Original Article

http://e-cacd.org/ eISSN: 2508-5948

Clinical Archives of Communication Disorders / Vol. 6, No. 2:141-148 / August 2021

Open Access

https://doi.org/10.21849/cacd.2021.00549

Acoustic characteristics of resyllabification process in Korean

Myoung Soon Lee, Hyun Park

Department of Speech-Language Therapy, Sangji University, Wonju, Korea

Purpose: This study aims to analyze acoustic characteristics of Korean words and nonwords according to resyllabification and meaningfulness.

Methods: The experimental data consisted of 10 homonyms and 10 corresponding words. Computerized Speech Lab (CSL) 4150B was used in a quiet place for recording. Moreover, the randomized word list was presented to 20 subjects, and they were asked to read naturally as if they were talking comfortably to the subjects. The analysis program was Praat 6151 win 64bit (Boersma & Weenink, 2021). Pitch, intensity, and duration of the words and the first and the second syllables were measured, and the resyllabification liaison rules and resyllabification influenced them. To investigate acoustic characteristics according to resyllabification, independent sample t-test and multivariate test were conducted using SPSS 26 for the statistical processing of a syllable's pitch, intensity, and duration changes.

Results: First, there was a significant difference between the groups in post-syllable pitch ratio in words and nonwords, which was 40s–50s pitch change was greater than that of 20s–30s. Second, the post-syllable pitch ratio was a significant difference between gender groups and according to the effect of the liaison rule. Third, the post-syllable duration ratio showed a significant difference between age groups. The post-syllable pitch ratio was a significant difference according to the effect of the liaison rule.

Conclusions: Therefore, when resyllabifications are generated by the liaison rule, the change of the post-syllable pitch can be explained by the focus prosody, and further research will be needed to establish a solid basis for this study.

Keywords: Acoustic, Liaison Rule, Resyllabification

INTRODUCTION

The phonological phenomenon in Korean is caused by the speed of words and rhythm patterns, and the utterance speed prosodic phonological phenomenon is related [1]. Syllabification is the bundle of phonemes in one unit, and they are very distinct linguistic units of Korean. The resyllabification occurs by liaison rule. This phenomenon occurs due to the simultaneous articulation of adjacent phonemes and the simplification of articulation in order for the speaker to communicate quickly and efficiently. Resyllabification occurs in the prosodic and syntactic structure by the liaison rule, which confuses writing.

Resyllabification refers to a phonological phenomenon in which the consonants at the end of the previous syllable are transferred to the initial phoneme of the following syllable phonetically, and the syllables component is changed [2]. Resyllabification is a

Received: August 22, 2021
Revision: August 30, 2021
Accepted: August 30, 2021

Correspondence:
Hyun Park

Department of Speech-Language Therapy, Sangji University, 83 Sangjidae-gil, Wonju, Korea
Tel: +82-337300869
Fax: +82-337300875
E-mail: cominglove@hanmail.net

phonological phenomenon commonly observed in everyday or slightly faster dialogues. This phenomenon also occurs when young students who begin to learn spelling write as they listen to them or when people who have not received average education write letters or other words as they pronounce them [2]. CVC is the largest syllable in Korean, and the phonemes at the end position of the syllable are limited and have various constraints [3]. Syllable nuclei and CV rules are universal in language, and the rules of the ending phoneme of syllables apply specifically to each language [4]. The resyllabificationliaison rule can explain the resyllabification in Korean, and all the syllable-final consonants of Korean are subject to the liaison rule. However, the phoneme /ŋ/ is not applied, which can be realized phonologically and phonetically only at the final position of the syllable. As such, the liaison rule changes the position of the end and changes the sound to the phonetics. The voiceless consonants /ㅂ, ㄷ, ㄱ/ at the end of the syllable are changed to the voiced sound [b, d, g] while becoming the initial syllable sound in the word. Finally, /ㄹ/ at the final position of the syllable changes from a lateral [l] to the alveolar flap [ɾ] phonetically. This study aims to analyze acoustic characteristics of Korean words and nonwords according to resyllabification and meaningfulness.

METHODS

Subjects

The subjects were educated at a university or higher and possessed neither articulation nor cognitive disorder. Twenty subjects participated in this experiment. They were 10 people in their 20s to 30s and 10 people in their 30s to 40s. The information of the subjects was presented in Table 1.

Procedure

The word and nonword list used in the experiment was selected by researchers in the homophonic nonword list of Park (2003)[5] as the meaning of the corresponding word as a high-frequency word. The experimental data consisted of 10 homonyms and 10 corresponding words. The list of words was presented in Table 2.

The experimental process was as follows. First, the experimental space was a quiet place where voice recording was possible, and the recording equipment was Computerized Speech Lab (CSL) 4150B. Second, the randomized word list was presented to the subjects, the most natural speech samples were collected without practice, and they were asked to read naturally as if they were talking comfortably to the subjects. Third, the distance between microphone and mouth was about 10-15 cm during recording.

Analysis

The recording was done three times, the first recording was excluded, and the most stable sample was selected in the second and third. The analysis program was Praat 6151 win 64bit [6]. Pitch, intensity, and duration of the words and the first and the second syllables were measured, and the resyllabification liaison rules and resyllabification influenced them. When the word consisted of 3 syllables, the first and second syllables of the word were measured separately and combined. During measuring, speech samples were labeled after the researchers listened three times in the spectrogram. Then, the ratio of each syllable's acoustic variable to the entire two syllables in the word was converted and applied as a statistical analysis variable.

Data processing

To investigate acoustic characteristics according to resyllabification, independent sample t-test and multivariate test were conducted using SPSS 26 for the statistical processing of a syllable's pitch, intensity, and duration changes.

Table 1. Subjects information

Division	N		Mean age	SD
20s–30s	M	5	27.40	5.78
	F	5		
40s–50s	M	5	48.60	4.86
	F	5		

Table 2. Experimental words and nonwords

Division	Corresponding words	Homophonic nonwords
Resyllabification	독일 (togil, German)	젭이 (tsjɛbi)
	악어 (agʌ, crocodile)	촐옥 (tsʰorokㄱ)
	석유 (sʌgju, oil)	굳우 (kudu)
	먹이 (mʌgi, food)	곧응어 (kodɯŋʌ)
	단어 (tanʌ, word)	반안아 (panana)
Syllabication	제비 (tsjɛbi, lottery)	도길 (togil)
	초록 (tshorokㄱ, green)	아거 (agʌ)
	구두 (kudu, shoe)	서규 (sʌgju)
	고등어 (kodɯŋʌ, mackerel)	머기 (mʌgi)
	바나나 (panana, banana)	다너 (tanʌ)

RESULTS

Acoustic Characteristics in Homophones by Meaningfulness

Acoustic Characteristics in Homophones According to Gender

In the phonological homonym structure, the pitch, intensity, and duration ratio was presented in Table 3 according to gender in words and nonwords.

The pitch ratio and intensity ratio are similar to or slightly higher than the entire syllables, and the duration ratio accounts for around 50% of the entire syllables. In other words, the pre-syllable pitch ratio of the males was 98.03%, which was slightly higher than that of the females. In other words, the post-syllable pitch ratio of females was 101.39%, in which the pitch of post-syllable is higher than the whole word pitch. In nonwords, the pre-syllable duration ratio of females (47.18%) was higher than that of males (45.28%).

According to the results of Table 4, there was a significant difference between the gender groups in post-syllable pitch ratio in words and nonwords, in which the female's pitch change was greater than that of male.

Acoustic Characteristics in Homophones According to Age

In the phonological homonym structure, the pitch, intensity, and duration ratio was presented in Table 5 according to age in words and nonwords.

In other words, the post-syllable duration ratio of those in their 40s-50s was 49.24%, which was longer than that of the 20s-30s group. In nonwords, the pre-syllable duration ratio of the 40s-50s group (45.88%) was higher than that of the 20s-30s group (39.63%). Also, in nonwords, the post-syllable duration ratio of the 40s-50s group (50.02%) was higher than that of the 20s-30s group (44.72%).

According to the results of Table 6, there was a significant difference between the age groups in the post-syllable pitch ratio in words and nonwords, in which the 40s-50s group's pitch change was greater than that of the 20s-30s group.

Acoustic Characteristics in Resyllabification by Liaison Rule

Acoustic Characteristics in Resyllabification According to Gender

In the phonological homonym structure, the pitch, intensity,

Table 3. Acoustic changes in homophones according to gender

Division	Index	Gender	N	M	SD
Word	Pre-syllable pitch ratio	M	100	98.03	12.80
		F	100	96.07	12.57
	Pre-syllable intensity ratio	M	100	98.42	3.85
		F	100	98.96	3.60
	Pre-syllable duration ratio	M	100	45.99	9.17
		F	100	46.57	9.63
	Post-syllable pitch ratio	M	100	99.81	8.57
		F	100	101.39	10.44
	Post-syllable intensity ratio	M	100	100.00	3.24
		F	100	99.50	3.09
	Post-syllable duration ratio	M	100	50.75	9.73
		F	100	51.84	14.83
Nonword	Pre-syllable pitch ratio	M	100	98.43	13.22
		F	100	98.01	13.69
	Pre-syllable intensity ratio	M	100	98.65	4.19
		F	100	99.66	2.95
	Pre-syllable duration ratio	M	100	45.28	11.71
		F	100	47.18	12.45
	Post-syllable pitch ratio	M	100	99.74	9.85
		F	100	100.59	11.31
	Post-syllable intensity ratio	M	100	100.08	2.82
		F	100	99.13	3.39
	Post-syllable duration ratio	M	100	52.79	21.00
		F	100	49.56	10.56

Table 4. Difference of acoustic changes in homophones according to gender

Division	Index	F	*p*
Word	Pre-syllable pitch ratio	0.001	0.981
	Pre-syllable intensity ratio	0.760	0.384
	Pre-syllable duration ratio	1.909	0.169
	Post-syllable pitch ratio	10.176	0.002**
	Post-syllable intensity ratio	0.002	0.964
	Post-syllable duration ratio	0.002	0.962
Nonword	Pre-syllable pitch ratio	0.429	0.513
	Pre-syllable intensity ratio	1.941	0.165
	Pre-syllable duration ratio	2.542	0.112
	Post-syllable pitch ratio	10.892	0.001**
	Post-syllable intensity ratio	3.538	0.061
	Post-syllable duration ratio	0.416	0.520

Table 6. Difference of acoustic changes in homophones according to age

Division	Index	F	*p*
Word	Pre-syllable pitch ratio	0.627	0.429
	Pre-syllable intensity ratio	3.135	0.078
	Pre-syllable duration ratio	1.543	0.216
	Post-syllable pitch ratio	5.909	0.016*
	Post-syllable intensity ratio	0.338	0.562
	Post-syllable duration ratio	3.044	0.083
Nonword	Pre-syllable pitch ratio	0.018	0.892
	Pre-syllable intensity ratio	1.800	0.181
	Pre-syllable duration ratio	0.622	0.431
	Post-syllable pitch ratio	4.867	0.029*
	Post-syllable intensity ratio	6.183	0.014*
	Post-syllable duration ratio	0.959	0.329

Table 5. Acoustic changes in homophones according to age

Division	Index	Age (year)	N	M	SD
Word	Pre-syllable pitch ratio	20s–30s	100	96.78	12.25
		40s–50s	100	97.31	13.17
	Pre-syllable intensity ratio	20s–30s	100	99.51	3.30
		40s–50s	100	97.88	3.96
	Pre-syllable duration ratio	20s–30s	100	41.53	12.94
		40s–50s	100	43.311	10.92
	Post-syllable pitch ratio	20s–30s	100	100.46	8.24
		40s–50s	100	100.75	10.76
	Post-syllable intensity ratio	20s–30s	100	99.71	3.01
		40s–50s	100	99.79	3.34
	Post-syllable duration ratio	20s–30s	100	44.29	12.40
		40s–50s	100	49.24	14.79
Nonword	Pre-syllable pitch ratio	20s–30s	100	97.15	13.20
		40s–50s	100	99.29	13.63
	Pre-syllable intensity ratio	20s–30s	100	99.39	2.99
		40s–50s	100	98.92	4.20
	Pre-syllable duration ratio	20s–30s	100	39.63	12.53
		40s–50s	100	45.88	14.63
	Post-syllable pitch ratio	20s–30s	100	100.65	9.28
		40s–50s	100	99.68	11.78
	Post-syllable intensity ratio	20s–30s	100	100.13	2.68
		40s–50s	100	99.07	3.49
	Post-syllable duration ratio	20s–30s	100	44.72	11.57
		40s–50s	100	50.02	23.05

and duration ratio was presented in Table 7 according to gender for resyllabification by liaison rule.

In resyllabification by liaison rule. The post-syllable pitch ratio of females was 166.93%, which was higher than that of

Table 7. Acoustic changes in resyllabification according to gender

Division	Index	Gender	N	M	SD
Resyllbication	Pre-syllable pitch ratio	M	71	98.17	13.09
		F	77	97.40	11.65
	Pre-syllable intensity ratio	M	71	98.57	3.88
		F	77	99.20	3.57
	Pre-syllable duration ratio	M	71	44.49	7.67
		F	77	45.87	9.83
	Post-syllable pitch ratio	M	71	118.96	29.83
		F	77	166.93	88.17
	Post-syllable intensity ratio	M	71	99.74	3.32
		F	77	99.32	3.26
	Post-syllable duration ratio	M	71	52.87	11.09
		F	77	53.29	13.20
Syllabication	Pre-syllable pitch ratio	M	129	98.26	12.97
		F	123	96.82	14.04
	Pre-syllable intensity ratio	M	129	98.52	4.10
		F	123	99.38	3.13
	Pre-syllable duration ratio	M	129	46.26	11.75
		F	123	47.51	11.83
	Post-syllable pitch ratio	M	129	152.81	56.96
		F	123	226.85	121.74
	Post-syllable intensity ratio	M	129	100.21	2.85
		F	123	99.31	3.25
	Post-syllable duration ratio	M	129	51.17	18.64
		F	252	50.15	15.94

males. In syllabication without liaison rule, the post-syllable pitch ratio of females was 225.85%, higher than that of males.

According to the results of Table 8, there was a significant difference between gender groups and the effect of the liaison rule. There was no interaction between gender and the effect of the liaison rule.

Post-syllable pitch ratio was a significant difference between gender groups and according to the effect of liaison rule. Therefore, when resyllabification by liaison rule occurred, post-syllable pitch changed within a word like stress effect (Table 9).

Acoustic Differences in Resyllabification According to Age

In the phonological homonym structure, the ratio of pitch, intensity, and duration was presented in Table 10 according to age for resyllabification by liaison rule.

In resyllabification by liaison rule, the post-syllable pitch ratio of 20s-30s group was 150.21%, which was higher than that of the 40s-50s group (136.71%). Also, the post-syllable duration ratio of the 40s-50s group was 56.46%, which was longer than that of the 20s-30s group (50.14%). In syllabication without liaison rule, the pre-syllable duration ratio of the 40s-50s group was 49.50%, which was higher than that of the 20s-30s group (44.03%).

Table 8. Multivariate Test for Acoustic Changes in resyllabification according to gender

Variables		F	df	*p*
Gender	Pillai's Trace	9.129	391.000	0.000***
Liaison rule	Pillai's Trace	5.657	391.000	0.000***
Gender * liason rule	Pillai's Trace	0.613	391.000	0.720

According to the results of Table 11, there was a significant difference between age groups and the effect of the liaison rule. There was no interaction between gender and the effect

Table 9. Difference Between Individuals in Acoustic Changes of Resyllabification by Gender

Variables	Index	df	MS	F	*p*
Gender	Pre-syllable pitch ratio	1	114.554	0.668	0.414
	Pre-syllable intensity ratio	1	52.083	3.830	0.051
	Pre-syllable duration ratio	1	160.002	1.370	0.243
	Post-syllable pitch ratio	1	346,595.315	47.712	0.000***
	Post-syllable intensity ratio	1	40.227	4.063	0.045
	Post-syllable duration ratio	1	64.267	0.298	0.585
Liaison rule	Pre-syllable pitch ratio	1	5.548	0.032	0.857
	Pre-syllable intensity ratio	1	0.417	0.031	0.861
	Pre-syllable duration ratio	1	269.534	2.308	0.130
	Post-syllable pitch ratio	1	204,696.119	28.178	0.000***
	Post-syllable intensity ratio	1	4.736	0.478	0.490
	Post-syllable duration ratio	1	813.601	3.773	0.053
Gender * Liaison rule	Pre-syllable pitch ratio	1	10.530	0.061	0.804
	Pre-syllable intensity ratio	1	1.246	0.092	0.762
	Pre-syllable duration ratio	1	0.431	0.004	0.952
	Post-syllable pitch ratio	1	15,823.835	2.178	0.141
	Post-syllable intensity ratio	1	5.508	0.556	0.456
	Post-syllable duration ratio	1	146.618	0.680	0.410

Table 10. Acoustic changes in resyllabification according to age

Division	Index	Age	N	M	SD
Resyllbication	Pre-syllable pitch ratio	20s – 30s	79	96.82	11.21
		40s – 50s	69	98.85	13.49
	Pre-syllable intensity ratio	20s – 30s	79	99.27	3.53
		40s – 50s	69	98.47	3.92
	Pre-syllable duration ratio	20s – 30s	79	44.02	9.32
		40s – 50s	69	46.57	8.15
	Post-syllable pitch ratio	20s – 30s	79	150.21	78.27
		40s – 50s	69	136.71	61.06
	Post-syllable intensity ratio	20s – 30s	79	99.76	3.13
		40s – 50s	69	99.26	3.46
	Post-syllable duration ratio	20s – 30s	79	50.14	9.50
		40s – 50s	69	56.46	14.00
Syllabication	Pre-syllable pitch ratio	20s – 30s	121	97.06	13.63
		40s – 50s	131	98.01	13.40
	Pre-syllable intensity ratio	20s – 30s	121	99.57	2.88
		40s – 50s	131	98.36	4.22
	Pre-syllable duration ratio	20s – 30s	121	44.03	11.154
		40s – 50s	131	49.50	11.78
	Post-syllable pitch ratio	20s – 30s	121	188.91	110.10
		40s – 50s	131	188.98	92.56
	Post-syllable intensity ratio	20s – 30s	121	100.03	2.65
		40s – 50s	131	99.53	3.42
	Post-syllable duration ratio	20s – 30s	121	47.13	8.28
		40s – 50s	131	52.93	20.27

Table 11. Multivariate test for acoustic changes in resyllabification by age

Variables		F	df	*p*
Age	Pillai's Trace	9.234	391.000	0.000***
Liaison rule	Pillai's Trace	4.899	391.000	0.000***
Age * liaison rule	Pillai's Trace	0.464	391.000	0.835

Table 12. Multivariate test for acoustic changes in resyllabification by age

Variables	Index	df	MS	F	*p*
Age	Pre-syllable pitch ratio	1	206.420	1.204	0.273
	Pre-syllable intensity ratio	1	92.169	6.843	0.009
	Pre-syllable duration ratio	1	1,492.409	13.341	0.000***
	Post-syllable pitch ratio	1	4,193.537	0.503	0.479
	Post-syllable intensity ratio	1	23.304	2.335	0.127
	Post-syllable duration ratio	1	3,412.292	16.463	0.000***
Liaison rule	Pre-syllable pitch ratio	1	8.286	0.048	0.826
	Pre-syllable intensity ratio	1	0.828	0.061	0.804
	Pre-syllable duration ratio	1	199.153	1.780	0.183
	Post-syllable pitch ratio	1	192,234.398	23.067	0.000***
	Post-syllable intensity ratio	1	6.847	0.686	0.408
	Post-syllable duration ratio	1	992.430	4.788	0.029*
Age * liaison rule	Pre-syllable pitch ratio	1	26.881	0.157	0.692
	Pre-syllable intensity ratio	1	3.897	0.289	0.591
	Pre-syllable duration ratio	1	198.697	1.776	0.183
	Post-syllable pitch ratio	1	4,272.638	0.513	0.474
	Post-syllable intensity ratio	1	0.000	0.000	0.996
	Post-syllable duration ratio	1	6.225	0.030	0.863

of the liaison rule.

Pre- and Post-syllable duration ratios had a significant difference between age groups. The post-syllable pitch ratio showed a significant difference according to the effect of the liaison rule. There was no interaction between age and the effect of the liaison rule (Table 12).

DISCUSSION

There was a significant difference between the gender groups in post-syllable pitch ratio in words and nonwords. A female's pitch change was more significant than that of males.

Females produce more changes in pitch of the post-syllable than males. Female is associated with high-frequency output and dynamic rhyme changes in her spoken language, focusing on the post-syllable.

The post-syllable pitch ratio was a significant difference according to the effect of the liaison rule. Therefore, when resyllabification by liaison rule occurred, post-syllable pitch changed within a word-like stress effect. The more significant change of post-syllable pitch in the post-syllable shows the focal prosody. This is related to the study that F0 is the most dynamic prosody factor for focal prosody [7,8].

When resyllabification by liaison rule occurred, post-syllable pitch changed within a word-like stress effect. This is also related to focal prosody. When the focus prosody is local, the specific sentence component exhibits accent and pitch change [9].

Therefore, when resyllabification is generated by the liaison rule, the change of the post-syllable pitch can be explained by the focus prosody, and further research will be needed to establish a solid basis for this study.

REFERENCES

1. Lee HB. Phonetic variations of korean speech sounds as condi-

tioned by tempo and rhythm. Language Research. 1982;18:115-120. Language Education Institute
2. Choi EY. A study on the syntactic constraint on the resyllabication process in Korean. English Language & Literature. 1995;14:243-266.
3. Kim KR. Application of phonological rules related to syllabication in Korea. Studies in Phonetics, Phonology and Morphology. 1995;1:35-48.
4. Rubach J. Final devoicing and cyclic syllabication in German, Linguistic Inquiry. 1990;21:79-94.
5. Park K. The role of phonologyy in acessing word meaning: evidence from semantic categorization of Hangul words. The Korean Jornal of Experimental Psychology. 2003;15:19-37.
6. Boersma P, Weenink D. 2021; retrieved from: https://www.fon.hum.uva.nl/praat/.
7. Lee MS. A comparative study on the prosodic characteristics of the sentences with syntactic ambiguity of right hemisphere damaged patients. Journal of Linguistic Science. 2012;61:185-206.
8. Lee MS, Park H. Characteristics of right hemispheric damaged patients in korean focused prosodic sentences. Therapeutic Science for Rehabilitation. 2019;8:69-81.
9. Ross E, Thompson RD, Yenkosky J. Lateralization of prosody in brain and the callosal in tegration of hemispheric language function. Brain and Language. 1997;56:27-54.