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An Acoustic Study of American English /l/ Variation Produced by Korean and Mongolian

Choi, Chung Hun* · Kang, Yong Soon**

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• Abstract

The purpose of this study is to show that non-natives' English /l/ pronunciation is strongly influenced by their mother tongue. Cross-linguistically, laterals show various articulatory and acoustic patterns. To be more specific, the current study compared the production of /l/ sound by

* First Author, Ph. D Student, Department of English Language and Literature, Sungkyunkwan University
** Corresponding Author, Professor, Department of English Language and Literature, Sungkyunkwan University

Koreans and Mongolians. The study collected the data of 16 subjects (8 Koreans and 8 Mongolians) and analyzed them using *Praat*. The results show that 1) Koreans showed high F2 and relatively low F1, probably influenced by ‘palatalization’ of Korean while Mongolians showed higher F1 and lower F2, originated from tongue backing for ‘pharyngeal constriction’ and ‘velarization’ in Mongolian [ɮ]. 2) Mongolians showed less F2-F1 difference than Koreans, particularly in postvocalic-/l/ position, implying Mongolians articulated dark /ɬ/ more accurately than that of Koreans. 3) Koreans’ duration of /l/ was slightly longer than Mongolians except for prevocalic-/l/. 4) As for intensity, Mongolian was considerably high. The results clearly indicate that English pronunciation of non-natives is interfered by their native language.

• Key words

Laterals, L1 interference, *Praat*, F1, F2, Acoustic

Ⅰ. Introduction

The goal of this study is to show the relationship between the phonetic realization of /l/ variation and acoustic characteristics for native Korean and Mongolian. For this purpose, we investigated the acoustic findings of American English lateral /l/ allophones produced by two language groups and compared them. A total of 16 subjects participated in the study. In order to explore the differences of spectral and temporal quality, we used *Praat* program. Further, we presented the stimuli with four different positions of word initial prevocalic-/l/ (PREV), word intermediate preboundary-/l/ (I-PREB), word intermediate postboundary-/l/ (I-POSTB), and word final postvocalic-/l/ (POSTV). In relation to this aspect, the acoustic indicators such as the major role of formant frequencies 1 and 2, the differences in F2-F1, the duration, and intensity were measured, respectively.

Laterals are commonly represented with various articulatory and acoustic patterns that depend on the phonological environment cross-linguistically. Phonetically, lateral behaves as a single segment with two distinct lingual gestures such as Coronal (tongue tip or blade) and Dorsal (tongue body) complex place node.[1] The function of a Coronal-Dorsal place complex node makes a variety of pronunciation and defines the characteristics of the laterality itself.[2] Moreover, the variable production of /l/ depends on the syllable structure, phonetic context, and individual phonation characteristics. Furthermore, American English /l/ has been traditionally classified as two allophones: 'light' /l/ in syllable initial position and 'dark' /ɬ/ or 'velarized'

1) Laura Walsh Dickey, *The Phonology of Liquids*, A Dissertation, University of Massachusetts Amherst, 1997, pp.48～52.
2) Ibid., p.52.

in syllable final position. In this aspect, the intervocalic /l/ preceding phonological boundary is phonetically represented to less light or less dark variation depending on the stress of the vowel preceding or following.[3] In light of the production of lateral variation, we investigated on how American English lateral /l/ allophones are produced by Koreans and Mongolians. Thereafter, we analyzed the consequence of production acoustically, followed by the comparisons.

The rest of this study is composed of the following sections. Section Ⅱ. provides the articulatory distinction of laterals of Korean, English, and Halh,[4] the dialect of Mongolian (hereinafter, “Halh” or “Halh Mongolian”). Section Ⅲ. presents the methodology of this study including data collection and acoustic measurement. Section Ⅳ. provides results and analysis of each acoustic parameter such as F1, F2 and F2-F1 difference, the duration and intensity for these two groups. Section Ⅴ. includes discussion. Finally, Section VI. concludes this study.

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3) Jiahong Yuan, & Mark Liberman, “/l/ Variation in American English: A Corpus Approach”, *Journal of Speech Sciences*, 1(2):35-46, 2011, p.42.

4) Davaajav Nasanbat, “An Acoustic Analysis of the English Vowels Produced by Mongolian Speakers”, Thesis for the Degree of Master in Arts, Soong Sil University, 2012. pp.7～9.
Halh (Khalkha) is a large dialect group in the Mongolian branch of the Altaic language family. It is an official language spoken by about 85% of the population in Mongol. Nasanbat (2012) revealed that most of Mongolian schools and universities have adopted English language curriculum as a mandatory subject in the flow of globalization.

Ⅱ. Articulatory Distinction of Laterals: English, Korean and Halh Mongolian

1. American English /l/

English lateral /l/ is articulated as “the tongue touches near the center of the alveolar ridge”, and simultaneously, the air flows freely over the side of the tongue.[5] This free flow of airstream prevents friction and makes sounding of a voiced alveolar lateral approximant.[6] The articulation of /l/ allophonic variation is produced by distinct gestures of the tongue body. The syllable initial position in light /l/ involves coronal gesture, raising of the tongue tip and fronting of the tongue blade toward the alveolar ridge for constriction. In contrast, the production of syllable final position in dark /ɬ/ or velarized is represented as dorsal gesture, lowering of the tongue pre-dorsum and retracting of the tongue post-dorsum toward the upper pharyngeal, leading to constriction.[7] In this respect, the degree of diversity on articulatory of /l/ sound is caused by the segmental position and the syllable boundary.

2. Korean /l/

Korean lateral /l/ is articulated as a voiced apical alveolar. It has two allophones such as apical flap [ɾ] and alveolar lateral [l]. In addition, the

5) Peter Ladefoged, & Keith Johnson, *A Course in Phonetics*, USA: CENGAGE Learning, 2015, p. 17.
6) Ibid., p. 189.
7) Daniel Recasens, “A cross-language acoustic study of initial and final allophones of /l”, *Speech Communication*, 54, 368-383, 2012, p.368.

production of Korean /l/ depends on the syllable position. For example, final position words (e.g., '*gil'*, 'road'; '*mool*,' 'water') are realized as non-velarized or clear /l/. In addition, voiced alveolar dental flap [ɾ] (e.g., '*iri',* 'here') and the geminate context (e.g., '*illi',* 'reason') are shown in the intervocalic position.[8] There is no liquid in word initial position in Korean except for a loanword (e.g., '*ramyun',* 'noodle'). In particular, Korean lateral /l/ possesses a feature of the palatalization which adds an [i]-like tongue position to a consonant. It processes the primary tongue tip gesture, moving toward the palatal region and lacking the dorsal gesture.[9]

3. Halh Mongolian /l/

Halh Mongolian lateral is classified as alveolar lateral fricative: voiceless [ɬ] and voiced fricative [ɮ].[10] Mongolian is typologically unusual for having a lateral fricative, which is pronounced as [ɮ] or [ɬ] in the context of speech independently, and its palatalized counterpart /lʲ/, but no plain /l/ (i.e., non-fricative).[11] The friction of Halh [ɮ] has a prominent feature of lateral pronunciation. As for the production, lateral fricative is realized with passively lowering the tongue tip and simultaneously raising the tongue body to the palate, thereby making larger obstruction.[12] In addition, while

8) Eun Jun, "Korean Speaker's Production of /r/ and /l/", *English Teaching*, Vol. 59, No.1, Spring 2004, p.45.

9) Bryan Gick et al., "Toward universals in the gestural organization of syllables: A cross-linguistic study of liquids", *Journal of Phonetics*, 34, 49-72, 2006, p. 52.

10) Jan-Olof Svantesson et al., *The Phonology of Mongolian*, Oxford University Press, 2005, pp.19～20.

11) Anastasia Karlsson, & Jan-Olof Svantesson, "What happens to consonant clusters in Mongolian speech?", In *[Host publication title missing]* (pp.74-81), Dept. of Linguistics and Phonetics, Lund University, 2007, pp.3～4.

12) Peter Ladefoged, & Ian Maddieson, *The sounds of the world's languages*, Oxford:

producing /l/, a central closure could facilitate for narrowing the aperture of lateral escape. This lateral gap is kept narrow, and as a result, the air escapes along with turbulence.[13] In other words, Mongolian lateral fricative involves raising the back of the tongue to the palate which makes larger obstruction[14] and greater dorsal constriction, causing proximity of F2-F1 to increase.[15] In general, Mongolian has used the Cyrillic alphabet for their writing system. Halh Mongolian lateral [ɮ] does not appear in word initial position except for loanwords (e.g., 'ɮam', 'лам', 'lama'; 'ɮuu', 'лүү', 'jar'),[16] whereas /ɮ/ occurs robustly in word medial position (e.g., 'səl(ɮ)əŋgəs', 'Сол онгос', 'Korea'; 'ʊl(ɮ)s', ' улс', 'country')[17] and in word final position (e.g., 'gaɮ', 'гал', 'fire'; 'saɮ', 'сал', 'raft').[18]

Ⅲ. Methodology

1. Subjects

A total of 16 subjects participated in this study. Eight female Korean native speakers were recruited from a club society in Han Kuk University of

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Blackwell Publishers, 1996, p.206.

13) Martin. J. Ball, & Joan Rahilly, *Phonetics: the science of speech*, London: Arnold, 1999, p.78.

14) Peter Ladefoged, & Ian Maddieson, op. cit., p.206.

15) Susan Lin, Patrice Speeter Beddor, & Andries W. Coetzee, "Gestural reduction, lexical frequency, and sound change: A study of post-vocalic /l/", *Laboratory Phonology*, 5(1):9-36, 2014, p.26.

16) Jan-Olof Svantesson et al., op. cit., pp.27～28.

17) 강사라, 김명화,『샌배노 몽골어』, 아시안 허브, 서울, 2017, p.42.

18) Jan-Olof Svantesson et al., op. cit., pp. 26～27.

Foreign Studies and eight female Mongolian native speakers were recruited from their religious community in Korea. The distribution of Korean students' age ranges from 19 to 23 (Mean=21.5; SD=1.41) and Mongolian students' age ranges from 19 to 28 (Mean=22.5; SD=3.12). It should be noted that all Mongolian subjects were native speakers of Halh Mongolian. When they participated in this study, they were undergraduate students in Korea. During participation, all subjects were asked to evaluate their own proficiency in English in terms of reading, writing, speaking, and listening. The list of their evaluation results is provided in Appendix C. In addition, the information of the subjects' language background is presented in Table 1 below.

〈Table 1〉 Subjects' Language Background (n=16)
Standard Deviations in Parenthesis

	Korean (8, Female)		Mongolian (8, Female)	
	Mean (SD)	Range	Mean (SD)	Range
First Exposure to English (years)	7 (1.51)	4 - 9	10.38 (2.83)	5 – 14
Learning English (years)	14 (2.39)	11 - 17	8.75 (1.58)	6 – 10
Proficiency in English	Average (n=6) Below the Average (n=2)		Average (n=5) Below the Average (n=3)	

2. Materials

The recording data are comprised of a total of 256 tokens (8 tokens x 2 iterations x 16 subjects). Each syllable position contains a lateral /l/ word, provided for analysis as follows: Word initial prevocalic-/l/, Word intermediate preboundary-/l/, Word intermediate postboundary-/l/, and Word final postvocalic-/l/. For instance, the initial position of light /l/ in '*leaf*',

'long'; the preboundary of less dark /ɬ/ following a stressed vowel in *'miller'*, *'pilot'*; the postboundary of less light /l/ preceding a stressed vowel in *'allay', 'belated'*; and the final position of dark /ɬ/ in *'steal', 'pool'.*

3. Data Collection

1) Recording

The subjects were asked to write their personal information on the questionnaire, which is provided in Appendix A. The collection of production was carried out individually in the sound-proof booth.[19] The subjects were seated on the chair and wore a headphone (Model: Sony MDR 7506). The microphone (Model: AT 4050) was placed about 30cm away from each subject. Each subject was asked to read the presented speech material twice. The target words were embedded in the final position of the carrier sentence as follows: "Now I say….". The subjects' utterance was recorded in Mic preamp built into Audio Interface (Model: Prism Sound Atlas), which is connected to the computer software (Pro Tools) placed outside of the sound-proof booth. Simultaneously, each production was stored in individual files. The production of words was digitalized and resolved to a 16bit amplitude at a 44.000Hz sampling frequency. The recording wave files were normalized for intensity (Average: -15～ -17 LUFS). Thereafter, we selected one file which was determined to have the better pronunciation from each.

19) The recording was implemented from July 24th, 2020 to August 13th, 2020 at Sunflower recording studio in Seong Nam-Si, Gyeonggi-do. A total of 32 people (18 Koreans and 13 Mongolians) participated in the experiment. For this study, we selected the wave file of 16 female undergraduate students.

2) Acoustic Measurement

The recording wave files were entirely segmented and annotated by using *Praat* program[20] although it was a subjective work. For measuring the acoustic signal, segmenting and labeling of the sound file were conducted on Text-Grid. We selected the boundary on the /l/ portion and each segment by auditory cues and visual inspection on the wideband spectrogram and waveform. The F1 and F2 value at the medial position on the stable portion of /l/ were measured. Huffman (1997) suggested that the value on the midpoint of /l/ was representative of the formant extrema.[21] The syllable initial light /l/ was identified by an abrupt F1 shifting and a short F1 transition duration[22] with intensity changes and a spectral discontinuity. The boundary of syllable final dark /ɫ/ was delimited at the F2 formant trajectory in a relatively stable state, and its intensity decreased significantly.[23] The duration of target syllable, lateral /l/, and the rime were extracted using *Praat* script. The selection of each duration automatically displayed the time range of the /l/. The duration of prevocalic-/l/ in initial position words (e.g., *leaf, long*) was measured from the beginning of the /l/ to the formant stabilized in the following vowel. Intervocalic-/l/ that appears after stressed vowel words (e.g., *miller, pilot*) was measured at the preboundary of syllable. In addition, the /l/ that occurs before stressed vowel words (e.g., *allay, belated*) was measured at the postboundary of syllable. Postvocalic-/l/ in final position

20) Paul Boersma, & David Weenink, (2021), "*Praat*: Doing phonetics by computer", [computer program]. Version 6.0.21, http://www.praat.org.

21) Marie K. Huffman, "Phonetic variation in intervocalic onset /l/'s in English". *Journal of Phonetics* 25, 115-141, 1997, p.124.

22) Rodger M. Dalston, "Acoustic characteristics of English /w, r, l/ spoken correctly by young children and adults", *Journal of the Acoustical Society of America*. 57, 462-469, 1975, pp. 465～466.

23) Daniel Recasens, op. cit., p.372.

words (e.g., *steal, pool*) was measured between the transition of beginning of the vowel to /l/ and the formant stabilized in the following /l/. Acoustic intensity value was measured directly with the green amplitude in dB on the right portion of the View & Edit window for each of different phonation types. Thereafter, the collected acoustic measurements were stored in Excel program, and then each mean and standard deviation of the acoustic value were calculated through Excel for analysis.

Ⅳ. Results and Acoustic Analysis

1. F1 and F2 for /l/

〈Table 2〉 Means of Formant Frequencies 1, 2 (in Hertz): Korean vs. Mongolian Standard Deviations in Parenthesis

	Phonological Environment	F1		F2	
		Mean (SD)	Range	Mean (SD)	Range
Korean	PREV	365 (47)	264 - 436	1586 (339)	1134 - 2171
	I-PREB	422 (69)	326 - 576	1411 (269)	1033 - 1838
	I-POSTB	463 (94)	370 - 669	1523 (340)	1025 - 2128
	POSTV	402 (125)	232 - 645	1308 (412)	789 - 2204
Mongolian	PREV	409 (56)	329 - 563	1428 (372)	865 - 2196
	I-PREB	453 (53)	376 - 564	1386 (300)	895 - 1948
	I-POSTB	463 (115)	265 - 719	1486 (308)	865 - 2022
	POSTV	466 (93)	313 - 616	1206 (356)	313 - 616

As shown in Table 2 above, the phonological environment is classified as four categories: Prevocalic-/l/ (PREV), Intermediate preboundary-/l/ (I-PREB), Intermediate postboundary-/l/ (I-POSTB) and Postvocalic-/l/ (POSTV).

Table 2 shows the numerical order of the mean values of F1 in Mongolians as follows: PREV=409Hz> I-PREB=453Hz> I-POSTB=463Hz> POST=466Hz. The mean values of F1 in Koreans are as follows: PREV= 365Hz> POSTV=402Hz> I-PREB=422Hz> I-POSTB=463Hz. On the other hand, the mean values of F2 in Mongolians showed the following: POSTV=1206Hz> I-PREB=1386Hz> PREV=1428Hz> I-POSTB=1486Hz. The mean values of F2 in Koreans varied in the progression as follows: POST= 1308Hz> I-PREB=1411Hz> POSTB=1523Hz> PREV=1586Hz.

Based on the above result, it was found that the mean values of F1 for Mongolians were higher than those of Koreans in all positions. On the contrary, the mean values of F2 for Koreans were higher than that of Mongolians. The noticeable difference was that while Koreans showed /l/ having a relatively high F2 and a low F1, Mongolians had a relatively higher F1 and a lower F2. This result indicates that Koreans produced the initial position in /l/ as English light /l/, and Mongolians produced the final position of /l/ as English dark /ɬ/. In other words, Koreans pronounced light /l/ more accurately because of influence of palatalization of Korean /l/, and Mongolians pronounced dark /ɬ/ more accurately because of influence by pharyngeal constriction.

This finding is supported by Yuan's (2009) following statement, "The light /l/ has a relatively high F2 and a low F1, whereas the dark /ɬ/ has a lower F2 and a higher F1".[24] In addition, "the variation of F2 values were caused by the tongue body configuration and oral cavity distribution: a relatively high F2 about 1500～2000Hz for clear /l/ and a lower F2 about 800～

24) Jiahong Yuan, & Mark Liberman, "Investigating /l/ variation in English through Forced Alignment", University of Pennsylvania, USA, *INTERSPEECH 2009 BRIGHTON*, 2009, p.2215.

1200Hz for dark /ɫ/".[25] According to the acoustic theory of speech production, the value of F1 and F2 of /l/ are determined based on the front cavity and the pharyngeal constriction. The front cavity conveys an articulatory narrowing for constriction, which causes a decrease in F1. On the other hand, the higher value of F1 indicates that the body of the tongue is more raised,[26] and the lateral passage is more constricted. Moreover, the tongue body moves from anterior to the hard palate for the constriction, which makes the high F2 value for palatalization as in Korean /l/. This influence by the palatalization of Korean is the reason why the mean value of F2 for Koreans is high in this study. Furthermore, Kwon (2006) suggests that the palatalization of Korean /l/ along with the lack of dorsal gesture is correlated with a relatively higher F2 in Korean /l/,[27] which influenced the production of English lateral /l/.

In contrast, a lower F2 value is related to a degree of tongue backing for articulation. The lowering of tongue pre-dorsum combined with retracting of the tongue post-dorsum brings the decreasing F2.[28] Additionally, the value of F2 has been used as an indicator of the pharyngealization degree in alveolar laterals. It is strongly supported by Simonet (2015) who stated, "The lower F2 value indicates a larger degree of 'pharyngealization' than higher F2 value".[29]

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25) Daniel Recasens, op. cit., p. 369.

26) Pierre Delattre, "The physiological interpretation of sound spectrograms". *The modern language association of America*, Vol. LXVI, No.5, 1951, p.868.

27) Bo-Young Kwon, "Features of First Language Transfer in Korean Speakers' Production of English /l/", *English Teaching*, 61(2), 179-207, 2006, p.182.

28) Pierre Delattre, "The physiological interpretation of sound spectrograms". *The modern language association of America*, Vol. LXVI, No.5, 1951, p.872.

29) Miquel Simonet, "An acoustic study of coarticulatory resistance in "dark" and "light" alveolar laterals", University of Arizona, Department of Spanish and Portuguese, *Modern Languages*, 545, 2015, p.143.

Significantly, most Mongolians showed more secondary articulation of pharyngealization for /l/ along with velarization. This type of phonetic pattern is due to tongue backing for pharyngeal constriction and velarization in Mongolian lateral fricative [ɮ]. The pharyngeal friction from the narrowing of the pharynx makes contribution to variable allophonic /l/ in every position for Mongolians. Ladefoged (2015) observed that the pharyngealized and velarized sounds have very little difference among the languages.[30] It explains why Mongolians' articulatory of postvocalic-/l/ matches up with American English dark /ɬ/ or velarized sound.

As discussed above, Koreans and Mongolians considerably transferred their mother tongue phoneme sound to target English sound of /l/. The result of the comparison demonstrated that Koreans produced light /l/ sound more accurately than Mongolians. In contrast, Mongolians produced dark /ɬ/ sound more accurately than Koreans.

2. F2-F1 Difference

Typically, the parameter F2-F1 difference has been applied as an acoustic cue for the degree of darkness in /ɬ/. The lower value of F2-F1 means the darker /ɬ/. As for the F2-F1 difference, Sproat and Fujimura (1993) found phonetic contrasts between canonical light /l/s and dark /ɬ/s, where light /l/ is 904.23～1315.71Hz and dark /ɬ/ is 515.34～908.96Hz.[31] In another instance, Ahn (2015) found that clear (or light) /l/'s range is over 1000Hz while the dark /ɬ/ has lower F2-F1 difference and its scope is 650～850Hz.[32]

30) Peter Ladefoged, op. cit., p.245.
31) Richard Sproat, & Osamu Fujimura, op. cit., p.299.
32) Miyeon Ahn, "Lexical Status and the Degree of /l/-darkening", *Journal of the Korean Society of Speech Science* Vol.7 No.3. 2015, p.75.

〈Table 3〉 Means of F2–F1 Difference (in Hertz): Korean vs. Mongolian
Standard Deviations in Parenthesis

	Phonological Environment	F2–F1	
		Mean (SD)	Range
Korean	PREV	1221 (322)	813 – 1795
	I-PREB	989 (276)	612 – 1405
	I-POSTB	1060 (338)	607 – 1730
	POSTV	905 (54)	457 – 1807
Mongolian	PREV	1019 (392)	458 – 1832
	I-PREB	934 (314)	519 – 1486
	I-POSTB	1023 (305)	511 – 1757
	POSTV	740 (349)	355 – 1323

Table 3 indicates that Mongolians showed F2-F1 difference value less than Koreans in every position, particularly in postvocalic-/l/ (Mongolian: Mean=740Hz, SD=349; Korean: Mean=905Hz, SD=54, the difference in F2-F1 is 165Hz). This result supports that Mongolians articulated dark /ɬ/ more accurately in postvocalic-/l/ position than that of Koreans. Moreover, Lin (2014) revealed the relationship between 'F2-F1 proximity' and the size of the alveolar constriction by using ultra sound imaging and found that the "greater F2-F1 proximity for /l/ (i.e., smaller F2-F1 distance), the more anterior gestures were reduced".[33] In addition, wider opening of the oral cavity leads to the weaker alveolar constriction, resulting in the value of F2-F1 which becomes smaller during the production of postvocalic-/l/ in final position.

Notably, both Koreans and Mongolians showed moderate degree of darkness in intervocalic preboundary (Mongolian: Mean=934Hz, SD=314; Korean: Mean=989Hz, SD=276, the difference is 55Hz), and showed

33) Susan Lin, Patrice Speeter Beddor, & Andries W. Coetzee, op. cit., p.12.

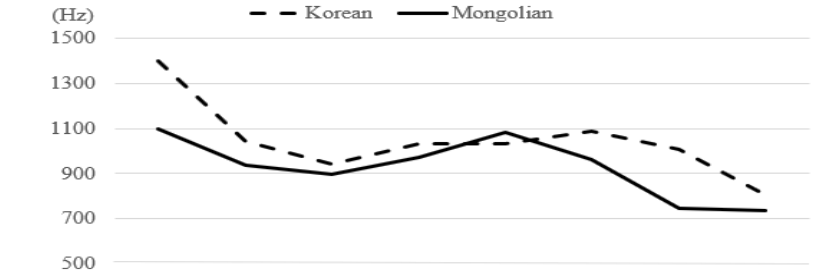
intermediate degree of lightness in intervocalic postboundary (Korean: Mean=1060Hz, SD=338; Mongolian: Mean=1023Hz, SD=305, the difference is 37Hz). As shown earlier, the sound of dark /ɬ/ in intermediate preboundary showed less dark than postvocalic-/l/. Moreover, the sound of light /l/ in intermediate postboundary was realized less light than prevocalic-/l/.

In the comparison of the light /l/ in onset position, Koreans exhibited that the value of F2-F1 was higher than that of Mongolians (Korean: Mean= 1221Hz, SD=332; Mongolian: Mean=1019Hz, SD=392, the difference is 202Hz). This result consistently demonstrates that Koreans produced light /l/ better and more accurately than Mongolians. Furthermore, the higher F2-F1 difference for Koreans indicates that their lateral /l/ sound transferred to target language phoneme by making dentoalveolar constriction for palatalized sound.

The determination of lower or higher F2-F1 value is correlated to the production of back and up tongue retraction and tongue advancement for front cavity lengthening.[34] The greater tongue retraction and tongue advancement with lowering the tongue dorsum, the smaller F2-F1 difference occurs.

As presented in Figure 1 below, the distribution of values prominently showed the sound of light /l/ except for '*pool*' produced by Koreans, whereas the value of Mongolians showed the sound of dark /ɬ/ except for '*leaf*' and '*allay*'. The word '*pool*' in the production of /l/ involves an [u]-like tongue position for dark /ɬ/, which is significantly compatible in dark /ɬ/ sound for both groups (Mongolian: 733z; Korean: 806Hz). The feature of phonetic [u] affected the production /l/ and allowed a F2 slope to be fallen.

34) Pierre Delattre, op. cit., p.870.



Word	leaf	long	miller	pilot	allay	belated	steal	pool
Korean	1400	1041	944	1035	1031	1090	1005	806
Mongolian	1099	939	895	973	1081	964	746	733

〈Figure 1〉 Line Showing the Comparison between Korean and Mongolian: F2−F1 Difference for Each Word

Typically, tongue backing and lip rounding tend to lower the value of F2,[35] inducing the dark /ɬ/ sound. As for Koreans, the word '*leaf*' has the largest value of F2-F1 difference. It is caused by tongue tip raising with a strong constriction that follows high vowel [i], which corresponds to light /l/. The value of lightness of '*long*' showed F2-F1 less than the word '*leaf*' due to adjacent vowel formant. Interestingly, Koreans' production of the word '*steal*' exhibits the quality of light /l/ with a rising F2 slope due to tongue tip fronting. It explains an influence of adjacent high vowel [i] for strong alveolar constriction.

The production of *'steal', 'pool'* by Mongolians substantially appeared in the sound of dark /ɬ/ (Mean=746Hz '*steal*', 733Hz '*pool'*). Judging from this, Mongolians produced dark /ɬ/ quite accurately. The production of dark /ɬ/ in syllable final position is represented by making greater retraction of tongue body and lowering tongue dorsum along with reduced alveolar gestures. The /l/ preceding with a stressed vowel such as '*allay', 'belated*' showed less

35) Ibid., p.872.

light quality of /l/ than the canonical light words '*leaf', 'long'*, which are similar to both groups. The /l/ following a stressed vowel word '*miller*' showed a darker /ɬ/ in Mongolians (Mean=895Hz) than that of Koreans (Mean=944Hz). It explains that Koreans produced a lighter /l/ in the word '*miller*' than Mongolians, to some degree.

Ultimately, this result demonstrates that the production of /l/ variation depends on the syllable position and certain degree of vowel coarticulation for both light /l/ and dark /ɬ/.

3. Duration

〈Table 4〉 Means of Duration (in ms): /l/, Ratio (%)[36], and Rime for Korean and Mongolian

Phonological Environment	Korean				Mongolian			
	/l/		Ratio (%)	Rime	/l/		Ratio (%)	Rime
	Mean (SD)	Range			Mean (SD)	Range		
PREV	146.59 (39.35)	93.78 - 237.91	26.57	404.46	148.35 (41.81)	98.69 - 260.97	30.31	343.67
I-PREB	135.57 (22.65)	93.89 - 176.49	23.91	244.61	124.08 (27.75)	85.19 - 197.67	25.12	200.72
I-POSTB	134.78 (18.66)	103.69 - 162.44	20.7	241.57	116.16 (25.16)	81.10 - 168.26	20.89	218.34
POSTV	170.66 (36)	104.32 - 233.65	28.99	353.54	143.81 (26.54)	105.27 192.25	26.65	324.89

Table 4 shows that the duration of Koreans' rime is longer than that of Mongolians in all positions. As for the duration of /l/, Koreans exhibited the

36) Ratio (%) indicates length of [l]/syllable length percentile. I-PREB was measured at the preboundary rime and I-POSTB was measured at the postboundary rime.

progression of I-POSTB: Mean=134.78ms (20.7%)> I-PREB: Mean=135.57ms (23.91%)> PREV: Mean=146.59ms (26.57%)> POSTV: Mean=170.66ms (28.99%).

Mongolians showed the progression of I-POSTB: Mean=116.16ms (20.89%)> I-PREB: Mean=124.08ms (25.12%)> POSTV: Mean=143.8ms (26.65%)> PREV: Mean=148.35ms (30.31%).

Koreans' duration of /l/ was relatively longer than that of Mongolians except for the prevocalic-/l/. The prevocalic-/l/ was slightly longer in Mongolians (Mean=148.35ms, 30.31%) than Koreans (Mean=146.59ms, 26.57%) with a difference of 1.76ms. Both Koreans and Mongolians showed that the longest duration of rime was in prevocalic-/l/ words, '*leaf*', '*long*' (Korean: 404.46ms; Mongolian: 343.67ms). The longest duration of '*leaf*', '*long*' was affected by following a stressed vowel for coarticulation. Moreover, Koreans and Mongolians showed the rime of the final position (Korean: 353.54ms; Mongolian: 324.89ms) fairly longer than both intermediate preboundary (Korean: 244.61ms; Mongolian: 200.72ms) and intermediate postboundary (Korean: 241.57ms; Mongolian: 218.34ms).

This result corresponds to Sproat and Fujimura's (1993) findings that longer rime duration has a relatively larger degree of darkness in /ɫ/,[37] whereas the quality of the light /l/ is not related to the duration of rime.[38]

4. Intensity

As shown in Table 5 below, the normalized intensity of Mongolians showed relatively higher than that of Koreans in every syllable position.

37) Richard Sproat, & Osamu Fujimura, op. cit., p. 307.
38) Ibid., p. 293.

〈Table 5〉 Means of Intensity (in dB): Korean vs. Mongolian
Standard Deviations in Parenthesis

Phonological Environment	Korean		Mongolian	
	Mean (SD)	Range	Mean (SD)	Range
PREV	76.56 (2.30)	72.16 – 81.42	78.83 (2.46)	73.87 – 82.37
I-PREB	77.16 (1.64)	74.37 – 80.12	80.18 (2.74)	74.85 – 84.43
I-POSTB	77.23 (2.06)	73.50 – 81.65	80.39 (2.08)	75.86 – 83.32
POSTV	71.53 (2.93)	66.30 – 77.21	73.99 (2.77)	69.77 – 79.75

Higher intensity is an indicator of greater constriction on the /l/ due to the fact that Mongolian lateral fricative [ɮ] inherits quite higher frequency noises. Mongolian lateral has lower sonority ranking than the class of fricatives due to their phonetic realization as pronounced in [ɬ] or [ɮ].[39)]

Notably, both Koreans and Mongolians revealed the same progression of intensity: POSTV> PREV> I-PREB> I-POSTB. It should be noted that the dark /ɬ/ in final position showed the lowest intensity in both groups of Koreans (Mean=71.53dB, SD=2.93) and Mongolians (Mean=73.99, SD=2.77), respectively, among other positions. The lowest intensity corresponds to a narrowing pharynx which leads to decreasing of the palate constriction. The light /l/ in syllable initial position for Koreans showed relatively higher than dark /ɬ/ position (PREV: Mean=76.56dB, POSTV: Mean=71.53dB, the difference is 5.03dB). The light /l/ in onset position for Mongolians also showed higher than dark /ɬ/ position (PREV: Mean=78.83dB, POSTV: Mean=73.99dB, the difference is 4.84dB). As observed earlier, syllable initial position of prevocalic-/l/ appears abruptly with a high level of intensity, whereas postvocalic-/l/ shows gradually lowering intensity caused by a lack of

39) Carmen Jany et al., “How universal is the sonority hierarchy?”: A cross-linguistic acoustic study”, 16th International Congress of Phonetics Sciences, Saarland University, Saarbrüken, 6-10, August 2007, p.1403.

constriction of the tongue body. In particular, Mongolians' production of intermediate postboundary in geminated /l/ words, '*allay'*, '*miller*' showed the highest energy, which indicates a greater constriction of the laterality (Mean=80.39dB, SD=2.08) in contrast to that of Koreans (Mean=77.23dB, SD=2.06). This comparison of intensity confirms that an unusual friction of Mongolian lateral interfered the articulatory for English /l/ for Mongolians.

Ⅴ. Discussion

This study investigated English lateral /l/ variation produced by Korean and Mongolian acoustically. The main finding was that both Koreans and Mongolians showed each language's distinct consonant /l/ articulatory habit which affects the production of American English /l/. Flege (1984) suggested that the 'transfer or interference' arose from structure or phonetic differences between L1 and L2 learners.[40] Additionally, we found that there is considerable acoustic distinction in the production of lateral /l/ variation for Koreans and Mongolians. Significantly, Koreans' /l/ has a relatively high F2 and a low F1, whereas Mongolians' /l/ has a relatively higher F1 and a lower F2. As a result, Koreans articulated light /l/ more accurately than Mongolians, whereas Mongolians produced dark /ɬ/ more accurately than Koreans.

Moreover, when comparing the F2-F1 difference, Mongolians showed F2-F1 value less than Koreans in every position, particularly in syllable final

40) James Emil Flege, & Richard D. Davidian, "Transfer and developmental processes in adult foreign language speech production", *Applied Psycholinguistics* 5, 323-347, 1984, p.324

position (Mongolian: Mean=740Hz; Korean: Mean=905Hz). Acoustically, the velarized or dark /ɬ/ is specified by the joint contribution of F1 and F2. The more the degree of velarization increases, the more F1 increases and F2 decreases.[41] The production of velarized dark /ɬ/ is considered as the tongue body lowering which consequently lowers the value of F2.[42] This comparison suggests that Mongolian lateral [ɮ] seems to inherit a sounding of dark /ɬ/. On the contrary, Korean /l/ has a sounding of light /l/. Thus, the mean value of acoustic parameter F2-F1 difference appeared as an indicator of distinguishing Koreans' production from Mongolians'.

The high value of F2 inherent in Korean /l/ that leads to Koreans' production of English /l/ was influenced by a secondary articulation of palatalization. In comparison, Mongolians' production of /l/ was affected by a secondary articulation of pharyngealization through retracting of the root of the tongue for /l/ as well as velarization by raising of the back of the tongue. Additionally, the higher value of F2-F1 difference for Koreans indicates that Korean /l/ sound interfered target language phoneme by causing dentoalveolar constriction. As a result, Koreans produced relatively light /l/ better and more correctly than Mongolians. As discussed above, the variation of laterality of /l/, light and dark, is caused by the segmental position and syllable boundary. In terms of intermediate syllable boundary of /l/, Koreans and Mongolians showed that the sound of dark /ɬ/ in intermediate preboundary was realized to be less dark than postvocalic-/l/ in final position. The sound of light /l/ in intermediate postboundary appeared to be less light than prevocalic-/l/ in onset position. This result is consistent with Yuan's

41) Daniel Recasens, Jordi Fontdevila, & Maria Dolors Pallares, "Velarization degree and coarticulatory resistance for /l/ in Catalan and German", *Journal of Phonetics* 23, 37-52, 1995, p.41.

42) Ibid., p.50.

(2011) proposal that a syllable position of intervocalic /l/ could be less light or dark according to the syllable boundary with stressed vowel.

Ⅵ. Conclusion

This study showed that Koreans' and Mongolians' production of American English lateral /l/ varies depending on the difference in position, adjacent vowel coarticulation, and individual differences. Remarkably, the distinct phonetic factors of native language clearly influenced the production of American English /l/ allophones for both groups. In particular, the noticeable finding was that the acoustic parameter 'F2-F1 difference' and 'Intensity' appeared as an indicator of distinguishing Koreans' production from Mongolians'. Most Mongolians showed F2-F1 difference less than that of Koreans, especially in postvocalic-/l/ position, as evidenced by the fact that Mongolians articulated dark /ɬ/ more accurately in the syllable final position than that of Koreans. This further confirms that Mongolians have higher F1 and relatively lower F2 originated from tongue backing for pharyngeal constriction of /l/ along with velarization of Mongolian /ɮ/. On the contrary, the higher value of F2-F1 difference for Koreans indicates that Korean lateral /l/ sound transferred to target language phoneme by generating dentoalveolar constriction for palatalization, as evidenced by the fact that Koreans articulated light /l/ more accurately than Mongolians.

In terms of intensity, Mongolians showed relatively higher intensity than that of Koreans in all of syllable positions. This supports that Mongolian lateral fricative [ɮ] inherits quite higher frequency noises. An unusual Mongolian lateral friction not only influences the degree of intensity but

contributes to variable phonetic quality of /l/.

As for the duration, Koreans showed relatively longer duration of /l/ than that of Mongolians except for the prevocalic-/l/. The prevocalic-/l/ was slightly longer in Mongolians than that of Koreans with a difference of 1.76ms. Additionally, the duration of Korean's rime was longer than that of Mongolians in all positions.

Ultimately, the outcome of this study revealed that Koreans produced light /l/ sound more accurately than Mongolians. In contrast, Mongolians produced dark /ɬ/ sound more accurately than Koreans.

The research for the production of English liquid phoneme /l/ by Mongolian has not been paid attention to so far. As such, the study of English liquid phoneme /l/ and /r/ produced by Mongolian will be necessary in the future.

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Appendix A

LANGUAGE BACKGROUND QUESTIONNAIRE*

Ⅰ General Information**

1. Speaker Code:
2. Sex: □ F □ M
3. Age:
4. Native Language:

Ⅱ Language Background

1. How old was your first exposure to English?
2. Where did you first encounter to English:
   □ At school □ Outside school □ Both
3. English instruction:
   a. How many years have you been learning English?
   b. Was your English instructor a native speaker? □ Yes □ No
4. Have you ever taken an English pronunciation class?
   □ Yes □ No
   a. If yes:
      Which course did you take and when?

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* This questionnaire is adapted from James G. Smith, “Acoustic properties of English /l/ and /ɹ/ Produced by Mandarin Chinese Speakers”, The degree of Masters of arts, Graduate Department of Linguistics University of Toronto, 2010, pp.91～93.

** Each subject was asked to provide the name of university they currently attend in Korea.

5. Have you ever stayed in the country of native English-speaking?
   □ Yes □ No
   a. If yes:
      i. Place:
      ii. Duration:
6. Have you taken English class in the country of native English-speaking? □ Yes □ No
   a. If yes:
      i. How long did you take them?
      ii. When did you take them?
7. Please show the following areas about your own proficiency in English?
   <5=Excellent 4=Good 3=Average 2=Poor 1=Very poor>
   Reading: Writing: Speaking: Listening:

Appendix B

〈Table B.1〉 Speech Material

Phonological Environment	Target Words
PREV	leaf, long
I-PREB	miller, pilot
I-POSTB	allay, belated
POSTV	steal, pool

〈Table B.2〉 Korean Subjects' Information (n=8)

Speaker Code	Sex	Age	Native Language	Affiliated University	First Exposure to English (years)	Learning English (years)	Proficiency in English
K1	F	23	Standard Korean	Hoseo Univ.	6	17	Average
K2	F	22	Standard Korean	Kyung Hee Univ..	8	14	Average
K3	F	20	Standard Korean	Han Kuk Univ. of F.S.*	9	11	Below the Average
K4	F	23	Standard Korean	Han Kuk Univ. of F.S.	7	16	Average
K5	F	22	Standard Korean	Han Kuk Univ. of F.S.	7	12	Below the Average
K6	F	21	Standard Korean	Han Kuk Univ. of F.S.	8	13	Average
K7	F	22	Standard Korean	Han Kuk Univ. of F.S.	4	17	Average
K8	F	19	Standard Korean	Han Kuk Univ. of F.S.	7	12	Average

*Han Kuk Univ. of F. S.: Han Kuk University of Foreign Studies.

〈Table B.3〉 Mongolian Subjects' Information (n=8)

Speaker Code	Sex	Age	Native Language	Affiliated University	First Exposure To English (years)	Learning English (years)	Proficiency in English
M1	F	20	Halh Mongolian	Ga Chon Univ.	14	6	Average
M2	F	22	Halh Mongolian	Kyung Hee Univ.	12	10	Average
M3	F	19	Halh Mongolian	Ga Chon Univ.	10	7	Average
M4	F	26	Halh Mongolian	Univ. of Science and Technology	12	10	Below the Average
M5	F	22	Halh Mongolian	Kyung Hee Univ.	10	10	Average
M6	F	28	Halh Mongolian	Univ. of Seoul	12	10	Below the Average
M7	F	20	Halh Mongolian	Myong Ji Univ.	8	9	Below the Average
M8	F	23	Halh Mongolian	Ga Chon Univ.	5	8	Average

Appendix C

〈Table C. 1〉 Korean Subjects' Self-Assessment of English Proficiency (n=8)

5(100%)=Excellent, 4(80%)=Good, 3(60%)=Average, 2(40%)=Poor,
1(20%)=Very Poor

	Reading	Writing	Speaking	Listening		
					Mean	Ratio (%)
K1	3	3	2	5	3.25	65
K2	3	2	4	3	3	60
K3	3	2	2	3	2.5	50
K4	4	3	4	4	3.75	75
K5	3	3	2	3	2.75	55
K6	3	3	3	3	3	60
K7	4	2	2	4	3	60
K8	3	3	4	4	3.5	70
					M=3.094 (n=8)	M=61.875 (n=8)

〈Table C. 2〉 Mongolian Subjects' Self-Assessment of English Proficiency (n=8)

5(100%)=Excellent, 4(80%)=Good, 3(60%)=Average, 2(40%)=Poor,
1(20%)=Very Poor

	Reading	Writing	Speaking	Listening		
					Mean	Ratio (%)
M1	3	3	3	4	3.25	65
M2	4	3	2	5	3.5	70
M3	4	4	4	4	4	80
M4	3	3	2	2	2.5	50
M5	3	2	3	4	3	60
M6	3	2	3	3	2.75	55
M7	4	3	1	2	2.5	50
M8	3	3	3	3	3	60
					M=3.063 (n=8)	M=61.25 (n=8)

한국과 몽골 대학생이 발음한 영어 설측음의 이음에 대한 음향학적 연구

최 정 훈* · 강 용 순**

이 연구의 목적은 한국인과 몽골인의 설측음 영어발음 분석을 토대로 외국인 화자의 영어 발음이 모국어의 영향을 받고 있음을 보이고자 하는 것이다. 영어 설측음 /l/이 단어내의 위치에 따라 밝은 /l/과 어두운 /ɬ/로 발음되는 조음상의 특징을 음향 분석의 항목인 F1, F2, F2-F1의 차이, 설측음 길이(Duration) 그리고 마찰강도(Intensity)를 프랏(*Praat)* 음성 분석 프로그램을 사용하여 분석하였다. 그 결과, 두 그룹의 참가자들이 발음한 미국영어의 설측음은 단어의 음운환경, 인접한 모음의 영향 그리고 개인의 음성적 실현의 차이에 따라 다양한 양상을 보여주었다. 특히, 각 모국어의 설측음 발성의 특징적인 조음방법이 음소 /l/의 전이(Transfer)와 간섭(Interference)의 현상으로 참가자들의 영어 설측음 발화에 영향을 주었다. 한국인은 한국어 설측음의 조음 특징인 구개음화(Palatalization)의 영향으로 밝은 /l/발음이 더 정확하였고, 몽골인은 마찰음이 혼합된 몽골어 설측음의 조음 방식인 인두 강 협착(Pharyngeal constriction)과 그와 동반한 연구개음화(Velarization)의 영향으로 어두운 /ɬ/을 더 정확하게 발음하였다. 설측음 길이에 대한 변별력은 크게 나타나지 않았으며, 몽골어 설측음의 특이한 협착과 마찰성의 영향으로 몽골인이 한국인보다 센 마찰강도를 보여주었다. 따라서 이 연구는 모국어의 간섭이 영어 설측음 발음을 다양하게 실현하는 요소임이 확인되었다.

* 성균관대학교 영어영문학과 박사과정생, 제1저자
** 성균관대학교 영어영문학과 교수, 교신저자

주제어: 영어 설측음, *Praat* 프로그램, 전이(Transfer),
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필자 E-Mail: jeonghh0715@gmail.com / yskang@skku.edu
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