

The Speech Characteristics of Korean Dysarthria: An Experimental Study with the Use of a Phonetic Contrast Intelligibility Test

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Abstract

This study was designed to suggest an assessment tool for analyzing the characteristics of Korean phonetic contrast intelligibility among dysarthric individuals. The intelligibility deficit factors of phonetic contrast in Korean dysarthric patients were analyzed through stepwise regression analysis. The 19 acoustic-phonetic contrasts proposed by Kent et al. (1999) have been claimed to be useful for clinical assessment and research on dysarthria. However, the test cannot be directly applied to Korean patients due to linguistic differences between English and Korean. Thus, it is necessary to devise a Korean word intelligibility test that reflects the distinct characteristics of the Korean language. To identify the speech error characteristics of a Korean dysarthric group, a Korean word list was audio-recorded by 3 spastic, 4 flaccid, and 5 mixed type of dysarthric patients. The word list consisted of monosyllabic consonant-vowel-consonant (CVC) real word pairs. Stimulus words included 41 phonemic contrast pairs and six triplets. The results showed that the percentage of errors in final position contrast was higher than in any other position. Unlike the results of previous studies, the initial-position contrasts were crucial in predicting the overall intelligibility among Korean patients.

Keywords: Korean phonetic contrast, intelligibility, dysarthria

1. Introduction

Among communication disorders caused by neurological defects, dysarthria is the most frequently observed. Generally, intelligibility tests are used to diagnose and treat dysarthria. Intelligibility is the concept of measuring the success of communication, and can be influenced by many factors[1]. Furthermore, intelligibility is not only an important research subject in the area of dysarthria, but also a crucial criterion for

diagnose and treatment in the clinical field[2].

Many factors must be considered in making an assessment tool to measure the intelligibility of dysarthric patients. Firstly, how can the context variables that can influence intelligibility be controlled? Secondly, can intelligibility be shown in a simplified index? Thirdly, can the cause of intelligibility deficit be found? And will this help in diagnosing and intervening dysarthria? Finally, can the results of the intelligibility test, which relies on subjective perception, be interpreted within other relevant measures such as acoustic or physiological test results[3,4]?

Kent et al.[5] suggested a monosyllabic word intelligibility test, using specific phonetic contrast, which met the above needs to

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some extent. Recently, a study was reported on Chinese speaking patients that applied the same assessment method [6]. It is asserted that certain phonetic features may be universally important in predicting intelligibility in speakers with dysarthria [7]. Other features are unique and thus crucial to research with non-English speaking patients. Therefore, tests need to be devised by systematically contrasting phonemes in countries using languages other than English. The 19 phonetic contrasts chosen by Kent and colleagues were based on long-term verified studies on dysarthria and segmental characteristics. Consequently, these phonetic contrasts were those frequently found in English-speaking dysarthric patients.

However, due to linguistic differences, there can be a difference in the error patterns with Korean-speaking patients. In fact, among the 19 contrasts, only 10 exist and contribute to meaning in the Korean language. Furthermore, research on the phonetic contrasts found only in Korean cannot be found in any foreign studies. For example, consonant contrast and contrast between voiced and voiceless sounds are non-existent in Korean or only come in allophone situations. Another example is the unique contrast between sounds such as lenis, fortis, and aspirates three series of contrast (or correlates) – in Korean. Until now, there have been no studies on how these factors are manifested by dysarthric patients. It is asserted that an intelligibility test made without consideration of the differences among languages should not be used directly in research or clinical fields in Korea.

The purpose of this study is to analyze the characteristics of Korean phonetic contrast intelligibility among dysarthric individuals. The main goals are to search for the intelligibility deficit factors of phonetic contrast, and then to find out the extent of contribution of those factors in overall intelligibility through stepwise regression analysis. The research questions are:

1. Are differences of intelligibility detected according to the position in the syllable (initial, medial, or final)?
2. Are differences of intelligibility detected according to the phonetic contrasts?
3. What is the degree of predictability in differences of the phonetic contrasts?

II. Method

2.1. Participants

The participants in this study were twelve Korean dysarthric

Table 1. Subject description.

Id	Sex	Age	Type of dysarthria*	Calculated intelligibility**
1	M	53	Flaccid	.53
2	F	43	Mixed (a+f+s)	.82
3	M	64	Mixed (f+s)	.09
4	M	68	Flaccid (+hypo)	.75
5	M	29	Spastic(+hyper)	.87
6	F	72	Spastic	.30
7	F	76	Mixed (s+f)	.25
8	F	35	Spastic (+hyper)	.65
9	M	61	Mixed (s+f)	.47
10	M	46	Flaccid	.89
11	F	56	Mixed (s+f)	.87
12	M	59	Spastic (+a)	.77

* a: ataxic, s: spastic, f: flaccid, hyper: hyperkinetic, hypo: hypokinetic
 ** the mean score of intelligibility from 160 mono syllable word intelligibility test.

patients between the ages of 29 and 77 (mean age: 55). They were given mono-syllable word contrast intelligibility test items to read. The output was recorded on a digital recorder in a quiet room. Descriptive data on the participants' age, sex, lesion site, subtype, and overall intelligibility scores are shown in Table 1.

2.2. Speech material for perceptual analysis

All test items were CVC (consonant initial, vowel medial, consonant final) monosyllabic words. Three categories were chosen in order to set up Korean phonetic contrasts. First, the positions of sounds in the syllable were differentiated into three (initial, medial, and final). Second, the kinds of contrast were categorized into two main types (consonant and vowel), then into smaller units. Consonants were divided into two: initial and final positions. For the initial positions, the manner, place, correlates, and combination (manner and place) were contrasted. For the final position, the manner, place, and combination were contrasted. Vowels were divided into three types: high-low, front-back, and combination. Third, each contrast item was examined. The individual phonetic contrast analysis was done. Refer to Kim [7] for the list of used items.

2.3. Procedure

One hundred items, each on a separate piece of paper, were given to the dysarthric participants to read. Thirty graduate students, majoring in Speech Pathology listened to and evaluated the 100 items. Twenty percent of the items were presented twice. The data that did not reach 80% of agreement among the listeners were excluded.

Words were presented at a rate of one every five seconds.

Table 2. Percentage of error and intelligibility score.

Phonemic contrast	% of error		rate score		
	Mean	SD	Mean	SD	
I*	Place	22.93	9.87	.58	.33
	Manner	18.80	10.09	.63	.31
	Homorganic	20.07	10.69	.58	.33
	Combination	25.57	12.08	.58	.34
M*	High-low	11.83	8.88	.66	.30
	Front-back	12.42	9.48	.67	.31
	Combination	12.58	9.57	.68	.33
F*	Place	39.42	13.49	.45	.32
	Manner	29.27	9.25	.53	.33
	Combination	29.92	9.52	.54	.32

* Initial, ** Medial, ***Final

Listeners were instructed to select the heard word out of five choices and immediately following this, to indicate the degree of ease or difficulty in identifying the word on a 6-point equal-appearing interval scale.

The incorrect answers were named the percentage of errors, and the 6-point scale was called the intelligibility rating. In this study, both the percentage of errors and intelligibility rating were used since they were considered to be compensative. However, more emphasis was put on the intelligibility rating considering the fact that the percentage of errors could have coincidental factors. A stepwise regression analysis was done and the total score of each subjects intelligibility rating was used to show the overall intelligibility. The correlation of overall intelligibility and the reading passage was .97.

III. Results

Intelligibility of the position in syllable and kinds of contrast.

The percentage of error according to position in the syllable was highest in final position with 31.8%, followed by initial position (22.4%), and medial position (14.6%). The intelligibility rating ranged from .67 to .51, with the highest percentage in medial position, the lowest in final, and then initial at .58.

The percentage of errors and the intelligibility rate according to the contrast in place and manner of articulation are shown in Table 2.

As shown, the percentage of error was the highest in place contrast in the final position with 39.42. The rate of intelligibility was equivalent.

The percentage of errors according to the different phonetic contrasts (initial, medial, final) are shown in figures 1, 2, and 3.

Table 3. The prediction variable F variance.

Prediction variable	F variance
Initial combination	1787.45***
Medial combination	77.65***
Initial homorganic	23.28***
Initial place	5.22*

* p < .05, ***p < .001

The highest percentage of error is 52% in bilabial-velar, place contrasts (담-탁 [tap]-[tak]) in final position. The lowest percentage of errors, on the other hand, was 6% in high/front-low/back vowel combination contrasts (깃-갓 [kit]-[kat]) in medial position. The percentage of errors was lowest with vowels, with consonants, the order was initial then final.

Prediction of intelligibility in kinds of contrast By stepwise regression analysis, it was determined that 90% of the variance in the phonetic intelligibility scores was accounted for by four variables: combination contrast, three series of contrast, place contrast in initial position, and combination contrast in medial position ($F(4,295) = 640.95, p < .001$). F variances for each variable are shown in Table 4.

The regression equation is as follows.

$$\text{Overall Intelligibility} = .097 + (.310 \times \text{initial combination}) + (.218 \times \text{medial combination}) + (.217 \times \text{correlates}) + (.108 \times \text{initial place})$$

IV. Discussion

Intelligibility according to Korean phonetic contrasts.

The first research question of this study was, is there a difference of intelligibility among speakers with dysarthria according to the position in syllables. The results showed that Korean dysarthric patients made the most errors in final position, followed by initial and medial positions. The vowel is an early developed speech sound and serves as the nucleus in Korean. From the results of this study, it can be inferred that people with dysarthria can produce vowels better than consonants. Among consonants, final-positioned consonants were found to be more difficult to produce than initial positioned consonants. In Korean, final-positioned consonants are less emphasized since they are implosive, voiceless sounds. This makes it more difficult for dysarthric speakers to discriminate them.

Secondly, the difference in the degree of intelligibility according to each contrast was represented in the figures 1, 2, and 3. As mentioned earlier, the data shows that the lowest

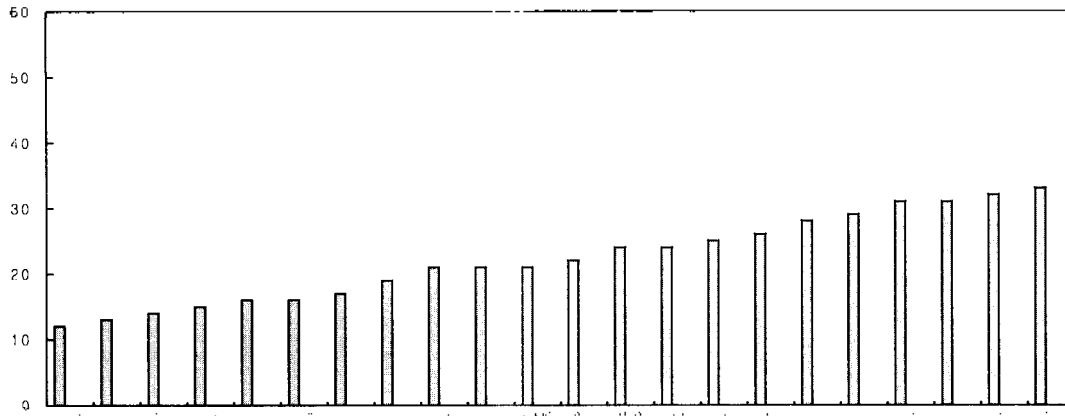


Fig. 1. The percentage of error in initial position.

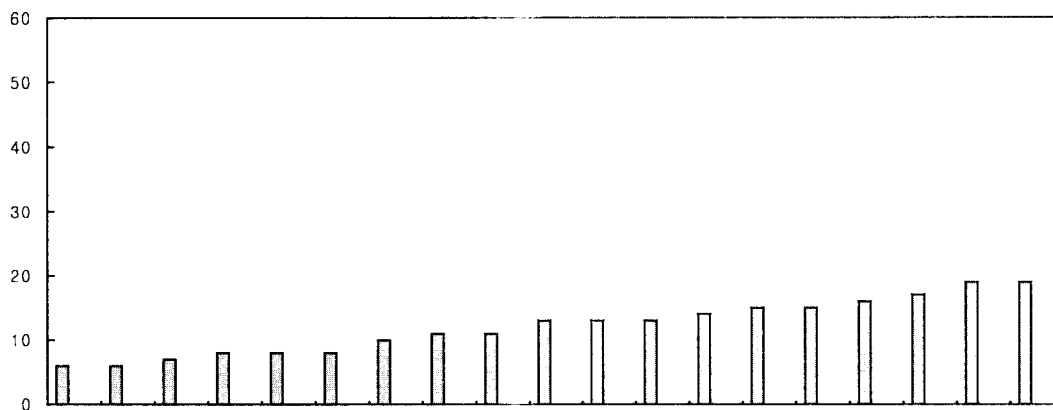


Fig. 2. The percentage of error in medial position.

intelligibility was found in /p:/k/ contrast of the final position. But in this study, only one or two items were given for each contrast and therefore, the opportunity of production per contrast was low. This meant that one little mistake could be of great influence and hinder accurate analysis.

There are several reasons why more items could not be produced. First, due to the fact that the aim of this study was to find out the rough characteristics of intelligibility according to the position in syllable in Korean, the whole phonetic contrasts had to be taken into consideration while developing each item. Secondly, it was difficult to have the patients produce the many items in a set time because of their physical limitations. Thirdly, there is a limit in Korean, to the number of meaningful monosyllabic words that could be included in specific phonetic contrast items. Therefore, only one or two pairs of words could be designed for each contrast.

As mentioned in the introduction, intelligibility is the degree of success in communication between the speaker and the listener. Therefore, all the contextual factors that can affect communication can influence intelligibility. When assessing valid

and reliable intelligibility, researchers must consider these factors. A monosyllabic word contrast intelligibility test is done by presenting pairs of words that have phonological contrasts. It helps to quickly find out why the listeners could not discriminate the sounds[5,7]. This assessment method can also supplement the former evaluator-dependent factor by setting standards for objective assessment. The currently known objective method is

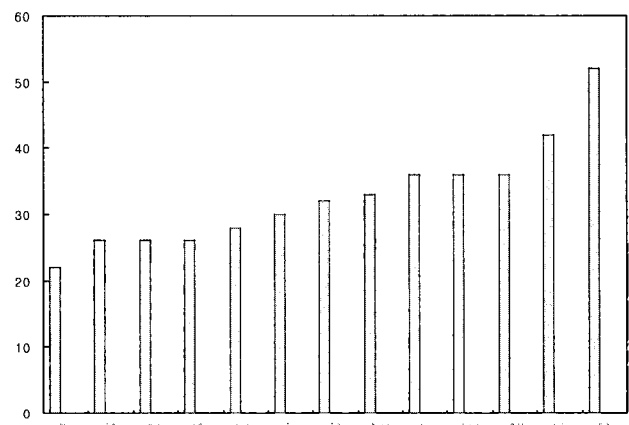


Fig. 3. The percentage of error in final position.

the acoustic-phonetic analysis method. A monosyllabic word is the smallest unit of communication, and its contrasts make it possible to measure phonetic-acoustic deficits[8].

Even severely dysarthric patients can communicate with monosyllabic words. Since the phonetic contrast intelligibility test can be used to measure intelligibility and indicate the nature and cause of the communication disorder, similar tests are being developed and used in the United States and other countries [6,9,10].

This study suggests that the monosyllabic word intelligibility test could be used to analyze the unique characteristics of Korean. In Korean, only 7 sounds are used in coda position. There are the three series of consonants and many other unique features as in other languages. In this study, the characteristics of Korean were carefully noted and various unique phonetic contrasts were included in the items. It is expected that this study would be a starting point for similar studies in other countries where English is not the mother tongue.

In order to predict the overall intelligibility, the percentages of errors according to phonetic contrasts were considered. It was shown that 90% of the degree of intelligibility relies on combination contrast, consonant correlates, and the place of articulation in the initial position and medial combination. The percentage of errors was higher in the final position, but initial position errors were more important in predicting overall intelligibility. This is contrary to the finding in Ansel & Kent's study[8] which was done with mixed-type cerebral palsy participants that the medial position was significant in predicting intelligibility. The findings of this study indicate that (1) the degree of intelligibility in Korean dysarthric patients varies by the place of articulation and (2) the initial position is important in predicting general intelligibility of Korean dysarthric patients.

This study was designed to suggest an analysis method for a Korean phonetic contrast intelligibility test. The limitation of this study was that the speech samples of dysarthric speakers were only an example of empirical data. An index of severity[9], subtype of dysarthria[7], gender (Kent et al., 1990; Kent et al., 1994), and age were not taken into consideration. Further analyses need to be carried out of the above categories.

The various tendencies in intelligibility according to the Korean contrast context are shown in this study. A suggested area for further study is to look more carefully at specific phonetic contrasts and research for more classified studies. In order for further studies to be pursued, verified research on the characteristics of Korean production and perception traits

according to different disorders must be carried out.

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