

## Phonological transparency and opacity in the sound substitutions of interlanguages

Mi-Hui Cho and Shinsook Lee  
(Pukyong National University and Hoseo University)

**Cho, Mi-Hui and Shinsook Lee. 2001. Phonological transparency and opacity in the sound substitution of interlanguages.** *Studies in Phonetics, Phonology and Morphology*. 7.2. 449-468. This paper examines the acquisition of English coronal fricatives by Japanese and Korean EFL learners. It has been noticed that Japanese and Korean learners show different patterns in producing English target coronal fricatives. Specifically, while Japanese learners of English produce target-appropriate realizations of English /s/ in prevocalic position, they tend to palatalize target /s/ before /i/, thus producing [ʃ]. By contrast, Korean speakers of English are likely to produce target /s/ in prevocalic position as the tense alveolar fricative [sʰ]. Further, they palatalize this target before /i/, thus producing the palatalized tense [ʃʰ]. The palatalized surface form [ʃ] by Japanese learners shows phonological transparency, whereas the palatalized tense [ʃʰ] by Korean learners shows phonological opacity because of the tense feature. It is proposed that the difference between Korean and Japanese learners' substitution patterns is not due to different rule applications but due to candidate-to-candidate faithfulness, namely a sympathy constraint. In addition, Japanese learners replace the English interdental fricative /θ/ with the alveolar fricative [s], while Korean learners replace it with the tense alveolar fricative [sʰ]. When target /θ/ occurs before /i/, the unpalatalized form [s] or [sʰ] emerges rather than the expected palatalized form [ʃ] or [ʃʰ] in both interlanguages. It is argued that this substitution pattern can also be handled with the same constraint ranking within Optimality Theory with Sympathy Theory. (Pukyong National University and Hoseo University)

Keywords: Korean-English interlanguage, Japanese-English interlanguage, opacity, sound substitution

### 1. Introduction

The English language has more fricatives than Japanese or Korean has. For example, English has various fricatives such as the interdental fricative /θ/ and the labiodental fricative /f/ that differ in the places of articulation. By contrast, Japanese has only /s/ and /z/. Similarly, Korean has only the lax alveolar fricative /s/ and tense /sʰ/. Thus, it is expected that Japanese and Korean learners of English would make errors when they learn target English fricatives that are not in the inventory of their native language. The phonemic inventories of English, Japanese and Korean fricatives are given below for comparison.

## (1) Phonemic inventories of English, Japanese and Korean fricatives

	Labiodental	Interdental	Alveolar	Alveopalatal
English	f, v	θ, ð	s, z	ʃ, ʒ
Japanese			s, z	
Korean			s, s'	

Given the differences in the inventories among English, Japanese and Korean, the most frequent error patterns would be sound substitutions in interlanguages. Thus, for example, it has been observed that English target /f/ is replaced by a bilabial fricative by Japanese learners, while a bilabial stop by Korean learners (Iverson, 1998). Likewise, an alveolar fricative substitutes target /θ/ in interlanguages. Specifically, scholars such as Lombardi (2000) and Weinberger (1990) show that target /θ/ is replaced with [t] in languages like Russian whereas [s] in languages like Japanese.

The purpose of this paper is to examine the sound substitution patterns in the acquisition of English coronal fricatives by Japanese speakers (Eckman and Iverson, 1999) and Korean speakers (Joh and Lee, 2001). Specifically, the substitution patterns of the interdental /θ/, alveolar /s/ and alveopalatal /ʃ/ will be investigated. In particular, the different realizations of target /s/ before /i/ in Japanese and Korean interlanguages, [ʃ] and [s'], respectively, will be examined, along with the replacement of target /θ/ with [s] by Japanese learners and [s'] by Korean learners. This paper will try to provide a testing ground for a better phonological theory by comparing between the rule-based approach and the constraint-based approach in accounting for the substitution patterns in both interlanguages.

The paper is organized as follows: Section 2 discusses substitution patterns by Japanese and Korean learners. Section 3 provides a rule-based analysis of the substitution patterns within a derivational theory and discusses shortcomings of the theory. Section 4 offers a constraint-based analysis of the patterns. In specific, it will be shown that Optimality Theory augmented with Sympathy Theory is superior to standard Optimality Theory, in accounting for the opaque substitution pattern of [ʃ'] for target /s/ before /i/ in Korean. Section 4 concludes the paper with summaries.

## 2. Data

Japanese speakers learning English are expected to have difficulty in producing English fricatives because many of English fricatives do not occur in their native Japanese. Consequently, Japanese EFL learners tend to replace an English fricative with some other sound that would be the

most similar one in the inventory of their native language. The same holds true for Korean EFL learners. In this section two dominant sound substitution patterns involving English coronal fricatives in both interlanguages are examined.

### 2.1 A Transparent Case in Japanese-English Interlanguage: Eckman and Iverson (1999)

Iverson (1998) and Eckman and Iverson (1999) reported sound substitution patterns of English coronal fricatives by Japanese EFL learners. According to them, English target /ʃ/ was almost target-appropriately produced. Although /ʃ/ does not belong to the Japanese phonemic inventory, it is allowed to occur before /i/ as a variant of /s/, and thus Japanese speakers may not have difficulty in pronouncing it. On the other hand, English target /s/ before /i/ was pronounced as palatalized [ʃ] whereas /s/ in prevocalic position except /i/ as [s]. Japanese learners also substituted alveolar fricative [s] for the English interdental fricative /θ/, as there is no /θ/ in Japanese. However, they did not palatalize [s] resulted from the substitution for /θ/ before /i/, although palatalization might be expected to apply to [s] before /i/. The sound substitution pattern by Japanese learners of English is given in (2).

- (2) Sound substitution pattern by Japanese speakers of English (Iverson, 1998; Eckman and Iverson, 1999)
- a. [ʃ] for target /ʃ/ before /i/  
[ʃ] 'sheet'
  - b. (i) [s] for target /s/ before a vowel other than /i/  
[s] 'sank'  
(ii) [ʃ] for target /s/ before /i/  
[ʃ] 'seat'  
[ʃ] 'sing'
  - c. (i) [s] for target /θ/ before a vowel other than /i/  
[s] 'thank'  
(ii) [s] for target /θ/ before /i/  
[s], \*[ʃ] 'thing'

The sound substitution pattern can be summarized as follows

- (3) Japanese Sound Substitution Patterns
- a. English /ʃ/ is realized target-appropriately either before /i/ or before a vowel other than /i/.
- (i) /ʃ/ → [ɕ] / \_\_ i                      (ii) /ʃ/ → [ʃ]
- b. English /s/ becomes [ɕ] before /i/ whereas it becomes [s] before a vowel other than /i/.

- (i) Palatalization: /s/ → [ʃ] / \_\_ i      (ii) /s/ → [s]  
 c. English /θ/ becomes [s] either before /i/ or before a vowel other than /i/.  
 (i) Substitution: /θ/ → [s] / \_\_ i      (ii) Substitution: /θ/ → [s]

While target /s/ before /i/ is palatalized as in (3bi), target /s/ before a vowel other than /i/ is realized target-appropriately as in (3bii). Japanese is considered to be transparent since palatalization occurs as expected when the environment (before /i/) is met. In the next subsection a similar but slightly different substitution pattern by Korean learners is introduced.

## 2.2 An Opaque Case in Korean-English Interlanguage: Joh and Lee (2001)

Joh and Lee (2001) examined the pronunciation of English coronal fricatives in prevocalic position by 37 Korean college students. According to them, 6 students out of 37 showed the following sound substitution patterns: English target /ʃ/ was produced almost target-appropriately; but target /s/ was replaced with [s'] whereas /s/ before /i/ with [ʃ']. In addition, target /θ/ was substituted with [s'] even before /i/ although there was a lexical diffusion as words like *thought* and *thick* were produced correctly. Since the pattern is almost the same among six participants, only the data of Subject 5 are presented below.

### (4) Data from Subject 5 (Joh and Lee, 2001)

- a. (i) [ʃ] for target /ʃ/ before /i/  
       [ʃ] 'she'                      [ʃ] 'sheet'  
       [ʃ] 'ship'                    [ʃ] 'sheep'  
 (ii) [ʃ] for target /ʃ/ before a vowel other than /i/  
       [ʃ] 'shirt'                    [ʃ] 'shall'  
       [ʃ] 'shock'                   [ʃ] 'shoes'  
 b. (i) [ʃ'] for target /s/ before /i/  
       [ʃ'] 'sing'                    [ʃ'] 'sick'  
       [ʃ'] 'sit'                     [ʃ'] 'silver'  
 (ii) [s'] for target /s/ before a vowel other than /i/  
       [s'] 'son'                    [s'] 'sand'  
       [s'] 'soup'                   [s'] 'sock'  
 c. (i) [θ]/[s'] for target /θ/ before /i/  
       [s'] 'think'                  [s'] 'thing'  
       [s'] 'thin'                   [θ] 'thick'  
 (ii) [θ]/[s'] for target /θ/ before a vowel other than /i/  
       [θ] 'thousand'              [s'] 'thirty'  
       [θ] 'thought'                [s'] 'thank'

While English target /s/ before /i/ was pronounced as palatalized [ʃ] by Japanese learners, the same target was produced as palatalized tense [ʃʰ] by Korean learners.

The substitution pattern in Korean can be schematized as in (5).

(5) Korean Sound Substitution Patterns

- a. English /ʃ/ is realized target-appropriately either before /i/ or before a vowel other than /i/.
  - (i) /ʃ/ → [ʃ] / \_\_ i
  - (ii) /ʃ/ → [ʃʰ]
- b. English /s/ becomes [ʃʰ] before /i/ whereas it becomes [sʰ] before a vowel other than /i/.
  - (i) Palatalization and Substitution: /s/ → [ʃʰ] / \_\_ i
  - (ii) Substitution: /s/ → [sʰ]
- c. English /θ/ becomes [sʰ] either before /i/ or before a vowel other than /i/.
  - (i) Substitution: /θ/ → [sʰ] / \_\_ i
  - (ii) Substitution: /θ/ → [sʰ]

The substitution patterns by Japanese and Korean learners are almost the same except the following pattern. The difference between Japanese and Korean is that target /s/ before /i/ is transparently palatalized in Japanese whereas it is palatalized and unexpectedly tensed in Korean as in (5bi).<sup>1</sup> Following Kiparsky (1973), the substitution of [ʃʰ] by Korean learners is considered opaque because substitution with tensing seems overapplied to the palatalized form [ʃ]. Notice that the substitution with tensing targets only [s] and [θ] but not [ʃ] in prevocalic position. This sort of opacity which appears to motivate opaque rule interactions requiring extrinsic rule ordering has challenged the recent nonderivational development of Optimality Theory (McCarthy and Prince 1993, 1995; Prince and Smolensky, 1993). This is because there are no rule ordering relationships and no intermediate stages in standard Optimality Theory (OT, henceforth) adopting parallelism. In the next section a rule-based derivational analysis for Japanese learners' transparency and Korean learners' opacity is presented and shortcomings of the derivational account are discussed.

### 3. A Derivational Account in a Rule-Based Theory

As noted above, the sound substitution patterns are similar between Japanese and Korean except the following pattern. The predominant difference is that English /s/ before /i/ is realized as the palatalized [ʃ] in the Japanese case, whereas it is realized as the palatalized tense [ʃʰ] in the Korean case. The surface realization of [ʃ] or [ʃʰ] for English /s/ before /i/ seems to result from the following two different rules within a derivational

<sup>1</sup> It has been informally noticed that Kyongsang EFL learners, who live in the southeastern part of Korea, also pronounce target /s/ before /i/ as [ʃ] not [ʃʰ]. Thus, Kyongsang speakers of English are similar to Japanese speakers in that only palatalization occurs transparently.

account.

(6) Rules

a. Japanese

- (i) Palatalization: /s/ → [ʃ] / \_\_ i
- (ii) Substitution: /θ/ → [s] / \_\_ V

b. Korean

- (i) Palatalization: /s, s'/ → [ʃ, ʃ'] respectively / \_\_ i
- (ii) Substitution: /θ, s/ → [s'] / \_\_ V

The data given above show that the native language palatalization is transferred in interlanguages. In Japanese /s/ is palatalized as [ʃ] before /i/, while in Korean lax /s/ and tense /s'/ in the same environment are realized as [ʃ] and [ʃ'], respectively (e.g. *os* 'clothes' + *i* 'nominative marker' → [oʃi]/ *s'i* 'seed' → [ʃ'i]) (Kim-Renaud, 1992; Shin, 1998). Accordingly, English target /s/ before /i/ could undergo the rule of Palatalization resulting in pronunciation errors. On the other hand, [s'] substitution seems to be a rule applied only in Korean-English interlanguage producing the tense alveolar fricative [s'] for target /s/ and /θ/ in prevocalic position by Korean EFL learners (Kim, 1999). In the case of Japanese, the same target is realized as [s] because there is no tense consonant in the inventory of Japanese.

These two rules would interact in the following way to derive [ʃ'] in the Korean case.

(7) Derivations for English /s/ before /i/ 'sing'

a. Bleeding order

Palatalization	[ʃ]
Substitution	Does not apply
PR	*[ʃ]

b. Counterbleeding order

Substitution	[s']
Palatalization	[ʃ']
PR	[ʃ']

If Palatalization would apply before Substitution as in (7a), then Substitution would be bled due to the created environment [ʃ], which is not met for Substitution. By contrast, Substitution should precede Palatalization in order to produce the palatalized tense [ʃ'] as in (7b). Since the reverse rule ordering is bleeding, the relationship between the rules is counterbleeding in the Korean case.

Even though the serial rule-based approach seems to be able to handle the opaque case [ʃ'] in Korean as well as the transparent case [ʃ] in Japanese, it has some shortcomings. First, extrinsically ordered applications of the two rules look arbitrary due to the lack of motivations. The ordering between the two rules is determined not depending on intrinsic reasons but seems to be manipulated depending on surface forms. Second, the intermediate form [s'] before /i/ after Substitution in Korean (i.e. 7b) is not occurring in Korean subjects who showed the above pattern, thus

positing an abstract intermediate stage.

Lastly but most importantly, the ordering in the Korean case seems to be reversed when it comes to target /θ/. That is, contrary to the case /s/ before /i/, the surface form [s'] for target /θ/ would be derived in the order in which Palatalization applies before Substitution, as in (8a). If the two rules were to apply in the reverse order, a wrong surface form \*[ʃ'] for /θ/ would result in words like *thing*, as shown in (8b).

(8) Derivations for English /θ/ 'thing'

a. Palatalization	Does not apply	b. Substitution	[s']
Substitution	[s']	Palatalization	[ʃ']
PR	[s']	PR	*[ʃ']

Then, there happens to be an ordering paradox in Korean because Substitution must precede Palatalization for target /s/ before /i/ on the one hand, while Palatalization must precede Substitution for target /θ/ on the other hand. This shows that rule ordering is an ad-hoc way just to account for surface forms.

If the rule of Substitution is separated into two, one for /s/ and the other for /θ/, the ordering to derive [s'] for target /θ/ in the Korean case would be as follows.

(9) Derivations for English /θ/ 'thing'

1. /s/-Substitution	Does not apply
2. Palatalization	Does not apply
3. /θ/-Substitution	[s']
PR	[s']

The rule /θ/-Substitution would be crucially ordered after /s/-Substitution and Palatalization. This way, the ordering paradox raised between Substitution and Palatalization in Korean in (8) seems to be resolved. Nonetheless, the subdivision of Substitution into two parts misses the phonological generalization of the merger between /s/ and /θ/ in Korean-English interlanguage. That is, Korean EFL learners produce the merged tense alveolar fricative [s'] for both targets /s/ and /θ/.<sup>2</sup> In the next section we argue that OT augmented with Sympathy Theory provides a better account of the sound substitution patterns including both transparency and opacity in the interlanguages than the rule-based derivation theory does.

<sup>2</sup> Some might argue that there is a motivation to divide the rule Substitution into two subparts because target /s/ is tensified before a vowel whereas the target /θ/ is tensified even before a consonant as in *three* [s'ri]. However, the only consonant that can occur before /θ/ is /r/ according to English phonotactics. Thus, it can be treated as an exception. In addition, it is not uncommon given that /r/ is the most sonorous consonant like vowels. Alternatively, considering the tendency that the default vowel /i/ is inserted in consonant clusters in Korean-English interlanguage, the environment becomes a prevocalic position like /s/, thus resulting in [s'iri].

#### 4. An Optimality-Theoretic Account of L2 Sound Substitutions

In this section we will show that the opaque sound substitution pattern in Korean cannot be handled within standard OT, although the transparent one in Japanese can. By contrast, OT with Sympathy Theory can deal with both opaque and transparent cases.

##### 4.1 A Standard Optimality-Theoretic Account of the Transparent Case in Japanese

Japanese EFL learners generally substitute the English interdental fricative /θ/ with the alveolar fricative [s] because /θ/ is not in the phonemic inventory of their native language. Thus, the high ranking of the markedness constraint \*θ which bans the occurrence of the interdental fricative /θ/ is motivated. This constraint seems to be undominated, as any candidate with the violation of this constraint is ruled out. The replacement of /θ/ with [s] leads to a violation of the relevant antagonistic faithfulness constraint Ident[place] since the surface form [s] differs from /θ/ in terms of articulation place.

(10) \*θ: Avoid the English interdental fricative.

The English interdental fricative /θ/ is replaced by the alveolar fricative [s], not by the palatalized fricative [ʃ]. This is because there is a constraint that requires the output place to be minimally different from the input place (see Dinnsen and Barlow, 1998 for a similar constraint).

(11) Minimal distance (Min Dis): Minimize a place difference.

Due to the constraint, which seems to be also undominated, an adjacent alveolar place to /θ/ is selected over a nonadjacent alveopalatal place.

Japanese EFL learners frequently palatalize the English alveolar fricative /s/ before /i/ resulting in the palatalized [ʃ]. This is because of the transfer effect of Japanese palatalization. The constraint of palatalization requires /s/ before /i/ be realized as [ʃ], as given in (12).

(12) Pal: Alveolar fricatives are not allowed before /i/.  
(cf. McCarthy, 1999)

The constraint also captures the fact of Korean palatalization where lax /s/ and tense /s/ before /i/ are palatalized to [ʃ] and [ʃ̚], respectively. Consequently, the constraint permits only the forms [ʃi] and [ʃ̚i] whereas it prohibits [si] and [s̚i].

Obeying the constraint of Palatalization results in a violation of the relevant antagonistic faithfulness constraint Ident[place] because palatali-




zation changes the input place feature alveolar into alveopalatal in output. Thus, the constraint of Palatalization outranks the faithfulness constraint Ident[place]. In addition, English target fricatives are replaced not with a stop but with a fricative in interlanguage. This is because the faithfulness constraint Ident[continuant] is undominated.

- (13) Ident[cont]: Correspondent segments in the input and output have identical values for the feature [continuant].

With these constraints, let us consider the substitution pattern where target /θ/ is realized as [s], as shown in (14).


- (14) The substitution of [s] for target /θ/ ‘thank’

	*θ	Min Dis	Ident [cont]	Pal	Ident [place]
a. [ʃ]		*!			*
b.  [s]					*
c. [θ]	*!				
d. [t]			*!		*

Candidate (a) fatally violates the Minimal Distance constraint, as the input /θ/ is realized as alveopalatal [ʃ]. Candidate (c) incurs a fatal violation of the constraint \*θ. Candidate (d) with a fatal violation of Ident[continuant] is also ruled out. Therefore, candidate (b) realized as the alveolar fricative wins out.

Target /s/ before a vowel other than /i/ is realized target-appropriately, whereas the same target before /i/ as palatalized [ʃ] in Japanese-English interlanguage. The tableau for target /s/ before /i/ is given in (15).

- (15) The substitution of [ʃ] for target /s/ before /i/ ‘sing’

	Pal	Ident [cont]	Ident [place]
a. [s]	*!		
b.  [ʃ]			*
c. [t]		*!	

Candidate (a) is out since it incurs a violation of Palatalization. Candidate (c) is also out of consideration because it surfaces as a stop, violating high ranked Ident[continuant]. Thus, candidate (b) emerges as the winner, since it only violates the low-ranked faithfulness constraint Ident[place].

Let us consider the replacement of /θ/ with [s] before /i/. Interestingly, Japanese EFL learners do not show the native language transfer of palatalization when it comes to target /θ/. Rather, they substitute [s] for

target / $\theta$ / in prevocalic position even before /i/. Accordingly, the alveolar [s] emerges rather than a palatalized fricative [ʃ]. This is different from the case of target /s/ before /i/ because target /s/ before /i/ becomes the palatalized [ʃ], as shown in (15). In order to rule out a candidate with a palatalized place feature, the constraint of Palatalization should be ranked below the constraint of Minimal Distance, as given in (16).

(16) The substitution of [s] for target / $\theta$ / before /i/ ‘thing’

	* $\theta$	Ident [cont]	Min Dis	Pal	Ident [place]
a. [ʃ]			*!		*
b. $\text{[s]}$				*	*
c. [ $\theta$ ]	*!				
d. [t]		*!			*

Candidates (c) and (d) are out due to the violation of the constraint \* $\theta$  and Ident[continuant], respectively. While candidate (a) violates the constraint Minimal Distance, candidate (b) violates the constraint Palatalization. Since Minimal Distance outranks Palatalization, it is candidate (b) that is the winner. The replacement of /s/ for target / $\theta$ / before a vowel other than /i/ can be handled with the same constraint ranking, as the optimal form [s] only violates the low-ranked Ident[place].

The following ranking is thus proposed for the transparent case of sound substitutions of English coronal fricatives by Japanese EFL learners.

(17) Ranking for the Japanese case: \* $\theta$ , Ident[continuant], Minimal Distance >> Palatalization >> Ident[place]

The ranking in (17) can account for target-appropriate realizations of the palatal fricative /ʃ/ in prevocalic position including /i/ by Japanese EFL learners because the surface form [ʃ] does not violate any of the relevant constraints. In the next subsection the sound substitution patterns of English coronal fricatives that show opacity by Korean EFL learners are analyzed

#### 4.2 A Sympathy Account of the Opaque Case in Korean

The English alveolar fricative /s/ is realized not as the lax (or plain) alveolar fricative [s] but as the tense alveolar fricative [s'] by Korean EFL learners. It is well-known that most Korean EFL learners substitute the tense alveolar fricative [s'] for the English alveolar fricative /s/ in prevocalic position, but they produce the lax alveolar fricative [s] for /s/ in clusters, as given in (18) (Kim, 1999:13).

- (18) Loanwords sourced with English /s/: Corresponding Korean fricatives
- |                                  |            |
|----------------------------------|------------|
| a. slump, smog, snack, skate     | Lax /s/    |
| b. salary, ceramic, single, size | Tense /s'/ |
| c. test, toast, postcard, disk   | Lax /s/    |

Specifically, Kim (1999) contends that Korean speakers appear to pick up on a phonetic aspect of English /s/ that the frication duration of [s] in a cluster is notably shorter (123 ms to 145 ms) than that of [s] occurring independently (145 ms to 162 ms). She further maintains that speakers of Korean may detect this difference and use it as a category-differentiating cue because Korean tense /s'/ is of longer duration than its lax counterpart /s/ and thus English /s/ is rendered as tense [s'] in Korean in prevocalic position whereas it is realized as lax [s] in a cluster (cf. Kim, 1986; Oh and Johnson, 1997; Choi and Jun, 1998).<sup>3</sup>

Based on the above facts, we propose the following markedness constraint for Korean-English interlanguage.

- (19) \*sV: Lax alveolar fricative /s/ cannot occur in prevocalic position.<sup>4</sup>

Then, the substitution of target /s/ with [s'] occurs because the markedness constraint of \*sV is undominated in Korean-English Interlanguage.

The satisfaction of the constraint \*sV leads to a violation of Ident[tense] that requires the same values for the feature [tense] between input and output. Then, the ranking proposed for the Japanese case should be revised in the following way to account for the Korean case.

- (20) Tentative ranking for the Korean case: \*sV, \*θ, Ident[continuant],  
Minimal Distance >> Palatalization >> Ident[place]>> Ident[tense]

With this ranking, let us consider the replacement of [s'] for target /s/ in prevocalic position.

<sup>3</sup> According to Choi and Jun (1998), Korean tense consonants are much longer than their lax counterparts and a vowel is shorter in length before tense consonants than before lax.

<sup>4</sup> Tense /s'/ also occurs in the words like *bus*, *gas*, *peace*, *news*, etc., as /s/ is produced with the inserted vowel /i/ in syllable final position.

(21) [s'] for target /s/ before a vowel other than /i/ 'son'

	* $\theta$	*sV	Ident [cont]	Min Dis	Pal	Ident [place]	Ident [tense]
a. [ʃ]						*!	
b. [s]		*!					
c. $\mathcal{O}$ [s']							*
d. [ʃ']						*!	*
e. [ $\theta$ ]	*!					*	
f. [t]			*!				
g. [t']			*!				*

Candidates (a) and (d) violate Ident[place], which is fatal, while candidate (b) violates the markedness constraint \*sV, as /s/ is not realized as tense before a vowel. Candidate (e) incurs a fatal violation of the markedness constraint \* $\theta$ . Candidates (f) and (g) both violate Ident[continuant] due to the change of the input feature value [+continuant] into [-continuant], and thus cannot be the winner. Although candidate (c) violates Ident[tense], the lower ranking of this constraint allows the candidate to be selected as the winner.

The constraints and their ranking above, however, cannot choose the optimal output in the replacement of [ʃ'] for target /s/ before /i/, which involves the counterbleeding rule ordering in the serial rule-based approach.

(22) Classic OT cannot handle the opaque substitution of [ʃ'] for target /s/ before /i/ in Korean 'sing'

	* $\theta$	*sV	Ident [cont]	Min Dis	Pal	Ident [place]	Ident [tense]
a. $\mathcal{O}$ [ʃ] (transparent)						*	
b. [s]		*!			*		
c. [s']					*!		*
d. $\mathcal{O}$ [ʃ'] (opaque)						*	*!
e. [ $\theta$ ]	*!					*	
f. [t]			*!				
g. [t']			*!				*

$\mathcal{O}$ : actual output     $\mathcal{O}$ : wrong output but optimal due to opacity effects

This is because candidate (a) violates only Ident[place], whereas the actual output, candidate (d), violates both Ident[place] and Ident[tense]. Any manipulation of constraint ranking cannot solve the problem within

standard OT, as the real but opaque output involves one more constraint violation than the fake but transparent optimal form.

It has shown that the replacement of [ʃ'] for /s/ before /i/ cannot be analyzed within standard OT. The incapability to select the real surface form in opacity cases has presented a challenge for classic OT and thus results in several modifications within OT. In specific, McCarthy (1999) proposes Sympathy Theory to solve the opacity problem within OT. The gist of Sympathy Theory is to permit candidate-to-candidate faithfulness in addition to the already established faithfulness between input-output, base-reduplicant, output-output and so on. For instance, as shown in the tableau (22) the opaque candidate (d), [ʃ'] is dependent on the intermediate form [s'] with respect to the feature [tense], which would be the form after Substitution but before Palatalization in the serial account. The problem is that candidate (c), [s'] in the tableau, reflects an intermediate form after Substitution that is neither an underlying representation nor a possible surface output. Thus, McCarthy proposes that an opaque candidate like (d) wins because it resembles a failed candidate (c) in terms of the feature [tense] whereas a transparent candidate (a) does not. The failed candidate (c) can be referred to as the sympathetic candidate indicated by the flower symbol  $\otimes$ . According to McCarthy, the sympathetic candidate is the one that obeys a designated input-output faithfulness constraint. The designated faithfulness constraint is called the selector and annotated by the mark  $\star$ . In this case the designated faithfulness constraint is Ident[place] because the phonology of the opaque case requires the form before Palatalization, namely the absence of Palatalization in the sympathetic candidate. Candidates (b), (c), (f), and (g) are forms that obey the selector constraint. However, only candidate (c) is the sympathetic flower candidate because it best satisfies the rest of the constraint system.

Since the actual but opaque output (d) in the tableau (22) resembles the feature [tense] of the sympathetic candidate (c), the sympathy constraint is  $\otimes$ Ident[tense], indicated by the same flower symbol used for the sympathetic candidate. It is the sympathy constraint that selects the opaque candidate as the winner by evaluating inter-candidate faithfulness. The sympathy constraint  $\otimes$ Ident[tense] would be obeyed by the opaque candidate (d) but violated by the transparent candidate (a). For the sympathy constraint to select the opaque candidate as the winner and to eliminate the transparent candidate it has to be ranked higher than the conventional faithfulness constraints Ident[place] and Ident[tense]. That is, it is more important to be faithful to the feature [tense] of the flower candidate than it is to comply with the faithfulness constraints. The following summarizes the sympathy analysis proposed.

#### (23) Sympathy analysis

Designated faithfulness constraint:  $\star$ Ident[place]

Sympathy constraint:  $\otimes$ Ident[tense]

An output correspondent of the sympathetic consonant has the same feature for [tense].

Rankings: \* $\theta$ , \*sV, Ident[continuant], Minimal Distance >> Palatalization,  $\odot$ Ident[tense] >>  $\star$ Ident[place], Ident[tense]

With these rankings, let us consider the opaque case of [ʃ'] below.

(24) Sympathy account of [ʃ'] for target /s/ before /i/ 'sing'

	* $\theta$	*sV	Ident [cont]	Min Dis	Pal	$\odot$ Ident [tense]	$\star$ Ident [place]	Ident [tense]
a. [ʃ]						*!	*	
b. [s]		*!			*	*		
c. $\odot$ [s']					*!			*
d. $\odot$ [ʃ']							*	*
e. [ $\theta$ ]	*!					*	*	
f. [t]			*!			*		
g. [t']			*!					*

Between the candidates (a) and (d) it is the candidate (a) that violates the sympathy constraint  $\odot$  Ident[tense] due to the lack of the tense feature correspondence with the sympathetic flower candidate. By contrast, candidate (d) with the tense feature obeys the sympathy constraint, although it incurs two violations of the faithfulness constraints  $\star$  Ident[place] and Ident[tense]. Therefore, the sympathy account in which the sympathy constraint outranks the conventional faithfulness constraints correctly selects candidate (d) as the winner.

The replacement of [s'] for /s/ in prevocalic position other than /i/ can also be accounted for with the same constraint ranking proposed in (23).

(25) [s'] for target /s/ before a vowel other than /i/ 'son'


	* $\theta$	*sV	Ident [cont]	Min Dis	Pal	$\odot$ Ident [tense]	$\star$ Ident [place]	Ident [tense]
a. [ʃ]						*!	*	
b. [s]		*!				*		
c. $\odot$ [s']								*
d. [ʃ']							*	*!
e. [ $\theta$ ]	*!					*	*	
f. [t]			*!			*		
g. [t']			*!					*

Candidate (c) is the sympathetic flower candidate like the case of [ʃ'] substitution for target /s/ before /i/. Along the same lines with the [ʃ']


substitution case, candidates (b), (e), (f), and (g) are out due to the violations of the undominated constraints. Candidate (a) loses out because it incurs a violation of the sympathy constraint as well as the faithfulness constraint  $\star\text{Ident}[\text{place}]$ . Differently from the [ʃ] substitution case, candidate (c), which is the sympathetic candidate at the same time, is not ruled out because the violation of the constraint Palatalization cannot be counted in the context other than /i/. Thus, it only incurs a violation of the faithfulness constraint  $\text{Ident}[\text{tense}]$ . On the other hand, candidate (d) incurs two violations of the faithfulness constraints  $\star\text{Ident}[\text{place}]$  and  $\text{Ident}[\text{tense}]$ . Consequently, candidate (c) emerges as the optimal output.

Now let us consider the substitution of [s'] for target /ə/ in prevocalic position.

(26) The substitution of [s'] for target /ə/ 'thousand'

	*ə	*sV	Ident [cont]	Min Dis	Pal	⊗Ident [tense]	★Ident [place]	Ident [tense]
a. [ʃ]				*!			*	
b. [s]		*!					*	
c.  [s']						*	*	*
d. [ʃ']				*!		*	*	*
e. ⊗[ə]	*!							
f. [t]			*!				*	
g. [t']			*!			*	*	*

(27) The substitution of [s'] for target /ə/ before /i/ 'thing'

	*ə	*sV	Ident [cont]	Min Dis	Pal	⊗Ident [tense]	★Ident [place]	Ident [tense]
a. [ʃ]				*!			*	
b. [s]		*!			*		*	
c.  [s']					*	*	*	*
d. [ʃ']				*!		*	*	*
e. ⊗[ə]	*!							
f. [t]			*!				*	
g. [t']			*!			*	*	*

In this case the sympathetic flower candidate is candidate (e) in both tableau (26) and (27) because it is the only candidate that does not militate against the designated faithfulness constraint, the selector  $\star\text{Ident}[\text{place}]$ . In both tableaux the winner is candidate (c) in spite of violating the sympathetic constraint  $\otimes\text{Ident}[\text{tense}]$  because all other candidates violate the undominated constraints.

The sympathy ranking in (23) also correctly accounts for target-

appropriate productions for /ʃ/ in prevocalic position.

(28) Appropriate production for target /ʃ/ ‘shirt’

	* $\Theta$	*sV	Ident [cont]	Min Dis	Pal	⊗Ident [tense]	★Ident [place]	Ident [tense]
a. $\text{☞} \otimes [\text{ʃ}]$								
b. [s]		*!					*	
c. [sʰ]						*	*!	*
d. [ʃʰ]						*!		*
e. [ $\Theta$ ]	*!						*	
f. [t]			*!				*	
g. [tʰ]			*!			*	*	*

(29) Appropriate production for target /ʃ/ before /i/ ‘sheet’

	* $\Theta$	*sV	Ident [cont]	Min Dis	Pal	⊗Ident [tense]	★Ident [place]	Ident [tense]
a. $\text{☞} \otimes [\text{ʃ}]$								
b. [s]		*!			*		*	
c. [sʰ]					*!	*	*	*
d. [ʃʰ]						*!		*
e. [ $\Theta$ ]	*!						*	
f. [t]			*!				*	
g. [tʰ]			*!			*	*	*

The sympathetic candidate is candidate (a) in both tableaux because it not only complies with the designated faithfulness constraint but also becomes more harmonious than candidate (d) does. In the evaluation of the whole ranking the sympathetic candidate (a) is also the winner since it does not involve any constraint violation. In sum, the sympathy analysis proposed for the opaque substitution of [ʃʰ] for target /s/ before /i/ in Korean-English interlanguage can account for all the substitution patterns.

### 4.3 Language Variation

Assuming that constraints are universal, the same constraints that adopted in Korean-English Interlanguage should be also adopted in Japanese-English interlanguage. Then, the only difference between the cases of Japanese and Korean would be constraint rankings. In specific, the constraint ranking proposed for the Korean case where the sympathetic constraint ⊗Ident[tense] is high ranked due to opacity effect cannot select the transparently occurring [ʃ] in Japanese case. Thus, the sympathetic



constraint should be ranked low so as not to show any opacity in Japanese case. Also the markedness constraint \*sV that is undominated in Korean should be ranked low because there are no tense consonants in the Japanese inventory.

- (30) \* $\Theta$ , Ident[continuant], Minimal Distance >> Palatalization >> ★  
Ident[place], Ident[tense] >> \*Ident[tense], \*sV

With this ranking, let us consider the transparent case of [ʃ] for target /s/ before /i/ in Japanese case.

- (31) Sympathy account also can handle the transparent substitution of [ʃ] for target /s/ before /i/ in the Japanese case ‘sheet’

	* $\Theta$	Ident [cont]	Min Dis	Pal	★Ident [place]	Ident [tense]	*Ident [tense]	*sV
a. $\text{[ʃ]}$					*			
b. $\text{[s]}$				*!				*
c. $\text{[s']}$				*!		*	*	
d. $\text{[ʃ']}$					*	*!	*	
e. $\text{[}\Theta\text{]}$	*!				*			
f. $\text{[t]}$		*!						
g. $\text{[t']}$		*!				*	*	

Along the same lines with the Korean opaque case, the sympathetic flower candidate could be candidates (b), (c), (f), and (g) because they comply with the selector, the designated faithfulness constraint ★Ident[place]. However, it is candidate (b) identified as the sympathetic candidate since it is a more harmonious candidate in that it better satisfies the constraint rankings among candidates (b), (c), (f), and (g). In the evaluation of all candidates in the tableau, candidate (e) is eliminated by the high ranked constraint \* $\Theta$ . Candidates (f) and (g) are out due to the constraint Ident[continuant]. Candidates (b) and (c) incur a fatal violation of the constraint of Palatalization. The competition is thus between the two candidates (a) and (d). Candidate (d) with a palatalized tense form further violates the faithfulness constraints ★Ident[place] and Ident[tense] as well as the lower ranked sympathetic constraint \*Ident[tense]. By contrast, candidate (a) becomes the winner because it only violates Ident[place].

Next, let us consider the target-appropriate realization of /s/ in prevocalic position other than /i/ in Japanese case.

(32) Sympathy account also can handle the target-appropriate realization of /s/ before a vowel other than /i/ ‘sank’

	* $\theta$	Ident [cont]	Min Dis	Pal	★Ident [place]	Ident [tense]	⊗Ident [tense]	*sV
a. [ʃ]					*!			
b. ⊗ $\theta$ [s]								*
c. [sʰ]						*!	*	
d. [ʃʰ]					*	*!	*	
e. [ $\theta$ ]	*!				*			
f. [t]		*!						
g. [tʰ]		*!				*	*	

Candidate (b) is the sympathetic flower candidate because it complies with the selector, the designated faithfulness constraint ★Ident[place] and it better satisfies the rest of the constraint rankings than other candidates that obey the selector constraint do. In evaluation candidate (e) is eliminated because of violating the constraint \* $\theta$ . Candidates (f) and (g) are out due to the constraint Ident[continuant]. Candidate (d) loses out because it violates both of the faithfulness constraints Ident[place] and Ident[tense]. Candidates (a) and (c) each incur one violation of Ident[place] and Ident[tense], and thus are ruled out. Therefore, candidate (b) wins out because it only violates the lower ranked constraint of \*sV.

Now let us consider whether other substitution patterns in the Japanese case can be handled with the same ranking proposed. In the substitution of [s] for target / $\theta$ /, which can be referred in (16), all empirically incorrect candidates are ruled out by the undominated constraints \* $\theta$ , Ident[continuant], and Minimal Distance. Consequently, the ranking change of the sympathetic constraint ⊗Ident[tense] from high to low does not really matter in this case. Likewise, in the target-appropriate realization of [ʃ] for target /s/ the ranking change of the sympathetic constraint does not affect the selection of the optimal output because the winner [ʃ] is the most faithful candidate and does not violate any constraint given.

Recall that only Korean case exhibits the opacity effect associated with the palatalized tense [ʃʰ] in the substitution pattern of target /s/ before /i/. The unexpected substitution of palatalized tense [ʃʰ] is attributed to the high ranking of the candidate-to-candidate faithfulness dubbed the sympathy constraint ⊗Ident[tense]. By contrast, no opacity effect in Japanese case where palatalized [ʃ] surfaces is attributed to the low ranking of the sympathy constraint as well as \*sV, as shown below.

(33) Language variation in rankings

- a. Constraint ranking in Japanese case without opacity: \* $\theta$ ,  
Ident[continuant], Minimal Distance >> Palatalization >> ★

- Ident[place], Ident[tense]>> ⊗Ident[tense], \*sV  
 b. Constraint ranking in Korean case with opacity: \*θ, \*sV,  
 Ident[continuant], Minimal Distance >> Palatalization,  
 ⊗Ident[tense] >> ★Ident[place], Ident[tense]

## 5. Summary and Conclusion

It has been shown that English coronal fricatives are frequently replaced by the sound that is the most similar in a native language. Thus, Japanese learners produce [s] for target /s/ in prevocalic position, while Korean learners produce [s'] for the same target. Similarly, target /s/ before /i/ is substituted with [ʃ] by Japanese learners whereas with [ʃ'] by Korean learners, which is due to the native language transfer effect of palatalization. The substitution of [ʃ'] for target /s/ by Korean learners is considered opaque because of the unexpected tense feature. Also, target /θ/ is replaced with [s] in the case of Japanese learners and with [s'] in the case of Korean learners. It has been shown that Sympathy Theory developed by McCarthy (1999) is able to handle the opaque case by Korean learners, equivalent of counterbleeding rule interaction in a rule-based theory, as well as the transparent case by Japanese learners.

## REFERENCES

- CHOI, S. and J. JUN. 1998. Are Korean fortis and aspirated consonants geminates?. *Language Research* 34-3, 521-546.  
 DINNSEN, D. A. and J. A. BARLOW. 1998. On the characterization of a chain shift in normal and delayed phonological acquisition. *Journal of Child Language* 25, 61-94.  
 ECKMAN, F. and G. IVERSON. 1999. Learnability in L2 pronunciation: splitting NL allophones into TL phonemes. In Peter Robinson (Eds.), *Representation and Process: Proceedings from the Third Pacific Second Language Research Forum*, 175-190. Tokyo: Aoyama Gakuin University.  
 ELLIS, R. 1994. *The study of second language acquisition*. Oxford University Press.  
 IOUP, G. and S. WEINBERGER. 1987. *Interlanguage phonology*. Newbury House, Cambridge, MA.  
 IVERSON, G. 1998. Some roles of phonology in second language acquisition. Paper presented at Hoseo Phonology Workshop.  
 JOH, J. and S. LEE. Re-examination of the role of formal instruction in L2 pronunciation. to appear in *Foreign Languages Education* 8-2(2001).  
 KIM, S. 1999. *Subphonemic duration difference in English /s/ and few-to-many borrowing from English to Korean*. Ph.D. Dissertation. University of Washington.

- KIM-RENAUD, Y. 1992. *Studies in Korean linguistics*. Hanshin Publishing Company: Seoul.
- KIPARSKY, P. 1973. Phonological representations. In O. Fujimura (Eds.), *Three Dimensions of Linguistic Theory*, pp. 93-106. Tokyo: Taikusha.
- LOMBARDI, L. 2000. Second language data and constraints on Manner: explaining substitutions for the English interdental. ROA # 418.
- MCCARTHY, J. 1999. Sympathy and phonological opacity. *Phonology* 16, 331-399.
- MCCARTHY, J. and PRINCE, A. 1995. Faithfulness and reduplicative identity. In J. Beckman, L. Dickey, and S. Urbanczyk (Eds.), *University of Massachusetts Occasional Papers 18: Papers in Optimality Theory*, 249-384. Amherst, MA: GLSA, University of Massachusetts.
- OH, M and K. JOHNSON. 1997. A phonetic study of Korean intervocalic laryngeal consonants. *Phonetic Science* 1, 83-100.
- PRINCE, A. and P. SMOLENSKY. 1993. Optimality theory. MS. Rutgers University and University of Colorado.
- SHIN, J. 1998. A spacio-temporal study of Korean affricates. *Proceedings of Acoustical Society of Korea* 17, 375-378.
- SMOLENSKY, P. 1995. On the internal structure of the constraint component of UG. ROA 86.
- WEINBERGER, S. 1990. Minimal segments in L2 phonology. In J. Leather and A. James (Eds.), *New Sounds 90: Proceedings of the Amsterdam Symposium under Acquisition of Second Language Speech*, 137-179. Amsterdam: University of Amsterdam.

Mi-Hui Cho  
Division of English Language and Literature  
Pukyong National University  
599-1 Nam-Gu Daeyeon3-Dong  
Pusan, 608-737, Korea  
Fax: +82-51-628-2791  
Tel: 051-620-6620  
e-mail: mhcho@pknu.ac.kr

Shinsook Lee  
Department of English Language and Literature  
College of Humanities, Hoseo University  
San 120-1 Anseodong  
Cheonan, Choongnam 330-180  
Fax: +82-41-560-8175  
Tel: 041-560-8175  
e-mail: leess@office.hoseo.ac.kr