Production of Stop-Nasal Sequences by Korean Learners of English: An Optimality Theoretic Approach*

In Kyu Park
(Chungbuk National University)

Park, In Kyu. (2006). Production of stop-nasal sequences by Korean learners of English: an Optimality Theoretic approach. *Language Research* 42(1), 1-18.

This study investigates how Korean learners of English produce stop-nasal sequences in English words/phrases like *Batman* and *a good neighbor*, and explores how their interlanguage phonology can be accounted for within the Optimality Theoretic framework, which characterizes a grammar as a set of violable universal constraints. In Korean, a stop is assimilated to its following nasal and becomes a nasal. The results show that Korean learners of English transfer Korean constraint ranking, which results in nasal-nasal sequences (like those of Korean) replacing stop-nasal sequences in L2. Vowel insertion also occurs; this appears to occur in perception (Park, 2002), and it results from a phonological constraint which rules out stop-nasal sequences at the phonetic level. This insertion gives rise to alternative input representations. Factors such as stress patterns, place of articulation, word boundary, or voicing play a role in stop nasalization and vowel insertion. The variations may be accounted for by some constraints proposed by Davis and Shin (1999) and a constraint proposed in this paper, and by adopting a model of floating constraints (Nagy and Reynolds, 1997) which yield the variable rankings apparent in L2 speech.

Key words: interlanguage phonology, stop nasalization, vowel insertion, Optimality Theory, floating constraint

---

* I would like to thank Patricia Donegan, Victoria Anderson, Ho-min Sohn, and Kenneth Rehg for their valuable suggestions and comments on earlier versions of this paper. Of course all remaining errors are my own.

1. Introduction

It is well known that second language learners, in general, show a preference for transferring the phonological system of the first language (L1) to the second language (L2).[1] In Korean, for example, a stop is assimilated to its following nasal in voicing and manner of articulation in words like /ipmat/ [immat] 'appetite' and /nat^{h}mal/ [nanmal] 'a word' (Kim-Renaud, 1974; Ahn, 1998), because Korean has a phonotactic constraint prohibiting stop-nasal sequences. This stop nasalization, which is an automatic phonological process, is sometimes transferred into L2, as in [əmnɔrməl] for *abnormal* and [gʊn mɛn] for *good men*. This study investigates how Korean learners of English produce stop-nasal sequences in English, and it explores how interlanguage[2] phonology can be accounted for within Optimality Theory, which explains the phonological system of L1 using a set of violable universal constraints (Prince and Smolensky, 1993; Kager, 1999). This paper addresses the following questions: (a) How do native Korean speakers produce a stop before a nasal in English? (b) Does Korean phonology affect Korean speakers' production of English stop-nasal sequences? More specifically, do they show L1 transfer (nasalization and vowel insertion)? (c) What factors play a role in stop nasalization and vowel insertion, respectively?

In the following section, I will briefly describe stop-nasal sequences in English and Korean and, in sections 3 and 4, I will discuss my experiment and results. In section 5, I will analyze Korean speakers' phonological variations of stop-nasal sequences in English using Optimality Theory.

2. Stop-nasal Sequences in English and Korean

In (American) English, glottalization (sometimes called "glottal reinforcement") occurs in syllable-final voiceless stops or voiceless stop-nasal sequences, whereas it does not occur in syllable-final voiced stops or voiced stop-nasal sequences (Giegerich, 1992). The bilabial, alveolar, or velar closure is usually preceded by glottal closure, so that a glottal stop is coarti-

1) Some examples of recent interesting research are Gass and Selinker 1994, Monahan 2001, and Major 2001.

2) The term "interlanguage" means "an adult second language learner's linguistic system" (Major, 2001).

culated with the supralaryngeal stop, as illustrated in the following:

(1) a. Syllable-final voiceless stops

cup	[kʰʌʔp]
beat	[biʔt]
buck	[bʌʔk]

b. Syllable-final voiced stops

cub	[kʰʌb]
bead	[bid]
bug	[bʌg]

c. Word-internal voiceless stop-nasal

topmost	[tɑʔpmoust]
Batman	[bæʔtmæn]
quickness	[kwɪʔknɪs]

d. Word-internal voiced stop-nasal

submit	[sʌbmɪt]
admiral	[ædmərəl]
ignore	[ɪgnɔr]

e. Word-external voiceless stop-nasal

group marriage	[gruʔp mærɪʤ]
hot money	[hɑʔt mʌni]
folk music	[foʊʔk mjuzɪk]

f. Word-external voiced stop-nasal

tub mat	[tʌb mæt]
good men	[gʊ̃d mɛn]
Big Mac	[bɪg mæk]

Stop-nasal sequences are not allowed in Korean. Thus, stop nasalization occurs automatically in the case of stop-nasal sequences, which are illustrated in (2) (Kim-Renaud, 1974; Ahn, 1998).

(2) a. Word-internal stop-nasal

/ipmat/	[immat] 'appetite'
/natʰmal/	[nanmal] 'a word'
/kukmul/	[kuŋmul] 'soup'

b. Word-external stop-nasal

/pap məkə/	[pam məgə] 'Have a meal.'
/kot nawa/	[kon nawa] 'Come out soon.'
/k'uk nullə/	[k'uŋ nullə] 'Push tightly.'

In Korean, syllable-final obstruents are not released, and voiced stops usually occur between voiced segments as allophones of plain stops.[3)]

3. Experiment

3.1. Subjects

The subjects who participated in the experimental study were two native speakers of American English and eight Korean learners of English. The general background of the participants is summarized in Table 1.

3) Released aspirated and tense stops are not voiced, as in /itʰal/ [itʰal] 'secession' and /pap'in/ [pap'in] 'busy.' Stops undergoing tensification are not also voiced, as in /paltal/ [palt'al] 'development.'

Most of the participants are graduate students in the University of Hawai'i at Mānoa. The native English speakers, JJ and LS, have a California accent and a Minnesota accent, respectively. The distinction between advanced and non-advanced learners of English is based on years of stay in English-speaking countries, and confirmed by a native English speaker's judgment of Korean learners reading a passage in English.

Table 1. Characteristics of Participants in Production Experiment

Level	Subjects	Age	Years of stay in English-speaking countries
Native English speakers	JJ	20-30	20-30
	LS	20-30	20-30
Advanced learners of English	YL	40-50	4-7
	ML	30-40	4-7
Non-advanced learners of English	SP	20-30	1-2
	HJ	20-30	1-2
	JC	20-30	1-2
	HK	20-30	1-2
	BS	20-30	0-1
	SS	30-40	3-4

3.2. Stimuli

The experiment focused on the sequences of an alveolar stop (/t, d/) and a nasal (/m, n/), excluding other places of stop articulation (bilabials and velars). A prosodic factor (stress) and boundary patterns (word boundary vs. no word boundary) were taken into consideration. Three types of stress patterns are as follows:

(3) a. stressed V-stop-nasal-stressed V: 'Bat**m**an
b. stressed V-stop-nasal-unstressed V: 'wi**tn**ess
c. unstressed V-stop-nasal-stressed V: a'**tm**ology

The number of the sequences was twenty-four: 2 stops (t and d) x 2 nasals (m and n) x 3 stress patterns (above) x 2 boundary patterns (word boundary vs. none). The sentences used are shown in the appendix. Recordings were made in a sound-attenuated recording studio at the University of Hawai'i at Mānoa. The order of tokens was randomized. In order to elicit data as naturally as possible, natural sentences that in-

cluded the tokens were constructed, and some distracter sentences were used in the set of stimuli. The subjects were asked to read each sentence as naturally as possible three times. Thus, the total number of tokens collected and investigated was 720 (24 stimuli x 10 speakers x 3 repetitions).

The target stop-nasal sequences were transcribed; this was done with the aid of waveforms and spectrograms in the case of unclear sequences. I categorized responses as 'correct,' 'nasalization,' and 'vowel insertion.' Although there were some cases of deletion, I classified it as nasalization, since it could be considered nasalization with complete assimilation. Inter-transcriber agreement was 91% on 10% of the utterances.

4. Results and Discussion

Table 2 below shows the results of the experiment.

Table 2. Mean (%) of Each Category with Regard to Factors

Speaker type	Nasalization	Correct	Vowel Insertion
Native English speakers	0%	100%	0%
Native Korean speakers	26%	62%	12%
Levels (Korean learners)	Nasalization	Correct	Vowel Insertion
Non-advanced learners	40%	40%	20%
Advanced learners	12%	84%	4%
Stress patterns	Nasalization (Adv/Non)*	Correct (Adv/Non)	Vowel Insertion (Adv/Non)
Stressed-Stressed	10% vs. 52%	90% vs. 45%	0% vs. 3%
Stressed-Unstressed	15% vs. 33%	75% vs. 37%	10% vs. 30%
Unstressed-Stressed	10% vs. 35%	88% vs. 37%	2% vs. 27%
Word boundary	Nasalization (Adv/Non)	Correct (Adv/Non)	Vowel Insertion (Adv/Non)
Word-internal	13% vs. 35%	82% vs. 39%	6% vs. 26%
Word-external	11% vs. 45%	86% vs. 40%	3% vs. 14%
Places of articulation	Nasalization (Adv/Non)	Correct (Adv/Non)	Vowel Insertion (Adv/Non)
Coronal-Coronal	18% vs. 42%	78% vs. 47%	4% vs. 11%
Coronal-Labial	6% vs. 38%	90% vs. 33%	4% vs. 29%
Voiced/Voiceless	Nasalization (Adv/Non)	Correct (Adv/Non)	Vowel Insertion (Adv/Non)
Voiceless	18% vs. 48%	76% vs. 40%	6% vs. 12%
Voiced	6% vs. 33%	92% vs. 39%	3% vs. 28%

* *Adv* and *Non* indicate 'Advanced learners' and 'Non-advanced learners,' respectively

4.1. Native English Speakers and Native Korean Speakers

The percentage of native English speakers' correct pronunciation was 100%. They did not show any tendency to produce a stop before a nasal as a nasal, or as a stop followed by a vowel. As for native Korean speakers, nasalization occurred frequently (26%), and vowel insertion also occurred (12%). In some cases, stop deletion was shown (1%), which was included in the category of nasalization, since it may be assumed that a stop possibly becomes a nasal before a nasal and then it is assimilated or deleted.

Native Korean speakers showed stop nasalization frequently, which illustrates L1 transfer. That is, stop nasalization in their productions in L1 was transferred to L2.

Park 2002 examines how Korean learners of English perceive stop-nasal sequences in English. The listeners who participated in the experimental study were two native speakers of American English and eight Korean learners of English. Nonsense words of two types (released/unreleased[4]) involving sequences of a stop and a nasal were recorded by two native English speakers, as shown in *epma, epna, ebma, ebna, etma, etna, edma, edna, ekma, ekna, egma, egna.* Words were placed in the carrier sentence 'I said _____ today/yesterday.' The task of the listeners was to choose the word they heard from a list. For instance, in response to the stimulus *epma,* a listener could choose one of the following: (a) *epma,* (b) *eppa,* (c) *emma,* (d) *epma,* (e) *epa,* (f) *ema,* and (g) *empa.* In making multiple choices, epenthesis, denasalization, nasalization, and stop/nasal deletion were taken into consideration. The Korean listeners' perception turned out to be different from the English listeners' perception. Overall, the Korean listeners significantly showed perception of an epenthetic vowel, which was affected primarily by the release and/or voicing of stops. Their perception of an epenthetic vowel correlates with the phonetic patterning of Korean, in which the release of a stop occurs only before a vowel (or a glide) and voiced stops occur only in syllable-initial position. This is evidence of the influence of phonology on perception.

---

4) Released/unreleased sounds in the nonsense words are involved in stops. Voiceless unreleased stops in English, in general, accompany a glottal stop, while voiceless released stops accompany a weak aspiration without glottal closure.

In the experiment on perception, native Korean speakers hardly ever perceived a stop before a nasal as a nasal. They perceived it as a stop or a stop followed by a vowel, depending on releasedness and/or voicing of the stop. Thus, their tendency to perceive those sequences correctly and not to perceive a nasalized segment may be explained by the possibility of stop-nasal sequences in the underlying representation. The tendency to perceive an epenthetic vowel, depending on the release and voicing of a stop, may be accounted for by the phonetic patterning of Korean, as noted above. Thus, it is assumed that stop nasalization in L2 production does not result from misperception. Rather, it may be accounted for by a phonological constraint prohibiting stop-nasal sequences at the phonetic level in Korean.

4.2. Native Korean Speakers

Korean non-advanced speakers showed more frequent stop nasalization than advanced learners (40% vs. 12%). Korean non-advanced speakers showed more frequent vowel insertion than Korean advanced learners (20% vs. 4%).

Each subject's production results are summarized in Table 3.

Table 3. Mean (%) of Each Subject's Production Results

Level	Subjects	Years of stay in English-speaking countries	Nasalization	Correct	Vowel Insertion
Adv	ML	4-7	6%	92%	3%
	YL	4-7	18%	76%	6%
Non	HK	1-2	35%	63%	3%
	SP	1-2	22%	61%	17%
	JC	1-2	13%	44%	43%
	HJ	1-2	44%	31%	25%
	SS	3-4	54%	26%	19%
	BS	0-1	72%	14%	14%

Subject BS, whose duration of stay in English-speaking countries is just four months, showed the most prominent L1 transfer (72%). Subject SS, whose duration of stay in English-speaking countries is 3 years and 6 months, also showed a very prominent L1 transfer (54%) because she

had little contact with native English speakers. Subjects HJ, SP, and HK, whose duration of stay in English-speaking countries is 1-2 years, also showed L1 transfer (44%, 22%, and 35%, respectively). Interestingly, subject JC, whose duration of stay in English-speaking countries is also 1-2 years, showed vowel insertion more frequently than stop nasalization (43% vs. 13%). Subjects ML and YL, whose duration of stay in English-speaking countries is over 4 years, rarely showed stop nasalization (6% and 18%) and vowel insertion (3% and 6%). Table 3 illustrates that the more L1 learners are exposed to L2 environment, the less L1 transfer occurs.

As for stress pattern, stop nasalization was most prominent in stressed-stressed sequences; 31% of all stressed-stressed sequences were nasalized. Vowel insertion was more prominent in other sequences; 20% of all stressed-unstressed sequences and 15% of all unstressed-stressed sequences underwent vowel insertion.

In the case of place of articulation, stop nasalization occurred more frequently in the same place of articulation (coronal-coronal) than in the different place of articulation (coronal-labial) (30% vs. 22%), whereas vowel insertion occurred more frequently in the different place of articulation than in the same place of articulation (17% vs. 8%).

As for word boundary, interestingly, stop nasalization occurred more frequently in word-external sequences than in word-internal sequences (28% vs. 24%), whereas vowel insertion occurred more frequently in word-internal sequences than in word-external sequences (16% vs. 9%).

Surprisingly, stop nasalization occurred more frequently with voiceless stops than with voiced stops (33% vs. 20%).[5] But vowel insertion was more prevalent with voiced stops (16% vs. 9%). This may reflect the phonetic patterning in Korean in which, if the stop is phonetically voiced, then it is perceived as being in syllable-initial position. Voiceless stops were more often perceived as syllable-final and were thus more often nasalized.

4.3. Korean Advanced and Non-advanced Learners

As for subjects, Korean advanced learners showed stop nasalization

5) This actually violates the similarity principle (Hutcheson, 1973), according to which more-similar sequences are more susceptible to assimilation than less-similar sequences. Thus, if the sequence /tn/ becomes /nn/, then the sequence /dn/ must become /nn/.

more frequently than vowel insertion (ML: 6% vs. 3%; YL: 18% vs. 6%). Korean non-advanced learners (BS, SS, HJ, SP, and HK) also showed stop nasalization more frequently than vowel insertion except for JC, as shown in Table 3.

As for stress pattern, Korean advanced learners showed stop nasalization and vowel deletion more frequently in the stressed-unstressed pattern than in the stressed-stressed pattern and unstressed-stressed patterns (15% vs. 10% vs. 10%, 10% vs. 0% vs. 2%, respectively). With Korean non-advanced learners, stop nasalization occurred more frequently in the stressed-stressed pattern than in the stressed-unstressed and unstressed-stressed patterns (52% vs. 33% vs. 35%), while vowel insertion occurred more frequently in the stressed-unstressed and unstressed-stressed patterns than in the stressed-stressed pattern (30% vs. 27% vs. 3%).

As for place of articulation, Korean advanced learners showed stop nasalization more frequently in the coronal-coronal sequence (that is, identical place of articulation) than in the coronal-labial sequence (that is, different places of articulation) (18% vs. 6%). Vowel insertion took place equally in both kinds of sequences (4%). With Korean non-advanced learners, stop nasalization occurred more frequently in the coronal-coronal sequence than in the coronal-labial sequence (42% vs. 38%). Vowel insertion, on the other hand, took place more frequently in the coronal-labial sequence than in the coronal-coronal sequence (29% vs. 11%).

As for word boundary, Korean advanced learners showed stop nasalization more frequently within a word than across a word boundary (13% vs. 11%), whereas Korean non-advanced learners showed stop nasalization more frequently across a word boundary than within a word (45% vs. 35%). Korean advanced learners showed vowel insertion more frequently within a word than across a word boundary (6% vs. 3%). Korean non-advanced learners showed vowel insertion more frequently within a word than across a word boundary (26% vs. 14%).

Korean advanced and non-advanced learners of English showed stop nasalization more frequently for voiceless stops than for voiced stops (18% vs. 6%, 48 vs. 33%, respectively). Korean advanced learners of English showed vowel insertion more frequently for voiceless stops than for voiced stops (6% vs. 3%), while Korean non-advanced learners of English preferred vowel insertion for voiced stops (28% vs. 12%).

5. Optimality Theoretic Account

5.1. Stop Nasalization in Korean

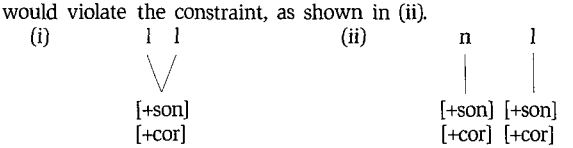
Davis and Shin (1999, p. 290) propose the constraints in (4) and the ranking in (5) below in order to explain obstruent nasalization, *n*-lateralization, *l*-nasalization, lateralization of coronal-liquid sequences, and nasalization of (non-coronal) obstruent-liquid sequences:[6]

(4) Constraints
   a. SyllCon (Syllable Contact): Avoid rising sonority over a syllable boundary.
   b. Max [lateral]: The feature [lateral] from an input segment is realized in the output.
   c. Max [nasal]: The feature [nasal] from an input segment is realized in the output.
   d. Ident [sonorant]: Corresponding segments are identical with respect to the feature [±sonorant].
   e. Ident-Onset [sonorant]: The [±sonorant] feature of an output onset is identical to the [±sonorant] feature of the corresponding input segment.
   f. Ident [place]: Corresponding segments are identical with respect to their place features.
   g. *Complex: Avoid complex onsets and complex codas (undominated).
   h. Similarity: *[+son, +cor] [+son, +cor][7] (A sequence of coronal so-

---

6) Obstruent-nasalization is illustrated in /sip-njən/ [sim.njən] 'ten years'; *n*-lateralization is illustrated in /non-li/ [nol.li] 'logic'; *l*-nasalization is illustrated in /kam-li/ [kam.ni] 'supervision'; lateralization of coronal-liquid sequences is illustrated in /tikit liil/ [ti.gil.li.il] 'the letter *t* and *l*'; nasalization of (non-coronal) obstruent-liquid sequences is illustrated in /cap-lok/ [cam.nok] 'a miscellany' (Davis and Shin, 1999, pp. 287-288). It is not clear why Davis and Shin (1999) distinguish *n*-lateralization from lateralization of coronal-liquid sequences. See Davis and Shin (1999) for the details.

7) According to Davis and Shin (1999, p. 309), a geminate coronal sonorant such as [nn] or [ll] would not violate this constraint, because it would have a structure in (i) with a single set of features. On the contrary, a sequence of different coronal sonorants such as [nl] or [ln] would violate the constraint, as shown in (ii).



norants is not allowed.).

(5) Ranking: SyllCon, Ident-Onset [sonorant], Similarity >> Ident [place] >> Max [lateral] >> Max [nasal], Ident [sonorant][8]

Davis and Shin (1999) account for Korean phonological phenomena mentioned above by using the constraints in (4) and their ranking in (5), some of which (obstruent nasalization and *n*-lateralization) are illustrated in the following tableaux:[9]

(6) a. Obstruent nasalization: /nat^{h}mal/ [nan.mal] 'a word'

/nat^{h}mal/	Syll-Con	Ident-Onset [son]	Similarity	Ident [place]	Max [lateral]	Max [nasal]	Ident [son]
a. nat.mal	*!						
b. nat.pal		*!				*	*
☞ c. nan.mal							*

b. *n*-lateralization: /c^{h}alna/ [c^{h}al.la] 'a moment'

/c^{h}alna/	Syll-Con	Ident-Onset [son]	Similarity	Ident [place]	Max [lateral]	Max [nasal]	Ident [son]
a. c^{h}al.na			*!				
b. c^{h}an.na					*!		
☞ c. c^{h}al.la						*	*

5.2. Stop Nasalization in L2

In second language production, native Korean speakers showed stop nasalization and vowel insertion in stop-nasal sequences. Stop nasalization in L2 production is not an effect of perception; rather, as a result of L1 transfer, it may be accounted for by a phonological constraint prohibiting stop-nasal sequences at the phonetic level (Syllable Contact) in Korean. In contrast, the vowel insertion that appears in L2 production does occur in perception (Park, 2002). It is triggered by the phonetic pat-

8) *Complex is highest in the ranking and irrelevant in Davis and Shin 1999.

9) The sign ☞ and [son] in the tableaux indicate an optimal output and [sonorant], respectively.

terning of Korean in which the release of a stop occurs only before a vowel (or a glide) and voiced stops occur only in the syllable-initial position. Thus, I propose that there would be two kinds of inputs: one is an input with a stop-nasal sequence and the other is an input with a stop-vowel-nasal sequence. For example, the inputs of *Batman* would be /ˈbætʰ̚mæn/ and /ˈbætʰi̚mæn/.

I also propose the following constraint:

(7) *V [-pal, -lab, -low]: A non-palatal, non-labial, and non-low vowel is not allowed when short.[10]

The constraint in (7) is motivated by *i*-deletion in Korean and *ə*-deletion in English. In casual/fast speech, /i/ in Korean tends to be deleted after a voiceless consonant, as illustrated in /pasi̚lak/ [pasɾak] 'rustling, crumbly,' /usi̚k'waŋsi̚lən/ [usk'waŋsɾən] 'absurd,' or /pitʰi̚ləpwa/ [pitʰɾəβa][11] 'try to twist it' (Kim-Renaud, 1987). In all but the most careful speech of English, schwa deletion occurs frequently in obstruent-*ə*-liquid-stressed vowel sequences, as illustrated in words like *Columbus, separate, correct, belief, saliva, canoe, balloon,* and so on (Giegerich, 1992; Spencer, 1996).[12]

Based on my proposal of two kinds of inputs and the constraint *V [-pal, -lab, -low] and by re-ranking the constraints,[13] there occur three variations from the two different inputs—correct production, nasalized production, and epenthetic production. In the case of an input without an epenthetic vowel, Tableau (8a) illustrates nasalized production (L1 transfer), which occurs mainly with Korean non-advanced learners; Tableau (8b) illustrates correct production, which occurs, especially, with Korean advanced learners; Tableau (8c) illustrates epenthetic production, which occurs mainly in Korean non-advanced learners.

10) /i̚/ is intrinsically shorter than /ə/ in Korean. Thus, /i̚/ is more susceptible to deletion.

11) Note that these forms violate other constraints—usually, dominant constraints. This problem is outside the scope of this paper.

12) Schwa may be first raised and then deleted (ə → i → ∅).

13) For convenience, only three of eight constraints in (4)—SyllCon, Ident-Onset [sonorant], and Ident [sonorant]—will be shown here.

(8) a. Nasalized production

/ˈbætʰˌmæn/	SyllCon	*V [-pal, -lab, -low]	Ident-Onset [son]	Ident [son]
a. ˈbæʔtˀˌmæn	*!			
b. ˈbætˀˌpʰæn			*!	*
☞ c. ˈbænˌmæn				*
d. ˈbæ.tʰiˌmæn		*!		

b. Correct production

/ˈbætʰˌmæn/	*V [-pal, -lab, -low]	Ident-Onset [son]	Ident [son]	SyllCon
☞ a. ˈbæʔtˀˌmæn				*
b. ˈbætˀˌpʰæn		*!	*	
c. ˈbænˌmæn			*!	
d. ˈbæ.tʰiˌmæn	*!			

c. Epenthetic production

/ˈbætʰˌmæn/	SyllCon	Ident-Onset [son]	Ident [son]	*V [-pal, -lab, -low]
a. ˈbæʔtˀˌmæn	*!			
b. ˈbætˀˌpʰæn		*!	*	
c. ˈbænˌmæn			!*	
☞ d. ˈbæ.tʰiˌmæn				*

Tableau (9c), for an input with a vowel /ɨ/, illustrates epenthetic production, which occurs mainly with Korean non-advanced learners; Tableaux (9a) and (9b) illustrate nasalized production and correct production, respectively, which do not occur prominently. The orthography supports the underlying representation without /ɨ/, and auditory perception often supports the underlying representation with /ɨ/. Nasalized production probably arises in most cases from the underlying representation without an epenthetic vowel /ɨ/, while correct production, with an epenthetic vowel /ɨ/ in the underlying representation, occurs in speech that is fluent enough for *V [-pal, -lab, -low] to be ranked higher than Ident [sonorant] and for SyllCon to be ranked lower than Ident [sonorant].

(9) a. Nasalized production

/'bæt^{h}i,mæn/	SyllCon	*V [-pal, -lab, -low]	Ident-Onset [son]	Ident [son]
a. 'bæ?t$^{\neg}$.,mæn	*!			
b. 'bæt$^{\neg}$.,p^{h}æn			*!	*
☞ c. 'bæn.,mæn				*
d. 'bæ.t^{h}i.,mæn		*!		

b. Correct production

/'bæt^{h}i,mæn/	*V [-pal, -lab, -low]	Ident-Onset [son]	Ident [son]	SyllCon
☞ a. 'bæ?t$^{\neg}$.,mæn				*
b. 'bæt$^{\neg}$.,p^{h}æn		*!	*	
c. 'bæn.,mæn			*!	
d. 'bæ.t^{h}i.,mæn	*!			

c. Epenthetic production

/'bæt^{h}i,mæn/	SyllCon	Ident-Onset [son]	Ident [son]	*V [-pal, -lab, -low]
a. 'bæ?t$^{\neg}$.,mæn	*!			
b. 'bæt$^{\neg}$.,p^{h}æn		*!	*	
c. 'bæn.,mæn			!*	
☞ d. 'bæ.t^{h}i.,mæn				*

In order to account for the phonological variations in L2 shown above, we may adopt a model of 'floating constraints' proposed by Nagy and Reynolds (1997).[14]

(10) a. Ranking hierarchy I

<----------(*Korean*)------SyllCon---- (*English*)------->

*V [-pal, -lab, -low]

Ident Onset [sonorant] >> Ident [sonorant]

14) In this model, accounting for the rates of intraspeaker variation of a language, they attempt to decrease the probable numerous grammars that an individual speaker may have due to variation in OT by using some floating constraints appearing anywhere within a relevant range in the ranking hierarchy.

b. Ranking hierarchy II
<----------(*nasal*)--*V [-pal, -lab, -low]--(*epenthetic*)-->
SyllCon
Ident Onset [sonorant] >> Ident [sonorant]

In (10a), SyllCon is a floating constraint that may be ranked above or below the constraint Ident [sonorant]. When the floating constraint, SyllCon, is ranked above Ident [sonorant], the ranking (and the output) will be like that of Korean, i.e., the output is a nasalized production. When the floating constraint, SyllCon, is ranked below Ident [sonorant], the ranking (and the output) will be like that of English, i.e., the output is a correct production.

In (10b), *V [-pal, -lab, -low] is a floating constraint that may be above or below the constraint Ident [sonorant]. When the floating constraint, *V [-pal, -lab, -low], is ranked above Ident [sonorant], the output is a nasalized production. When the floating constraint, *V [-pal, -lab, -low], is ranked below Ident [sonorant], the output is an epenthetic production.

We get three actual rankings from (10a) and (10b) because one of a total of four rankings is overlapped[15] and thus three optimal candidates. With each of the two kinds of inputs, three tableaux are put in (8) and (9). We actually get three optimal candidates because each of the three optimal candidates may result from different rankings. One of the three rankings predicts a nasalized production, another ranking predicts a correct production, and the other ranking predicts an epenthetic production, as shown in Tableaux (8) and (9), respectively.

6. Conclusion

The purpose of this study has been to examine how Korean learners of English produce stop-nasal sequences in English and to explore how its interlanguage phonology can be accounted for within the Optimality Theoretic framework. Korean learners' production is very different from native English speakers' production. Overall, in production, Korean learners of English showed stop nasalization more frequently than vowel

15) (10a) gives two rankings and (10b) gives two rankings, but one of the two rankings in (10a) is the same as one of the two rankings in (10b) (that is, (8a)).

insertion. L1 transfer occurred more frequently with Korean non-advanced learners. Factors such as stress patterns, place of articulation, word boundary, and voicing played a role in stop nasalization and/or vowel insertion. The results show that Korean learners of English transfer Korean constraint ranking, which results in nasal-nasal sequences (like those of Korean) replacing stop-nasal sequences in the second language. Vowel insertion also occurs; this appears to occur in perception (Park, 2002), and it results from a phonological constraint which rules out stop-nasal sequences at the phonetic level. This insertion gives rise to alternative input representations. The variations could be accounted for by some constraints proposed by Davis and Shin (1999) and *V [-pal, -lab, -low] proposed in this paper, and by adopting a model of floating constraints which yield the variable rankings apparent in L2 speech.

References

Ahn, S.-C. (1998). *An Introduction to Korean Phonology.* Seoul: Hanshin Publishing Co.

Davis, S. and S.-H. Shin. (1999). The syllable contact constraint in Korean: An Optimality-Theoretic analysis. *Journal of East Asian Linguistics* 8, 285-312.

Gass, S. and L. Selinker. (1994). *Second Language Acquisition: An Introductory Course.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Giegerich, H. J. (1992). *English Phonology.* New York: Cambridge University Press.

Hutcheson, J. W. (1973). *A Natural History of Complete Consonantal Assimilations.* Unpublished doctoral dissertation. Ohio State University. Columbus, OH.

Kager, R. (1999). *Optimality Theory.* New York: Cambridge University Press.

Kim-Renaud, Y.-K. (1974). *Korean Consonantal Phonology.* Unpublished doctoral dissertation. University of Hawai'i at Mānoa. Honolulu, HI.

Kim-Renaud, Y.-K. (1987). Fast speech, casual speech, and reconstructing. *Harvard Studies in Korean Linguistics* II, 341-359.

Major, R. C. (2001). *Foreign Accent: The Ontogeny and Phylogeny of Second Language Phonology.* Mahwah, NJ: Lawrence Erlbaum Associates.

Monahan, P. J. (2001). Evidence of transference and emergence in the interlanguage. From Rutgers Optimality Archive: http://ruccs.rutgers.edu/roa.html, ROA 444-0701.

Nagy, N. and B. Reynolds. (1997). Optimality Theory and variable word-final deletion in Faetar. *Language Variation and Change* 9, 37-55.

Park, I. K. (2003). Perception of stop-nasal sequences in English by Korean learners of English. In K. Hales and A. Terveen, eds., *Proceedings 2002 Selected Papers from the Sixth College-wide Conference for Students in Languages, Linguistics, and Literature* (pp. 100-106). Honolulu, HI: College of Languages, Linguistics, and Literature, University of Hawai'i at Mānoa.

Prince, A. and P. Smolensky. (1993). *Optimality Theory: Constraint Interaction in Generative Grammar.* RuCCS (Rutgers University Center for Cognitive Science) Technical Report 2. Piscataway, NJ: Rutgers University.

Spencer, A. (1996). *Phonology.* Cambridge, MA: Blackwell.

Appendix: Stimuli

Word-internal stop-nasal sequences

1. They watched ***Batman*** yesterday. (*stressed-stressed*)
2. The **atmosphere** in this restaurant is nice. (*stressed-unstressed*)
3. He says that **atmology** is a field of natural science. (*unstressed-stressed*)
4. They took a **catnap** during the daytime. (*stressed-stressed*)
5. They **witnessed** that it was the driver's fault. (*stressed-unstressed*)
6. We made a new snack and called it **Carrotnip** cookies. (*unstressed-stressed*)
7. Her **godmother** is Mary. (*stressed-stressed*)
8. The **admiral** is very handsome. (*stressed-unstressed*)
9. This ticket **admits** one person. (*unstressed-stressed*)
10. She is very **good-natured**. (*stressed-stressed*)
11. I wish to **goodness** you had told me that before. (*stressed-unstressed*)
12. We made another snack and called it **Saladnip** crackers. (*unstressed-stressed*)

Word-external stop-nasal sequences

1. A **pot marigold** is a beautiful flower. (*stressed-stressed*)
2. Did you **get my** letter? (*stressed-unstressed*)
3. I saw her **at Mary's** party. (*unstressed-stressed*)
4. I **put nice** pictures on that shelf. (*stressed-stressed*)
5. They **put notorious** gangsters in jail. (*stressed-unstressed*)
6. We met **at Nancy's** house. (*unstressed-stressed*)
7. I watched *A Few* ***Good Men*** yesterday. It was very exciting. (*stressed-stressed*)
8. Joe **led me** through the maze quickly. (*stressed-unstressed*)
9. Thanks to them, he **could make** it. (*unstressed-stressed*)
10. She is a **good neighbor**. (*stressed-stressed*)
11. They **made notorious** gangsters go to jail. (*stressed-unstressed*)
12. You **should knock** on the door, when you come into the office. (*unstressed-stressed*)

Distracters

1. May I have some water?
2. I forgot it.
3. It's getting warmer.

In Kyu Park
Department of English Language and Literature
Chungbuk National University
12 Gaeshin-dong, Heungduk-gu
Chungbuk, Korea 361-763
E-mail: jamesinkyu@hanmail.net

Received: Mar. 31, 2006
Revised version received: May 15, 2006
Accepted: May 31, 2006