tenkɨla$_2$n			*!			
[-atr]	tenka$_1$lən			*!		*	*
	tenka$_1$la$_2$n			*!		*	
'clanging'	tɛ$_2$nkɨlən						*!
	☞tɛ$_2$nkɨla$_2$n -atr						
	tɛ$_2$nka$_1$lən					*!	*
	tɛ$_2$nka$_1$la$_2$n					*!	

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
	k'ukicək	*!			*		
k'OkËcAk	k'ukica$_2$k			*!	*		
[-atr]	k'ukɛ$_1$cək			*!	*	*	*
	k'ukɛ$_1$ca$_2$k			*!	*	*	
'crumpling'	k'okicək					*	*!
	☞k'okica$_2$k -atr					*	
	k'okɛ$_1$cək					* *!	*
	k'okɛ$_1$ca$_2$k					* *!	
pOsËsË	pusisi	*!			*		
[-atr]	pusisɛ$_1$			*!	*	*	
	pusɛ$_1$si			*!	*	*	*
'shining'	pusɛ$_1$sɛ$_1$			*!	*	* *	
	☞posisi [-atr]					*	*
	posisɛ$_1$					* *!	
	posɛ$_1$si			*!		* *	*
	posɛ$_1$sɛ$_1$					**!*	

As in bisyllabic cases, [-ATR] spreads rightwards because of ALIGN-R, unless the RTR/LO condition is violated as the examples tɛ$_2$nkɨla$_2$ŋ 'clanging' and k'okica$_2$k 'crumpling' show. The representation of the optimal forms of tɛ$_2$nkɨla$_2$ŋ 'clanging' and k'okica$_2$k 'crumpling' have a "gapped

configuration". According to Archangeli and Pulleyblank (in press), the gapped configuration has received virtually no motivation, although it has frequently appeared in the autosegmental literature (cf. McCarthy 1984a, Cole 1987, Archangeli and Pulleyblank 1987, Vago 1988, etc.). Archangeli and Pulleyblank (in press), among others, claims that the gapped configuration is ill-formed since it violates the locality (adjacency) condition, while the twin peak[12] configuration is well-formed. The case of Korean, however, shows that the twin peak configuration is not suitable in this grammar because this representation[13], having an additional [-ATR] feature, violates the highly ranked constraint REC-F.

To summarize, the basic hypothesis here is that harmony is interrupted by the effect of the grounded condition RTR/LO. ALIGN-L ensures that the feature [-ATR] aligns to the left edge of the words. ALIGN-R causes this [-ATR] feature to spread to the following vowels. Therefore, ALIGN-L and ALIGN-R together derive the harmonizing effect (spreading). This harmony is blocked, however, by the RTR/LO condition when the non-initial vowels are not low. As a result, the non-initial moras of each word surface as [+ATR] ([i], [ɨ]) in such cases. In other words, the feature [-ATR] aligns to the right vowel of words like sa_2pa_2k 'crunching'

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[12]See Archangeli and Pulleyblank (in press:18).

[13]For example, $\underset{\text{-atr}}{te_2}\underset{\text{-atr}}{nkila_2}n$

without incurring any violation. If [-ATR] is not aligned to the right, then the form will violate ALIGN-R. Therefore, harmony proceeds to the right in normal cases. In cases with high unrounded vowels, however, harmony cannot proceed for it will incur an (additional) RTR/LO violation. For example, the form **pa$_2$nsil** for the word 'smiling' will be the optimal one even though it violates ALIGN-R because it is more important to obey the higher ranked constraint RTR/LO. The fact that [i] and [ɨ] are neutral only in non-initial syllables is because ALIGN-L is ranked higher than RTR/LO. However, the high round vowels ([u],[ü]) are not neutral; they participate in harmony even though they incur an RTR/LO violation because of the more highly ranked RD/RTR condition. Hence, we can conclude that high vowels do not participate in harmony (RTR/LO) only in non-initial syllables (ALIGN-L>> RTR/LO>> ALIGN-R), but they do so when they are rounded (RD/RTR>> RTR/LO).

It is interesting to note that Optimality Theory, in addition to explaining the harmony effect through the interaction of faithfulness and alignment constraints, gives a principled account of the neutrality of high unrounded vowels in terms of grounded conditions.

Words without lexical [-ATR] Specifications; Dark Sound Symbolic Words

Dark sound symbolic words do not have lexical [-ATR] specifications; and as the input of each word lacks this feature, REC-F becomes relevant for this class.

(63)

Korean		PARSE	REC-F	ALIGN-L	RD/RTR	RTR/LO	ALIGN-R
kËlc'Ok	☞kilc'uk				*		
'tall'	kilc'ok -atr		*!	*		*	
	$k\varepsilon_1$lc'uk -atr		*!		*	*	*
	$k\varepsilon_1$lc'ok -atr		*!			* *	
	☞pənsil						
pAnsËl	pən$s\varepsilon_1$l -atr		*!	*		*	
'smiling'	pa_2nsil -atr		*!				*
	pa_2n$s\varepsilon_1$l -atr		*!			*	

In the examples shown in (63), REC-F eliminates all potential candidates that involve a [-ATR] specification. Such a feature is not present in the input forms; any output

faithful to the input will be ranked above a form that violates REC-F. These cases are trivial since all the non-optimal forms violate the highest ranked REC-F (PARSE is irrelevant as there is no [-ATR] feature to be parsed in the input).

The vowel harmony in sound symbolic words is described by tongue root harmony in this study. Light sound symbolic words are characterized by the addition of a [-ATR] morpheme and the harmony effect is derived by the interaction of PARSE, ALIGN, and grounded conditions. The dark sound symbolic words do not have this [-ATR] morpheme underlyingly ,and, therefore, any forms that have retracted vowels are ruled out by the constraint REC-F. As a consequence, all vowels surface as advanced in dark sound symbolic words.

3.1.2. A-initial Suffixes

In the initial syllable position of A-initial suffixes, [ə] alternates with [a] as demonstrated in (64).

(64)

a. po-a	'Look!'
ka-a > ka	'Go!'
ko-a	'beautiful'
malk-a	'clean'
b. cip-ə	'Pick (it) up'

pɛ-ə	'Cut (it)'
cü-ə	'Hold (it)'
ki-ə	'Mark (it)'
mul-ə	'Bite!'
sə-ə > sə	'Stop!'
mɛ-ə	'Tie (it)'
k'ö-ə	'Tempt (him)'

[a] appears after an adjective or a verb stem whose last vowel is either [a] or [o] as in (64)a. [ə] appears after all other vowels as with the examples in (64)b. When the suffix is followed by other A-initial suffixes, vowel harmony is not observed in these subsequent suffixes (i.e.mak-as'-əs'-ə , *mak-as'-as'-a '(He) had blocked (it)') (Kim-Renaud 1986). The domain of harmony, therefore, is restricted to the area between the stem final vowel of verb or adjective and the initial vowel of A-initial suffixes.

The vowel harmony in A-initial suffixes is related to the harmony in sound symbolic words in that both of them observe ATR harmony. Unlike sound symbolic words, however, the vowel harmony in A-initial suffixes is conditioned by the feature of the stem vowel. If the stem vowel of the adjective or the verb is [+BK], harmony may proceed (i.e. po-a 'Look!', malk-a 'clean'). However, if the triggering vowel is [-BK], harmony is blocked (i.e. mɛ-ə 'Tie(it), k'ö-ə

'Tempt(him)')[14]. To account for the differences, we need to invoke the additional constraint ALIGN-R^{β} which is formulated as follows:

(65) **ALIGN-α-R^{β}**: The right edge defined by feature α aligns with the right edge of Domain D, when the stem vowel is [+BK].

(Domain D = area between the stem final vowel of verb or adjective and the initial vowel of A-initial suffixes)

The above condition is restricted to the case in which the feature aligns to the suffixal vowels. Therefore, by ranking ALIGN-R^{β} higher than ALIGN-R, we can get the correct result for the harmony in both sound symbolic words and A-initial suffixes. That is, ALIGN-R^{β} is irrelevant for the sound symbolic word case since the application is restricted to the suffix vowels, and is thus vacuously satisfied. ALIGN-R does not have a crucial effect on A-initial suffix case because ALIGN-R^{β} is ranked higher. The following tableau is submitted for the explanation of PDK A-initial suffix vowel harmony.

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[14]The harmony in sound symbolic words proceeds regardless of the feature of the stem vowel (i.e.kɛlcok 'tall').

(66)

Korean	PARSE	REC-F	ALIGN-L	ALIGN-R$^{\beta}$	ALIGN-R
pu-ə -atr	*!				
pu-a$_2$ -atr			*!		
po-ə -atr				*!	*
☞po-a$_2$ -atr 'Look!'					
mɛ-ə -atr	*!				
mɛ-a$_2$ -atr			*!		
☞mɛ-ə -atr 'Tie it'					*
mɛ-a$_2$ -atr				*!	

In the above tableau, only the relevant constraints for the analysis are highlighted although all the constraints are present in the grammar. That is, the grounded conditions RD/RTR and RTR/LO are not included because they do not have any crucial effect on the analysis. Of the four candidates

for the word 'Look', the RD/RTR condition is violated in the first two forms. But these forms are already ruled out by the higher constraints PARSE and ALIGN-L, respectively. The RTR/LO condition is violated in the third and fourth candidates. The fatal violation, however, is that of the ALIGN-R^{β} constraint which rules out the third form. In the second example, 'Tie it', the RD/RTR condition is irrelevant since there are no round vowels and the RTR/LO condition is satisfied by all the candidates. Hence, the effects of the conditions RD/RTR and RTR/LO are not crucial in this case. The ranking which includes the entire set of constraints for PDK is: ***PARSE>> REC-F>> ALIGN-L>> RD/RTR>> RTR/LO>> ALIGN-R$^{\beta}$>> ALIGN-R.***

ALIGN-R^{β} is slightly different from ALIGN-R in that the application of this constraint is restricted to cases where a stem vowel is [+BK]. To illustrate the effect of ALIGN-R^{β}, let us compare **po-ə** and **mɛ-ə**, the third candidates of each example. **po-ə** violates ALIGN-R^{β} since the stem vowel is [+bk]. Therefore, the optimal candidate for the word 'Look!' is **po-a$_2$**. **mɛ-ə** is the optimal form of 'Tie it' for the stem vowel is [-BK], therefore, it does not violate ALIGN-R^{β} even though it violates ALIGN-R. **mɛ-a$_2$** is ruled out by ALIGN-R^{β} because the feature [-ATR] aligns rightward from a [-BK] vowel.

Stems without lexical [-ATR] specification take the suffix [ə] as shown in the tableau (67).

(67)

Korean	PARSE	REC-F	ALIGN-L	ALIGN-R$^{\beta}$	ALIGN-R
☞mul-ə 'Bite!'					
mul-a_2 -atr		*!	*		
mol-ə -atr		*!		*	*
mol-a_2 -atr		*!			

This case, too, is as simple as that of dark sound symbolic words, since the candidates with retracted vowels violate the highly ranked constraint REC-F as well as others.

The harmony in A-initial suffixes differs from the harmony in sound symbolic words in that it is conditioned by the feature of the stem vowel, and shall be explained by invoking an additional constraint ALIGN-R$^{\beta}$. Here, neutrality is not observed since we are only looking at low back vowels ([ə],[a_2]) in non-initial syllables. Nevertheless, the harmony in both sound symbolic words and A-initial suffixes is explained by the same ranking in PDK grammar.

3.2. Later Middle Korean

Before we begin, let us review the vowel system of Later Middle Korean. LMK has an underlying seven-vowel system; this was shown in (38) and is here repeated as (68).

(68)

i	ɨ	u
	ə	o
	a	ʌ

The feature specifications of these vowels are as follows:

(69) LMK vowel feature specification

	i	ɨ	ʌ	u	o	ə	a
atr			(-)		(-)		(-)
rnd				+	+		
bk		+	+	+	+	+	+
low						+	+

These vowels are divided into two sets as we have discussed in the beginning of section 3.1.: the 'light' (yang) vowels [o,ʌ,a] and the 'dark' (yin) vowels [u,ɨ,ə]. This traditional yin/yang division is based on the harmony system. Within a word, vowels must be all dark or light except that the vowel [i] may cooccur with either dark or

light vowels. LMK vowel harmony is said to have been observed morpheme internally as well as in the combination of a stem with suffixes (Park,1990). Unlike PDK, LMK vowel harmony involves almost every word. Some examples are given in (70).

(70)

a.stem internally

Dark		Light	
kulum	'cloud'	namo	'tree'
pənkəy	'lightning'	sarʌm	'man'
simil	'twenty'	kaci	'branch'
micikəy	'rainbow'	kamakoy	'crow'
nilkup	'seven'	kilʌma	'saddle'
kiypyəl	'news'		
mili	'in advance'		
tili	'field'	tozak	'thief'
təuk	'very'	malssʌm	'saying'
chəzəm	'beginning'	api	'father'
əmi	'mother'		
nəmu	'too much'		

b.between a stem and a suffix

Dark		Light	
pəl-ə	'to earn-INF'	sal-a	'to live-INF'
pul-ə	'to blow-INF'	tol-a	'to turn-INF'

məl-ə	'far'	mʌl-a	'ignorantly'
nə-nin	'you-TOP'	na-nʌn	'I-TOP'
nun-in	'eye-TOP'	son-ʌn	'hand-TOP'
ki-lil	'he-ACC'	halmi-lʌl	'grandmother-ACC'
kə-lil	'vehicle-ACC'		
kypyə-lil	'news-ACC'	tozʌk-ʌl	'thief-ACC'
səli-lil	'frost-ACC'	api-lʌl	'father-ACC'
kulum-il	'cloud-ACC'	mʌzʌm-ʌl	'mind-ACC'
min-il	'people-ACC'	li-lʌl	'village-ACC'
cip-iy	'house-GEN'	kot-ʌy	'flower-GEN'
mək-um	'eating'	cap-om	'holding'
tuyh-əy	'behind-LOC'	pʌlʌm-ay	'wind-LOC'
kulum-əy	'cloud-LOC'	namo-ay	'tree-LOC'
kilh-əy	'street-LOC'	kaci-ay	'branch-LOC'
tuy-əy-nin	'behind-LOC-TOP'	alp-ay-nʌn	'front-LOC-TOP'
təl-um-il	'deduct-Nom-Acc'	al-om-ʌl	'know-Nom-Acc'

(S.O.Lee 1984, S.H.Park 1990, Song 1990)

In the harmony system of LMK, [u] alternates with [o], [i] alternates with [ʌ], and [ə] alternates with [a]. As we can see from the above data, [i] alone is a neutral vowel in LMK, whereas both [i] and [i] are neutral in PDK.

In previous studies of LMK (Ledyard 1966; B.G.Lee 1985[15]; Park 1982), the harmonizing feature of vowel harmony

[15]Although Lee (1985) advocates a horizontal harmony analysis for Korean vowel harmony, he also suggests a different type of harmonic distinction, [ATR], based on his

has largely been assumed to be the tongue body feature [back] or [low]. None of these analyses, however, correctly distinguishes between the two harmony groups according to the feature specifications in (69). The analysis that adopts the feature [back] as the harmonizing feature (Ledyard 1966, etc.) takes [a,ʌ,o] as [+back] and [u,ɨ,ə,i] as [-back]. On the other hand, the analysis in which the harmonizing feature is [low] groups [a,o,ʌ] as [+low] while all others are regarded as [-low]. These hypotheses, however, are suspicious because it is generally accepted that the features of the LMK vowel system are similar to those of the PDK vowel system[16] (Huh 1985, Hwang 1986, K.M.Lee 1987). Therefore, the harmonizing feature of LMK vowel harmony can be specified as neither [back] nor [low]. In this study, as in PDK, we will take [ATR] as the harmonizing feature in accordance with the argument presented in Song (1990:62);

> "The contrast between [ɨ] vs. [ʌ], [ə] vs. [a], and [u] vs. [o] can be described by referring to tongue root movement from an articulatory point of view: as the tongue root is moved forward, the tongue body is compressed and therefore raised, conversely, as the tongue root is retracted, the tongue body is pulled down and therefore lowered (Hall & Hall,1980:207).

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interpretation of *Hunmin-chongum-haerye* (Explanation of the Korean Script of fifteenth century).
[16]Compare (43) with (69).

Therefore, we can assume that [ɨ,ʌ,u] are [+ATR] and [a,o,ʌ] are[-ATR]."

Hence, vowel harmony in LMK ,as in PDK, can be characterized by the feature [ATR]. The LMK vowels are divided into two sets by this feature:

(71)

i	ɨ	u	dark=[+ATR]
	ə	o	light=[-ATR]
	a	ʌ	

3.2.1. Optimality Account

This section will give the optimality account for Later Middle Korean. We will see the changes in the grammar through LMK to PDK and discuss how OT can explain this variation. The hypothesis is that the differences in the grammar of each stage (i.e.LMK and PDK) are the result of changes in the ranking of the universal constraint set.

Let us consider some of the crucial data from (70) which are repeated here as (72).

(72)

Dark		Light	
nəmu	'too much'	namo	'tree'
əmi	'mother'	kaci	'branch'
min-ɨl	'people-ACC'	li-lʌl	'village-ACC'
məl-ə	'far'	mʌl-a	'ignorantly'

LMK vowel harmony involves nearly the entire vocabulary while PDK vowel harmony is found only in sound symbolic words and A-initial suffixes. The other difference is found in regard to the neutral vowels: PDK has two neutral vowels, [i] and [ɨ], in non-initial syllables; whereas LMK has only one neutral vowel, [i], regardless of position. For example, the vowel [i] is neutral even in syllable initial positions as the word **li-lʌl** shows. Also, we can see that the vowel [ɨ] is not neutral when we compare suffixes like **-ɨn** vs. **-ʌn** 'TOP' from the examples in (70)b. These differences are explained by the ranking of constraints shown in tableau (73). Again, we are assuming that the morphemes which have light vowels have lexical [-ATR] specification while those with dark vowels do not.

(73) Words with lexical [-ATR] Specification

	PARSE	REC-F	BK/RTR	RTR/LO	ALIGN-L	ALIGN-R
nəmu -atr	*!		* *			
nəmo / -atr			*!	*	*	
namu \ -atr			*!			*
☞namo \/ -atr 'tree'				*		
kəci -atr	*!		*			
kəcɪ / -atr			*!	*	*	
☞kaci \ -atr 'branch'						*
kacɪ \/ -atr				*!		

In PDK, the constraint ALIGN-L is ranked higher than the grounded conditions since the high unrounded vowels [i,ɨ] are neutral only in non-initial syllables. However, the vowel [i] in LMK is neutral regardless of its position in the syllable. Therefore, both of the alignment conditions are

ranked lower than the grounded conditions. In fact, the alignment constraints do not play a crucial role in LMK. The RD/RTR condition of PDK is replaced and therefore pushed much lower in the hierarchy by the BK/RTR[17] condition in LMK. In LMK, there is no need to group round vowels together because all round vowels are back. We must, however, distinguish round vowels in PDK since front rounded vowels ([ö,ü]) do exist.

Let us consider the word for 'tree'. The first candidate violates PARSE, the highest ranked constraint. The second and third forms are ruled out by BK/RTR because the [+BK] vowels [ə] and [u] are [+ATR]. They also violate lower ranked constraints such as RTR/LO and ALIGN. The form **namo** is optimal even with the violation of RTR/LO ([-ATR] is parsed to nonlow vowel [o].) because it beats all other candidates. However, the violation of this constraint (RTR/LO) is fatal when we have the high front vowel [i]. The first and second forms for 'branch' are ruled out by PARSE and BK/RTR, respectively, in the same manner as in 'tree'. The fourth candidate **kacı** is ruled out by RTR/LO because the optimal form **kaci** passes this constraint and violates only ALIGN-R which is ranked lower in the hierarchy. That is, when there is the vowel [i], it is better not to align [-ATR] to this vowel because it will incur an RTR/LO

[17]BK/RTR Condition: If [+BK] then [-ATR], not [+ATR].

violation. [-ATR], however, can be parsed to vowels like [ɨ] and [u] due to the BK/RTR condition.

The following tableau shows that it is more important to satisfy the BK/RTR condition when there is competition between BK/RTR and RTR/LO conditions.

(74)

	PARSE	REC-F	BK/RTR	RTR/LO	ALIGN-L	ALIGN-R
li-lɨl -atr	*!		*			
☞li-lʌl / -atr 'village'				*	*	
lɪ-lɨl \ -atr			*!	*		*
lɪ-lʌl V -atr				* *!		
mɨl-ə -atr	*!		* *			
mɨl-a / -atr			*!		*	
mʌl-ə \ -atr			*!	*		*
☞mʌl-a V -atr 'ignorantly'				*		

The form **mʌl-a** is optimal even with an RTR/LO violation because the form without this violation **mɨl-a** violates BK/RTR which is ranked higher. The forms that have the vowel [ɨ] violate BK/RTR. The BK/RTR condition prevents [ɨ] as well as all other advanced back vowels ([u,ə]) from surfacing in such a case. Hence, we may conclude that the fact that [ɨ] is not neutral in LMK is due to the relatively high ranking of the BK/RTR condition in this grammar.

Morphemes with dark vowels can be explained easily as in the dark sound symbolic words case in PDK. The forms in which [-ATR] is parsed to a vowel will violate REC-F. The optimal form, therefore, is the one without retracted vowels as the following tableau shows.

(75) Words without lexical [-ATR] specification

	PARSE	REC-F	BK/RTR	RTR/LO	ALIGN-L	ALIGN-R
☞nəmu 'too much'			**			
nəmo / -atr		*!		*	*	
namu \ -atr		*!	*			
namo V -atr		*!		*		
☞min-il 'people-ACC'			*			
min-ʌl / -atr		*!		*	*	
mɪn-il \ -atr		*!	*	*		*
mɪn-ʌl V -atr		*!		**		

In this section, the diachronic changes in the vowel harmony phenomena in LMK and PDK have been explained by the differences in the two grammars' ranking systems within the Optimality Theory framework. The diachronic changes are illustrated in the following scales.

(76) Diachronic Change

LMK: PARSE>>REC-F>>BK/RTR>>RTR/LO>>ALIGN-L>>ALIGN-R

PDK: PARSE>>REC-F>>ALIGN-L>>RD/RTR>>RTR/LO>>ALIGN-R

We claimed in the beginning of this chapter that certain constraints are still crucial after the reranking while certain constraints cease to play a crucial role after moving down in the hierarchy. As we can see from the above scales, the ALIGN-L constraint was moved up to a position higher than the relevant grounded conditions in the change from LMK to PDK, and both ALIGN-L and the grounded conditions were crucial in PDK after the reranking from LMK. However, the BK/RTR condition, which was moved down in PDK, ceased to play any crucial role in the grammar after the change in ranking.

CHAPTER 4

CONCLUSION

This study presents the hypothesis that the vowel harmony patterns of Korean can be described as ATR harmony and that a better grasp of this harmony system can be achieved with the application of Optimality Theory. The concept of *constraint interaction* allows the characteristics of neutral vowels in the harmony process to be accounted for by the interaction of grounded conditions with constraints on alignment and the appropriate ranking of these constraints, namely RTR/LO>> ALIGN-R.

The standard OT claim that an individual grammar is the result of variation in the ranking of the universal constraint set is further developed here to conclude that different historical stages in a single language can also be treated as the result of changes in the ranking. We have shown how LMK grammar develops into PDK grammar by reranking some of the constraints: while the grounded conditions are ranked higher than ALIGN-L in LMK, the ALIGN-L constraint is moved up in PDK because it is important to align the feature [-ATR] to the left edge of a word. The fact that neutral vowels are found only in non-initial syllables in PDK whereas they are found in any position in LMK can be

accounted for by the changes in ranking from LMK to PDK. The BK/RTR condition is moved down since this constraint cannot group PDK round vowels including front round vowels. The differences in the inventories of LMK and PDK are responsible for the different role of the BK/RTR condition in each stage.

Further work, however, is needed on other languages, in order to substantiate the claim that diachronic change is characterized by variation in constraint rankings.

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APPENDIX : List of Constraints

1. **ALIGN-α-L/R:** The left/right edge defined by feature α aligns with the left/right edge of Domain D.
2. **ALIGN-α-R$^{\beta}$:** The right edge defined by feature α aligns with the right edge of Domain D, when the stem vowel is [+BK].
3. **ATR/HI:** If [+ATR] then [+high], not [-high].
4. **ATR/LO:** If [+ATR] then [-low], not [+low].
5. **-COD:** Syllables must not have a coda.
6. **DISYLL:** The Reduplicant is minimally disyllabic.
7. **FILL:** Syllable positions must be filled with underlying segments.
8. **HI/ATR:** If [+high] then [+ATR], not [-ATR].
9. **LO/ATR:** If [+low] then [-ATR], not [+ATR].
10. **MAX:** The reduplication is phonologically identical to the base.
11. **ONS:** Syllables must have an onset.
12. **PARSE:** An F-element (feature or node) α must be dominated by an appropriate node in the prosodic tree.
13. **REC-F** (Recoverability of F-element): An F-element α that is present in an output form is also present in the input.
14. **REC-P** (Recoverability of Path): For any path between an F-element α and some anchor β, if α is associated to β in the output then α is associated to β in the input.

15. **RD/RTR**: If [+RD] then [-ATR], not [+ATR].

16. **R≤ROOT**: The Reduplicant (R) contains only the root.

17. **RTR/HI**: If [-ATR] then [-high], not [+high].

18. **RTR/LO**: If [-ATR] then [+low], not [-low].