Sound replacement in the acquisition of English consonant clusters: a constraint-based approach

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Lee, Shinsook, and Mi-Hui Cho. 2002. Sound replacement in the acquisition of English consonant clusters: a constraint-based approach. *Studies in Phonetics, Phonology and Morphology.* 8.2. 255-271. This paper investigates Korean EFL learners' production errors involving sound replacement in the acquisition of English consonant clusters. Specifically, this paper shows that the predominant replacement errors with the laviodental fricative /f/, the interdental /ɵ/, and the alveopalatal /ʃ/ in the acquisition of English consonant clusters (e.g. *flat* [plæt]*, three* [s'ri], *scarf* [skarp], *month* [mʌns], *shrimp* [s'rɪmp]) can be accounted for by the interaction between markedness constraints such as *f and *ɵ, and faithfulness constraints within a constraint-based theory. The paper also considers complex error patterns involving sound substitution and vowel epenthesis or consonant deletion (e.g. *shrimp* [s'irɪmp], *shrub* [s'ʌb]) and shows that these patterns can be accounted for by the alternating ranking among Max(segment), Dep(segment) and *Complex. In addition, the substitution of [s'] for /ʃ/ in the acquisition of /ʃr/ sequence and the realization of [t'] for target /ɵ/ in case of /ɵr/ sequence are shown to demonstrate cases of the emergence of the unmarked; otherwise low-ranked markedness constraints on place and manner play a crucial role in the selection of the optimal output. (**Hoseo University and Pukyong National University)**

Key words: sound replacement, combinatory errors, consonant clusters, markedness and faithfulness constraints, the emergence of the unmarked

1. Introduction

Sound replacement is one of the most commonly used strategies both in first and second language acquisition. According to Stoel-Gammon and Dunn (1985), and Dinnsen (1999), many children who acquire English as their first language frequently show replacement errors (e.g. *juice* [dus], *shoe* [tu], *read* [wid]. *leg* [wɛg]). Similarly, many second language learners of English tend to substitute a target sound with the native language sound which is similar to the target sound (cf. Jenkins, 2000). For instance, Weinberger (1990) and Lombardi (2000) report that many Japanese and Russian speakers of English have a tendency to produce [s] and [t], respectively, for the English interdental fricative /ɵ/ (e.g. *thing* [siŋ], *thank* [sæŋk] (Japanese speakers), [tiŋ], [tæŋk] (Russian speakers)). Korean speakers of English also show replacement errors, especially when the target sound is not present in their native language (e.g. *fine* [paɪn], *three* [s'ri]). Moreover, complex error patterns involving sound replacement and vowel epenthesis or consonant deletion also occur in the acquisition of the target system. For instance, as many children learning English as their first

language often produce the target word *light* as [waɪ], Korean EFL learners sometimes produce English words like *wolf* as [wʊlpɨ].

Recently, some researchers like Eckman and Iverson (1999), and Cho and Lee (2001) examine Korean EFL learners' sound substitution errors, yet their research is limited in that they only deal with English coronal fricatives, but not other sounds. Moreover, there has been no experimental study on Korean EFL learners' replacement error patterns of English consonant clusters. Furthermore, although there have been some studies on single error patterns such as insertion and sound substitution, complex error patterns involving sound replacement have not been deserved much attention in the language acquisition literature.

The purpose of this paper is, thus, to investigate sound replacement errors in the acquisition of English consonant clusters by Korean speakers of English. Specifically, this paper will show that the predominant replacement errors involving the laviodental fricative /f/, the interdental /ɵ/, and the alveopalatal /ʃ/ in the acquisition of English consonant clusters can be accounted for by the interaction between markedness and faithfulness constraints within a constraint-based theory developed by MaCarthy and Prince (1995). The paper will also consider complex error patterns with replacement and show that these patterns can be explained by the alternating ranking among Max(segment), Dep(segment) and *Complex. In addition, the paper will examine other emerging substitution errors in the acquisition of /ʃr/ and /ɵr/ sequences, which demonstrate the emergence of the unmarked.

The paper is structured as follows: Section 2 briefly reviews second/foreign language literature on sound substitution errors. Section 3 conducts a case study on the acquisition of English consonant clusters by Korean EFL learners. Section 4 offers a constraint-based analysis of Korean EFL learners' error patterns involving replacement. Section 5 concludes the paper with a brief summary.

2. Literature review on second/foreign language phonology: sound substitution

Much research in second language acquisition has focused on negative language transfer and universal factors in accounting for production errors made by second language learners. For instance, according to Weinreich (1953), and Lado (1957), all substitutions are due to the absence of a particular sound in the speaker's native language, as the second language learner ought to select the native language sound which closely approximates the novel sound in the target language. In specific, Weinreich analyzes various substitution errors at the phonic level, and Lado also investigates all substitution errors in terms of native language transfer.

Yet, not all errors can be attributed to native language transfer. For example, Nemser (1971) observes that some Hungarian speakers of English

produce [sɵ] for the English /ɵ/, which is neither English nor Hungarian. This and similar nontransfer substitutions cannot be regarded as resulting from native language transfer and thus they are called universal or developmental variants, because they are similar to what often occurs in the course of native language acquisition. Moreover, transfer cannot explain the types of substitutions that occur. Specifically, Weinberger (1990) argues that the contrastive analysis espoused by Weinreich (1953), and Lado (1957) is not able to account for the different substitution errors made by Japanese and Russian speakers of English in the acquisition of English interdental fricatives /ɵ/ and /ð/. That is, Japanese speakers of English substitute [s] and [z] for English /ɵ/ and /ð/, respectively, whereas Russian speakers of English replace [t] and [d] for target sounds. (e.g. *thing* [siŋ], *them* [zɛm] (Japanese speakers), [tiŋ], [dɛm] (Russian speakers)). Thus, Weinberger adopts underspecification theory and claims that Japanese speakers' error type results from the fact that /s/ and /z/ are the least marked segments in Japanese, while Russian speakers' error type is due to the fact that /t/ and /d/ are the least marked segments in Russian.

Recently, however, researchers like Major (1994), and Hanchin-Bhatt and Bhatt (1997) investigate the interaction between language transfer and universal developmental factors, and claim that both transfer and universal factors affect the construction of second language phonology. In particular, Hanchin-Bhatt and Bhatt analyze the production of English clusters by Japanese and Spanish speakers of English within Optimality Theory (Prince and Smolensky 1993 and McCarthy and Prince 1995), arguing that Optimality Theory better suits with language variation than any other theory.

Similarly, Lombardi (2000) opts for Optimality Theory in analyzing the substitution patterns of English interdentals by Japanese and Russian speakers of English. In specific, Lombardi argues that the theory of underspecification is much controversial and that Weinberger's account does not explain how the learner can arrive at the correct underspecified representations. She also rejects a rule-based approach, claiming that it is impossible for the speaker as a child to have acquired a rule which changes the interdentals to native sounds, as there are no interdentals in the speaker's native language, and thus there are no L1 data on which such a rule can be based.

So far, we have briefly reviewed some studies on second/foreign language phonology, focusing on sound substitution. Although, the studies examined addressed important issues concerning sound replacement, few studies have investigated combinatory error types involving replacement which can occur in the course of second language acquisition, along with sound substitution. Moreover, although Lombardi tries to analyze the substitution patterns within Optimality Theory, her analysis is limited in that it only considers the substitutions of English interdentals, but not other sounds. Likewise, Hanchin-Bhatt and Bhatt (1997)'s constraint-based analysis

of Japanese and Spanish EFL learners' English clusters only examines vowel insertion and consonant deletion, but not sound substitution. Thus, in the present study we investigate both sound substitution and a hybrid form of errors with sound substitution, which emerge in the production of English clusters by Korean EFL learners, and offer a constraint-based analysis of these errors.

3. A case study

3.1 Subjects

The subjects were 60 Korean learners of English and they were from the college of social sciences and the college of humanities. They were all enrolled in a required English listening class for freshmen and could be classified as intermediate level learners of English, as they had been learning English for 7 years. All of them had been taught by Korean teachers of English except at college and had never had any training on pronunciation by native speakers of English.

3.2 Materials

In order to measure the subjects' pronunciation of English voiceless clusters in both word-initial and word-final positions, a total of 118 sentences were used: 40 sentences beginning with and 78 sentences ending with all types of clusters that could occur at each position were examined. In specific, sound sequences consisting of obstruent plus obstruent, and obstruent plus sonorant were tested in word-initial position, and sound sequences consisting of obstruent plus obstruent, sonorant plus obstruent, and sonorant plus sonorant were tested in word-final position. All the clusters were further subdivided depending on the place and manner of articulation in order to see whether segmental sound properties were important factors in accounting for the acquisition of clusters. (See Appendix.) The present study used sentences instead of word lists so as to elicit the subjects' natural pronunciation without letting them notice their pronunciation was being tested. Moreover, the words containing all the clusters tested were carefully selected in such a way as to make each sound occur before both front and back vowels, and to minimize the influence of orthography, which can affect the results of any study using the reading of materials.

3.3 Procedure

For the production test, each subject was interviewed individually and was asked to read the given sentence list clearly with a pause about three seconds between sentences so that sentence-final clusters may not be affected by the sounds of the following sentences.

The subjects' readings were tape-recorded using a high-quality MD recorder and narrow transcribed only for the target sounds under investigation by three trained linguists and a native American speaker who also had training on phonetic transcription. The transcribers judged each subject's pronunciation independently of one another and wrote down the result on the work sheet for the individual subject. The transcribers cross-checked the result each time the transcription of a subject's production of the target clusters was finished. In the cases in which there was disagreement among the transcriptions it was resolved through repeated listening to the items in question and discussion. The inter-rater reliability was about 90%.

3.4 Results

The result of the experiment showed that the replacement error was the most predominant, taking up 11.2%, even though other error types such as deletion, insertion, and a hybrid form of errors were also observed. Moreover, replacement was the most predominant error type regardless of position: word-initial replacement error rate was 11.1% and that of word-final was 11.3%. In specific, replacement error occurred saliently when a target cluster contained either /f/ or /ɵ/ (e.g. *flat* [plæt], *three* [s'ri], *scarf* [skarp], *month* [mʌns]), yet replacement of the interdental fricative occurred more frequently than that of the labiodental fricative.[1] Other replacement types were also observed. For instance, the alveopalatal fricative /ʃ/ was often produced as the tense alveolar fricative [s'] or the lax [s] (e.g. *shrimp* [s'rɪmp])[2], and word finally, /ŋɵ/ was produced as [ns] (e.g. *length* [lɛns]) in some cases.

The combinatory error type took up 2.9% and the most common combinatory types were composed of insertion plus replacement and deletion plus replacement. In specific, in word-initial consonant sequences, the type of insertion plus replacement or that of deletion plus replacement prevailed (e.g. *shrimp* [s'ɨrɪmp], [s'ɪmp]), but in word-final sequences, the pattern of insertion plus replacement was the most predominant (e.g. *triumph* [traɪʌmpɨ], *north* [nɔ:rs'ɨ]). Some representative data of sound replacement and a combinatory error type involving replacement are given in (1).

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[1] This result confirms the observations made by researchers like Major and Faudree (1996), and Lombardi (2000), which claim that interdental fricatives are one of the most difficult sounds to acquire in second language acquisition.

[2] Some subjects produced words like *shrimp* as [srɪmp], in which the alveopalatal fricative /ʃ/ was replaced by the lax alveolar fricative [s].

(1) Data[3]

a. Subject 6 (Subject is identified by number.)

(i) target cluster with /f/

[pl]at	'flat'	[pl]our	'flour'
[pr]ightened	'frightened'	[pr]eeze	'freeze'
[sp]ere	'sphere'	[sp]ynx	'sphynx'
triu[mp]	'triumph'	ny[mp]	'nymph'
sca[rp]	'scarf'	so[pt]	'soft'

(ii) target cluster with /ɵ/[4]

[s'r]ee	'three'	wea[ls]	'wealth'
hea[ls]	'health'	wo[rs]	'worth'
mo[ns]	'month'	seve[ns]	'seventh'
stre[ŋs]	'strength'	le[ŋs]	'length'

(iii) target cluster with /ʃ/

[s'ɨr]imp	'shrimp'	[s']ubs	'shrubs'

b. Subject 38

(i) target cluster with /f/

[pr]ightened	'frightened'	[sp]ere	'sphere'
[sp]ynx	'sphynx'	li[pt]	'lift'
so[pt]	'soft'	wo[lp]	'wolf'
yourse[lp]	'yourself'	triu[mp]	'triumph'
ny[mp]	'nymph'	ba[rp]	'barf'
sca[rp]	'scarf'		

(ii) target cluster with /ɵ/

[s'r]ee	'three'	[s'r]ough	'through'
mo[ns]	'month'	seve[ns]	'seventh'
stre[ŋs]	'strength'	le[ŋs]	'length'
wea[ls]	'wealth'	hea[ls]	'health'
wo[rs]	'worth'	no[rs]	'north'

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[3] English has both double and triple consonant clusters (e.g. *street, spring*, etc.). Because of English phonotactics, however, three consonant clusters seldom have /f/, /ɵ/, or /ʃ/ as their member, even though predominant replacement errors occur when the cluster has one of these fricative sounds. That is, replacement errors are observed in only few cases with respect to three consonant clusters. Thus, we will focus only on double consonant clusters in this paper. Also, replaced voiceless stops were usually aspirated (e.g. *flat* [pʰlæt], *triumph* [tʰraɪʌmpʰɨ]), even though word-final voiceless stops were unreleased in some cases (e.g. *scarf* [skarp̄]). Yet, in this paper we will not provide phonetic details concerning aspiration, as aspiration itself is not a main focus of the paper.

[4] According to Kim (1999), and Cho and Lee (2001), the English target /s/ is tensified before a vowel in Korean-English interlanguage. In fact, their argument is supported by the examples such as *shrimp* (cf. (1aiii), [s'ɨrɪmp]), in which /ʃ/ is produced as [s'] before the inserted vowel /ɨ/. Yet, words like *three* and *through*, where target /ɵ/ is realized as [s'], also show that [s] is tensified even before the consonant /r/. However, /r/ is the most sonorous consonant like vowels, and thus it is not uncommon that [s] is realized as tensed [s'] before /r/.

c. Other patterns
(i) target cluster with /ɵ/
[t'ɨr]ee 'three'
[t'ɨr]ough 'through' (Subject 37)
(ii) target cluster of /ŋɵ/
stre[ns] 'strength'
le[ns] 'length' (Subject45)

As the data above show, Subject 6's and Subject 38's replacement errors mostly occurred when a target cluster consists of either /f/ or /ɵ/. Yet, there was a lexical diffusion among subjects, as Subject 38 produced words like *flat* and *flour* target-appropriately, whereas Subject 6 did not. Subject 6 also made combinatory errors in the acquisition of the /ʃr/ sequence. Further, the realization of target clusters, especially /ɵr/ and /ŋɵ/, varied depending on subjects (cf. (1c)). In addition, there was a lexical diffusion even within the same subjects (Subject 6: *north* [nɔ:rɵ], but *worth* [wɔ:rs]). These facts seem to suggest that the acquisition of sound systems does not occur in the across-the-board fashion. That is, stages of language acquisition may vary depending on subjects and lexical items within the same subjects. In what follows, we provide an analysis of these phenomena within a correspondence-theoretic framework.

4. A constraint-based analysis

In the acquisition of English consonant clusters, Korean EFL learners generally replace the English laviodental and interdental fricatives /f/ and /ɵ/ with the bilabial stop [p] and the alveolar fricative [s] (or [s']), respectively, since /f/ and /ɵ/ are not in the phonemic inventory of the Korean language. Thus, the high ranking of the markedness constraints *f and *ɵ which ban the occurrence of the laviodental fricative /f/ and the interdental fricative /ɵ/ is motivated.[5] These constraints seem to be undominated, as any candidate with the violation of these constraints is ruled out. The replacement of /f/ with [p] leads to a violation of the relevant antagonistic faithfulness constraints Ident[continuant] and Ident [place], as the surface form [p] differs from /f/ in terms of continuancy and articulation place. Yet, the realization of [s] for /ɵ/ leads to a violation of Ident[place] but not of Ident[continuant].

[5] An anonymous reviewer suggests that the Structure Preservation Principle should shift non-existing sounds in Korean on output, instead of individual markedness constraints such as *f. However, learnability problems concerning particular sounds are generally handled in terms of markedness constraints specific to the sounds within Optimality Theory (cf. Lombardi, 2000). Thus, we will use markedness constraints, given in (2), rather than the Structure Preservation Principle.

(2) a. *f: Avoid the laviodental fricative /f/.
b. *ɵ: Avoid the interdental fricative /ɵ/.

(3) a. Ident[cont]: Correspondent segments in the input and output have identical values for the feature [continuant].
b. Ident[place]: Correspondent segments in the input and output have identical values for the feature [place].

The realization of English clusters by Korean speakers of English shows that *Complex, which prohibits the occurrence of clusters in their native language, is relatively low-ranked in Korean-English interlanguage. However, when the *Complex constraint is high-ranked, vowel epenthesis or consonant deletion occurs along with replacement, as shown in combinatory error types such as *triumph* [traɪʌmpɨ] and *shrimp* [s'ɪmp]. This results in a violation of the relevant antagonistic faithfulness constraints Dep(segment) or Max(segment), in addition to markedness constraints.

(4) *Complex: No onset or coda clusters are allowed.

(5) a. Max(segment): Every segment of the input has a correspondent in the output. (No phonological deletion.)
b. Dep(segment): Every segment of the output has a correspondent in the input. (No phonological insertion.)

With these constraints, let us first consider the substitution pattern of target clusters with /f/.

(6) The production of [pl] for target /fl/ 'flat'[6]

/flæt/	*f	Max (segment)	Dep (segment)	*Com-plex	Ident [cont]
a. flæt	*!			*	
☞b. plæt				*	*
c. fæt	*!	*			
d. fɨ.læt	*!		*		
e. pɨ.læt			*!		*
f. pæt		*!			*

The tableau in (6) shows that the marked segment /f/ in word-initial cluster is substituted by [p]. In specific, candidates (a), (c), and (d) all fatally violate the undominated constraint *f. Candidate (e) incurs a fatal violation

[6] The motivation for low-ranking of Ident[continuant] will be given below. Also, Ident[place] does not play an active role in the selection of the optimal output, and thus it is included in the tableaux only when it is relevant.

of Dep(segment) in order not to violate *Complex, in addition to the violation of Ident[continuant]. Likewise, candidate (f) fatally violates Max(segment) by deleting input segment. Thus, candidate (b), which does not violate any high-ranked constraints, wins out. From this tableau, we see that the constraints Max(segment) and Dep(segment) outrank *Complex.

(7) The production of [pt] for target /ft/ 'soft'

/sɔft/	*f	Max (segment)	Dep (segment)	*Com-plex	Ident [cont]
a. sɔft	*!			*	
☞ b. sɔpt				*	*
c. sɔ.fɨt	*!		*		
d. sɔf.tɨ	*!		*		
e. sɔt		*!			
f. sɔ.fɨ.tɨ	*!		**		
g. sɔ.pɨt			*!		*

The tableau in (7) demonstrates that the marked segment /f/ in cluster was also replaced with [p] in word-final position. Specifically, candidate (b), where the /ft/ cluster is realized as [pt], emerges as the winner, since its violation of *Complex and Ident[continuant] is not relevant to the selection of the optimal output. In contrast, candidates (a), (c), (d), and (f) are all out of consideration due to a fatal violation of *f. Candidate (e) violates Max(segment) in order not to violate *Complex, which is fatal. Similarly, candidate (g) with an inserted vowel between the cluster fatally violates Dep(segment), and is ruled out.

(8) The production of [mpɨ] for target /mf/ 'triumph'

/traɪʌmf/	*f	Max (segment)	*Com-plex	Dep (segment)	Ident [cont]
a. traɪ.ʌmf	*!		*		
b. traɪ.ʌmp			*!		*
c. traɪ.ʌm.fɨ	*!			*	
☞d. traɪ.ʌm.pɨ				*	*
e. traɪ.ʌm		*!			

In (8) candidates (a) and (c) violate the undominated constraint *f. Candidate (e) violates Max(segment) by deleting the input segment /f/, which is fatal. Candidate (b) with the realization of [mp] for target /mf/ is ruled out, due to its violation of *Complex, which is high-ranked. Consequently, candidate (d), where target /mf/ is realized as [mpɨ], emerges as the winner, despite its violation of Dep(segment) and Ident [continuant].

This seems to indicate that the ranking between Dep (segment) and *Complex can alternate depending on lexical items at the stage of acquisition.

The marked segment /ɵ/ is also avoided regardless of position, as the following tableaux show.

(9) The production of [s'r] for target /ɵr/ 'three'[7]

/ɵri/	*ɵ	Max (segment)	Dep (segment)	*Com-plex	Ident [cont]
a. ɵri	*!			*	
b. ɵɨ.ri	*!		*		
☞c. s'ri				*	
d. s'ɨ.ri			*!		
e. tri				*	*!
f. ɵi	*!	*			

In (9) candidates (a), (b), and (f) are out due to the violation of the undominated constraint *ɵ. Candidate (d) is also out, as it incurs a fatal violation of Dep(segment). The selection is thus narrowed down between candidate (c) and candidate (e). Both candidates violate *Complex, yet candidate (e) incurs another fatal violation of Ident[continuant] because /ɵ/ is realized as [t]. Consequently, candidate (c) wins out.

(10) The production of [ns] for target /nɵ/ 'month'

/mʌnɵ/	*ɵ	Max (segment)	Dep (segment)	*Com-plex	Ident [cont]
a. mʌnɵ	*!			*	
☞b. mʌns				*	
c. mʌn		*!			
d. mʌn.ɵɨ	*!		*		
e. mʌn.s'ɨ			*!		
f. mʌs		*!			

The tableau in (10) illustrates that the marked segment /ɵ/ is replaced by [s]. In specific, candidates (a) and (d) are ruled out due to the violation of *ɵ. Candidates (c) and (f) are also out of consideration due to a fatal

[7] The optimal candidate (c) violates Ident[tense], in order not to violate the high-ranked constraint *sV (cf. Cho and Lee, 2001), which bans lax /s/ in prevocalic position in English-Korean interlanguage (cf. footnote 4). This suggests that Ident[tense] should be low-ranked. However, we will not mention constraints like *sV or Ident[tense] in this paper, as these are not main concern of the paper. Additionally, the production of [s'] for /ɵ/ violates Ident[strident], which has no effect on the outcome, and thus we will omit the constraint for simplicity.

violation of Max(segment). Likewise, candidate (e) is not the winner because of its fatal violation of Dep(segment). Therefore, candidate (b) is the optimal output, despite its violation of *Complex.

Now, let us consider the production of /ʃr/ sequence. In specific, many subjects including Subject 6 produced /ʃr/ cluster as [s'ɨ.r] or [s'], showing substitution plus vowel insertion or substitution plus consonant deletion. In particular, the alveopalatal sound /ʃ/ is produced as [s']. This is because the alveopalatal place is more marked than the alveolar place universally. One piece of evidence comes from the first language acquisition data. For example, Amahl (Smith, 1973) produces *shoe* as [tu] in an early stage, which in turn changes into [su] in the following stage. Similar cases are also reported in Dinnsen (1992). Hence, the following ranking between the markedness constraints on place is proposed.

(11) *Alveopalatal place>> *Alveolar place

This ranking can account for the substitution pattern of /ʃr/ sequence, as the following tableaux show.

(12) The production of [s'ɨ.r] for target /ʃr/ 'shrimp'[8]

/ʃrɪmp/	Max (seg)	*Com -plex	Dep (seg)	*Alveo-palatal	*Alve-olar	Ident [place]
a. ʃrɪmp		*!		*		
b. s'rɪmp		*!			*	*
c. ʃɨ.rɪmp			*	*!		
☞d. s'ɨ.rɪmp			*		*	*
e. ʃɪmp	*!			*		
f. s'ɪmp	*!				*	*

In (12) candidates (a), (b), (e), and (f) are all ruled out due to their fatal violation of either *Complex or Max(segment). Both candidates (c) and (d) violate Dep(segment) by breaking the /ʃr/ cluster with an inserted vowel. This leaves the choice up to the makredness constraints on place, which favors the candidate with the alveolar sound. Therefore, candidate (d) emerges as the winner. Then, this can be understood as a case of the emergence of the unmarked (cf. McCarthy and Prince, 1995), as otherwise low-ranked markedness constraints such as *Alveopalatal and *Alveolar play a decisive role in the selection of the optimal output. Additionally, these markedness constraints on place should outrank the faithfulness constraint Ident[place] (at least in the lexical items with /ʃr/ sequence), as Subject 6 was not able to distinguish between /ʃ/ and /s/.

[8] We do not count *Alveolar violations with respect to [r] for expository convenience.

(13) The production of [s'] for target /ʃr/ 'shrub'[9]

/ʃrʌb/	Dep (seg)	*Com-plex	Max (seg)	*Alveo-palatal	*Alve-olar	Ident [place]
a. ʃrʌb		*!		*		
b. s'rʌb		*!			*	*
c. ʃɨ.rʌb	*!			*		
d. s'ɨ.rʌb	*!				*	*
e. ʃʌb			*	*!		
☞f. s'ʌb			*		*	*

In (13) candidates (a), and (b) are out because of a fatal violation of *Complex. Candidates (c) and (d) with a Dep(segment) violation are also ruled out, as input consonant deletion is preferred over vowel insertion in case of *shrub*. Both candidates (e), and (f) violate Max(segment), yet candidate (f) is selected as optimal due to the low-ranking of *Alveolar.

Now, let us turn to other replacement-related error patterns. For instance, Subject 37 produced target cluster /ɵr/ as [t'ɨ.r]. This means that Subject 37 preferred the alveolar stop [t] to the alveolar fricative [s] for target /ɵ/. It is well-documented that stops are less marked than fricatives (cf. Lombardi, 2000), as all languages have stops but not all have fricatives (Maddieson, 1984), and as the first language acquisition facts show that fricatives are learned later than stops (cf. Vihman, 1996). Then, the realization of [t'ɨ.r] for target /ɵr/ can be accounted for by the following ranking of the markedness constraints on manner, as shown in (15).

(14) *Fricatives>> *Stops

(15) The production of [t'ɨ.r] for target /ɵr/ 'three'[10]

/ɵri/	*ɵ	Max (seg)	*Com-plex	Dep (seg)	*Fricative	*Stop	Ident [cont]
a. ɵri	*!		*		*		
b. ɵɨ.ri	*!			*	*		
c. s'ri			*!		*		
d. s'ɨ.ri				*	*!		
e. tri			*!			*	*
☞f. t'ɨ.ri				*		*	*
g. ɵi	*!	*			*		

[9] The vowel [ɨ] in candidate (c) is realized as [u] due to coarticulation with the preceding consonant [ʃ]. Yet, we will not deal with the vowel quality of an inserted vowel for simplicity.

[10] Most subjects distinguish between target clusters with /t/ and those with /s/ (cf. (1)), which suggests that Ident[continuant] should outrank markedness constraints *Fricatives and *Stops. Yet, this is not the case in Subject 37's production, as he produces [t'] instead of [s] or [s'] for target /ɵ/. Also note that the optimal output (f) violates Ident[tense], which is low-ranked (cf. footnote 7).

In (15) candidates (a), (b), (c), (e), and (g) are all ruled out due to their fatal violation of either *ɵ or *Complex. Both candidates (d) and (f) violate Dep(segment). This leaves the choice up to the markedness constraints on manner, and thus candidate (f) wins out due to the low-ranking of *Stops, even though it incurs another violation of Ident[continuant]. This suggests that the constraint Ident[continuant] should be low-ranked, as its violation is not relevant to the selection of the optimal output. In addition, the realization of [tɨ.r] for /ɵr/ is another case of the emergence of the unmarked, as otherwise inactive markedness constraints on manner play a crucial role in the selection of the optimal form.

Finally, let us move on to the substitution of [ns] for target /ŋɵ/. This type of substitution shows that the nasal consonant [ŋ] assimilates to the following substituted sound [s] due to ease of articulation. Thus, the constraint Agree plays a crucial role, as shown in (17).[11]

(16) Agree: Nasals should share place features with the following obstruents.

(17) The production of [ns] for target /ŋɵ/ 'length'

/lɛŋɵ/	*ɵ	Max (segment)	Dep (segment)	*Com-plex	Agree	Ident [place]
a. lɛŋɵ	*!			*	*	
b. lɛnɵ	*!			*	*	*
☞c. lɛns				*		**
d. lɛŋs				*	*!	*
e. lɛɵ	*!	*				
f. lɛŋ		*!				
g. lɛŋ.ɵɨ	*!		*		*	

In (17) candidates (a), (b), (e), and (g) are all out of consideration because they incur a fatal violation of *ɵ. Similarly, candidate (f) is ruled out due to a violation of Max(segment). Both candidates (c) and (d) violate *Complex, but candidate (d) is worse than candidate (c) because of its fatal violation of Agree. As a result, candidate (c) surfaces as the optimal output, although it violates Ident[place] twice. This suggests that the constraint Agree should outrank Ident[place], as the tableau above shows.

In sum, the discussion up to now suggests the following constraint ranking for the replacement-related error patterns of English clusters by Korean EFL learners.

[11] An anonymous reviewer points out that this substitution pattern conflicts with Korean place assimilation, where only alveolars assimilate to labials or velars, but not vice versa (e.g. *Han Kang* [haŋkaŋ] 'the Han river'). However, interlanguage is an independent language, and thus it is not surprising that constraint rankings in interlanguage may differ from those of a native language.

(18) Constraint ranking[12]

a. Overall ranking: *f, *ɵ>>Max(segment), Dep(segment), *Complex, *Alveopalatal, *Fricatives >>*Alveolar, *Stops, Agree>> Ident [cont], Ident[place]

b. Rankings of specific error patterns

(i) Replacement only case: Max(segment), Dep(segment)>> *Complex

(ii) Replacement and vowel insertion case: Max(segment), *Complex>>Dep(segment)

(iii) Replacement and consonant deletion case: Dep(segment), *Complex>>Max(segment)

5. Conclusion

This paper has shown that Korean EFL learners' production errors involving sound replacement in the acquisition of English consonant clusters can be accounted for by the interaction between markedness constraints and faithfulness constraints within a constraint-based approach developed by McCarthy and Prince (1995). Specifically, this paper has shown that both sound replacement and combinatory error types involving sound substitution in the acquisition of English clusters with /f/, /ɵ/, or /ʃ/, can be attributed to the markedness constraints such as *f and *ɵ and to the alternating constraint ranking among Max(segment), Dep(segment) and *Complex. Moreover, the substitution patterns for target /ʃr/ sequence and the realization of [t'] instead of [s] or [s'] for target /ɵ/ in the acquisition of /ɵr/ sequence are shown to demonstrate cases of the emergence of the unmarked; otherwise low-ranked markedness constraints play a crucial role in the selection of the optimal form.

APPENDIX

Sample Items for the Production Test
Please read the following sentences. (Put pause between sentences.)

1. Spoons are on the table.
2. Classes will be held inside this building.
3. Play a game according to the rules.
4. Flat tires are on the road.
5. Try it one more time.
6. Sneezing bothers me.
7. Turn on the lamp.

[12] If a Korean EFL learner acquires target-appropriate pronunciations, then faithfulness constraints should outrank markedness constraints like *f, and *ɵ

8. Please give me a hint.
9. Crimes are increasing nowadays.
10. What do you think?
11. Steel workers had hard times due to recessions.
12. Did you have lunch?
13. The king celebrated his triumph.
14. Slaves were freed by the Civil War in the U.S.
15. I visit my grandma once a month.
16. Defense is better than offense.
17. Diligence is better than offense.
18. What is meant by Wasp?
19. The day has come at last.
20. Three students came to the party.
21. This is an easy task.
22. I need your help.
23. The dragon swallowed the donkey in one gulp.
24. A nut always goes with a bolt.
25. Cotton is cheaper than silk.
26. One of the famous brand names is ‘Welch’.
27. Princes Snow White lived a happy life.
28. A dog seems similar to a wolf.
29. Frightened babies are crying.
30. His statement is false.
31. Did you see the film?
32. Love is better than wealth.
33. Smoothies are beverages.
34. She plays the harp.
35. Skip your meal.
36. The dog didn't bark.
37. He is a man of art.
38. I was born in March.
39. ‘Sphere’ is a hard word to pronounce.
40. I always barf.
41. She doesn’t have any charm.
42. Tom is a man of worth.
43. Sodom was under God’s curse.
44. He made her harsh.
45. Don’t tease the girl.
46. She cut out a shirt on a pattern.
47. Don’t take the lift.
48. It was a stupid act.
49. The bridge is about to collapse.
50. His death was abrupt.

51. Don't bring the box.

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