Transition of Phonological Rule Application in Learner Speech*

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Jong-mi Kim (2013), Transition of Phonological Rule Application in Learner Speech. Studies in Linguistics 28, 1-26. In the development of learner speech, we expect both the decreasing interference of native phonology and the increasing acquisition of target phonology. We examine how these two types of phonological interaction occur as the learner proficiency increases. For this study, we collected 2,804 word data of L2 English in isolation form and embedded in sentences. These data were elicited from 92 Korean adult learners of American English. Our results indicate that the learner speech may suppress the L1 rule application in significantly earlier stage of language learning than the stage when an L2 rule applies. Furthermore, the L1 rule in learner speech is different from the L1 rule in native speech. (Kangwon National University)

Key Words: learner speech, interlanguage phonology, English rule of unaspiration, Korean rule of /-alternation, Korean English, phonological rules in learner speech, L2 phonology

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1. Introduction

One common characteristic of learners of a foreign language who acquired the language in late adolescence or adulthood is that their productions of the phonetic segments and sequences are a product of complex interactions between L1 and L2 phonetic realization rules. Even though most L2 learners prefer to speak and pronounce the target language like a native speaker (see Timmis 2002, Derwing 2003 for English), native listeners can readily identify that their speech is foreign accented and, more importantly to our discussion, what the speaker’s native language might be.1 This justifies the characterization of the accented phonological patterns as being due, to a considerable extent, to interference from the native language phonology (Strange and Shafer 2008: 153). Of particular interest in this paper is the question how learners suppress native phonology and acquire target phonology, and how successful the attempt is.

In relation to learners’ development of suppressing L1 interference and acquiring L2 phonology, this research attempts to answer three questions of the transition of phonological rule application in learner speech.

1. [Suppression of L1 phonology] How common is it to suppress L1 phonology rules?
2. [Acquisition of L2 phonology] How common is it to acquire L2 phonology rules?
3. [Developmental transition] Do the suppression and acquisition of the phonological rules take place by learning over time?

We present counter examples to the claims in literature for these three questions. Our examples show positive case to the first question, negative

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case to the second question, and positive case for the third question. In contrast, the views in the literature are negative for the first question, varied for the second question and negative for the third question.

The views for the first question on L1 phonology in literature is often answered negatively in that the role of L1 is central in L2 phonological processing, because L2 learners often use L1 rules when phonologically encoding words or phrases (Kormos 2006:27). Broselow (1987) also found that transfer of phonological rules played a significant role in accented speech. To mention one more literature, Benson (1988) examined the speech of two Vietnamese learners of English, and reported that almost all of the modifications (81 out of 92) were due to LI transfer. In summary, LI transfer has often been considered a prominent factor affecting L2 phonological acquisition and use. Our data in later sections will report the statistics that the learners quickly learn to suppress L1 phonology as soon as their proficiency increases from novice level.

The views for the second question on L2 phonology in literature vary in that many studies report some success in the acquisition of L2 phonology, while others report the failure of acquiring L2 phonology. In other words, previous studies show varying degrees of acquisition rate in L2 speech: easier acquisition of stress assignment rules of L2 (Kim 2005), and difficult acquisition of vowel reduction in L2 (Kim & Lee 2005).

For an extreme case of the failure in acquisition, Archibald (1997) investigated the production and perception of English stress by native speakers of non-accentual languages such as Chinese and Japanese, in which pitch and/or tone is stored as part of the lexical entry. His results suggest that Chinese and Japanese participants stored L2 stress specifications for each lexical item in L2 rather than computed it on the basis of stress assignment rules. In other words, these subjects have failed in acquiring the stress assignment rules. We will later give another negative case for this question in that learners have a drastically lower rate of L2 acquisition than the rate of L1 suppression.
In relation to the unsuccessful learning of L2 rules, Flege, Frieda, Walley and Randazza (1998) who also has the negative view to our second question, indicates that L2 phonemes are acquired on an individual basis, and that combinations of sounds constituting words or morphemes are not learned as one unit. This view is construed that L2 phonological rules will not be learned at all, because phonological rules always deals with combinations of sounds from one (1) to many numbers to define the phonological environment. We will later oppose this view by presenting the evidence that learners do acquire some L2 phonology.

The varied view of acquiring L2 phonology in literature also includes so-called 'U-shaped' pattern of acquiring L2 phonology (Abrahamsson 2003, among others). That is, L2 learners’ acquisition of phonology is supposedly fairly accurate in the beginning, but becomes highly erroneous with general development of proficiency, and then the accuracy increases again at further stages of development. Our own investigation, however, does not find evidence to U-shaped learning.

To move on to our third question for the developmental transition, the views in literature are negative in that adult learners improve insignificantly in foreign pronunciation (Scovel 1988, among others). In other words, the phonological rule is hardly acquired. We will later answer this third question more positively by presenting some improvement by explicit learning.

The methods we employ to answer these three questions are taken from suggestions in literature. To test the first question on L1 phonology, we select a post-lexical rule of L1 allophone with L2 phonemic change, following Eckman and Iverson (1995, as cited in Kormos 2006:118). According to Eckman and Iverson, when L2 learners want to acquire an L2 sound that is an allophone in L1, they have to suppress the application of L1 post-lexical rules in L2 phonological processing.2

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2 A post-lexical rule applies to all words, regardless of their lexical specification. All rules we discuss in this paper are post-lexical.
To test the second question on L2 phonology we select a syllable sensitive L2 rule, because Archibald (1998) has proposed that the acquisition of syllabification rules in L2 often takes place simultaneously with learning new L2 phonological feature distinctions.

Furthermore, we select an L2 rule that the phonological feature is already available in L1 so that the learners do not have to learn a new feature. This is to facilitate testing "U-shapedness" of phonological acquisition (Abrahamsson 2003), for which learners must have better command at least in some stages (Time 1 and Time 3). Our own investigation will later present counter evidence of U-shaped learning.

To test the third question on developmental transition, we use explicit instruction, because literature claimed that conscious attention to phonology is necessary in order to acquire phonology (Schmidt 1995: 17).

By incorporating the research methods suggested in literature, our research questions are to test concrete cases as the following:

(1) Research question on suppression of L1 phonology:
   By using a post-lexical rule of L1 allophone with L2 phonemic change, will the error rate by L1 rule application be significantly less than 50% of the data with the rule environment?

(2) Research question on application of L2 phonology:
   By using a syllable sensitive phonological rule of L2 with L1 phonemic features, will the error rate by failed application of L2 be significantly less than 50% of the data with the rule environment?

(3) Research question on suppression of L1 phonology:
   Will the post-test results after an explicit instruction be significantly better than the pre-test results?
The following section will explore the phonological rules of Korean and English, with which these three research questions will be answered.

2. Phonological rules in Korean and English

The mismatches by different phonological alternations concern the allophonic or phonemic rules in L1 and L2 that have phonemic status in the other languages. There are four types of mismatches that bring the phonemic changes: 1) L2 phonemic changes by an L1 allophonic rule, 2) L2 phonemic changes by L1 phonemic rules, 3) L1 phonemic changes by L2 allophonic rules, and 4) L1 phonemic changes by L2 phonemic rules. The following are all these four types of phonological mismatches.

2.1. L2 phonemic change by L1 allophonic rule: Liquid Alternation of syllable onset consonants in Korean

The English phonemes /l/ and /r/ may often be mixed up in L2 English speech of L1 Korean learners by the Liquid Alternation rule in Korean phonology. By this rule, the liquid phoneme /l/ becomes [r] in syllable initial position as in salang [r] 'love,' but [l] in syllable final position as in salsal [l] 'softly.' This rule is allophonic in L1 Korean, but causes a phonemic change in L2 English as in the word light with the incorrect pronunciation [r]ight. In other words, the English listeners will understand the intended word light with incorrect meaning for right. This example is included in our data to see the suppression of L1 phonology.

2.2. L2 phonemic change by L1 phonemic rules: Liquid Assimilation, Nasal Assimilation, Coda Stopping and Coda Simplification in Korean

The English phonemes /l/ and /n/ may often be mixed up in L2 English speech of L1 Korean learners by the sonorant assimilation rules
in Korean phonology. There are two different sonorant assimilation rules in Korean: Liquid Assimilation and Nasal Assimilation. Both rules are phonemic to change a phoneme to a different phoneme in Korean.

Of these rules, the Liquid Assimilation changes the phoneme /n/ to /l/ when they are adjacent. For example, the word sinla becomes [sillala] ‘the Shilla dynasty’, and thułni becomes [thułlili] ‘fake teeth.’ On the other hand, the Nasal Assimilation rule changes the sequence of a nasal or oral stop and a sonorant phonemes to nasal stops. For example, soklisan becomes [soqnsinan] ‘the Sokli Mountain’; wangsipli becomes [waŋsimpni] ‘the Wangsipli place’; t’aŋlala becomes [t’aŋama] ‘the Tamra dynasty’; apbni becomes [amni]; and kkocb’nveum becomes [kkonnveum] ‘flower fragrance.’

Both of these rules are phonemic in L1 Korean, which also cause phonemic changes in L2 English. By the rule of Liquid Assimilation, the English word only is pronounced with the incorrect pronunciation o[l]ly. In other words, the English listeners will understand the intended word only with incorrect meaning for early. More examples of this rule are all night and one room with incorrect l-substitutions: all [l]ight and wa[l]lroom. On the other hand, by the rule of Nasal Assimilation, the English words Big Mac and at night are pronounced with the incorrect pronunciation Bi[ŋ] Mac and a[n] night. In other words, the English listeners will misunderstand the intended word Big Mac and at night to be the different word Bing Mac and and night.

In addition, the Korean rules of Coda Stopping as in beos [bøt] ‘friend,’ and Coda Simplification as in kaps [kap] ‘price’ bring phonemic changes for both Korean and English as in these examples /s/ to /t/ and /ps/ to /p/. For example, the English word concept is pronounced with the incorrect pronunciation conce[p] due to Coda Simplification. These rules are included in our data to see the suppression of L1 phonology.

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3 Our data in Section 4 will later show that Coda Stopping does not occur, as in the English words, bus and business *[t].
2.3. L1 phonemic change by L2 allophonic rule: Unaspiration rule in English

The Korean phonemes of plain stops /p, t, k/ may often be mixed up with the other phonemes of aspirated stops /pʰ, tʰ, kʰ/ in L2 English speech of L1 Korean learners by the Unaspiration rule in English phonology. There are two unaspirated environments for voiceless onset stops in English: after /s/ and in unstressed syllable onset. The Unaspiration rule is allophonic in English, although the feature unaspiration is phonemic in Korean phonology. In English, the Unaspiration rule makes complementary distribution of the Aspiration rule that applies to stressed syllable onset that does not begin with s, as in pie [pʰɪ], totality [tɒtʰæ lətɪ], volcano [vɔlkʰəmoʊ] and child [ʧʰaɪld]. In Korean, on the other hand, the aspirated stops are phonemically distinct from unaspirated stops as in pʰal 'eight' vs. pʰal 'foot', tʰal 'mask' vs. tʰal 'moon', kʰal 'knife' vs. kal 'to go', and fʰal 'sticky vs. fʰal 'well.'

Of these unaspiration environments, the post-/s/ environment makes the English allophone /p, t, k, f/ to be unaspirated after an /s/ in syllable onset. For example, the English words, speaker, style and screen, remains unaspirated as in s[p=]eaker, s[t=]yle and s[k=]reen. Unaspirated symbol is a superscript '‐' sign according to the extension of International Phonetic Alphabet (Handbook of the International Phonetic Association 1999:190). While the aspirated pronunciation, s[pʰ]eaker, s[tʰ]yle, and s[kʰ]reen, would be considered incorrect by the native listener of English. They often consider the words to be peaker, tile, and cream, whose onset stops are aspirated as in [pʰ, tʰ, kʰ]. On the other hand, the unaspiration environment of unstressed syllable onset makes the English allophone /p, t, k/ to be unaspirated in the onset position of unstressed syllables as in the examples, apple, application, appreciate, atlas, beauty, and airport. These examples are included in our data to see the application of L2 phonology.
2.4. L1 phonemic change by L2 phonemic rules: Vowel Reduction and Geminate Simplification

The English phonemic rules of Vowel Reduction and Geminate Simplification correspond to Korean phonemic changes. For the Vowel Reduction rule, many English vowels are reduced to the phoneme /ǝ/ in unstressed syllables. For instance, the vowel [æ] in the word *add* is reduced to schwa [ǝ] in reduced syllable as in *addition*. The distinction of these two vowels [æ] and [ǝ] are phonemic in both English and Korean. In Korean, the closest vowel equivalents still make minimal pair of words as in *dek* 'house' and *dǝk* 'virtue.'

We do not test this rule, because the data will confound the results by equivalence classifications (Flege 1995) of L1 unreduced vowel [ʌ] and the new L2 reduced phoneme [ǝ]. According to Flege’s Speech Learning Model (Flege 1995), equivalence classifications between the L1 and L2 sounds will be the ones that are difficult to perceive in the L2, because those sounds do not contrast in the L1. Flege concludes that the sounds that are similar but not quite the same in both languages will be hardest to master. For this reason, we do not take this rule of vowel reduction to test our research questions.

On the other hand, the geminate simplification rule of English simplifies geminate consonants to a single consonant. For example, the English words *summer* and *running* would be pronounced with a single consonant as in *su[m]er* and *ru[n]ing*. The consonantal length is phonemic in Korean, thus, *eonni* 'sister' and *eoni* 'freeze' are two different words, as well as *eomma* 'mother' and *eoma* 'Whoops.' We do not test these data because the measurement on double consonant duration as opposed single one is not established. We do not want to risk claiming whether or not the rule applied without knowing the criteria.

In relation to these two L2 phonology rules, the readers are referred to previous publications by the author (Kim and Lee 2005). The vowel
reduction rule in Kim and Lee (2005) showed small amount of, yet statistically significant, improvement that conforms to our present study.

Other rules not included for this study are the cases that the rule application does not bring any phonemic changes in either languages, but only allophonic changes. This kind of mismatches is not of primary concern in this study, because the allophonic differences are not psychologically real.

3. Method

Our method of investigation is to study the learner speech of English by Korean native speakers by both cross-sectional and longitudinal methods.

3.1. Speech materials

The speech materials consisted of read speech of L2 English by L1 Korean learners. All speech materials had both words in isolation and the same words embedded in sentences. The recording lists are shown in the data in (4), (5), and (6). Underlined are the segments of interest. We use International Phonetic Alphabet (IPA) symbols for phonetic transcription of erroneous sounds in parentheses [ ].

(4) Recording list for L2 phonemic change by L1 allophonic rules:
Liquid Alternation for syllable onset [r] and syllable coda [l] in Korean
a. English word: light [r], plate [r], stair [l]
   b. In English context:
      Where do you live in Korea? [r]
      Where are they playing tennis? [r]
      There was no confirmation about the policy. [l]
(5) L2 phonemic change by L1 phonemic rules:
Liquid Assimilation, Nasal Assimilation, Coda Stopping and Coda Simplification in Korean
a. English word
   *only*: [nn/ll] by Liquid Assimilation
   *application*: [mn] by Nasal Assimilation
   *business*: [t] by Coda Stopping
   *act* [k], *axe* [k] : by Coda Simplification
b. In English context:
   *We were in line at that time*: [nn/ll] by Liquid Assimilation
   *Stop running it*: [mn] by Nasal Assimilation
   *Where are they playing tennis?* [t] by Coda Stopping
   *What makes you think you are the best actor?* [k] by Coda Simplification

(6) L1 phonemic change by L2 allophonic rules: Unaspiration after onset /s/ and in unstressed onset in English
a. English word:
   *splendid, style, screen; apple, application* [pʰ, tʰ, kʰ]

b. In English context:
   *How splendid the idea was!* [pʰ]
   *I stared at her.* [tʰ]
   *I screamed at him.* [kʰ]
   *I have four apples.* [pʰ]
   *Fill in the application form.* [pʰ]

Words in the recording lists in (4) are subject to the Korean allophonic rules of Liquid Alternation, in Section 2.1. Korean has a single phoneme for liquid sounds, which becomes [r] in onset and [l] in coda of a syllable (e.g. [r] for *light* and [l] for *tile*).

Words in (5) are subject to the Korean phonemic rules of Liquid Assimilation, Nasal Assimilation, Coda Stopping and Coda Simplification,
in Section 2.2. The phoneme /l/ triggers the Liquid Assimilation rule, to make the input sound sequence /nl/ to [ll] (e.g. only [ollı]). We will later return to the discussion that the learner phonology is different from the native phonology to allow either [nn] or [ll] for the input sequence /nl/, while the native phonology allows only [ll] as in /sinlɑ/ [sillɑ], but not *[sinnɑ].

In comparison, words in (6) are subject to the English allophonic rule of Unaspiration in Section 2.3. Stop consonants in English are not aspirated after an onset [s] as in screen, and in an unstressed syllable as in apple.

These recording lists in (4) through (6) were used to obtain L2 English speech materials spoken by Korean adults who might be using either English phonology rules or Korean phonology rules.

3.2. Participants

Research participants consists of 92 Korean learners of English. The learner participants were all college students in their twenties. None of the research participants had noticeable accents of their native language. None had hearing or speech problems.

3.3. Data acquisition procedure

The data acquisition procedure comprised of two steps: 1) listening test for learners and 2) recording of learner speech. For the first step of the experiment, all learner participants took the listening component of Test Of English for International Communication (TOEIC).4 We then

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4 We assigned five different ranks in accordance to the score intervals in the TOEIC Can–Do Guide (Chauncey Group International 2000) as a valid indication of English language proficiency of speaking to the listening comprehension score: 1) 5–100, 2) 105–225, 3) 230–350, 4) 355–425, and 5) 430–495. We used the test set that conforms to this Can–Do Guide where listening test recordings were spoken by native speakers of the General American English.
used the scaling of score intervals in *TOEIC Can-Do Guide* (Chauncey Group International 2000) as co-variance units for our cross-sectional results. In other words, the results of TOEIC listening tests were used to categorize students by the level of proficiency.

For the second step of the experiment, we recorded Korean learner speech of the English words in English context. The learners briefly listened to and repeated after the native speech recordings before they produced their own speech. The recording took place two times: 1) on the very first week of class instruction, and 2) after seven weeks of instruction. The pronunciation instruction in class included many different aspects of pronunciation including, but not focused on, the Korean *l*-alternation and the English Unaspiration rules.

### 3.4. Analysis

We measured the acoustic features that are relevant to the phonological phenomena in Korean and English. To evidence the application of Korean rule of *l*-alternation, we identified the expected erroneous sounds as presented in the data sets (4) and (5): *[r]* for *light*, *[nn]* or *[ll]* for *only*, etc. Figure 1 illustrates an incorrectly produced nasal *[n]* for the target liquid *[l]* in L2 English word *only*, spoken by an L1 Korean learner.
Nasal consonant quality was determined by a very low first formant centered at about 250 Hz, and a large region above the first formant with no energy. This speaker has a second, rather faint, nasal formant just below 2000 Hz. We do not see a formant in the neighborhood of 1100 or 1200 Hz that is typical of most initial laterals for most speakers.

On the other hand, we also identified the expected erroneous sounds by ignoring the English rule of Unasperiration in unstressed onset or after onset [s]. For example, the English word *screen* in learner speech may have an aspirated [kʰ], unlike the target phone [k=]. The aspiration was detected by the acoustic cues of 1) silence (stop gap), 2) release burst indicated by a strong vertical spike, and 3) a long VOT of more than 30 ms as short friction noise (scattered marks after the release) before vowel formants begin.

For analysis, we compared the learner speech with the native speech. For less clear cases of acoustic features, we additionally used the perceptual judgment by Korean research assistants as well as the native speakers of English. Inter-rater reliability among research assistants was high for a sample test of 92 instances, as Cronbach’s alpha was .803.
We counted only the expected errors by the Korean phonology and English phonology as outlined in Sections 2 and 3.

4. Results

A total of 2,804 word data ( = 92 learners for pretest for cross-sectional study * 27 words in word and sentence level utterances + 16 learners for post test in longitudinal study * 5 words * 2 rules of L1 and L2 pair * 2 contexts of word and sentence level pair ) were acquired from the recorded corpus of learner speech in word level and sentence level production by 92 Korean learners of English. The results of the study are shown in Figure 2 for cross-sectional study and Figure 3 for longitudinal study.\(^5\)

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\(^5\) Part of the data has been used in Kim (2009a), although the selection, scope, and analysis of the data are different from this paper, because the purpose of the two papers were different.
Cross-sectional study: Error rate (%) of L2 English speech by L1 Korean learners show successful suppressing of L1 Korean rules in both word level (a) and sentence level (c), and unsuccessful application of L2 English rules in both word-level (b) and sentence-level (d).
These figures represent the interference error rates in percentage in which either the native phonology rule interfered as in (a&c), or the target phonology rule failed to apply as in (b&d). To be specific, the application rates of L1 Korean rule of $l$-alternation are shown in (a&c), and failure of applying the L2 English rule of Unaspiration are shown in (b&d).

The words in 2(a) are light [r], plate [r] and stare [l] for Liquid Alternation; only [ll] for Liquid Assimilation; application [mn] for Nasal Assimilation; business [t] for Coda Stopping; and act [k] and axe [k] for Coda Simplification. The words in 2(b) are splendid, style and screen for Unaspirated [p=], [t=], [k=] after onset s; and apple and application for Unaspirated [p=] in unstressed onset. The words in 2(c) are live [r], playing [r], there [l] for Liquid Alternation; in line [ll] for Liquid Assimilation; stop running for [mn] by Nasal Assimilation; tennis [t] for Coda Stopping; and makes [k] for Coda Simplification. The words in 2(d) are splendid, stared, screamed for Unaspirated [p=], [t=], [k=] after onset s; and apples and application for Unaspirated [p=] in onset C.

The results in Figure 2 are from the cross-sectional study, while those in Figure 3 are from the longitudinal study. The cross-sectional results in Figure 2 show two things. First, we observe the relative frequency between the successful suppression of L1 Korean rule in (a&c) and the unsuccessful application of L2 English rule in (b&d). Secondly, there is some correlation between the speaker proficiency of listening and the error rates in production.

Let us first examine the relative frequency of L1 rule interference and L2 rule acquisition in cross-sectional results in Figure 2. In Figure 2 (a&b) for word-level production, the error rate by Korean rule interference in 2(a) is much lower than the error rate by English rule failure in 2(b). The paired $t$-test results showed the significant ($p = .001$) difference between the interference rate of L1 rule in 2(a&c) and the failure rate of L2 rule in 2(b&d). We included the same number of data from each side, by excluding some L1 samples with no errors. For the test (L1-rule mean = .10, $sd = .299, n = 433$; L2-rule mean = .55, $sd = .498, n = 433$),
the 95% CI for the difference in means is .450, \( sd = .568 \) \( (t = 16.5, p = .001, df = 432) \). The effect size is .79 \( (= .450 / .568) \), which is a large effect size.

In sentence-level production 2(c) and 2(d) as well, the interference rate by Korean rule application in 2(c) is much lower than the failure rate of English rule application in 2(d). The \( t \)-test results showed the significant \( (p = .001) \) difference between the application rate of L1 rule in learner speech 2(c) and the failure rate of L2 rule in learner speech 2(d). For the test \( (L1\text{-rule mean} = .08, sd = .276, n = 435; L2\text{-rule mean} = .60, sd = .491, n = 435) \), the 95% CI for the difference in means is .513, \( sd = .569 \) \( (t = 18.8, p = .001, df = 434) \). The effect size is .90 \( (= .513 / .569) \), which is a very large effect size. To sum up, both word level production in (a&b) and the sentence level production in (c&d) show much lower interference rate by L1 rule than the failure rate of L2 rule application. Thus, Research Question 1 for L1 rule is answered positively, while the Research Question 2 for L2 rule is answered negatively.

To move on to the postponed discussion of the correlation between the speaker proficiency and the error rates in cross-sectional results, we shall discuss the developmental results in relation to Research Question 3. The figures in 2(a) and 2(c) for error rates by L1 phonology do not answer for the Research Question 3, because error rates are too low to discuss any further decrease regardless of the speaker proficiency development. That is, learners suppress the L1 rule interference from an early stage of learning.

On the other hand, in Figures 2(b) and 2(d), learner speech acquires increasingly more of the L2 phonology rules as the learner proficiency.

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6 Included speech samples are all speech samples of L2 rules and the same number of most erroneous speech samples of L1 rules in Figure 2. Included samples of L1 rules are \textit{light} [r], \textit{plate} [r], \textit{stare} [l], \textit{only} [l] and \textit{application} [mn] in word level utterances; and \textit{live} [r], \textit{playing} [r], \textit{there} [l], \textit{inline} [ll] and \textit{makes} [k] in sentence level utterances. Missing samples were due to bad audio signal or because the speaker skipped reading those.
increases. In other words, the error rates decrease as a function of speaker proficiency in both Figure 2(b) and 2(d). The average error percentages decrease as the learner proficiency increases for word level (69.6 > 59.8 > 52.2 > 39.2) in 2(b), and for sentence level (77.4 > 65.8 > 52.6 > 43.6) in 2(d). Output from a Pearson Correlation shows the strong correlation between the proficiency levels and failure of L2 rule application in words and sentences. For word level utterances, the effect size is $r = -.229, p = .001$ (statistical at $\alpha = .05$ level), and $n = 433$. This is a large effect size (a strong relationship). For sentence level utterances, the effect size is $r = -.282, p = .001$ (statistical at $\alpha = .05$ level), and $n = 435$. This is also a large effect size (a strong relationship). We thus find the developmental results in Figure 2 that answer positively for the Research Question 3.

Let us now turn to the results from the longitudinal study in Figure 3. The pre-test and post-test results before and after instruction are demonstrated in terms of L1 rule interference and L2 rule acquisition.

![Figure 3](image.png)

(Figure 3) Longitudinal study: Error rate (%) of L2 English speech by L1 Korean learners in the pre-test decreases significantly in the post-test for both word level in (a) and sentence level in (b).

The longitudinal results in Figure 3 show two things. First, we observe the relative frequency between the successful suppression of L1
Korean rule and the unsuccessful application of L2 English rule in both word-level production in 3(a) and in sentence-level production in 3(b). Secondly, the error rates decrease over time in both word-level production in 3(a) and in sentence-level production in 3(b).

As shown in Figure 3(a) and 3(b), the differences between the interference of L1 rule (L1 Korean rule) and the failure of L2 rule application are distinct. For word level utterances of both pre test and post test (L1-rule mean = .12, \(sd = .328\), \(n = 320\); L2-rule mean = .56, \(sd = .497\), \(n = 320\)), the 95% CI for the difference in means is .441, \(sd = .584\) (\(t = 13.5, p = .001, df = 319\)). The effect size is .76 (\(= .441 / .584\)), which is a large effect size. For sentence level utterances of both pre test and post test (L1-rule mean = .08, \(sd = .264\), \(n = 320\); L2-rule mean = .63, \(sd = .485\), \(n = 320\)), the 95% CI for the difference in means is .550, \(sd = .558\) (\(t = 17.6, p = .001, df = 319\)). The effect size is .99 (\(= .550 / .558\)) which is a very large effect size.

In other words, at all stages in Figures 3(a) and 3(b), failure rates of L2 rule application are higher than the interference rate of L1 rule application. The results thus answer positively to our Research Question 1 and negatively to Research Question 2 in that learner speech avoids the native phonology interference faster than the acquisition of target phonology rules.

Figure 3 also shows the results from the longitudinal study, in which the average error rate before instruction decreases after instruction. Errors made in pre-test significantly decreases in the post test for word-level errors by L2 rules and sentence-level errors by both L1 and L2 rules. (L2-rule mean for word-level pre-test = .68, \(sd = .470\), \(n = 160\); for post-test = .45, \(sd = .499\), \(n = 160\); the 95% CI for the mean difference is .225 (\(t = 4.15, p = .001, df = 318\)). L2-rule mean for sentence level pretest = .77, \(sd = .423\), \(n = 160\); for post-test = .48, \(sd = .501\), \(n = 160\); the 95% CI for the mean difference is .288 (\(t = 5.55, p = .001, df = 318\)). L1-rule mean for sentence level pre-test = .11, \(sd = .309\), \(n = 160\); for post-test = .04, \(sd = .205\), \(n = 160\); the 95% CI for the mean difference is .063 (\(t = 3.18, p = .001, df = 318\)).
= 2.13, \( p = .001, \ df = 318 \)). However, word-level L1 rule suppression showed insignificant improvement, because many L1 rules started out as zero (0) errors in the pretest, allowing no possible improvement in the post test. In overall, we find that the developmental results in Figure 3 answer positively to our Research Question 1, negatively to the Research Question 2, and positively for the Research Question 3.

5. Discussions and Conclusion

The results indicate that learner speech manifests a significantly more difficult L2 rule acquisition than L1 rule suppression, in both word-level and sentence-level production. In addition, the error rate decreases according to the speech proficiency in the cross-sectional study. Furthermore, the longitudinal study shows that the error rate drops more distinctively after instruction, which indicates that an explicit instruction is effective to phonological acquisition of learner speech.

We thus have answered for all the Research Questions. For the first question on suppression of L1 phonology, it is very common that learners do suppress L1 phonology, as the average error rate is much below 50%. For the second question on acquisition of L2 phonology, L2 phonology rules are not well acquired as the error rate is much higher than the case of suppression of L1 phonology. For the third question on developmental transition, the suppression and acquisition of the phonological rules seem to take place over time, as the learner production after the instruction is higher than the production before the instruction. This answer to the third question has the additional support from cross-sectional study that the error rates decrease as the learner proficiency increases.

Additional findings in this study are the following. First, learners obey the phonological feature of L2 rather than the phonological feature of L1. In our study the feature [±aspiration] is phonemic in Korean but allophonic in English, while the feature [±lateral] is phonemic in English but allophonic in Korean. In other words, the lateral feature distinguishes [r/l]
as different phonemes in English, but as different allophones in Korean. Our data show that learners did much better in the lateral distinction than aspiration distinction. This finding conforms Han (2006) whose learner subjects perceived better of L2 features in Japanese and Korean. On the other hand, the result is against Brown (2000) who argues that the phonemic properties of the L1 system determine how the L2 sound system will be perceived.

The second finding is that phonological acquisition pattern in Figure 2 does not show the U-shape as Abrahamsson (2003) claims. That is, our subjects did not perform in the pattern of being good in the first stage, then bad at the second stage, then good again in the last stage. In other words, our cross-sectional study does not show intermediate bad stage.

The third finding is that the learner phonology is different from the L1 phonology. For our first example, the learner phonology often changes /nl/ to [nn] as in in-line skate [nn], unlike the L1 phonology that changes /n/ to [l] in Section 2.2. This supports the presence of the so-called ‘interlanguage’ grammar (Selinker 1972).

For our second example of learner phonology, the nasalization rule in L1 phonology applies differently. In L1 Korean in Section 2.2, the liquid consonant /l/ becomes /n/ after a nasal stop [m] and [ŋ], but not [n], as in t’amla [mn] ‘the Tamra dynasty,’ and djangla [djangnæ] ‘future,’ but not sinl[a] [ll] *[nn] ‘the Shilla Dynasty.’ For learner phonology, the nasalization rule seems to be triggered by all the nasal consonants including /n/ as well, as in Camry [mn], kingl[y] [yn], and in-line skate [nn].

For our third example of learner phonology, the L1 Liquid Alternation rule works differently in learner speech from L1 speech. In L1 phonology the liquid consonant /l/ becomes [r] in onset and [l] in coda. However,

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7 Markedness criteria (Eckman 1977) does not seem to be relevant here, because literature do not differentiate the markedness ranking of unaspirated voiceless stop or the central liquid /r/. Our error rate did not measure retroflexness, but only the non-lateral quality of the liquid.
learner phonology does not make the onset /l/ to [r] in onset clusters as in *p[^r]lay. Instead, learners often insert a vowel before this liquid and make it a syllable coda. Thus, the data p[^r]lay do not become p[^r]lay, but becomes p[^w]lay.

Moreover, the liquid sound /r/ in syllable final position does not undergo the L1 phonology rule, but deleted. According to the L1 phonology rule, the phonetic realization of the liquid phoneme is [l], instead. Thus, the word stare does not become sta[l]e but becomes sta[e] with deletion of the liquid. On the other hand, the L2 phoneme /l/ in syllable final position remains unchanged as in sale and bowl.

Some limitations in this study include the limited number of phonological alternation phenomena that involve mainly the L1 rules of Liquid Alternation and Sonorant Assimilations and L2 rules of Unaspiration. Although the previous work by the author has dealt with the L1 rules of vowel insertion (Kim 2009b) and the L2 rules of vowel lengthening (Park & Kim 2008), a holistic view of the various phenomena awaits for a comprehensive analysis that interweaves 1) the phonemic changes of sound quality (e.g. l/r), 2) the allophonic changes of sound quality (e.g. pʰ/p=), 3) changes in syllabic structure (e.g. vowel insertion), and 4) changes in segmental duration (e.g. vowel lengthening).

The results of this study may be applied to pronunciation teaching. Certain segmental difficulties such as unaspiration in this paper and vowel reduction in Kim and Lee (2005) are strikingly salient in L2 accented speech. These segmental rules may be taught with emphasis in pronunciation programs. Ultimately, the choices a pronunciation teacher makes should be based on factors that have been shown to influence intelligibility and comprehensibility.

주제어: 학습음, 중간언어 음운론, 영어 무기음화 규칙, 국어 유음동화규칙, 한국 학습자의 영어음, 학습음의 음운 규칙, 제2 언어 음운규칙
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