

Variability of Voice Onset Time in Childhood Apraxia of Speech in Korea

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Abstract. The purpose of the study was to examine voice onset time (VOT) and its variability in children with childhood apraxia of speech (CAS) compared to typically developing children. Twelve children with CAS aged 9-12 years old and 20 children who were age-matched participated in the study. This study measured VOT and variabilities of VOT during the production of /p' a/, /t' a/, /k' a/. For variability measures of VOT, each participant was asked to repeat speech tasks three times and the average value of the rates and its standard deviation were obtained. The verification of the hypotheses was tested by using T-test of the significance level of 0.05. The results showed that the variability of VOT in CAS group was more significantly higher than control group. But VOT of /p' a/, /t' a/, /k' a/ between the experimental group and the control group was not significantly different. The results suggested that variability of VOT might be more distinctive speech feature to children with CAS than the VOT.

Keywords: Childhood apraxia of speech, Voice Onset Time, Apraxia, Variability

1 Introduction

According to American Speech-Language-Hearing Association, in clinical circumstances, vowel error, inconsistent variability error in word shadowing task and confusion of intonations are used in the diagnosis of Childhood Apraxia of Speech [1]. Nevertheless, so far there has been lack of CAS studies and standard of diagnosis for Korean speakers. Unlike in English, as intonations are not outstanding in Korean, standard of diagnosis for English cannot be applied to Korean speakers. Therefore, to precisely diagnose CAS in Koreans, standards of diagnosis applying the characteristics of Korean are required.

This study investigated the characteristics of VOT and variability of VOT of Korean CAS using acoustic analysis and suggested basic material for diagnosis of CAS.

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2 Methods

2.1. Subjects

This study analyzed 6 children with CAS at the age of 9 through 12 and 10 normal children with the same distribution of gender and age. CAS was diagnosed in a medical center and subjects were without problems in hearing and structure of oral cavity. Summary of standard for diagnosis of CAS defined by this study is as follows; first, there are errors in the imitation tasks of nonverbal language (e.g. movement of tongue); second, there is decrease in the coordination of articulation muscle in diadochokinetic tasks; third, there is decline in the imitation of daily motions; fourth, there are inappropriate pause in the sentence.

Normal children were selected as those without problems in hearing and structure of oral cavity and those over 30 percentile as the result of Korea National Health Screening Program for Infants and Children. Information on the subjects is presented in Table 1.

Table 1. Information on the subjects with childhood apraxia of speech

No	Age	Gender	Causes	Post onset time (year)
1	9 ; 1	male	Problems of metabolism	2
2	10 ; 1	male	Brain tumors	4
3	11 ; 8	male	Problems of metabolism	8
4	12 ; 10	female	Problems of metabolism	11
5	12 ; 11	female	Genetic problems	2
6	12 ; 11	male	Problems of metabolism	9

2.2 Measurement

In this study, /p*a/,/t*a/,/k*a/ were selected as check words because tense consonants are easier to be produced than aspirated consonants in children compared with adults [2].

VOT of collected utterance data was analyzed by using wave form of Praat (version 5.3.17) and spectrograph (Fig.1).

Variability of VOT was calculated in standard deviation of the difference in performance after calculating each value of VOTs performed 3 times Fig. 4. At this time, it was defined that the bigger the standard deviation, the greater the variability.

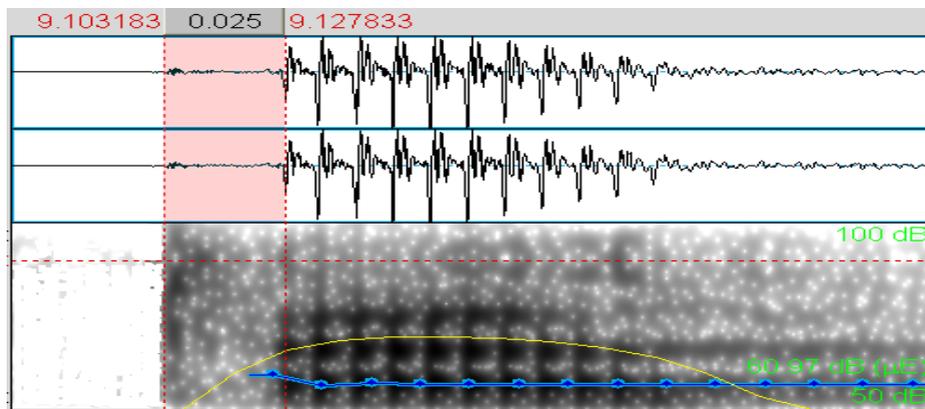


Fig. 1. Measured section of VOT is presented

3 Results

3.1 VOT

As the result of Mann-Whitney U test, there was no significant difference in average VOT between children with CAS and normal children in the test words /p*a/,/t*a/,/k*a/.

3.2 VOT variability

Values of VOT variability of children with CAS and normal children are presented in Table 1. As the result of Mann-Whitney U test, there was significant difference between children with CAS and normal children in the test words /p*a/, /t*a/, /k*a/. In /p*a/. VOT variability of children with CAS was 9.9ms, which was 5 times significantly higher than that of normal children with 2.1ms ($p=0.016$). In addition, VOT variability of children with CAS was around 2 times ($p=0.008$) significantly

higher than that of normal children in /t*a/ and 2.5 times (p=0.003) significantly higher in /k*a/.

Table 1. Values of VOT variability of children with CAS and normal children

		N	Mean	SD	Min	Max	z	p
/p* a/	CAS	6	9.994	10.929	1.700	31.372	-2.388	.016
	Normal	10	2.115	1.447	.471	4.320		
/t* a/	CAS	5	4.197	1.362	2.5	5.715	-2.483	.008
	Normal	10	2.194	.807	1.247	3.859		
/k* a/	CAS	6	8.783	2.891	5.354	12	-2.824	.003
	Normal	10	3.349	2.110	.471	7.118		

4 Discussion

This study verified the difference of VOT and VOT variability between children with CAS and normal children using acoustic analysis.

In this study, there was no significant difference in average VOT between children with CAS and normal children in the test words /p*a/, /t*a/, /k*a/. In many studies, those with AOS had longer VOT than normal people and especially, in a study on adults with AOS, the difference of VOT length stood out [3, 4, 5]. And yet, as these preceding studies were conducted on adults with AOS, it is difficult to directly compare their results with that of this study. Therefore, there are two possible explanations for the fact that there was no difference in average VOT between children with CAS and normal children; first, characteristics of AOS caused by acquired brain damage such as aphasia are different from those of CAS caused by developmental problems. The studies that compared VOT of Koreans with AOS with that of normal adults reported that those with AOS had longer average VOT [3, 4]. Moreover, VOT of those with AOS was not only longer in all the plosives than normal adults [3] but was significantly longer than (those with) aphasia [5].

This study verified that there was a significant difference between children with CAS and normal children in variability of VOT rather than in average VOT. This result implies that it may be more effective to measure the variability of VOT in the diagnosis of Korean CAS rather than to measure average VOT.

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