

## Stress assignment rules in Korean English

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**Kim, Jong-mi. 2005. Stress assignment rules in Korean English.** *Studies in Phonetics, Phonology and Morphology* 11.2. 71-82. Although literature on second language pronunciation has thus far focused only on the difficulties of acquiring the target sound by adult learners, we argue that some target phonology rules are apparently as easy to acquire as instantaneous. We compared the F0 slope of stress assignment rules in English as spoken by 25 native speakers and by 46 Korean learners. The learners had an average of 10-minute instruction with less than a week of practice period. The stimulus words, sentences, and paragraph contrast the compound stress rule and nuclear stress rule in compound nouns and noun phrases such as the 'White House' and 'a white house.' We measured the F0 values of the speech data and normalized them by the average pitch of individual speakers. The result indicates that both the native speakers and the learners had an F0 drop ( $p < .01$ ) for the compound nouns but an F0 rise ( $p < .01$ ) for noun phrases. We also observed that the learners showed a more characteristic ( $p < .05$ ) F0 slope than the native speakers did. We thus conclude that Korean learners easily learn stress assignment in English, which is realized as pitch. (Kangwon National University)

Keywords: compound stress in English, F0 normalization, stress assignment rules, Korean learners of English, English as a foreign language

### 1. Introduction<sup>1</sup>

It is generally known that adult language learners are slower or unable to attain target-like pronunciation than child language learners (Scovel, 1988; and many others). Accordingly, literature on second language pronunciation has mainly discussed the difficulties of learning the target phonology, and very few studies conducted on its successful learning by adult learners. This is also true for the literature on Korean learners of English as a foreign language in which numerous learning problems have been raised. Many different types of segmental and prosodic errors in Korean English are extensively discussed in Kim (2002) as in many others in the field. In all major aspects of phonology, Korean adult learners of English have been reported to undershoot the target, for instance, of vowel quality by Koo (2001), of consonantal quality by Lee and Lee (2004), of syllable structure by Lee *et al.* (2002), of rhythm by Lee and Kim (2005), of stress in Yang (2002), and of intonation by Um (2004).

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On the other hand, Kim and Flynn (2004) find that Korean learners show a good command of the English stress assignment rules on an imitation task after a very short phonetic lesson. The data were gathered from 1 model native speaker and 30 learners who produced about ten phrases or sentences each. We would like to elaborate this aspect in this study by increasing the number of native and learner data for statistic significance.

In English compound nouns, stress is assigned on the left side of the constituents, whereas in noun phrases, stress is assigned on the right side of the constituents. The former is known as "the compound stress rule" and the latter "the nuclear stress rule" (Chomsky and Halle, 1968: p.17). Despite their numerous citations, the rules have never been, to our knowledge, statistically proved to be significant in acoustic measurements.

One major goal in this study is to prove the two contrasting stress assignment rules in English by means of acoustic measurements. Acoustic cues of stress rules have been proposed to be F0 values (Hz) that reflect pitch height (Jeong, 2003), or speech duration (milliseconds) that reflects relative loudness (Kim and Flynn, 2004). These cues are related to the nature of 'stress,' whose relative prominence is represented by pitch height, loudness, vowel length, muscular tension, or respiratory energy (Ladefoged, 2001: p.93). A common practice for stress measurement is to trace F0 values, as in Beckman *et al.* (1997) and many others for American English. We thus hypothesize that native speech shows contrastive F0 trace depending on the compound stress rule and nuclear stress rule.

- (1) **Hypothesis 1:** The contrastive stress assignment rules for compound stress and nuclear stress are observed in the F0 trace of native speech.

The F0 trace is often used to measure the accentual phenomena of Korean language as well as those of English (Koo, 1986; Jun, 2000; among others). In addition, F0 measurement is claimed to demonstrate a strong correlation with non-native characteristics of English stress in Korean and Japanese speech (Jeong, 2003; Park *et al.* 2003, among others). We thus hypothesize that the stress assignment pattern in Korean English can be observed in terms of the F0 trace.

- (2) **Hypothesis 2:** Korean learners manifest a contrast between the compound stress rule and the nuclear stress rule in the F0 trace, when they have a good command of the rules.

The hypothesis (2) differs from (1) in that the former concerns the native speech, while the latter, the learner speech. In both L1 and L2 speech of English we hypothesize the F0 realization of stress assignment.

Then, the next question is whether Korean learners would have a command of the stress assignment rules themselves. Previous findings in literature seem to support this. Both Jeong (2003) and Kim and Flynn

(2004) show that learners do command the stress assignment rules to a certain extent. In Jeong's study (2003: pp. 18-21), learners who had no lesson and no practice could command the rules in words and phrases, although they could not do so in sentences and paragraphs. In contrast, both Jeong (2003: pp. 21-36) and Kim and Flynn (2004) report that learners who had a short lesson and practice time seemed to have acquired the rules in all utterance units. The nature of data in these two studies were different in that learners practiced after the native speech model in Kim and Flynn (2004), but not in Jeong (2003). We then construe that the learners might have acquired the rules better by the increased amount of the instruction. Can Korean learners acquire the stress assignment rules by a certain amount of instruction?

- (3) **Hypothesis 3:** Koreans readily acquire the stress assignment rules in English by a certain amount of instruction.

To test this hypothesis, we have to include a short-term learning process for our subjects. Since previous literature has tested the inquiry with a small number of native speakers (three in Jeong, 2003; one in Kim and Flynn, 2004) due to different purposes of investigation, we need to verify the hypotheses with a more number of subjects. Our data represent 25 native speakers of American English and 46 Korean learners.

The subsequent sections demonstrate how the F0 values represent a good command of the stress assignment rules in English as spoken by Korean learners. Section 2 presents the methods of the experiment; Section 3, the results of measurements; and Section 4, conclusions and discussions.

## 2. Methods

### 2.1 Materials

The recording materials were the same as in the previous study to compare the results (Jeong, 2003; Kim and Flynn, 2004). They were comprised of 12 contrastive sets of compound nouns and noun phrases, and 7 sentences and 1 paragraph that contained these contrastive compound nouns and noun phrases. The full materials are listed below.

- (4) a. the White House (the residence of the President of the United States)
- b. white house (a house that is white in color)
- (5) a. a lighthouse (a tall tower with a light for warning ships)
- b. a light house (a house that lets in a lot of light, or that is painted with a light color)
- (6) a. a blackboard (a large slate used for writing with chalk)
- b. a black board (a long piece of wood that is black in color)

- (7) a. a darkroom (a special room used in photography)  
b. a dark room (a room that is dark)
- (8) a. a hotplate (an electric cooking device)  
b. a hot plate (any plate that is hot)
- (9) a. a hard-ball (a baseball)  
b. a hard ball (any ball that is hard)
- (10) a. The residence of the President of the United States is the White House.  
b. I really want to live in a white house on the hill.
- (11) a. I can't see the blackboard.  
b. It is made of a black board. (a long piece of wood that is black in color)
- (12) Not all dark rooms are darkrooms. (a special room for photography)
- (13) There's a hot plate on the hotplate. (an electric cooking device)
- (14) I want to have a hard ball to play hardball. (a baseball)
- (15) Since I've been living by the sea, I've seen a lighthouse from my dark room through the broken window. But, I have long wanted to move to a beautiful city where I can live in a white house on the hill to work with my photography in a dark room. I have to work hard so that I can recover from the catastrophic economic cutbacks that occurred last year. If they offer an excellent base salary, I can get a job even as a porter in the White House to secure my future. If my dreams come true, I might carry all my possessions, including a hotplate for cooking and even a hard ball for hardball (baseball).

Notice that the stimulus list itself in its orthography contains the contrastive information about compound nouns and noun phrases: eg., 'a blackboard' for a compound noun vs. 'a black board' for a noun phrase. It is easy to notice the grammatical structure by the orthographic unit, depending on whether or not there is a space between the two constituent words. We followed the general orthographic convention and elicited a natural reading of the subjects, although the orthographic cues might have facilitated learning the stress assignment rules for our subjects.

## 2.2 Participants

A total of 71 participants were tested, among whom 25 were native speakers of American English and 46 were native speakers of Korean learning English as a foreign language. Some of the Korean learners (30 people) read only one-third of the data, although the rest of the participants read the whole list. These learners had to read the randomized list of the data that was inter-mixed with other 100 words and sentences.

All participants' hearing and vision were normal, without a significant medical or psychiatric history. The dialects of the native speakers were mostly a Northern or Western variety of educated American English (92%),

while the Korean learners a Mid-west variety of educated Korean (95%). All learners have never lived outside of Korea, although one speaker who read 1/3 list of data traveled to England for months. The education levels of native speakers included 24% of high school and 76% of college or post-graduate education. All Korean subjects had college education, and they were learning English as a foreign language in a college. The English proficiency level of Korean learners varied at a small range, and the majority were in the intermediate level of English with a score range of 460 - 700 of the standardized TOEIC test. We also tested the learners on listening and speaking proficiency; and all the learners were evaluated to be in the intermediate level for these two other criteria as well.

### 2.3 Procedure

All Korean learners were at first given a 10-minute training session in a college class, during which all 20 items in the stimulus list were presented in a handout, either by themselves or intermixed with other words and sentences. The teacher (author) explained to the students the phonological rules in the list including that the compound nouns such as 'White House' are assigned the stress on the left-side constituent, and the noun phrases such as 'a white house' are assigned the stress on the right-side constituent. The teacher told the students that the rules were what they might have already learned in their high school classes. Then, the learners listened to and repeated after the model native speech in the stimulus list. In contrast, the native speakers in this study did not have any lesson or training session about the stress assignment rules in English. All speakers answered that they understood the meanings of all utterances in the stimuli list.

The learners were allowed to do more 'listen-and-repeat' practices on their own if their time had permitted. The native model speech material was available in the lab computers, in CDs, and by web-downloads. For approximately 60% of the data acquired, however, the learners had only a 5 minute practice, due to the immediately following recording schedule. The learners were allowed to have later recording schedule only if their recording list includes other 100 words and sentences. All recordings were completed within a week.

Following the practice time, the subjects were asked to read the stimulus materials in a quiet room. We recorded their speech in a digital form using a PC. The sampling rate was 16 KHz and 16 bits. Korean learners were asked to read only once, while the native speakers twice. For native speech, the second-time recording was taken for the data, although the first-time recording was occasionally taken to replace a weak, noisy or unnatural speech signal. The recording took approximately 2 minutes per subject. A total of 1,523 data (= 3,046 constituent words) were obtained for the morphological structure of compound nouns or noun phrases: 777 data from the Korean learners and 746 data from the native speakers.

## 2.4 Analysis

To analyze the data, F0 value was measured in the mid-point of the vowels of interest by Pitchworks (version 5.0, by Scicon Company). When the F0 value showed an anomaly due to, for example, laryngealization, preceding aspiration, then the measurement was taken from one of the closest available time domains of the same vowel. For other types of anomalies such as a super-high F0 value by computation failure of the given software, we compared the F0 traces with different software such as CSL by Kay Elemetrics or Speech Station 2 by Sensimetrics, and took a more reasonable F0 value. All the measured data were then employed as "the raw F0 values."

We then normalized the raw F0 values with the average pitch of each speaker. In concrete, all F0 values were first divided by the average F0 value of all stressed syllables per speaker, and then timed by the average F0 value for all speakers. The following formula represents our normalization process.

$$(16) \textit{Normalized F0} (\text{Hz}) = \{ \text{RawF0} / ( \sum_{i=1}^m \text{F0self} / m ) * ( \sum_{i=1}^n \text{F0all} / n ) \}$$

(where: Normalized F0(Hz) = normalized F0 value, Raw F0 = the raw F0 values, F0self = F0 values for each speaker, and F0all = F0 values for all speakers)

The results in the subsequent sections are based on the normalized F0 values, although the raw F0 values will be compared when needed. We compare the degree of F0 drop and rise in the contrasting structures of the noun compounds and the noun phrases, as employed in Jeong (2003).

## 3. Results

The results indicate a significant contrast in the two types of stress assignment rules in English for both the native and learner speech. The F0 difference ( $\Delta F0$ ) of a given element from that of the preceding element indicates a pitch drop or rise: a negative value for pitch drop and a positive value for pitch rise. In other words, the F0 difference between adjacent elements represents the F0 slope of pitch rise or pitch drop.

$$(17) \quad \Delta F0 (\text{Hz}) = F0_{\text{right}} - F0_{\text{left}}$$

(where:  $\Delta F0$  (Hz) = F0 value differences, F0left = F0 values of the first constituent of the structure, and F0right = F0 values of the second constituent of the structure.)

We will refer  $\Delta F0$  (Hz) in (17) as the "F0 slope" because it indicates an F0 drop or rise. Table 1 lists the average F0 slope (Hz) of the normalized F0 values in the compound nouns and noun phrases as well as their standard deviations (in parentheses) in native and learner speech. The last column quantifies the difference of the two contrasting slopes.

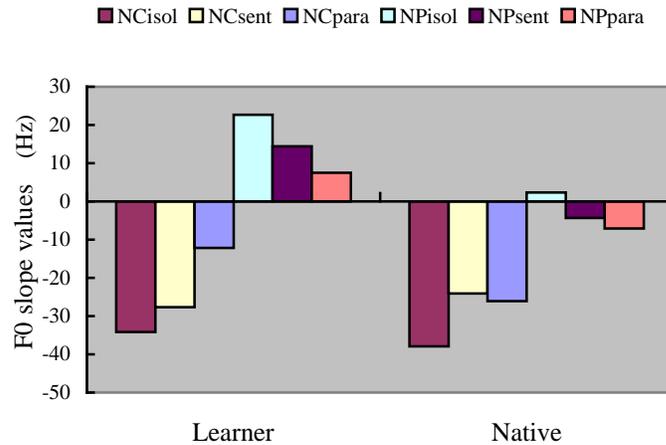
**Table 1. Average F0 slope values (Hz) in the compound nouns compared to their counterpart noun phrases ( $n = 1,523$ )**

| Speakers | Word      | $\Delta F0$ in CN | $\Delta F0$ in NP | $\Delta F0$ (NP-CN) |
|----------|-----------|-------------------|-------------------|---------------------|
| Native   | Isolation | -37.9 (24.5)      | 2.3 (17.1)        | 40.3 (23.6)         |
|          | Sentence  | -21.9 (14.3)      | -4.3 (15.4)       | 17.6 (21.6)         |
|          | Paragraph | -26.1 (15.5)      | -7.1 (20.2)       | 19.1 (20.3)         |
| Learner  | Isolation | -34.2 (13.4)      | 22.7 (17.2)       | 56.9 (28.9)         |
|          | Sentence  | -27.7 (19.7)      | 14.4 (19.4)       | 42.1 (31.9)         |
|          | Paragraph | -12.2 (16.3)      | 7.5 (10.1)        | 19.6 (18.1)         |

In Table 1, the F0 slope values of the compound nouns ( $\Delta F0$  in CN) are all smaller than their counterparts of the noun phrases ( $\Delta F0$  in NP). This fact is quantified in the last column ( $\Delta F0$  (NP-CN)) where every instance of the subtraction of the two contrasting slopes derives a positive value. In fact, all the F0 slope values of the compound nouns ( $\Delta F0$  in CN) are smaller than -12.2 Hz, while their counterpart values in the noun phrases ( $\Delta F0$  in NP) are greater than -7.1 Hz. A small negative value of  $\Delta F0$  such as -4.3 Hz or -7.1 Hz, may still indicate the stress placement on the right-side element, since the F0 trace in utterances tends to decline toward the end part. For the majority of the noun compounds, the F0 values are greater on the left side in the constituents, indicating that the speakers put stress on the left. The stress difference ( $p < .01$ ) between the noun compounds and the noun phrases are consistently observed regardless of the difference in structural units: words in isolation, sentences, and paragraphs. The distinction is successfully made in both native speech ( $n = 746$ ) and learner speech ( $n = 777$ ). We did not find any significant difference in the subset of learner speech (30 people) who read only one-third of the randomized list of the data embedded in other 100 words and sentences. This subset result conforms to Kim and Flynn (2004).

To determine the significance of the acquired data, the t-test was employed for every pair of the words with contrastive compound nouns and noun compounds. A total of 711 CN/NP pairs were collected from 71 speakers who were given 6 CN/NP pairs in words, 5 in sentences and 3 in paragraphs. From the 711 pairs, we excluded 50 pairs of which the  $p$ -value was greater than .05. These 50 pairs were interestingly occurred from only one structure pair, i.e., 'a [darkroom]<sub>CN</sub>' vs. '[a dark room]<sub>NP</sub>' embedded in a sentence in native speech. The remaining 684 pairs were undergone to further statistical analysis with the normalized F0 value differences (Hz)

for the compound nouns and noun phrases. The average F0 value difference is summarized in the following Figure 1.



**Figure 1. F0 slope values (Hz) for the noun compounds as compared to those for the noun phrases in learner and native speech ( $n = 1,368$  with individual  $p < .05$ ). (Note: Learner = learner speech, Native = native speech, NCisol = noun compounds in isolation, NPisol = noun phrase in isolation, NCsent = noun compounds in sentence, NPsent = noun phrase in sentence, NCpara = noun compounds in paragraph)**

As shown in Figure 1, the F0 slope values of the noun compounds are all negative, less than -10 Hz; while those for the noun phrases are all greater. This dichotomy indicates that both the native speakers and learners distinguish the stress placement in terms of pitch level, where the compound nouns are assigned a stress on the left element and the noun phrases on the right element in the constituents. It is interesting to note in Figure 1 that the F0 slope values are progressively flatter in isolation, sentences, and paragraphs. Another interesting fact in the figure is that the learners made a sharper distinction between the two stress assignment rules: compound stress and nuclear stress. The distinction emerges clearer when we compare the F0 slope values of the two structures as in Table 2. Table 2 is different from Table 1 since it excludes statistically unimportant data.

**Table 2. F0 slope values (Hz) of the noun compounds and the noun phrases for statistically significant samples ( $n = 1,368$  with individual  $p < .05$ )**

| Speakers | Word      | $\Delta F0$ in CN | $\Delta F0$ in NP | $\Delta F0$ (NP-CN) |
|----------|-----------|-------------------|-------------------|---------------------|
| Native   | Isolation | -37.9             | 2.3               | 40.2                |
|          | Sentence  | -24.1             | -1.8              | 22.3                |
|          | Paragraph | -26.1             | -7.1              | 19.1                |
| Learner  | Isolation | -34.2             | 22.7              | 56.9                |
|          | Sentence  | -27.7             | 14.4              | 42.1                |
|          | Paragraph | -12.2             | 7.5               | 19.7                |

The F0 slope values in Table 2 indicate that the F0 slopes glided down drastically for the compound nouns, while they either level or rise up for the noun phrases. In other words, the compound nouns have stress on the left element (stronger negative values), while the noun phrases have stress on the right element (weak negative or positive values). When stress is on the right, then the slope values are weak negative or positive values, given that the F0 trace declines in human utterances. The differences of the two contrasting slopes are shown in the rightmost column ( $\Delta F0$  (NP-CN)). The positive values in this column indicate that the compound stress slope is downwards, while the nuclear stress slope is either level or upwards. Table 2 shows a large amount of positive values in the last column, meaning that the compound stress was assigned to the left, and the nuclear stress was assigned to the right. Thus, the data support all of our three hypotheses:

- (18) a. HYPOTHESIS 1 ATTESTED: Native speech shows the stress assignment rules in terms of the F0 slopes as in Table 1 and Table 2.
- b. HYPOTHESIS 2 ATTESTED: Learner speech shows the stress assignment rules in terms of the F0 slopes as in Table 1 and Table 2.
- c. HYPOTHESIS 3 ATTESTED: Koreans readily learn the stress assignment rules in as a short learning time as 15 minutes to 1 week.

For Hypothesis 1 about the native speech, 13 out of the 14 CN/NP pairs in our data (6 pairs in isolation + 5 pairs in sentences + 3 pairs in paragraphs) demonstrated a significant contrast. Only one CN/NP pair in sentences was inconsistently produced ( $p = 0.812$ ). This exceptional pair happened to be embedded in a difficult context for instantaneously understanding the morphological structure: 'Not all dark rooms are darkrooms.'

For Hypothesis 2 about the learner speech, all 14 CN/NP pairs showed a significant contrast. It is interesting to see that Korean learners were even better at commanding the stress assignment rules as far as pitch realization is concerned. Although we do not yet know the precise reasons of this fact, we observed during the experiment that the learners associated only the

high pitch with stress assignment, but not the low dip of pitch as reported in the native speech by Beckman *et al.* (1997). We further notice that the learners showed a sharper contrast in a smaller unit of utterances, and thus the F0 slopes are progressively greater from paragraphs, sentences, and words. We do not know this reason either, although it is possible that the longer utterances contain more linguistic variables that learners must cope with.

All these results are consistent to the previous studies by Jeong (2003), and Kim and Flynn (2004), although the focus and the data are different. Jeong (2003) focuses on the production by less competent Korean learners. Jeong's result is based on the absence of a native model speech and 'listen-and-repeat' practice period, and the absence of the F0 normalization procedure that were newly adopted in this study. Kim and Flynn (2004) focus on the learner F0 values in an imitation task that showed a progressively greater discrepancy from that of the native model speech in the order of isolation, sentences and a paragraph.

#### 4. Conclusions and Discussions

From these findings on the acquisition of stress assignment rules by Korean learners of English as a foreign language, we conclude that some aspects of L2 phonology are easy to learn for adult learners. This is an interesting conclusion because L2 phonology is usually known to be difficult to acquire as mentioned in our preceding discussions, and because Korean learners are poor at commanding the stress-timed rhythm in English (Lee and Kim, 2005). The disparate result might be resolved in terms of the difficulties of vowel reduction in unstressed syllables by Korean learners (Kim *et al.*, 2005). In other words, Korean learners may learn stress assignment well, but not stress reduction that would in turn affect the overall stress-timed rhythm.

Why would stress assignment be easy, while stress reduction is difficult for Korean learners of EFL? It may be due to the fact that the Korean native accentual pattern is realized by pitch height (Koo, 1986; Jun, 2000; among others). English stress assignment is also easy for Korean learners in terms of assigning high pitch. In contrast, stress reduction is difficult for Korean learners, whose L1 phonology does not have unstressed vowels.

Then, the next question is, "How can we reflect these findings of learning stress rules in second language education?" We suggest that we first identify different levels of difficulty in L2 phonology for a given group of learners, and then reflect the ordering in the class curriculum. To take examples from our discussion, the stress assignment rules for the compound nouns and noun phrases would be taught earlier in the curriculum than the stress reduction rules for Korean learners of English as a foreign language.

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