

Characteristics of Korean Diphthong in Patient with Dysarthria caused by Stroke: Analysis with Sound Spectrogram

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Abstract. This study investigated the acoustic phonetic characteristics of Korean diphthongs in 16 healthy controls, in 8 speakers with spastic dysarthria, and in 8 speakers with flaccid dysarthria. The subjects read /ja/, /wi/ and mean formant values were analyzed based on the spectrograms. The formant transition duration for the vowel /ja/ was longer for speakers with flaccid dysarthria than the control speakers and speakers with spastic dysarthria. When speaking the vowel /wi/, the tongues of speakers with flaccid and spastic dysarthria were pulled back more than those of control speakers. We observed that there are differences in the patterns of error observed in flaccid dysarthria and spastic dysarthria speakers.

Keywords: Acoustic Analysis, Dysarthria, Phonetic Characteristics, Diphthong

1 Introduction

The Acoustic Speech Analysis is useful in the case of diphthongs, which consist of two phonemes, a glide and a vowel, that are connected quickly in a gliding motion [1]. When producing glides, the movement of the tongue cannot be easily observed. Diphthong errors and their precise articulatory movements which are difficult to identify with auditory-perceptual judgment can be identified indirectly using acoustic speech analysis [2]. This study investigated the acoustic phonetic characteristics of Korean diphthongs in speakers with spastic dysarthria, and speakers with flaccid dysarthria.

2 Methods

2.1 Subjects

A total of 32 subjects, 16 male speakers and 8 speakers with spastic dysarthria and 8 speakers with flaccid dysarthria and a control group of the same sex and age group, participated in this study.

2.2 Materials

The test words are Korean diphthongs including /ja/, /wi/. The Korean diphthongs/ja, wi/were chosen for this study for the following reasons: First, /ja/ was selected to observe and F2 at the same time. Tongue and jaw movements are maximized in the /ja/ diphthong. Second, /Wi/ was selected to observe F2 when there is no change of F1. /Wi/ is a diphthong without jaw movement, but forward and backward movement of the tongue is emphasized.

2.3 Data Analysis

The microphone used in the study was aShure PG48-LC and the distance between the microphone and the mouth was 5 cm. The Spectrograph was created with a sampling rate of 11,025 Hz and collected data were analyzed using Praat (version 4. 6.06).

The procedure for analyzing the collected data was as follows: First, based on formant representations on the spectrogram, the analysis sections of the diphthongs were determined. A section in the beginning of the diphthong was chosen where all F1, F2 and F3 values were displayed referring to previous studies [3-5]. In the study, the first section was defined as a glide because Korean diphthongs are rising diphthongs. The third section was defined as a vowel because it showed the same value as the formant of a single vowel as shown in a previous study [3]. The average value of the transition interval was calculated to be the value obtained by subtracting the average value of the third section from the average value of the first section.

3 Results

3.1 The mean formant frequency values for /ja/ in different regions

The average value of the F1 peak for glides in the control group was the highest (654 Hz), followed by the group with flaccid dysarthria (573 Hz) and the group with spastic dysarthria (541 Hz). For the vowels, the average value of the F1 peak for speakers with flaccid dysarthria was 763 Hz, for the control group it was 742 Hz, and for the group with spastic dysarthria it was 638 Hz. The mean formant frequency values of F2 for glides were 1639 Hz in the group with flaccid dysarthria, 1443 Hz in the control group, and 1341 Hz in the group with spastic dysarthria. The formant transition duration of F1 as well as F2 for the flaccid dysarthric speakers is more unstable and lasts longer than in the control speakers. On the other hand, the speakers with spastic dysarthria show little change in transition duration and little tongue movement (forward/backward).

3.2 The mean formant frequency values for /wi/ in different regions

The mean formant frequency values for /wi/ in different regions are illustrated in Figure 2. The mean formant frequency values of the F2 peak for glides and vowels in the control group were 2268 Hz (1st region) and 2282 Hz (3rd region), for speakers with spastic dysarthria the peak was at 2117 Hz (1st region) and 2154 Hz (3rd region), and for the flaccid dysarthric speakers the peak was at 1931 Hz (1st region) and 1917 Hz (3rd region).

4 Discussion

First, The Jaws of the speakers with spastic dysarthria were more closed than that of the control group when beginning articulation and less tongue movement was observed than in the control group during the transitions. On the other hand, compared with the control group, speakers with flaccid dysarthria had exaggerated jaw and tongue movements and the mean formant frequency values of F1 and F2 were instable.

Second, tongues of speakers with both flaccid and spastic dysarthria were retracted during the formant transitions.

We observed that there are differences in the patterns of error observed in flaccid dysarthric speakers and spastic dysarthric speakers when pronouncing diphthongs even when the errors sound the same. The results of our study can be used as basic material to understand the characteristics of diphthongs produced by speakers with dysarthria.

References

1. Ferrand, C. T.: *Speech Science: An Integrated Approach to Theory and Clinical Practice* (2nd ed.). Allyn and Bacon. Boston (2006)
2. Keith, J.: *Acoustic and Auditory Phonetics* (2nd ed.). Blackwell. Boston (2003)
3. Yang, B. G.: An acoustical study of Korean diphthongs. *MALSORI* 25, 3--26 (1993)
4. Yang, B. G.: A phonetic study of diphthongs. *Dongguinonzip* 21, 19--36 (1994)
5. Bae, N. J.: Acoustic comparison of diphthong production between hearing-impaired and normal hearing children. master's thesis. Hallym University. Chuncheon (2003)