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ANALYSIS OF ARTICULATION OF FRICATIVE PRAEALVEOLAR SIBILANT "S" IN CONTROL POPULATION

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Defective pronunciation of one or more mother language phones, i.e. dyslalia, represents the most frequent speech impairment both in children and adult people. Cases of persisting speech disorder need professional approach and help. The aim of the study was to obtain a model of physiological articulation of the sibilant "s" in children. The method of FFT spectral analysis was made use of. Results will serve for further use in evaluation of speech impairment.

INTRODUCTION

The most common and frequent speech defect in children and adults is dyslalia, which means defective pronunciation of one or more mother language phones, while pronunciation of the other phones is correct. There are usually individual differences in the articulation development: speech of some children at the age of approximately three is acoustically entirely mature, while other children have difficulties with pronunciation of some phones still at the age of six. With dyslalia, it is therefore important to differentiate so called *incorrect pronunciation* that adjusts itself gradually through distinctive inhibition, by means of which pronounced words are analyzed and create correct acoustically articulated connections. Up to the age of 5, children's dyslalia is considered a physiological phenomenon, (so-called *physiological dyslalia*), sometimes; however, this pronunciation persists up to the age of 7 (so-called *prolonged physiological dyslalia*). Alternatively, *an impaired, defective pronunciation*, when the pronunciation anomaly is fixed, is of significantly pathological character. It appears either from the start of pronunciation development, or, if incorrect pronunciation persists up to the time when the pronunciation stabilizes according to the language habits and standards, which means around the age of seven *("true dyslalia")*. In this case, the defective pronunciation requires professional treatment. Chances for a spontaneous adjustment are slim.

The phonetic aspect of speech ontogenesis is governed by the rule of the least physiological exertion that means that the child first generates those phones that require the least articulatory exertion and later more demanding phones. As the last, children learn to handle phonemes that are characteristic for their mother language.

According to this rule, a Czech speaking child first generates vowels in this order:
- articulatory basis with the greatest frequency is the vowel "a"
- this is followed by "u" and "o"
- development of "e" and especially "i" vowel is more complicated
- "au" diphthong stabilizes before "ou" diphthong

The sequence of the consonant fixation process is as follows:
- bilabial occlusive *p, b, m*
- alveolar occlusive *t, d, n*
- labiodental fricative *f, v*
- velar occlusive *k, g*
- lateral fricative *l*
- palatal occlusive *ď, ť, ň*
- velar fricative *ch, h*
- alveolar fricative sibilants *s, z, š, ž*
- alveolar semiocclusive *c, č*
- vibrant *r*
- specific Czech vibrant *ř* is usually managed as the last.

DYSLALIA

The dyslalia may effect individual phones, syllables, as well as words and according to this we recognize *phone, syllable and word* dyslalia.

The phone dyslalia has one of three basic forms:

- *Mogilalia* is a type of dyslalia when a child skips one of the phones.
- *Paralalia* is a substitution of a phone by another, less demanding on articulation.
- *Distortion of individual phones* – the most common type of dyslalia. Here the phone is generated in a different way and in a different articulatory position, so its sound is outside the usage of the given language community. Adding the suffix -ism (indicating accidental characteristics) indicates a phone generated in a similar way to the Greek phone and by the Latin name of the generation position (for example *sigmatism interdental*).

Multiplex dyslalia indicates multiple dyslalia with which most of the phones are pronounced defectively, regardless the form of their incorrect pronunciation.

Syllable and word dyslalia does not necessarily mean that separate individual phones are not pronounced correctly, but in phone groupings, the child skips, reduces, makes metathesis, mixes up the phones in such a way that the speech may be garbled into incomprehensibility.

Specific assimilation is a special type of dyslalia. Here the speaker is able to pronounce certain phones separately and pronounces them even in words where they appear individually. If in the same word, however, their variations appear, assimilation of one to another results. Assimilation occurs mostly with sibilants: series *"s, z"* assimilates to series *"š, ž"* and vice versa.

ORTHOPHONY OF CONSONANTS "S" and "Š"

Regarding a relatively complex and delicate articulatory mechanism and mainly due to high hearing differentiation, the sibilants develop over a relatively long period of time.

Consonants "s","z"

Praealveolar fricative sibilants (sharp sibilants) (Fig. 1)

Narrowing occurs by pressing longitudinal edges of the tongue towards the upper gum; a crevice remains between the ridge of the tip of the tongue and front part of the alveoli. The lip crevice is narrow (lip opening in horizontal direction is prolonged and corners of the mouth are sharpened into so called small smile). Vocal cords are open with "*s*", clenched and vibrating with *"z"*. Characteristic buzz is high (4–10 kHz). With "s", articulation is steady and the hiss therefore sharper, the tone of the oral cavity is higher than with "z", whose articulation is less energetic.

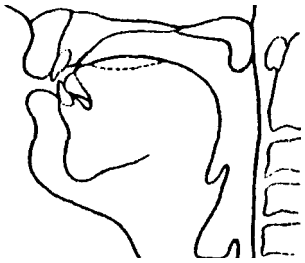

Fig. 1. Fonation "s".

Comparison "s","z"

Postalveolar fricative sibilants (dull sibilants) (Fig. 2)

Narrowing occurs by pressing sides of tongue edges towards the upper gum, tongue mass, however, is shifted generally backwards. A crevice remains between the ridge of the tip of the front part of the tongue and the hind part of the alveolar protrusion. The distance of the narrowing from the front incisors is greater. The tip of the tongue is usually tilted down. The lips are slightly rounded (corners of the mouth are closer together, the lip opening is shortened and rounded by pursing lips).

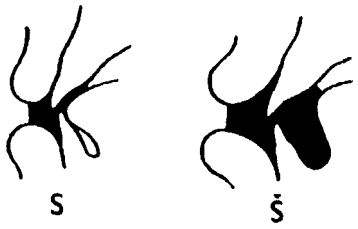

Fig. 2. Difference between "s" – "š".

SIGMATISM

Defective generating of the series "s" consonants (s, z, c consonants) and "š" (š, ž, č consonants) are summarily designated as sigmatism (lisp). The results of an extensive research of children's pronunciation, who started in the first year of elementary school, have shown, that sigmatism (second after rotacism) in Czech language is the most frequent defect of phone articulation. Within the research, 5,599 children were examined, which represents almost half of this part of the population. Dyslalia was detected in 2,135 of them, it means more than 38 %: At least 16 % had defective more than one phone. Considering the total number of dyslalia patients, sharp sibilant sigmatism occurred in 43 % and with dull sibilants in 22.44 %.

Very rare are cases of mogilalia, when the child skips sibilants; more frequent is paralalia, it means parasigmatism, when sibilants are substituted for *"t"* and *"ch"* consonants or perhaps are substituted for one another. Frequent substitutions are series "s" sibilants *(s, z, c)* for series "š" sibilants *(š, ž, č)* and *vice versa*.

There are a variety of sibilant defects. We recognize the following types of defects of sibilant generating:

- *Interdental sigmatism*, when tip of the tongue protrudes to certain degree between bottom and upper incisors. Development of this is considered as related to the bite defect, habit of respiration by mouth and growth of adenoids. This type of sibilant defect is most common.
- *Addental sigmatism* – tip of the tongue leans against the hind wall of upper incisors and this is how characteristic dull hiss, similar to "t" phone, develops. This is considered related to intra-auricular hearing impairment.
- *Bilabial* – sibilant is generated by means of both lips, expiratory stream leaks between the lips, which are pushed out forward.
- *Labiodental* – sibilant is generated between the bottom lip and upper incisors and is actually substituted by "f" consonant (this is why it is possible to consider this type of sigmatism as parasigmatism).
- *Lateral* – expiratory stream leaks along the side of the tongue instead of through the center of the oral cavity. The main causes of the lateral sigmatism are various irregularities in development of denture bite. Sometimes it develops during the first and second dentition replacement. However, the opposite cases are also recorded when during this replacement the lateral sigmatism disappeared.
- *Nasal* – the tongue, due to his position, closes the oral cavity and insufficient palatine pharynx closure enables air to stream through the nose. The result is unpleasant nasal murmur.
- *Laryngeal* – is characterized by sharp murmur initiated in the larynx and is typical for palatolalia.
- Sigmatism stridens – excessively sharp, conspicuous, usually habitual hiss that is especially distinct with whispering.
- Aspirational sigmatism – isolated case of sibilant defect resulting from non-professional pronunciation training within the family. The sibilants are generated by means of labiodental sound during short, spasmodic inspiration.

MEASUREMENTS

Voice and speech parameters of tested sound "s" were analyzed in control population of 19 children aged 10–12 years. Recording was used in order to evaluate the sibilant spectrum. A Czech rhyme used in speech therapy dealing with sigmatism was recorded: "Byl jeden les, v lese byl pes, v lese byl kos a ten byl bos".

For recording, we made use of the MZ-R3 minidisk and a set with AKG C 10005 microphone, the Behringer MX 802 mixing table, the Sennheiser HD 250 linear II headphones. The FFT (Fourier Analysis) was carried out by the means of the SoundForge 5.0 program with the Delta 66 sound card.

RESULTS

Figure 3 depicts an example the spectral analysis FFT of the word "kos". Upper maximum value 1 and 2, lower minimum of spectrum limit of the sibilant, and the maximum density of the signal were measured. The Table summarizes the results.

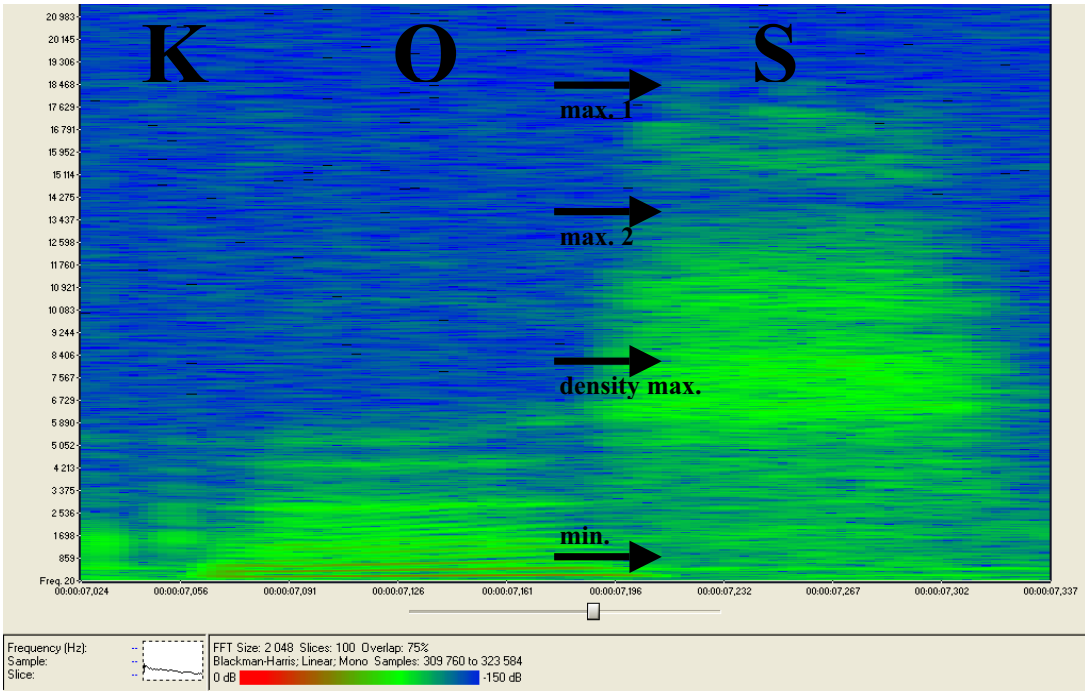

Fig. 3. Spectral analysis FFT of the word "kos".

Table 1. Results of FFT analysis performed during the pronunciaton of the word "kos" by 19 children (age range 10–12 years) (see Fig. 3).

Proband	max. 1 [kHz]	max. 2 [kHz]	min. [kHz]	max. density [kHz]
1	16.7	13.5	1.2	5.5
2	17.0	13.4	1.5	10.1
3	18.4	13.8	1.0	7.7
4	16.5	13.5	1.3	6.1
5	×	13.8	1.2	10.4
6	16.5	13.6	1.0	5.6
7	17.2	13.4	2.3	7.4
8	×	13.5	2.7	7.9
9	×	13.1	1.5	7.0
10	16.8	13.6	1.4	8.6
11	16.0	13.7	2.2	10.4
12	16.8	13.7	1.5	5.6
13	16.7	13.6	2.0	5.9
14	×	12.7	1.6	4.5
15	×	13.8	2.3	6.0
16	16.0	13.4	3.0	7.5
17	×	13.5	1.4	8.5
18	16.9	13.5	1.7	10.0
19	×	13.3	1.9	9.1

Mean value of max. 1 for the whole group is 16.8 kHz, SD = 0.6. Mean value of max. 2 is 13.5 kHz, SD = 0.3. Mean value of min. is 1.7 kHz, SD = 0.5. Maximum density mean value is 7.6 kHz, SD = 1.8.

DISCUSSION

Causes of sigmatism, as of other types of dyslalia, are as follows: unsuitable educational conditions and incorrect speech models; defective sense organs, especially hearing and sight; insufficiency of emotional relations; defects of central nervous system; general locomotive clumsiness of the child and obviously anomaly in speech organs. In dyslalia etiology, mainly denture and denture bite defects, adherent tongue and cleft palate play a significant role.

M. Sovák already pointed out possible relationship between defective sibilant pronunciation and dental anomalies in 1932. Through an articulation defect research of 2,080 children and adults with denture and dental bite defects, he found a sibilant defect in 726 cases. The individual types of sigmatisms showed as follows: Interdental sigmatism – 61.8 %, lateral s. – 21.3 %, addental s. – 7 %, nasal s. – 3.5 %, combination of lateral and interdental s. – 0.5 %.

CONCLUSION

An increase in technical, cultural and social quality level definitely brings also an increase in demands not only for person's ability to express himself or herself, but also for formal aspects of language. Because of the great frequency of sibilants in the speech, their defected and distorted pronunciation exerts a very negative effect on the ethics (perhaps the worst effect out of all the pronunciation defects). Sometimes it even creates almost an infantile impression. Lisp not only worsens quality of the speech expression, but it may also negatively affect person's psyche and his or her place in the society.

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