Korean Journal of English Language and Linguistics, **Vol 24, September 2024, pp. 1011-1027**
DOI: 10.15738/kjell.24..202409.1011

KOREAN JOURNAL OF ENGLISH LANGUAGE AND LINGUISTICS

ISSN: 1598-1398 / e-ISSN 2586-7474
http://journal.kasell.or.kr

Production of Lexical and Phrasal Stress by Native Speakers and Korean Learners of English*

Hyunah Baek (Ajou University) · **Shinsook Lee** (Korea University)

Received: August 3, 2024
Revised: September 23, 2024
Accepted: September 27, 2024

Baek, Hyunah (first author)
Assistant professor, Department of English Language and Literature
Ajou University
206 World cup-ro, Yeongtong-gu
Suwon-si, Gyeonggi-do, Korea
Tel: 031) 219-2838
Email: hyunahbaek@ajou.ac.kr

Lee, Shinsook (corresponding author)
Professor, Department of English Language Education
Korea University
145 Anam-ro, Seongbuk-gu
Seoul, Korea
Tel: 02) 3290-2353
Email: leesseng@korea.ac.kr

*This research was supported by the College of Education, Korea University Grant in 2024.

ABSTRACT

Baek, Hyunah and Shinsook Lee. 2024. Production of lexical and phrasal stress by native speakers and Korean learners of English. *Korean Journal of English Language and Linguistics* 24, 1011-1027.

This study examined how Korean learners of English produce lexical and phrasal stress compared to native English speakers. Forty Korean speakers learning English as a foreign language and 11 native English speakers read aloud sentences designed to elicit contrasts in lexical stress (e.g., *súspect* as a noun vs. *suspéct* as a verb) and phrasal stress (*príntout* as a compound noun vs. *print óut* as a phrasal verb). Acoustic analysis on the recorded tokens (maximum pitch, maximum intensity, and duration of words and syllables) revealed that the English speakers used duration as the most reliable cue for both lexical and phrasal stress. Intensity was used as another significant cue to lexical stress but not to phrasal stress, and no significant use of F0 was found for either stress type. Korean speakers with higher English proficiency marked the lexical stress contrast more clearly than those with lower English proficiency, mainly by producing the first syllable in nouns longer than in verbs. However, the Korean speakers did not employ any of the three acoustic correlates examined to mark the contrast in phrasal stress, regardless of their proficiency in English. These results are interpreted with relevance to previous findings in the literature, and suggestions are made regarding relevant teaching methods.

KEYWORDS

lexical stress, phrasal stress, second language prosody, production, acoustic analysis

1. Introduction

In speech sounds, vowels carry prosodic features including length, pitch, and intensity of sounds. Prosody serves not only to express paralinguistic information (speakers' emotions or attitudes) but also linguistic information such as lexical contrast, sentence structure, and information structure. Since languages have prosodic systems that differ from one another, one of the challenges of learning a new language is learning appropriate ways to use and understand prosody according to the grammar of the target language. A failure to master the nativelike use of target language prosody may hinder spoken communication (Anderson-Hsieh and Koehler 1988, Hahn 2004, Munro and Derwing 1995, Sereno et al. 2016).

Two languages that are prosodically distinct from each other are English and Seoul Korean (henceforth 'Korean'). Jun's prosodic typology (Jun 2005, 2014) compares the two languages as follows. First of all, they differ in terms of word-level prosody, as English is a stress-timed language, whereas Korean does not have any of the typologically defined word-level prosody (stress, tone, or lexical pitch accent). They also have different ways of marking prominence at the phrase level: English is one of the head-prominence languages, in which phrase-level prominence marks the phrase head, while Korean is an edge-prominence language, which uses prominence as a means of marking the edge of a word and a phrase. Lastly, Korean is considered to have stronger macro-rhythm (i.e., phrase-internal tonal rhythm) than English, because English has multiple types of pitch accents and their domain is slightly larger than one content word, whereas in Korean, one word often forms a prosodic unit called an Accentual Phrase, whose right edge is typically marked by a rising tone.[1]

Given these differences between English and Korean, it is not surprising that native speakers of one language learning another as a second/foreign language (L2) often exhibit non-nativelike prosody. While a number of studies have demonstrated such learning difficulty either at the word-level or at the phrase-level, little research has attempted to compare L2 learning patterns at these two levels. The main purpose of this study is on investigating whether Korean learners of English display differences in using phonetic cues such as pitch, duration, and intensity to realize prominence at these two levels in their English productions. The study also compares the results of Korean learners to those of native English speakers. The remaining of this section reviews major findings in the literature on lexical and phrasal stress in English (section 1.1) and on the production of English stress by Korean learners of English (section 1.2) and presents an overview of the current study (section 1.3).

1.1 Lexical and Phrasal Stress in English[2]

English prosody has two levels of prominence systems–lexical stress and phrasal stress. Lexical stress is

[1] An Accentual Phrase (AP) in Korean contains a lexical item optionally followed by case markers or postpositions. As shown in the example below, an AP assigns a tonal pattern of either High-High-Low-High or Low-High-Low-High to its syllables depending on the laryngeal feature of the first segment (Jun 2005). The final high tone serves as an AP boundary tone (highlighted below), and it may be overridden by a sentence-final boundary tone, such as a low tone in a declarative sentence.

Wusungi-ka	enehak-ul	kongbuhay-yo
(L H L **H**)$_{AP}$	(L H L **H**)$_{AP}$	(L H L L)$_{AP}$
Wooseung-TOP	linguistics-ACC	study-DEC

'Wooseung studies linguistics.'

[2] In the terminology introduced in Jun (2005, 2014), phonological prominence assigned to a syllable at the lexical level is referred to as *stress*, and the postlexical-level prominence is called *pitch accents*. In this paper, we use the term *lexical stress* and *phrasal stress* to refer to these two types of prominence.

prosodic prominence assigned to one or more syllables in a word, and different lexical stress patterns result in a contrast in word meaning (e.g., *belów* vs. *bíllow*) or in the syntactic category of words (e.g., *incréase* vs. *íncrease*). In a single word, the lexically stressed syllable is typically higher in pitch, louder in intensity, and longer in duration (Cooper et al. 2002, Cutler 2005, 2015, Fry 1955, Ladefoged and Johnson 2015, Lehiste and Peterson 1959, Lieberman 1960). For example, Lehiste and Peterson (1959) compared a native speaker's production of word pairs such as *pérvert-pervért* embedded in the carrier sentence 'Say the word … again.' They found that the stressed syllables were marked by a characteristic pitch curve and a relatively greater amplitude. Also, Lieberman (1960) recorded 16 native English speakers' productions of noun-verb pairs embedded in different sentences (e.g., *We had a contract*. vs. *Don't contract the flu.*) and measured the fundamental frequency (F0), amplitude, and duration of each syllable. Then, two observers listened to the recordings and judged which syllable was stressed. The results indicated that stressed syllables tended to be produced with higher F0, greater relative amplitude and longer duration and that in the cases in which any one of these acoustic cues was not clearly used, the use of other cues compensated for this lack to facilitate stress perception.

Similar acoustic cues to prominence can be used to mark phrasal stress. Phrasal stress refers to the pattern that one lexical item is produced more prominently than other lexical items in the same phrase. For instance, in the declarative sentence "*Eat another cookie and I'll kill you*," the words *cookie* and *kill* receive phrasal stress (or pitch accents, in other words) and thus are produced with greater prominence compared to the other words in the sentence (Pierrehumbert and Hirschberg 1990). The assignment of phrasal stress can also serve to mark the syntactic category of word sequences. For example, when *lie down* is used as a phrasal verb (e.g., *I need to lie down and rest for a while*.), both lexical items receive phrasal stress, but the second element tends to carry greater prominence, i.e., higher pitch, greater intensity, and longer duration (Cheun 2005, Hewings 2004). In contrast, when the same sequence of words functions as a compound noun (e.g., *I felt much better after having a short lie-down*.), the first element is produced with greater prominence than the second (Cheun 2005, Hewings 2004).[3]

Given the important role that prosody plays in English words and sentences, it is not surprising that the literature on second language acquisition suggested suprasegmental features such as stress, rhythm, and intonation yield greater influence on speech communication than segmental features do (Celce-Murcia et al. 2010, Sardegna and Dickerson 2023).

1.2 Korean Speakers' Production of English Stress

Unlike English, the prosody of Korean relies mainly on prosodic phrasing patterns, and it does not have a phonological system of prominence assignment at the lexical or phrasal level (Jun 2005, 2014). Consequently, native speakers of Korean learning English as an L2 often face difficulty realizing lexical or phrasal stress in their English productions as well as perceiving acoustic cues to stress in spoken words and sentences. For example, Korean learners of English were shown to realize English lexical stress only by increasing the intensity of the stressed syllables but not using other prosodic cues such as pitch and duration (No 1998).

Kim and Koo (2010) investigated the production of English words for which stress position determines their parts of speech (e.g., *protest*) by Korean learners of English before and after a two-week training program. They analyzed the F0, intensity, and vowel duration of the stressed syllables to find that the length of the stressed vowel was shorter in the learners' productions than in native productions and that there was a larger variation among verbs. They also found that the Korean speakers generally exhibited greater intensity and F0 than the native

[3] Throughout the rest of this paper, we will use the acute accent mark (´) to indicate relatively stronger prominence on either of the two lexical items, as in *lie dówn* for a phrasal verb and *líe-down* for a compound noun.

speakers did, although the difference did not reach statistical significance. After training, the Korean speakers managed to lengthen stressed vowels as native speakers did, demonstrating a positive effect of instruction on lexical stress. Also, Lee and Cho (2011) compared the F0, intensity, and duration of stressed and unstressed vowels in suffixed words (e.g., *regularity*, *commitment*) produced by Korean learners of English, Japanese learners of English, and native speakers of English. Their results indicated that the native speakers produced stressed syllables with longer duration than unstressed syllables compared to the two learner groups, but they exhibited the opposite pattern when it comes to intensity. There was no significant group difference in F0.

The difficulty in realizing stress in L2 English also extends to the production of phrasal stress. Lim (2016) compared the productions of phrasal verbs (verb + particle; e.g., *speak up*) and prepositional verbs (verb + preposition; e.g., *listen to*) by native speakers of American English and Korean learners of English. The native speakers were found to distinguish the two types of constructions by producing the particles with longer duration, greater intensity, and higher F0 compared to the prepositions, whereas Korean learners of English tended to produce both lexical items with similar degrees of prominence regardless of construction types. These previous results together suggest that the realization of English stress by Korean learners of English is acoustically different from how native speakers realize stress, posing a possibility of communication breakdown.

1.3 Present Study

The large body of literature on stress production by Korean learners of English has focused on one prominence domain (either lexical stress in most cases or phrasal stress in others; e.g., Guion 2005, Trofimovich and Baker 2006, Yun 2012), and little attempt has been made to compare the learning of lexical stress and phrasal stress. Although the acoustic realizations of lexical and phrasal stress in English are similar to each other, their assignment takes place at two different domains–lexical and phrasal–and it is likely that their learning does not necessarily co-occur. Since lexical stress is assigned on an item-by-item basis, its learning must be closely associated with the learning of individual vocabulary items. In contrast, as the assignment of phrasal stress follows rule-governed patterns based on the syntactic and information structure of utterances, the learning of phrasal stress must occur hand in hand with the learning of L2 syntax and semantics. Therefore, comparing the productions of lexical stress and phrasal stress is expected to shed light on the complex interface between the phonetic, lexical, and syntactic aspects of L2 learning.

The present study thus aimed to investigate the acoustics of lexical stress and phrasal stress in English sentences produced by native speakers of English and Korean learners of English. To this end, two groups of speakers–native speakers and Korean learners of English–were invited to produce words contrasting in lexical stress as well as two-word phrases differing in their syntactic properties.

2. Method

2.1 Participants

Forty adult Korean speakers learning English as a foreign language (29 females and 11 males) participated in the production study as part of their coursework for an undergraduate program at a university in Seoul, Korea. They were all English-language education majors (or double majors), and they were 21.35 years old on average (*SD* = 1.02). They reported that they had started learning English at the age of 7 on average (*SD* = 1.27). In addition, 11 native speakers of North American English (7 females and 4 males) were recruited as a control group. They

reported that they grew up in the states of California (*n* = 4), Wisconsin (*n* = 2), Texas (*n* = 1), New York (*n* = 1), or Ontario, Canada (*n* = 1). One speaker refused to provide the information. They were 27.19 years old on average (*SD* = 13.22), and they were attending the same university as a visiting or graduate student or working as an English language lecturer.

2.2 Materials

Seven pairs of experiment items were used for each stress contrast (lexical stress and phrasal stress). The pairs contrasting in lexical stress consisted of a noun (N) and a verb (V) differing in the stress pattern (e.g., *súspect* vs. *suspéct*). These words were all disyllabic. The phrasal stress pairs consisted of a verb and a particle differing in the stress pattern such as *príntout* as a compound noun (CN) and *print óut* as a phrasal verb (PV). The target items were embedded in a sentence that provided cues to their syntactic category. Example sentences are given in (1)-(2), and a complete list of the experiment items and sentences is provided in the Appendix.

(1) Lexical stress pair

a.	Thomas was the main **suspect** in the crime.	*Noun*
b.	When she asked for money, I began to **suspect** her honesty.	*Verb*

(2) Phrasal stress pair

a.	There's a **printout** of the report next to the computer.	*Compound noun*
b.	I'll **print out** the report and give you a copy.	*Phrasal verb*

2.3 Procedure

The experiment sessions took place in a quiet room with a participant and an experimenter sitting across a table. The participants were asked to complete a read-aloud task, in which they read aloud the experiment sentences presented on a computer monitor as naturally as possible. The experiment sentences were presented one at a time in a semi-randomized order, so that a pair of experiment items (e.g., *súspect* and *suspéct*) never appeared in a row. The participants were instructed to read the sentences silently to comprehend the meaning before reading them aloud, and they were encouraged to practice producing the sentences as many times as needed. They were also allowed to repeat the sentences as many times as they needed until they felt their utterance was natural. In cases of such repetitions, the final utterance was used in the analysis.

The English speakers' productions were recorded with a dynamic head-mounted microphone (SM10A-CN) and a digital recorder (Zoom H6). The Korean speakers' productions were recorded with a Sony ECM-MS907 microphone on a laptop using Audacity. All recordings used a sampling rate of 44.1 kHz.

After the recording, the Korean speakers completed the Lexical Test for Advanced Learners of English (LexTALE; Lemhöfer and Boersma 2012) on a computer. The LexTALE is an un-speeded lexical decision task on 60 trials, and it takes approximately 3-4 minutes to complete. Although it is intended to measure vocabulary knowledge, LexTALE scores were found to be correlated with general English proficiency test scores such as the Test of English for International Communication (TOEIC) (Lemhöfer and Boersma 2012). The LexTALE has been used to measure participants' L2 proficiency in recent prosody studies (Ganga et al. 2024, Kim and Tremblay 2021, Perdomo and Kaan 2021). The average LexTALE score of the current participants was 65.5 out of 100 (*SD* = 10.07).

2.4 Data Analysis

2.4.1 Speech segmentation and acoustic measurements

Out of a total of 1,428 utterances (2 stress types × 7 target words × 2 conditions × 51 speakers), six utterances were excluded due to production errors such as omitting a word or substituting a word with another. In the remaining utterances, the target words contrasting in lexical stress (e.g., *súspect* vs. *suspéct*; 712 tokens) were segmented at syllable boundaries, and those contrasting in phrasal stress (e.g., *príntout* vs. *print óut*; 710 tokens) were segmented at word boundaries. All segmentation was conducted by a phonetically trained research assistant using Praat (version 6.0.49; Boersma and Weenink 2023).

From each segmented interval, three acoustic measures were obtained: maximum pitch, maximum intensity, and duration. First, the maximum F0 of each interval was measured using the *Get maximum pitch* function in Praat, and the obtained Hertz values were converted to semitones (st) to remove individual variations in pitch range ($12\log_2 F0/F_{ref}$, base = 1 Hz). Secondly, after scaling the average intensity of each utterance token to be 70 dB, the maximum intensity of the target intervals was obtained using the *Get maximum intensity* function of Praat. Finally, the duration of the intervals was measured in milliseconds (ms).

2.4.2 Statistical analysis

In order to find out whether each group of speakers used the three acoustic correlates to realize the contrasts in lexical and phrasal stress, a mixed-effects regression model was built for each acoustic measurement and each speaker group using the lmer() function from the *lme4* package (Bates et al. 2015) in R, version 4.2.1 (R Core Team 2023). In the models on the English speakers' data, the fixed effects were *Condition* (N vs. V for lexical stress pairs; CN vs. PV for phrasal stress pairs), *Interval* (syllables for lexical stress pairs; words for phrasal stress pairs), and their interactions. The two levels of *Condition* and *Interval* were contrast-coded as 1 and -1, so that the intercepts of the models represent the grand means. In addition to *Condition* and *Interval*, the models on the Korean speakers' data also included the participants' *LexTALE* scores and its interaction with *Condition* and *Interval* as fixed effects.

Comparing the prosody of different types of words and phrases (N vs. V and CN vs. PV) requires a paradigmatic comparison rather than a syntagmatic one. In linguistics terms, a syntagmatic relation refers to a structural relationship between neighboring elements within an utterance, while a paradigmatic relation refers to a contrast between distinct linguistic units, such as phonemes, words, or sentences (Cole 2015). For example, in the pair, *íncrease* vs. *incréase,* a syntagmatic investigation is likely to show that the second syllable is longer than the first in both words, due to the differences in vowel quality and the number of segments. On the other hand, a paradigmatic comparison would still reveal a substantial difference between words, such as the pattern that, despite the segmental features, the first syllable tends to be longer in nouns compared to the same syllable in verbs. In order to compare the prosodic patterns across conditions paradigmatically, we focus on interpreting the interactions between Condition and Interval, rather than the simple effects of each variable.

For the random effect structure, a full model was fit with by-participant and by-item random intercepts as well as by-participant and by-item random slopes for both fixed effects. When a model failed to converge, the random effect that captured the smallest variance was removed until the model fit reached convergence (Barr et al. 2013). The *p*-values were obtained using the *lmerTest* package (Kuznetsova et al. 2017).

3. Results

3.1 Lexical Stress Results (N-V Pairs)

Results of the acoustic analysis on the productions of noun-verb pairs (e.g., *súspect* vs. *suspéct*) are summarized in Figure 1. The top panel illustrates the maximum pitch, maximum intensity, and duration of each syllable in the productions by the English speakers. The bottom panel shows the productions by the Korean speakers, who were split into High and Low groups at the median of their LexTALE scores for the visualization purpose (median = 64.4). Summaries of the linear mixed-effects models for the English and the Korean speakers are provided in Tables 1 and 2, respectively.

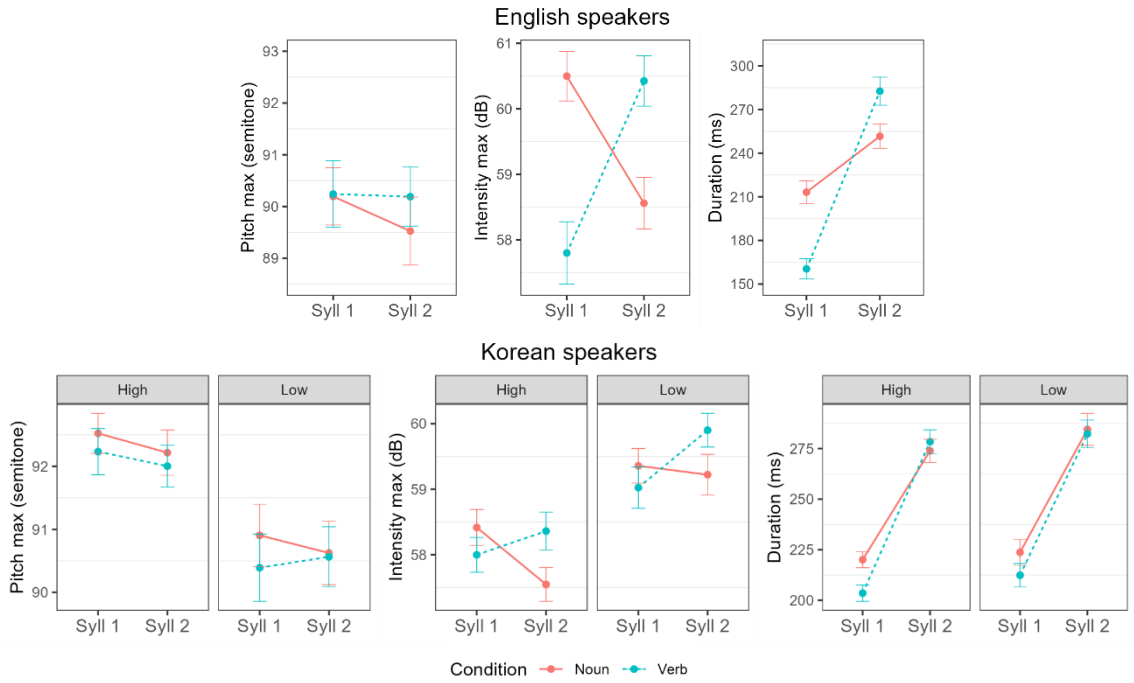

Figure 1. Maximum Pitch (semitones), Maximum Intensity (dB), and Duration (ms) of Syllables in the N-V Pairs Produced by the English Speakers (Top) and the Korean Speakers (Bottom).

In the English speakers' productions, nouns were produced with a slightly lower maximum pitch on the second syllable compared to corresponding verbs. However, the statistical model indicated that Condition and Interval did not have a significant interaction effect on maximum pitch. More noticeable differences between nouns and verbs were found in terms of maximum intensity and duration. The first syllable was produced with greater intensity in nouns, whereas in verbs, the second syllable was greater in intensity. This result is statistically indicated by the significant interaction between Interval and Condition on maximum intensity (β = 1.137, *SE* = 0.154, t = 7.374, p < 0.001). Also, while the second syllable was generally longer than the first syllable, which is likely the result of their segmental properties, the first syllable was relatively longer and the second syllable was shorter in nouns

compared to verbs. The interaction between Interval and Condition had a significant effect on duration (β = 21.238, *SE* = 2.614, *t* = 8.125, $p < 0.001$). In other words, depending on the intended stress pattern, the English speakers produced the lexically stressed syllable (i.e., the first syllable in nouns and the second syllable in verbs) with relatively greater intensity and longer duration.

Table 1. Linear Mixed-Effects Regression Models on Maximum Pitch, Maximum Intensity, and Duration of Syllables in the N-V Pairs Produced by the English Speakers (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$).

Maximum pitch					
	β	***SE***	***t***	***p***	
(Intercept)	89.996	1.510	59.604	0.000	***
Interval (Syll 1 vs. Syll 2)	0.180	0.133	1.352	0.178	
Condition (N vs. V)	-0.219	0.289	-0.758	0.477	
Interval:Condition	0.155	0.133	1.159	0.247	
Maximum intensity					
	β	***SE***	***t***	***p***	
(Intercept)	59.348	0.765	77.572	0.000	***
Interval (Syll 1 vs. Syll 2)	-0.176	0.296	-0.594	0.574	
Condition (N vs. V)	0.235	0.154	1.525	0.128	
Interval:Condition	1.137	0.154	7.373	0.000	***
Duration					
	β	***SE***	***t***	***p***	
(Intercept)	227.526	14.304	15.907	0.000	***
Interval (Syll 1 vs. Syll 2)	-39.824	15.707	-2.535	0.040	*
Condition (N vs. V)	6.015	5.784	1.040	0.338	
Interval:Condition	21.238	2.614	8.125	0.000	***

The Korean speakers' productions of nouns and verbs did not differ in terms of maximum pitch, as none of the fixed effects was statistically significant. They tended to show greater intensity on the first syllable in nouns and on the second syllable in verbs, but the interaction between Interval and Condition on maximum intensity was not statistically significant. Although the simple effect of Interval and its interaction with LexTALE on intensity were found to be significant (indicating that speakers with higher English proficiency tended to exhibit a greater intensity difference between the first and second syllables than those with lower English proficiency did), these effects did not concern differences between nouns and verbs. The difference between nouns and verbs in the Korean speakers' productions was the most evident in terms of syllable duration. While the first syllable tended to be shorter than the second syllable, as was in the English speakers' results, the speakers with higher English proficiency tended to produce the first syllable relatively longer in nouns compared to those with lower English proficiency. These patterns yielded a statistically significant three-way interaction between Interval, Condition, and LexTALE (β = 0.348, *SE* = 0.158, *t* = 2.199, *p* = 0.028). This indicates that the productions by the Korean speakers with higher English proficiency were more similar to the English speakers' productions, with lexically stressed syllables produced with longer duration.

Table 2. Linear Mixed-Effects Regression Models on Maximum Pitch, Maximum Intensity, and Duration of Syllables in the N-V Pairs Produced by the Korean Speakers (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$).

Maximum pitch					
	β	***SE***	***t***	***p***	
(Intercept)	86.800	4.554	19.062	0.000	***
Interval (Syll 1 vs. Syll 2)	-0.910	0.547	-1.662	0.105	
Condition (N vs. V)	0.104	0.439	0.236	0.813	
LexTALE	0.080	0.069	1.170	0.251	
Interval:Condition	0.402	0.408	0.987	0.324	
Interval:LexTALE	0.015	0.008	1.992	0.055	
Condition:LexTALE	0.000	0.006	0.016	0.987	
Interval:Condition:LexTALE	-0.005	0.006	-0.878	0.380	
Maximum intensity					
	β	***SE***	***t***	***p***	
(Intercept)	63.435	2.671	23.749	0.000	***
Interval (Syll 1 vs. Syll 2)	-1.389	0.468	-2.966	0.003	**
Condition (N vs. V)	0.120	0.597	0.201	0.842	
LexTALE	-0.071	0.040	-1.771	0.086	.
Interval:Condition	0.018	0.468	0.038	0.969	
Interval:LexTALE	0.021	0.007	3.030	0.003	**
Condition:LexTALE	-0.004	0.009	-0.429	0.671	
Interval:Condition:LexTALE	0.004	0.007	0.533	0.594	
Duration					
	β	***SE***	***t***	***p***	
(Intercept)	285.796	28.899	9.889	0.000	***
Interval (Syll 1 vs. Syll 2)	-33.810	21.288	-1.588	0.122	
Condition (N vs. V)	19.814	12.799	1.548	0.130	
LexTALE	-0.616	0.415	-1.484	0.148	
Interval:Condition	-18.721	10.440	-1.793	0.073	.
Interval:LexTALE	0.020	0.267	0.073	0.942	
Condition:LexTALE	-0.249	0.177	-1.406	0.169	
Interval:Condition:LexTALE	0.348	0.158	2.199	0.028	*

3.2 Phrasal Stress Results (CN-PV Pairs)

Results of the acoustic analysis on the productions of CN-PV pairs (e.g., *príntout* vs. *print óut*) are summarized in Figure 2. Summaries of the linear mixed-effects models for the English and the Korean speakers are provided in Tables 3 and 4, respectively.

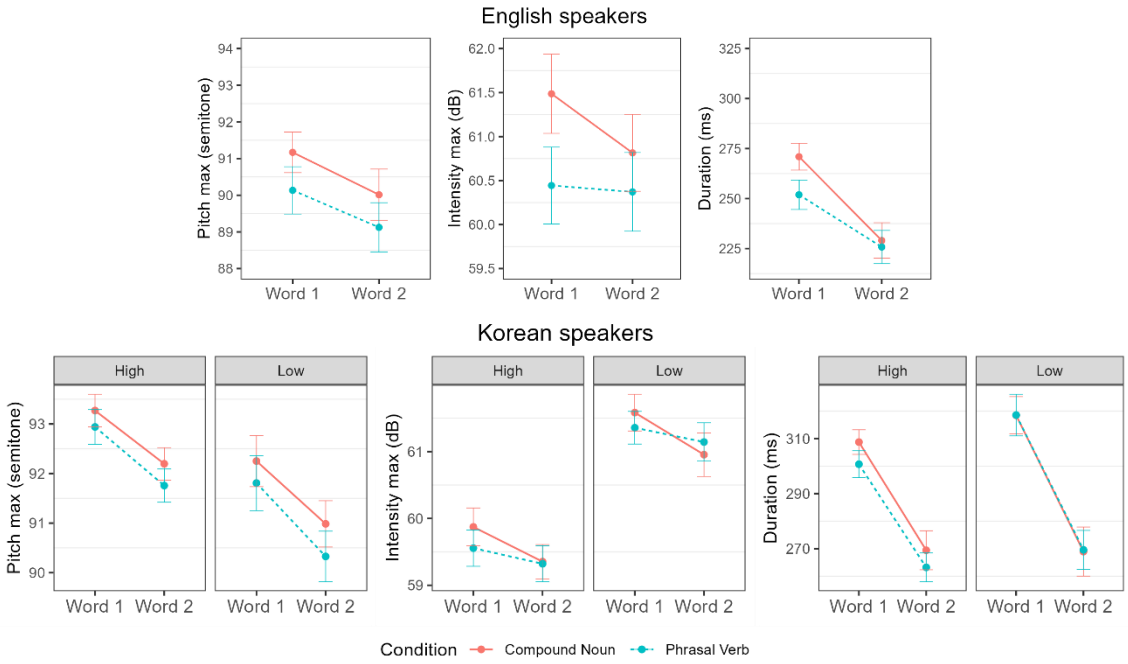

Figure 2. Maximum Pitch (semitones), Maximum Intensity (dB), and Duration (ms) of Words in the CN-PV Pairs Produced by the English Speakers (Top) and the Korean Speakers (Bottom).

Table 3. Linear Mixed-Effects Regression Models on Maximum Pitch, Maximum Intensity, and Duration of Words in the CN-PV Pairs Produced by the English Speakers (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$).

Maximum pitch					
	β	***SE***	***t***	***p***	
(Intercept)	90.156	1.516	59.457	0.000	***
Interval (Word 1 vs. Word 2)	0.541	0.241	2.250	0.065	
Condition (CN vs. PV)	0.463	0.530	0.874	0.408	
Interval:Condition	0.038	0.157	0.243	0.808	
Maximum intensity					
	β	***SE***	***t***	***p***	
(Intercept)	60.757	0.978	62.149	0.000	***
Interval (Word 1 vs. Word 2)	0.190	0.251	0.757	0.478	
Condition (CN vs. PV)	0.371	0.489	0.758	0.470	
Interval:Condition	0.147	0.127	1.161	0.247	
Duration					
	β	***SE***	***t***	***p***	
(Intercept)	244.395	19.333	12.641	0.000	***
Interval (Word 1 vs. Word 2)	16.598	9.515	1.744	0.127	
Condition (CN vs. PV)	5.091	2.184	2.330	0.021	*
Interval:Condition	4.360	2.183	1.997	0.047	*

Table 4. Linear Mixed-Effects Regression Models on Maximum Pitch, Maximum Intensity, and Duration of Words in the CN-PV Pairs Produced by the Korean Speakers (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$).

Maximum pitch					
	β	***SE***	***t***	***p***	
(Intercept)	88.740	4.742	18.714	0.000	***
Interval (Word 1 vs. Word 2)	0.593	0.491	1.206	0.235	
Condition (CN vs. PV)	0.803	0.377	2.129	0.036	*
LexTALE	0.050	0.071	0.708	0.483	
Interval:Condition	0.118	0.333	0.355	0.722	
Interval:LexTALE	0.000	0.007	0.043	0.966	
Condition:LexTALE	-0.009	0.005	-1.802	0.072	
Interval:Condition:LexTALE	-0.002	0.005	-0.476	0.634	
Maximum intensity					
	β	***SE***	***t***	***p***	
(Intercept)	65.264	2.793	23.363	0.000	***
Interval (Word 1 vs. Word 2)	-0.337	0.604	-0.558	0.580	
Condition (CN vs. PV)	-0.314	0.511	-0.614	0.543	
LexTALE	-0.077	0.042	-1.833	0.075	
Interval:Condition	-0.057	0.374	-0.153	0.879	
Interval:LexTALE	0.008	0.009	0.934	0.356	
Condition:LexTALE	0.006	0.006	0.853	0.399	
Interval:Condition:LexTALE	0.002	0.006	0.385	0.700	
Duration					
	β	***SE***	***t***	***p***	
(Intercept)	345.800	37.020	9.341	0.000	***
Interval (Word 1 vs. Word 2)	47.330	16.540	2.861	0.008	**
Condition (CN vs. PV)	-10.320	11.710	-0.881	0.381	
LexTALE	-0.868	0.512	-1.696	0.098	
Interval:Condition	0.828	9.847	0.084	0.933	
Interval:LexTALE	-0.396	0.195	-2.034	0.049	*
Condition:LexTALE	0.191	0.156	1.224	0.223	
Interval:Condition:LexTALE	-0.007	0.149	-0.049	0.961	

As shown in Figure 2, the English speakers produced the first word with a higher maximum pitch than the second word regardless of the syntactic type of the elicited phrases. The interaction between Interval and Condition thus did not have a significant effect on maximum pitch. Also, while CNs but not PVs tended to be produced with greater intensity on the first word than the second, the interaction between Interval and Condition did not reach statistical significance. Rather, the English speakers were found to differentiate CNs and PVs in the durational aspect. In their productions, the first word was generally longer than the second, which is likely due to segmental differences, and CNs were generally longer than PVs, presumably due to their syntactic properties. More importantly, the first word was lengthened to a greater degree in CNs compared to corresponding PVs, as indicated by a significant interaction between Interval and Condition on duration (β = 4.36, *SE* = 2.183, *t* = 1.998=7, *p* = 0.047). These results suggest that the English speakers phonetically marked phrasal stress by lengthening the

stressed word (the first word in CNs but not the same word in corresponding PVs), while the pitch and intensity cues were not employed significantly. The results further suggest that it is not always the case that the second element in a phrasal verb carries greater acoustic prominence such as higher pitch, greater intensity, and longer duration (Cheun 2005, Hewings 2004), possibly because the target words were embedded in various carrier sentences in the current study and sentence context could have influenced the prominence of the target words to some extent.

Unlike the English speakers' results, the Korean speakers' productions failed to exhibit any consistent difference between CNs and PVs in the three acoustic measurements. They generally produced the first word with a higher maximum pitch than the second, and both words in CNs were produced with a higher maximum pitch than PVs in general. However, there was no significant interaction between Interval and Condition on maximum pitch. The first word also tended to be produced with greater intensity than the second, but Interval and Condition did not have a significant interaction on maximum intensity, either. Moreover, the first word was generally longer than the second, as was the case in the English speakers' results, and the Korean speakers with lower English proficiency tended to show a bigger durational difference between the two words. Nevertheless, the durational cue was not used to mark the different phrasal stress patterns of CNs and PVs, as indicated by the non-significant interaction between Interval and Condition. Although Figure 2 seems to suggest that the Korean speakers with higher English proficiency tended to produce both words in CNs slightly longer than the same items in PVs unlike those with lower English proficiency, there was no significant three-way interaction between Interval, Condition, and LexTALE on duration. The lack of a three-way interaction in all three models indicates that the Korean speakers with higher English proficiency were not different from those who are less proficient in that they all failed to phonetically distinguish the phrasal stress contrast in their productions.

4. Discussion and Conclusion

This study aimed to examine how lexical and phrasal stress in English is phonetically realized in the productions by native speakers of English and Korean learners of English as a foreign language. The results of the production experiment showed that the English speakers differentiated the contrast in lexical stress as in *súspect* (noun) and *suspéct* (verb) by producing the stressed syllable with relatively greater intensity and longer duration. In marking the contrast in phrasal stress as in *príntout* (CN) and *print óut* (PV), they primarily used the durational cues by producing the first word in CNs with longer duration compared to PVs. The Korean speakers' productions indicated that they as well did not employ pitch or intensity cues to mark the contrast in stress. For the lexical stress pairs, an increase in English proficiency scores was associated with clearer stress marking, namely, a longer duration of the first syllable in nouns than in verbs. However, the Korean speakers did not employ any of the three acoustic correlates examined (maximum pitch, maximum intensity, and duration) to mark the contrast in phrasal stress, regardless of their proficiency in English.

For the English speakers, syllable or word duration was used as the most reliable cue for both lexical and phrasal stress. Intensity was used as another significant cue to lexical stress but not to phrasal stress, and no significant use of F0 was found for either stress type. Lee and Cho (2011) presented similar results from their production study, in which native English speakers produced lexically stressed vowels longer than unstressed vowels, but their productions of stressed versus unstressed vowels did not significantly differ in terms of F0 or intensity. The fact that not all three prosodic cues are consistently used for stress marking is not surprising, given that there can be variations among individual speakers in the use of each cue (Lieberman 1960) and that prosodic cues are not

the only indication of stress in English, as segmental information such as vowel reduction also provides an important cue. Also, the result indicating no significant use of F0 cues presumably has to do with the fact that the target words were embedded in various carrier sentences in the current study. Since F0 on syllables and words is largely affected by the pitch contour of the entire phrase or sentence, the availability of F0 as a cue to stress must be limited. As a result, among the three acoustic correlates representing speech prosody, English stress seems to be best reflected by duration, while intensity and pitch serve rather as secondary cues.

Duration also serves as a primary stress cue in the Korean speakers' productions, but only in the case of lexical stress but not phrasal stress. Moreover, a significant role of English proficiency was found, as higher English proficiency was associated with a more native-like use of duration in marking lexical stress. This suggests that as a learner's English proficiency develops, they become better at differentiating syllable durations to reflect their stress status. This finding is also closely related to Kim and Koo (2010), who showed that after a two-week training on English stress, Korean speakers learned to lengthen a vowel when stressed compared to when it is not stressed. It thus appears that the mastery of native-like stress production correlates with overall L2 proficiency, and direct and explicit training (even short-term) can result in noticeable improvement.

Unlike lexical stress, the Korean speakers failed to prosodically mark phrasal stress using any of the three acoustic correlates examined. The phrasal stress contrast used in this study involved phrases consisting of the same combination of a verb and a particle but belonging to different syntactic categories: compound nouns (*There is a printout of the report…*) and phrasal verbs (*I will print out the report …*). The assignment of phrasal stress on either of the two words may be determined at the post-lexical level.[4] Understanding the post-lexical assignment of phrasal stress requires advanced knowledge of the intricate interplay between syntax and prosody in English, and using prosody to appropriately realize phrasal stress must be more challenging to L2 speakers than lexical stress. Our result is therefore similar, although not directly comparable, to Lim's (2016) production study, in which Korean learners of English failed to prosodically distinguish phrasal verbs (e.g., *speak up*) and prepositional verbs (e.g., *listen to*). Furthermore, the literature on L2 acquisition have shown a general tendency for L2 English learners to avoid phrasal verbs in written tasks such as multiple-choice and translation (Dagut and Laufer 1985, Koo 2019, Kweon 2006, Liao and Fukaya 2004). As phrasal verbs trigger common learning difficulty even when no speech production is required, the need to clearly articulate unfamiliar phrasal verbs in a production task must have caused greater difficulty.

We would like to note that, as stated in the *Statistical analysis* section, the current study investigated the use of acoustic cues paradigmatically, i.e., across different words and phrases. That is, when we draw a conclusion that a stressed syllable is reliably produced with longer duration, it implies that a stressed syllable (such as the first syllable in *súspect*) tends to be longer compared to the corresponding syllable in a different context where is it not stressed (such as the first syllable in *suspéct*). This paradigmatic comparison allowed us to identify the relative acoustic differences across different words and phrases, which are observed regardless of the segmental properties of the target words/phrases.

The current study provides an empirical basis for teaching skills for stress instructions. Given that native English

[4] An anonymous reviewer pointed out that the contrast between a compound noun and a phrasal verb can also be considered a type of lexical stress contrast. This may be true in that the first element receives greater prominence in the case of a compound noun while the second element tends to carry greater prominence in the case of a phrasal verb. However, examples like *stéel wàrehouse* "warehouse made of steel" vs. *stèel wárehouse* "warehouse for storing steel" indicate that one should refer to syntactic information or use a syntactic analysis (Yurtbaşi 2017, p. 42). Thus, it is likely that the production of these phrases reflects the speakers' understanding of the post-lexical relationship between the two individual lexical items at least to some extent.

speakers used duration as a reliable cue for both CN-PV and N-V pairs, teachers/pronunciation instructors could visualize the length of stressed vowels (syllables) using spread-out capital letters, bolding, or pulling a rubber elastic band a lot, especially for lower-level English learners (Hewings 2004). For higher/advanced-level English learners, pronunciation instruction should move beyond controlled activities; they should practice lexical and phrasal stress in the communicative framework. For instance, learners are provided with a list of CN-PV pairs (e.g., *a breakdown/break down*, *a buyout/buy out*, *a getaway*/*get away*, *a workout/work out, etc.*) and create their own story using some of the CN-PV pairs from the list and tell it to their partners, paying a special attention to the length of a stressed vowel (syllable) (Celce-Murcia et al. 2010, Hewings 2004, Levis and Silpachai 2018). English learners should also have the opportunity to get feedback on the type of errors in implementing lexical and phrasal stress (e.g., shorter duration in vowels/syllables than native English speakers). Further, auditory enhancement through exaggerated lengthening of stressed vowels (syllables) (along with increased intensity and pitch) would help English learners understand the properties of stressed vowels (syllables), which could lead to their increased/improved intelligibility of stress.

The current study did not investigate Korean learners' perception of English lexical and phrasal stress. Given that pronunciation instruction should focus not only on production but also on perception (O'Brien 2022), future research should examine how Korean learners of English perceive the acoustics properties of lexical and phrasal stress. Also, using diverse carrier sentences in the experiment in the current study may have affected the results, since the structure of a sentence can influence the prosody of words inside it. A follow-up study can be conducted to test whether the current findings can be replicated using carrier sentences that are semantically and syntactically more controlled. Nevertheless, considering that learners are more frequently exposed to words and phrases embedded in various sentences rather than in isolation, the result of this study certainly has implications on the learning of English stress by Korean learners of English.

References

전상범(Cheun, S.). 2005. 『영어음성학개론(*Introduction to the English Phonetics*)』. 서울: 을유문화사(Seoul: Eulyoo Publishing Company).

Anderson-Hsieh, J. and K. Koehler. 1988. The effect of foreign accent and speaking rate on native speaker comprehension. *Language Learning* 38, 561-593.

Barr, D. J., R. Levy, C. Scheepers and H. J. Tily. 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language* 68(3), 255-278.

Bates, D., M. Mächler, B. M. Bolker and S. C. Walker. 2015. Fitting linear mixed-effects models using *lme4*. *Journal of Statistical Software* 67(1), 1-48.

Boersma, P. and D. Weenink. 2023. Praat: doing phonetics by computer (version 6.0.49) [Computer Software] Available online at http://www.praat.org

Celce-Murcia, M., D. M. Brinton and J. M. Goodwin. 2010. *Teaching Pronunciation*. Cambridge: Cambridge University Press.

Cole, J. 2015. Prosody in context: a review. *Language, Cognition and Neuroscience* 30(1-2), 1-31.

Cooper, N., A. Cutler and R. Wales. 2002. Constraints of lexical stress on lexical access in English: Evidence from native and non-native listeners. *Language and Speech* 45(3), 207-228.

Cutler, A. 2005. Lexical stress. In D. B. Pisoni and R. E. Remez, eds., *The Handbook of Speech Perception*. Malden, MA: Blackwell Publishing.

Cutler, A. 2015. Lexical stress in English pronunciation. In M. Reed and J. M. Levis, eds., *The Handbook of English Pronunciation*. New Jersey: John Wiley & Sons.

Dagut, M. and B. Laufer. 1985. Avoidance of phrasal verbs. *Studies in Second Language Acquisition* 7, 73-79.

Fry, D. B. 1955. Duration and intensity as physical correlates of linguistic stress. *Journal of the Acoustical Society of America* 27(4), 765-768.

Ganga, R., H. Ge, M. E. Struiksma, V. Yip and A. Chen. 2024. Prosodic processing in sentences with 'only' in L2 and L2 English. *Studies in Second Language Acquisition* 46, 478-503.

Guion, S. G. 2005. Knowledge of English word stress patterns in early and late Korean-English bilinguals. *Studies in Second Language Acquisition* 27, 503-533.

Hahn, L. D. 2004. Primary stress and intelligibility: Research to motivate the teaching of suprasegmentals. *TESOL Quarterly* 38(2), 201-223.

Hewings, M. 2004. *Pronunciation Practice Activities*. Cambridge: Cambridge University Press.

Jun, S.-A. 2005. Prosodic typology. In S.-A. Jun, ed., *Prosodic Typology: The Phonology of Intonation and Phrasing*, 431-458. Oxford: Oxford University Press.

Jun, S.-A. 2014. Prosodic typology: By prominence type, word prosody, and macro-rhythm. In S.-A. Jun, ed., *Prosodic Typology II: The Phonology of Intonation and Phrasing*, 520-539. Oxford: Oxford University Press.

Kim, H. and A. Tremblay. 2021. Korean listeners' processing of suprasegmental lexical contrasts in Korean and English: A cue-based transfer approach. *Journal of Phonetics* 87, 1-15.

Kim, O. Y. and H.-S. Koo. 2010. A study on the stress realization of English homographic words. *Phonetics and Speech Sciences* 2(2), 51-60.

Koo, J.-Y. 2019. Preference to one-word verbs over phrasal verbs. *Korean Journal of Linguistics* 44(1), 1-28.

Kuznetsova, A., P. B. Brockhoff and R. H. B. Christensen. 2017. lmerTest package: tests in linear mixed effects models. *Journal of Statistical Software* 82(13), 1-26.

Kweon, S.-O. 2006. Avoidance of phrasal verbs by Korean EFL learners. *Studies in Modern Grammar* 45, 173-197.

Ladefoged, P. and K. Johnson. 2015. *A Course in Phonetics* (7th ed.). Stamford, CT: Cengage Learning.

Lee, S.-S. and M.-H. Cho. 2011. An acoustic analysis of stressed and unstressed vowels in English nouns: A cross-language case study. *English Language and Linguistics* 17(3), 61-88.

Lehiste, I. and G. E. Peterson. 1959. Vowel amplitude and phonemic stress in American English. *Journal of the Acoustical Society of America* 31(4), 428-435.

Lemhöfer, K. and M. Broersma. 2012. Introducing LexTALE: A quick and valid Lexical Test for Advanced Learners of English. *Behavior Research Methods* 44(2), 325-343.

Levis, J. M. and A. O. Silpachai. 2018. Prominence and information structure in pronunciation teaching materials. In *Proceedings of the 9th Pronunciation in Second Language Learning and Teaching Conference*, 216-229.

Liao, Y. and Y. Fukuyama. 2004. Avoidance of phrasal verbs: The case of Chinese learners of English. *Language Learning* 54(2), 193-226.

Lieberman, P. 1960. Some acoustic correlates of word stress in American English. *Journal of the Acoustical Society of America* 32(4), 451-454.

Lim, S. Y. 2016. Acoustic properties of English vowels between the phrasal verbs and prepositional verbs. *Mirae Journal of English Language and Literature* 21(1), 319-336.

Munro, M. J. and T. M. Derwing. 1995. Foreign accent, comprehensibility, and intelligibility in the speech of second language learners. *Language Learning* 45, 73-97.

No, G.-H. 1998. Stress placement and phonological competence of L2 learners. *English teaching* 53(2), 3-19.

O'Brien, M. G. 2022. Making the teaching of suprasegmentals accessible. In J. Levis, T. Derwing and S. Sonsaat-Hegelheimer, eds., *Second Language Pronunciation: Bridging the Gap Between Research and Teaching*, 85-106. New Jersey: Wiley Blackwell.

Perdomo, M. and E. Kaan. 2021. Prosodic cues in second-language speech processing: A visual world eye-tracking study. *Second Language Research* 37(2), 349-375.

Pierrehumbert, J. B. and J. Hirschberg. 1990. The meaning of intonational contours in the interpretation of discourse. In P. R. Cohen, J. Morganand M. E. Pollack, eds., *Intentions in Communication*, 271-311. Cambridge, MA: MIT Press.

R Core Team. 2023. R: A language and environment for statistical computing (version 4.2.1) [Computer software]. Available online at https://www.R-project.org

Sardegna, V. and W. Dickerson. 2023. Improving the pronunciation of English polysyllabic words through orthographic word-stress rules. In V. Sardegna and A. Jarosz, eds., *English Pronunciation Teaching: Theory, Practice and Research Findings*, 81-97. Bristol, UK: Multilingual Matters.

Sereno, J., L. Lammers and A. Jongman. 2016. The relative contribution of segments and intonation to the perception of foreign-accented speech. *Applied Psycholinguistics* 37(2), 303-322.

Trofimovich, P. and W. Baker. 2006. Learning second language suprasegmentals: Effect of L2 experience on prosody and fluency characteristics of L2 speech. *Studies in Second Language Acquisition* 28, 1-30.

Yun, G. 2012. Korean EFL learners' production and perception of English stress differences and word recognition. *Korean Journal of English Language and Linguistics* 12(3), 601-631.

Yurtbaşi, M. 2017. Stress placement on phrases and compounds in English. *International Online Journal of Primary Education* 6(2), 39-46.

Appendix: Experiment sentences

Stress type	Target word	Condition	Sentence
Lexical stress	*conduct*	Noun	The children's **conduct** during the concert was excellent.
		Verb	I've always wanted to **conduct** an orchestra.
	present	Noun	She gave me a watch as a **present** for my birthday.
		Verb	It's my pleasure to **present** the winner of the honorable prize.
	suspect	Noun	Thomas was the main **suspect** in the crime.
		Verb	When she asked for money, I began to **suspect** her honesty.
	object	Noun	There is a strange **object** on the top shelf.
		Verb	I don't think anyone would **object** if we finish the meeting early.
	produce	Noun	The vegetable shop sold only **produce** grown on local farms.
		Verb	I have to **produce** the report by the end of the week.
	discount	Noun	I will give you a **discount** on the price if you buy three.
		Verb	We can't **discount** the possibility that John has had an accident.
	record	Noun	The time was a new world **record** for a female runner.
		Verb	I asked if I could **record** her lecture.
Phrasal stress	*send off*	Compound noun	We gave him a good **send-off** before he left for Australia.
		Phrasal verb	I must **send off** this parcel before the post office closes.
	hide away	Compound noun	The robbers had a **hideaway** in the mountains.
		Phrasal verb	He couldn't **hide away** from his parents any longer.
	lie down	Compound noun	I'm not feeling very well. I'm going to have a **lie-down** for a nap.
		Phrasal verb	I'm tired. I think I might go and **lie down** for a nap.
	stop over	Compound noun	My ticket to Sydney includes a **stopover** in Singapore.
		Phrasal verb	We've got a spare room if you want to **stop over** in Seoul.
	print out	Compound noun	There's a **printout** of the report next to the computer.
		Phrasal verb	I'll **print out** the report and give you a copy.
	break out	Compound noun	There's been a **breakout** from the prison.
		Phrasal verb	He felt a cold sweat **break out** on his forehead.
	turn out	Compound noun	There was a **turnout** of 95% in the election.
		Phrasal verb	The play didn't **turn out** to be a great success.

Examples in: English
Applicable Languages: English
Applicable Level: Intermediate, High-intermediate and Advanced level