ACOUSTIC ANALYSIS OF UTTERANCE: CHILDREN WITH DEVELOPMENTAL DYSPHASIA

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Abstract

Development of an algorithm for automatic evaluation of utterances of children with developmental dysphasia is the main subject of our project. Software applications utilizing this algorithm should be helpful to speech therapists as an instrument for recognition of damage and defects of speech and a level of voice insult. There is a methodical approach to recording and recognizing speech disorders of patient's utterances.

1 Introduction

The main problem of developmental dysphasia (specifically impaired development) is a disorder of speech signal processing [1]. The exact cause and the origin of this disorder is unknown. Probably it occurs during the prenatal period, during birth or following it. There is a full or partial loss of ability to learn a verbal communication, although the conditions are appropriate. Developmental dysphasia is diagnosed by observation and understanding of patient's utterances, their graphical expression, motor skills and orientation in time and space.

2 Database

In the collaboration with the speech therapist and phoniatrist from Department of Phoniatrics at 1st Faculty of Medicine Charles University and General Faculty Hospital in Prague was made a list of suitable events for subsequent analysis (see Table 1). Recordings were acquired with a sampling frequency of 48kHz at 24-bit quantization.

Table 1: LIST OF RECORDED SPEECH PHENOMENON IN CZECH

Vocals (endurance)	*A E I O U*	spontaneous or repeated by patterns utterances (depend on patients age)
Tagging images (isolated words)	*máma, babička, čokoláda, sluníčko, popelnice, košile, silnice, Rákosníček, hamburger, velryba, ucho, ředkvička, fotbalista*	spontaneous, repeated by patients with delayed speech development
Nursery rhyme	*En ten týky, dva špalíky, čert vyletěl z elektriky. Bez klobouku bos, natloukl si nos.*	spontaneous
Rapid repetition of syllables	*PA-TA-KA* *BA-DA-GA*	repeated by patients older than 7 years
Sibilants (endurance)	*S, Š*	spontaneous
Description of routine activities by using a sequence of images	*Morning and following activities before going to nursery/school*	spontaneous

Currently, the recordings database includes utterances from 86 healthy children and from 81 children with developmental dysphasia (see Table 2). Every one of them is affected by varying degrees of severity of developmental defects. To assess age-dependent parameters is not necessary to

separate the patients by their gender, because the difference between male and female voice to take effect later in teenage.

Table 2: NUMBER OF PATIENTS IN AGE CATHEGORIES

Age [years]	**4**	**5**	**6**	**7**	**8**	**Σ**
healthy children	4	10	18	32	22	**86**
children with developmental dysphasia	6	27	27	16	5	**81**

3 Methods

Vocal Analysis

Vocal analysis has been done in comparison patients with developmental dysphasia with healthy children. It could be observed age-dependent trends of fundamental frequency F0 in both groups of utterances. The same age-dependent trends can be seen in first two formants F1 and F2.

Isolated words analysis

Evaluation of isolated words is pursued by the DTW (Dynamic Time Warping) [2]. Monitoring intelligibility of isolated words is realized by comparing identical content utterances from patients with developmental dysphasia and healthy patients. The method is analyzed in detail in [2] and the results are in Figure 1, where we can observe differences in the pronunciation of healthy and handicapped children. This difference is smaller for a small number of syllables.

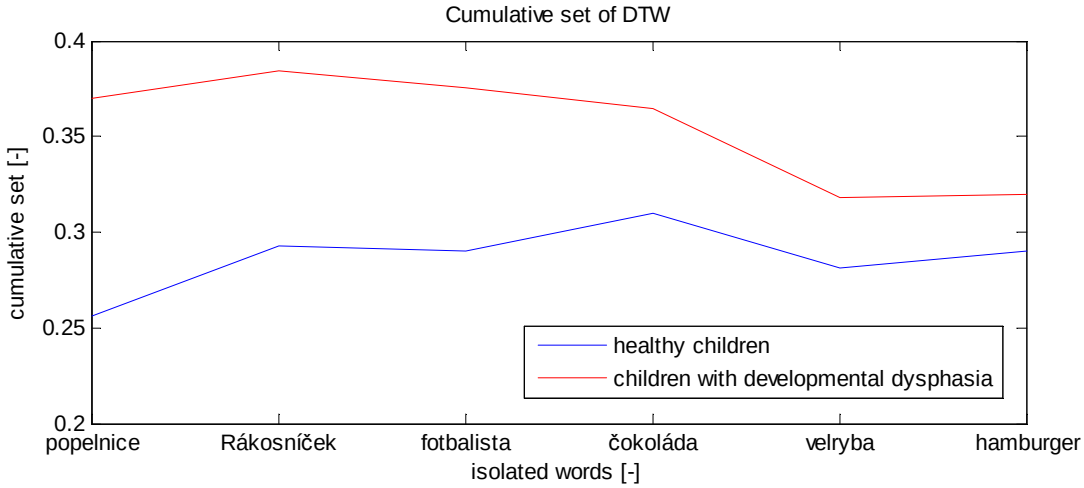

Figure 1: Cumulative set of DTW

Analysis of rhymes

Rhyme analysis is carried out by the well known nursery rhyme. There are speech rate changes during the utterances, which is interesting for the research. It is also the degree of compliance with verse and rhyme in their speech. Both groups of utterances are compared by the length and number of pauses in the utterances too [3].

Sibilant analysis (*/S/* and */SH/*)

Sibilant analysis is performed by comparing healthy and handicapped children. The spectral centre of gravity, standard deviation, spectral kurtosis and slope of the sibilants are the observed parameters. For the purposes of this comparison is needed to extract the sibilance of whole words. Patients with developmental dysphasia have a problem with just saying a separate */S/* and */SH/*. It is also observed duration of sibilants.

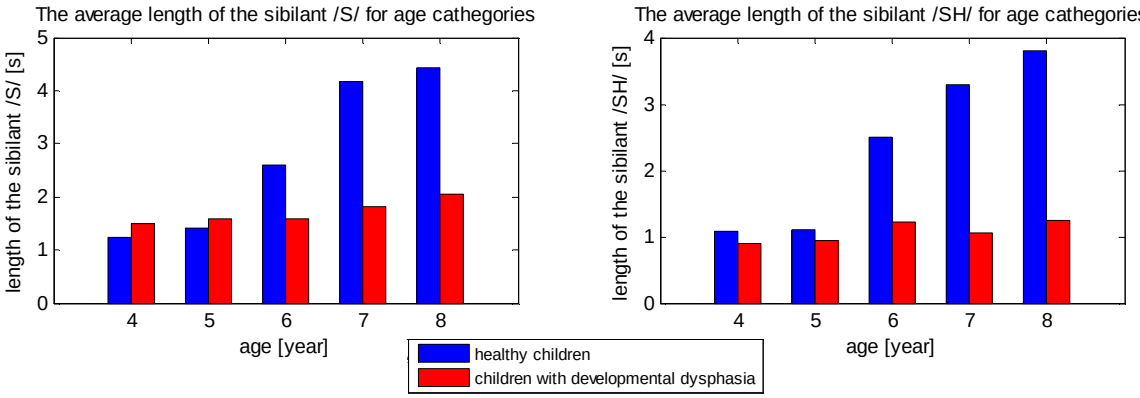

Figure 2: Analysis of the czech sibilants

Analysis of spontaneous speech utterance

As stated in the Table 1, spontaneous speech is obtained by using the description of a sequence of images. In this case we can judge the degree of diversity of expression. Patients with the most severe disabilities are able to describe the picture story using only verbs. Simple sentences that contain only the subject and predicate characterized speech less severely affected patients. Describe image by whole sentence is capable from healthy children. Other suitable parameters for assessing the quality of speech are the number of words or pause/whole utterances ratio.

4 Results

There are results which are obtained by annual recordings of utterances from patients and research. Characteristics suitable for the differentiation of healthy children and children with developmental dysphasia are DTW, spectral centre of gravity, standard deviation, spectral kurtosis, slope and duration of sibilants; speech rate and its changes during the utterance; the number of words and speech-pause ratio of spontaneous speech utterance. Age dependent characteristics (common for the both groups of children) are F0, F1 and F2. There are no differences in age dependent trends between healthy children and children with developmental dysphasia.

For the following research it's necessary to extend the database of patients in different age categories (particularly 3-4 years old and 9-12years old patients). It is also necessary to extend the database of records of pediatric patients with other disorders. We need a backward classification from phoniatrists and speech therapeutists, of course.

References

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