Statistical analysis of acoustical parameters in the voice of children with juvenile dysphonia

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BUTE

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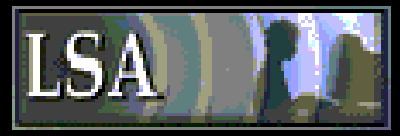

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Most of the research in this field focuses mainly on adult voices, but what about the children's voices?

- **Main question: Is it necessary to build a completely different system in order to automatically recognize functional dysphonia (FD) in children's cases or is it possible to train the system with healthy and pathological voices of adults?**

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- **Dysphonia is the disorder of the articulation as a complex function. It is a pathological condition showing varied based symptoms due to several etiologic factors and pathogenesis diversity.**
- **Functional dysphonia (FD) is a multifaceted voice disorder. It refers to a voice problem in the absence of a physical condition.**
- **Juvenile dysphonia is when functional dysphonia occurs at an early age.**

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- **Juvenile dysphonia is when functional dysphonia occurs at an early age.**
- **Discomfort associated with dysphonia are: pressure on the neck, forced coughing, shortness of breath.**
- **The frequency of dysphonia among the 3-10-year-old population can be put between 20-30%. The data therefore suggest that almost every fourth or fifth child produces a pathological voice. The studies agree that dysphonia is more often found among boys than girls, the ratio being 70-30%.**

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  - Acoustic parameters like Jitter, Shimmer, HNR (Harmonics-to-Noise Ratio) in the automatic classification of results from the healthy and pathological voices are improved in a big extent using continuous speech

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- **The acoustic parameters were also compared with two sample T-tests in the case of children, between healthy and pathological group.**

- **Different approaches were carried out: acoustic parameters from (the Hungarian SAMPA) vowels [E] and [o] were extracted from adult and children's speech samples and compared by statistical analyses.**

- **Differences and similarities of healthy voice samples between the adult and child group was examined. At the beginning of our research male and female samples were treated together, seeing the difference we arrived at the conclusion that it is better to treat them separately.**

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- The duration of the recordings are about one minute each. Every patient had to read out aloud one of Aesop's Fables, “The North Wind and the Sun”. This folktale is frequently used in phoniatrics as an illustration of spoken language. It has been translated into several languages, Hungarian included.

Participants and methods / Juvenile dysphonia and Healthy Child Speech Database

FD child

Healthy child

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- **Both databases were annotated and segmented on phoneme level, using the SAMPA phonetic alphabet.**

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Pre-processing methods

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- **Among the 14 Hungarian vowels, [E] and [o] are usually analysed in case of adults. There are approximately 50 [E] vowels in the tale that was read.**

- **In the case of the children, the vowel [o] is the poem's most frequent one, with 16 pieces, and there are only 9 pieces of the vowel [E]. The statistical analyses were made extracting the vowels [E], [o] from each database.**

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Parameters	Short description
Jitter_ddp	the average absolute difference between consecutive differences between consecutive periods, divided by the average period
Shimmer_ddp	the average absolute difference between consecutive differences between the amplitudes of consecutive periods
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- **For the extraction of the acoustic parameters Praat software was used. The acoustic parameters were measured in the middle of the vowels.**

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Acoustic Parameters	Short description	Equation
Jitter_ddp	the average absolute difference between consecutive differences between consecutive periods, divided by the average period	$Jitter(ddp) = \frac{\frac{1}{N-2}\sum_{i=2}^{N-1}\lvert(T_{i+1}-T_i)-(T_i-T_{i-1})\rvert}{\frac{1}{N}\sum_{i=1}^{N}T_i}$ [%], Ti is the duration of the i-th interval and N is the number of intervals
Shimmer_ddp	the average absolute difference between consecutive differences between the amplitudes of consecutive periods	$Shimmer(ddp) = \frac{\frac{1}{N-2}\sum_{i=2}^{N-1}\lvert(A_{i+1}-A_i)-(A_i-A_{i-1})\rvert}{\frac{1}{N}\sum_{i=1}^{N}A_i}$ [%]
HNR	Harmonics-to-Noise Ratio quantifies noise in the speech signal, caused mainly due to incomplete vocal fold closure	$HNR = 10 \cdot lg\ \frac{E_H}{E_N}\ [dB]$
MFCC1	the first component of the mel-frequency cepstral coefficients	$c_{k-1} = \sum_{j=1}^{N} P_j \cos\left(\frac{\pi(k-1)(j-0,5)}{N}\right)$, N represents the number of spectral values and Pj the power in dB of the jth spectral value (k runs from 1 to N)

Statistical analyses

- **SPSS20.0 software was used**
- **Two sample T-tests were used for statistical significance testing.**
- **Where F tests showed significant variances of an acoustic parameter within the groups (with significance level 95% (α = 0.05), Welch's T-test was used.**
- **Our assumption is that the distributions are normal, but T tests are relatively robust to moderate violations of the normality assumption.**
- **The null hypothesis is that the means are equal.**

Results / Comparison of healthy and FD children

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	[E]	[o]
	p - values	
Jitter_ddp	**0.018****	**0.000*****
Shimmer_ddp	**0.000*****	**0.000*****
mean_HNR	**0.072***	**0.003*****
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- * p < 0.1
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The poem contains 9 instances of [E] and 16 instances of [o] sounds.

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Results / Comparison of healthy adults and children /1

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	Vowel									
	[o]					[E]				
	Child		Male			Child		Male		
	Mean	Std. Dev.	Mean	Std. Dev.	p-value	Mean	Std. Dev.	Mean	Std. Dev.	p-value
Jitter_ddp	1.095	0.740	1.448	1.533	**0.020****	1.414	1.084	1.986	1.791	**0.000*****
Shimmer_ddp	7.514	3.698	8.654	6.962	0.109	9.669	5.268	12.125	10.070	**0.003*****
mean_HNR	17.982	4.232	12.872	4.776	**0.000*****	13.262	3.914	8.337	4.068	**0.000*****
MFCC1	245.977	45.554	265.013	54.779	**0.000*****	175.224	32.372	208.357	51.887	**0.000*****

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	Vowel									
	[o]					[E]				
	Child		Male			Child		Male		
	Mean	Std. Dev.	Mean	Std. Dev.	p-value	Mean	Std. Dev.	Mean	Std. Dev.	p-value
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Results / Comparison of healthy adults and children /2

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	Vowel									
	[o]					[E]				
	Child		Female			Child		Female		
	Mean	Std. Dev.	Mean	Std. Dev.	p-value	Mean	Std. Dev.	Mean	Std. Dev.	p-value
Jitter_ddp	1.095	0.740	0.904	1.026	**0.013****	1.414	1.084	1.173	1.155	**0.011****
Shimmer_ddp	7.514	3.698	5.813	4.653	**0.000*****	9.669	5.268	7.755	5.717	**0.000*****
mean_HNR	17.982	4.232	17.109	5.223	0.370	13.262	3.914	12.764	4.408	0.128
MFCC1	245.977	45.554	249.780	47.506	0.347	175.224	32.372	177.965	43.429	0.320

Results / Comparison of healthy adults and children /2

	Vowel									
	[o]					[E]				
	Child		Female			Child		Female		
	Mean	Std. Dev.	Mean	Std. Dev.	p-value	Mean	Std. Dev.	Mean	Std. Dev.	p-value
Jitter_ddp	1.095	0.740	0.904	1.026	**0.013****	1.414	1.084	1.173	1.155	**0.011****
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Results / Comparison of healthy adults and

Differences exist in the examined acoustical parameters even between healthy child and healthy adult groups.

A decision system that inquiries child's voice trained with adult voice samples would likely detract erroneous conclusions

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	[o]					[ɛ]				
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	[o]					[E]				
	Female		Male			Female		Male		
	Mean	Std. Dev.	Mean	Std. Dev.	p-value	Mean	Std. Dev.	Mean	Std. Dev.	p-value
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Results / Comparison of healthy males and fema

It is reasonable to separate male and female samples when we have small dataset.

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	[o]					[E]				
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- It is necessary to carry out the investigations separately on children's voices as well, we cannot use adult voices to make any conclusions to children's voices.
- In order to build an automatic decision making system that recognizes FD it is advisable to train the system separately for adult males, adult females and children.

Thank you for your attention!

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