A Comparative Study of Korean and French Vowel Systems*

- An Experimental Phonetic and Phonological Perspective -

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ABSTRACT

This paper aims to investigate the acoustic characteristics of the vowels attested in Korean and French and to seek a way of understanding them from a phonological point of view. We first compare the two vowel systems by measuring the actual frequencies of the formants using CSL. It is shown that the first and second formants vary in wider range in French compared to Korean. In order to understand the two vowel systems from a phonological point of view, we apply the theory of Licensing Constraints, proposed and developed by Kaye (1994), and Charette and Kaye (1994). We propose the licensing constraints placed upon the vowels both in Korean and French. For Korean, we propose the licensing constraints such that *both elements I and U must be heads*. For French, we claim the following licensing constraints: *U in a headed expression must be head, A cannot be head, and Nothing can only license an expression A in it.*

Keywords: vowel system, acoustic characteristics, element, Licensing Constraints

1. Introduction

There has been much research in various theories regarding the vowel system both in Korean and French. However, as far as we understand, there have not been any systematic and over-all studies to compare the vowel systems of the two languages from both experimental phonetic and phonological perspective. Therefore, in this paper, we try to investigate the acoustic characteristics of the vowels attested in both languages and their phonological behaviour using the theory of licensing constraints.

In section 2, on the basis of spectrographic analysis, we present the acoustic characteristics of the vowels found in the two languages. In section 3, we consider the vowel systems of Korean and French in turn from a phonological viewpoint. We present a brief outline of the licensing constraints(3.1) and propose the licensing constraints of Korean with some supporting evidence(3.2). We then analyse the vowel system of French(3.3). In the

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final section, we give our summaries and conclusions.

2. An Experimental Phonetic Point Of View

2.1 Methods

As mentioned already, we conducted this experiment in order to compare the acoustic characteristics of the vowels found in Korean and French. We recorded the data from a native French speaker (34 year old male) and a standard Korean speaker (41 year old male) and analysed it using CSL 4300 B (Kay Elematrics Co.) at the phonetics laboratory of Kyungpook National University. Speakers pronounced the simple vowels in isolation and words which contain these vowels ten times each to measure the actual vowel qualities.[1] A formant chart was attained by the average value of the first and second formant frequencies(F1 and F2) of all the vowels found both in Korean and French.

2.2 Results

Figure 1 and 2 below show a formant chart of vowels in Korean and French respectively.[2] They show formant one plotted on the vertical axis against formant two on horizontal axis. They reflect the difference of the vowel qualities found in Korean and French. Note that vowels [i] and [u] appear at the top left and right of the graph, and [a] is in the bottom, with all the other vowels in between. The measured frequencies of the two formants for each vowel in the two languages are given in (1) (2) below:

1) In previous researches, similar experimental results were presented. For Korean refer to Ahn (2000). See Landercy and Renard (1977) and Seo *et al.* (1993) for French.
2) We note that the assumptions about how many vowels are available at the level of lexical representation of Korean vary among phonologists. In approaching the vowel system of Korean, however, we here assume Korean to contain 7 vowels, since we ourselves do not distinguish the two vowels [æ] and [ɛ] in pronunciation. For French, we will only consider oral vowels including the non-phonemic schwa [ə].

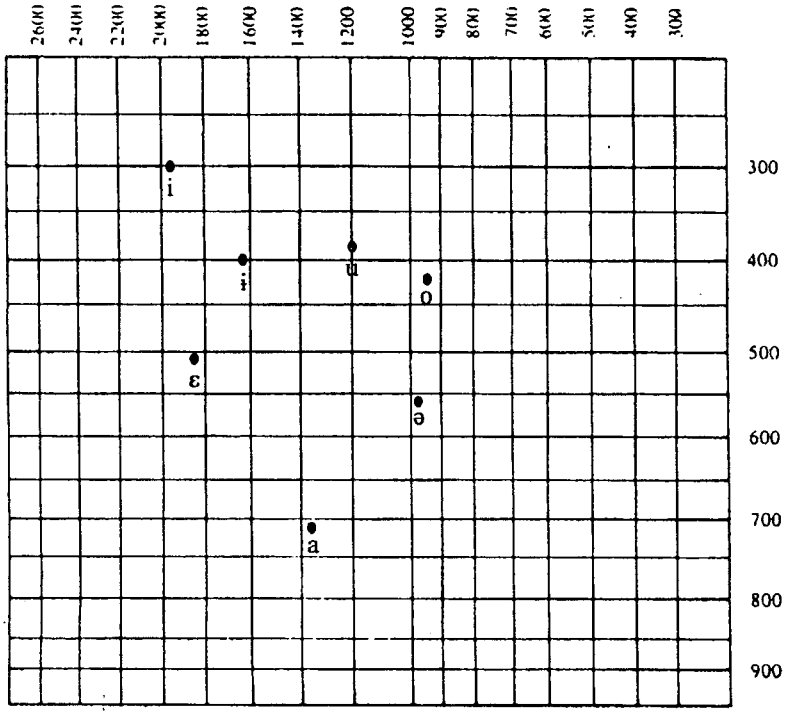

Figure 1. A formant chart of Korean vowels

(1) The acoustic quality of Korean vowels (appeared in Hz)

Vowels	i	u	ɨ	o	ə	ɛ	a
F_1	300	380	400	420	560	510	710
F_2	1,980	1,200	1,620	950	990	1850	1,380
F_2-F_1	1,680	820	1,220	530	430	1340	670

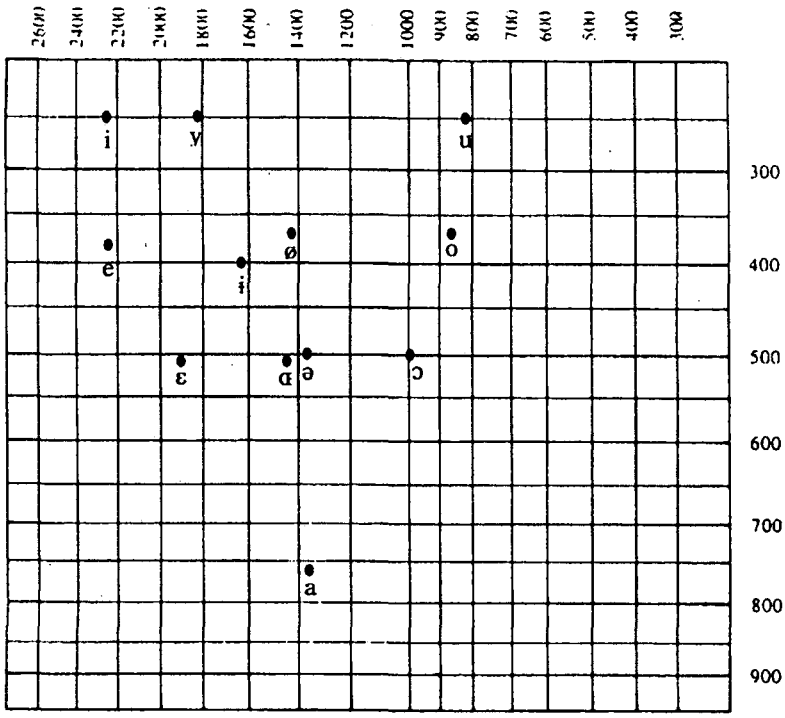

Figure 2. A formant chart of French vowels

(2) The acoustic quality of French oral vowels (appeared in Hz)

Vowels	i	e	ɛ	a	y	ø	œ	u	o	ɔ	ə
F_1	250	380	510	770	250	370	510	250	370	500	500
F_2	2260	2240	1900	1380	1810	1420	1460	820	870	1000	1380
F_2-F_1	2010	1860	1390	610	1560	1050	950	570	500	500	880

The minimum value of F_1 in Korean is 300 Hz and maximum value is 710 Hz, meaning that the difference is 410 Hz. However, the minimum value of F_1 in French is 250 Hz and maximum value is 770 Hz. The difference is 520 Hz. It means that the height of vowels ranges in a wider extent in French compared to Korean. Besides, the difference of F_2 between the values of maximum and minimum is 1,440 Hz in French, whereas 1,030 Hz in Korean.

Note that the distance between the two formants decreases in the non-front vowels, whereas the distance increases in front vowels, as Ladefoged (1982) pointed out. Note also that the F_1 of the two high vowels (e.g. [i] and [u]) in Korean is higher than that in French. It means that the two vowels in Korean are pronounced in lower positions, since the first formant is inversely related to vowel height.

Let us now go into the discussion of how the two vowel systems are understood from a phonological point of view. For understanding of the vowel systems of the two languages, we here employ the theory of licensing constraints. Before analysing the vowel systems, we will present a brief account of the theory.

3. A Phonological Point of View

3.1 An Overview of the Theory of Licensing Constraints

The representational system for a segment in Government Phonology(henceforth, GP; Kaye, Lowenstamm & Vergnaud (1990), Charette & Kaye (1994)) differs from that of other theories in many ways. One of these differences is that the ultimate constituent of an expression is not the phonological feature but the element. All phonological segments are made up either of elements or combinations of elements. In this paper, we limit ourselves only to the elements A, I, and U, which are relevant to the present discussion. In the representation of vowels, these are interpreted as non-high(low), front, and round respectively.

If the elements I, A, and U are allowed to combine without any constraints with respect to head/operator relationship, twelve headed expressions are generated as in (3) below:[3)]

(3) (I) (A.I) (I.A) (I.U)
(A) (U.I) (U.A) (A.U)
(U) (A.U.I) (I.U.A) (A.I.U)

Notice in (3) that the operators in a combined expression are not ordered with respect to each other. This means that (A.U.I) and (U.A.I) represent the same phonological segment. In other words, the important thing is whether an element is present or absent as an operator in an expression. Besides the expressions represented in (3) above, empty-headed expressions will also be generated. These are given in (4) below:

(4) (-) (I.-) (A.I.-) (U.A.-)
(A.-) (U.I.-)
(U.-) (A.U.I.-)

3) The head of an expression is on the right, the operator(s) on the left, viz. (operator.head) Heads are underlined. Therefore, for instance, if an expression is (A.U), it means that the element A is the operator, and the element U is the head. Throughout this paper, we will represent vowels in this way.

The symbol (-) indicates a head without an element represented. One might expect that each of the expressions represented in (3) has an empty-headed counterpart, but -for the reason mentioned above- this is not the case. That is, expressions (U.I.-) and (I.U.-) indicate the same phonological segment.

Note that segments can have either head only (eg. (A)), operator(s) only (eg. (A.-) and (U.A.-)), or both head and operator(s) (eg. (A.U) and (A.U.I)). In this system, every expression can have only one head. Double headed expressions are not permitted. Therefore, expressions such as *(A.I), *(A.U.I) and *(U.I) are excluded from being a well-formed structure.

As seen in (3) and (4) above, if we allow three elements (i.e. A, I, and U) for the representation of vowels and free combination with each other, then the number of possible expressions is twenty. However, if we assume a language to contain, for instance, 10 vowels, there are too many. To our knowledge, no language in the world has such a huge vowel system. Therefore, we need a mechanism which reduces the twenty possibilities to all and only the phonological expressions found in a given language. Accordingly, the theory of licensing constraints was introduced.[4)]

Licensing constraints define the way in which elements can combine at the level of lexical structure. They are concerned with the following: what elements may be heads, and whether heads can license operators. For instance, if a licensing constraint says *the element I must be head*, then the expression (I.A) is ill-formed, but the expression (A.I) is acceptable. For instance, if a licensing constraint says *the element U cannot license operators*, then the expression (U) is well-formed, whereas the expression (A.U) is ruled out. As a result, once licensing constraints for a particular language are correctly fixed, we can generate phonological expressions available at the level of lexical representation of the language. This is because we are able to eliminate all the expressions which are not attested in the language by means of licensing constraints. Moreover, we are also able to predict the various phonological phenomena in a language.

In what follows, we will propose the licensing constraints placed upon the lexical representation of vowels both in Korean and French. We will show that the proposed licensing constraints will generate the vowel systems of the two languages.

3.2 The Vowel System of Korean

3.2.1 Licensing Constraints of Korean

The total vocalic inventory of Korean is assumed to contain the seven vowels shown in

4) There has been much research regarding licensing constraints with reference to various languages. Refer to Cobb (1993 & 1995) for Uyghur and Zulu respectively. See Denwood (1997) for Khalkha Mongolian and Walker (1995) for Vata. Finally, refer to Charette and Göksel (1994) for Turkish.

(5) below.

(5) Vocalic inventory of Korean

a	pata	'sea'
i	kirin	'giraffe'
u	kurim	'cloud'
o	koki	'meat'
ə	kəmi	'spider'
ɛ	kɛ	'crab'
ɨ	kinɛ	'swing'

In order to get a suitable representation of the vowels above, we now propose the following licensing constraints:

(6) a. I must be head.
b. U must be head.

Constraints (6a) eliminates all expressions where I is an operator. Expressions such as (I.U), (A.I.U), (I.U.A), (I.A), (I.-), (U.I.-), (A.U.I.-) and (A.I.-) must go. These are boxed in (7) below:

(7)	(I)	(A.I)	(I.A)	(I.U)	
	(A)	(U.I)	(U.A)	(A.U)	
	(U)	(A.U.I)	(I.U.A)	(A.I.U)	
(-)	(I.-)	(A.I.-)	. (U.A.-)		
	(A.-)	(U.I.-)			
	(U.-)	(A.U.I.-)			

As a result, we reduce the total to twelve expressions. Constraint (6b) further reduces the total to seven, since all expressions where U is not a head are now ill-formed. This thus eliminates all expressions such as (U.-), (U.A.-), (U.I), (A.U.I) and (U.A) from the vowel system of Korean. These are circled in (8) below:

(8)	(I)	(A.I)		
	(A)	(U.I)	(U.A)	(A.U)
	(U)	(A.U.I)		
(-)			(U.A.-)	
	(A.-)			
	(U.-)			

By means of the licensing constraints given in (6), we have been able to exclude all the expressions which are not attested in Korean. By means of (6a), we have excluded the boxed expressions as shown in (7). We have also eliminated the circled expressions by means of constraint (6b), as shown in (8). The remaining permitted expressions are given below:

(9)

	(I)	(A.I)	
	(A)		(A.U)
	(U)		
(-)			
	(A.-)		

Each vowel with its internal representation is given in (10) below:

(10) Representation of vowels in Korean

a	(A)
i	(I)
u	(U)
o	(A.U)
ə	(A.-)
ɛ	(A.I)
ɨ	(-)

We have so far considered the licensing constraints placed upon the vowel system of Korean. We have proposed that *the elements both I and U must be head.* The task is now to support the licensing constraints in (6) above with evidence of how elements behave with respect to some phonological processes.[5)]

3.2.2 Supporting Evidence

In providing evidence that the licensing constraints in (6) are correctly fixed, we will briefly discuss the process of umlaut as an instance. Umlaut is a process in which an I-less vowel(so-called back vowel) gains the element I by the effect of the following vowel i. The umlauted version of each vowel is given with their internal representations in table (11) below:

5) There are some phonological processes to support that the licensing constraints in (6) are justified, including a/ə alternation and umlaut. However, in this paper, we only briefly consider the process of umlaut. For a more detailed discussion, refer to Kim (1996).

(11) Underlying vowels vs. umlauted counterparts

underlying vowels	umlauted vowels
i (-)	i (I)
a (A)	ɛ (A.I)
ə (A.-)	ɛ (A.I)
u (U)	not found
o (A.U)	not found

Note that umlauted versions of all vowels contain the element I as head in their internal representation. Note also that umlaut takes place if and only if a vowel does not contain the element U in its representation. However, if it does include the element U, umlaut fails.[6] This is because both the elements U and I must be heads, meaning that they cannot come together in an expression, i.e., *(I.U) *(U.I). Therefore, the proposal saying that *both I and U must be heads* can be justified. In the next section, we will consider the vowel system of French.

3.3 The Vowel System of French

3.3.1 Licensing Constraints of French

By the same method we employed in the previous section, we will now analyse the vowel system of French. In French there are 10 oral vowels, as in (12) below:

(12) Vocalic inventory of French

i	ici
e	métro
ɛ	tete
a	patte
y	**yu**sure
ø	**eu**x
œ	h**eu**re
u	m**ou**
o	**o**ser
ɔ	**o**pinion

6) However, in older generation's Korean which contains 10 vowels (a, i, u, o, ə, ɛ, ɨ, æ, ö and ü), vowels [o] and [u] undergo umlaut when followed by the vowel [i], as in [cukita]~[cükita] 'to kill' and [koki]~[köki] 'meat'. It means that combination of the elements U and I is allowed in this vowel system. For a detailed discussion about licensing constraints of older generation's Korean, refer to Kim (1996).

We propose a set of licensing constraints below which generate the vowels in (12) such that:

(13) a. U in a headed expression must be head.
b. A cannot be head.
c. Nothing can only license an expression A in it.

Constraint (13a) eliminates all expressions where U is an operator in headed expressions. Accordingly, expressions such as (U.I), (A.U.I), (U.A) and (I.U.A) must go. These are boxed in (14) below:

(14)					
		(I)	(A.I)	(I.A)	(I.U)
		(A)	[(U.I)]	[(U.A)]	(A.U)
		(U)	[(A.U.I)]	[(I.U.A)]	(A.I.U)
	(-)	(I.-)	(A.I.-)	(U.A.-)	
		(A.-)	(U.I.-)		
		(U.-)	(A.U.I.-)		

As a result, we reduce the total to sixteen expressions. Constraint (13b) further reduces the total to fourteen, as all representations where A is a head are now ill-formed. This thus eliminates both the expressions (A) and (I.A) from the vowel system of French. These are circled in (15) below:

(15)					
		(I)	(A.I)	((I.A))	(I.U)
		((A))			(A.U)
		(U)			(A.I.U)
	(-)	(I.-)	(A.I.-)	(U.A.-)	
		(A.-)	(U.I.-)		
		(U.-)	(A.U.I.-)		

Constraint (13c) again reduces the total to eleven, as all expressions where operators are licensed without A in headless expressions are now disallowed. Thus, expressions such as (I.-), (U.-) and (U.I.-) must go. These are starred in (16) below:

(16)		(I)	(A.I)	(I.A)	(I.U)
		(A)			(A.U)
		(U)			(A.I.U)
	(-)	*(I.-)	(A.I.-)	(U.A.-)	
		(A.-)	*(U.I.-)		
		*(U.-)	(A.U.I.-)		

By means of the licensing constraints given in (13), we have been able to exclude all the expressions which are not attested in French. By means of constraint (13a), we have excluded the boxed expressions as shown in (14). We have also eliminated the circled expressions and starred expressions by means of constraint (13b) and (13c) respectively. The remaining permitted expressions are given below:

(17)		(I)	(A.I)		(I.U)
					(A.U)
		(U)			(A.I.U)
	(-)		(A.I.-)	(U.A.-)	
		(A.-)			
			(A.U.I.-)		

The representation of each vowel found in French is as follows:

(18) Representation of vowels in French

i	(I)
e	(A.I)
ɛ	(A.I.-)
a	(A.-)
y	(I.U)
ø	(A.I.U)
œ	(A.U.I.-)
u	(U)
o	(A.U)
ɔ	(U.A.-)
ə	(-)

Let us now briefly consider whether the licensing constraints in (13) are correctly fixed for French.

3.3.2 Supporting Evidence

In order to examine whether there is empirical evidence for the licensing constraints in (13) above, let us consider the nasal vowels found in French. In GP, nasality is represented by the element L in the representation of vowels. More precisely, L appears in the representation of vowels as head, as claimed by Kaye (1994) and Ploch (1995). It means that those four vowels cannot lexically be headed, because they have their nasal counterparts. As discussed earlier, two headed expressions (i.e., *(A.I.N), *(A.N), *(A.U.I.N) and *(U.A.N)) are not allowed in the representation of GP. The followings are the internal representation of French nasal vowels:

(19) ɛ̃ (A.I.N)
œ̃ (A.U.I.N)
ɔ̃ (U.A.N)
ɑ̃ (A.N)

If the vowels in (19) above were already headed, N representing nasality could not be added to be realised as nasal vowels. Therefore, we may conclude that the licensing constraints where all vowels which have their nasal counterparts are headless are legitimate.

4. Summary and Conclusion

In this paper, we have investigated the vowel systems of Korean and French in both experimental phonetic and phonological perspective. To summarise, formant frequencies one and two vary in wider range in French compared to Korean. While the difference of F_1 between the maximum and minimum value of Korean is 430 Hz, the difference is 520 Hz in French. As well, the difference of F_2 between the values of maximum and minimum is 1440 Hz in French, whereas 1030 Hz in Korean. Using the theory of Licensing Constraints, we have analysed the two vowel systems from a phonological point of view. For Korean, we have proposed the licensing constraints such that *both elements I and U must be heads*. For French, we have claimed a set of licensing constraints: *U in a headed expression must be head, A cannot be head, and Nothing can only license an expression A in it.* It seems that, in comparison with French, Korean contains less vowels and ranges in narrower extent, since it has stronger licensing constraints *both elements I and U must be heads*.

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