SOME ESSENTIAL DIFFERENCES IN THE VOCAL CHARACTERISTICS OF CHILDREN WITH AND WITHOUT VOICE DISORDERS

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When children come into contact with their peers in pre-school institutions, conflicts for domination begin. The children often shout and speak outside their register. This behavior negatively affects the proper development of their phonation mechanisms. The purpose of the present work is to determine the differences between the vocal characteristics of a group of children with vocal disorders and a control group in several Zagreb kindergartens. The voices of children identified as having vocal disorders were analyzed, with the voice parameters measured providing good measuring characteristics for distinguishing the groups. The voice onset time, maximal time of sustained consonant, and the fundamental frequency perturbations were analyzed.

INTRODUCTION

The initial hypothesis for this work is related to the discovery of the dysphonias depend on vocal resistance or tension. We would expect the most common form of dysphonia, hyperkinetic dysphonia, to arise in children. The first sign of disturbed phonation is dysphonia, and the most common form of dysphonia is hoarseness.

Brodnitz (according to Wilson, 1979) considers that complete pure strength is the main element of many voice disturbances and said, "Children who use and often abuse their voices burden their vocal cords by shouting until nodules appear." In preschool institutions, the child comes into contact with its peers and begin to struggle for domination. They shout very frequently and speak outside their register, which causes a negative affect on the development of the phonation mechanisms. Voice abuse, such as shouting and talking too loudly during playing, is according to many authors the main cause of child hoarseness. Böhme (1969) considers that 30-40% of all hoarseness in childhood is the result of hyperkinetic dysphonia.

The purpose of this investigation was to identify the vocal features that distinguish a preschool group with voice disorders from a group without voice disorders. The following vocal parameters were investigated: voice onset time, perturbations of frequency and intensity of the fundamental laryngeal tone, and the maximal time of sustained consonant.

METHOD

Subjects

The sample included thirty-six children with voice problems and thirty-one without voice problems. They were selected at random from a population of preschoolers (502 children) at eight kindergartens in Zagreb, on the basis of the subjective evaluations of the children's voices (as judged by an examiner) and spectral analyses of the voic-

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es of the subjects. The subjects were of both sexes, aged between five and seven.

Apart from voice problems, the subjects of the first group did not have any other disturbance in their oral communication.

Phonatory Tasks and Recording Procedures

There were three different phonatory tasks: 1) Spontaneous speech in which the subjects were asked to talk about television cartoons (Tom and Jerry). 2) Sustained consonant production in which the subjects were asked to articulate consonant /s/ as long as they could (as a respiratory measurement). The consonant was repeated three times with rest periods between consonants. 3) The subjects were required to repeat the syllable / sa/ three times with rest periods (as a VOT measurement). Some of these tasks have been used in other voice research (Boone, 1989).

The examiner demonstrated each of the phonatory tasks. The sustained consonant task was repeated until the examiner judged that three acceptable consonant samples were produced. The subjects were seated in a sound-treated room, and their voices were immediately recorded on audio tape. The microphone (Sennheiser, ME 66) was placed so that it was 40 cm from the subject's lips. The voice samples of the subjects were recorded on a high-quality tape recorder (Uher, 4000 Report Monitor).

Acoustic Analysis

Measures of fundamental frequency perturbations and intensity, voice onset time, and maximal sustained consonant productions were obtained using an acoustic spectral analysis program by Bruel and Kjaer 2123 Real Time Frequency Voice Analyzer, which makes possible the reading of the three vocal parameters: time, frequency, and intensity. The audio recorder that was used in these investigations was connected to the voice analyzer. In this way, we obtained 67 spectrograms of both groups.

Selection of variables

In the following order, the variables were selected to obtain an objective evaluation of the parameters of the children's voices:

1. Fo - fundamental frequency in Hz (hertz);
2. Fod - intensity of Fo in dB (decibel);
3. Num - number of columns around Fo above 40 dB (on the spectrogram, as an indicator of Fo perturbations or jitter). The / Num/ parametar is just one more of the several ways of Fo variability observation on the Real Time Frequency Voice Analyzer 2123 (see copies of spectograms in the paper);
4. Vot - in the syllable /sa/ in msec;
5. Tim - maximal time of the sustained consonant /s/ in sec.

Some of these variables been used in other voice research (Titze, 1993; Krom,

Table 1. *Means, standard deviations, and analysis of variance of both groups (statistical level = 0.05)*

VARIABLES	MEAN		STANDARD DEVIATION		PROB.
	X	X_1	SD	SD_1	
FO (Hz)	256	271	29	22	0.1030
FOD (dB)	58	57	1.1	1	0.6430
NUM (nr. of columns)	6	6	1.4	0.8	*0.0000
VOT (msec.)	204	251	50.3	119.5	*0.0364
TIM (sec.)	3.0	4	1.3	1.2	*0.0500

Legend:
X - mean of group with voice disorders
X_1 - mean of group without voice disorders
sd - standard deviation of group with voice disorders
sd_1 - standard deviation of group without voice disorders

Table 2. Discriminant analysis of both groups

WiLks'lambda = 1.5173 F = 56.86 P = 0.0000

VARIABLES	COEFF. DISCRIM	COEFF. CORREL.
FO	0.230	0.572
FOD	-0.066	0.013
NUM	* -0.822	* -0.764
VOT	0.293	0.580
TIM	0.258	0.423

1993; Wolfe, 1995; Milenković, 1987). These variables been used very often in voice literature because they describe the basic acoustical characteristics of voice and voice pathology. The differences between the groups, were established by a discriminative analysis and a one-factor variance analysis at a statistical significant level (0.05).

RESULTS

The results from Table 1 show that the groups have a statistically significant difference with respect to the variables Num, Vot, and Tim.

In the group with hoarse voices, the number of columns around the fundamental tone (above 40 dB) as we can see on spectrograms in the paper, ranged from 4 to 9 columns, with an average of 6. The control group showed a media value of 4 columns. Thus, the smaller the number of columns, the better the voice, while a higher number of columns represented a disordered voice. Greater Fo perturbations in the voice disturbance group accompanied greater changes harmonic intensity, including from 58 dB, through 49 dB, to 54 dB. In the control group the intensity of harmonics was more stable with a level of 54 dB. The statistically significant differences at the 0.05 level on the Vot (P=0,03) correlate with the results of Dembitz (1987), who obtained a shorter time of initial phonation with dysphonic children as compared to a group with no laryngeal pathology.

A shorter time of sustained consonant /s/ productions in the disordered voice group can indicate, apart from disturbed respiratory control, also a disturbance of the resonance. This fact is essential for the explanation of the non - statistically significant differences for the variables Fo and Fod (frequency and intensity of Fos.) According to Brackett (1971), voices may differ in pitch even if they have the same basic frequency. What distinguishes them is the part played by the resonator.

The groups tested varied very considerably in voice quality. The group with voice disorders showed an exceptionally

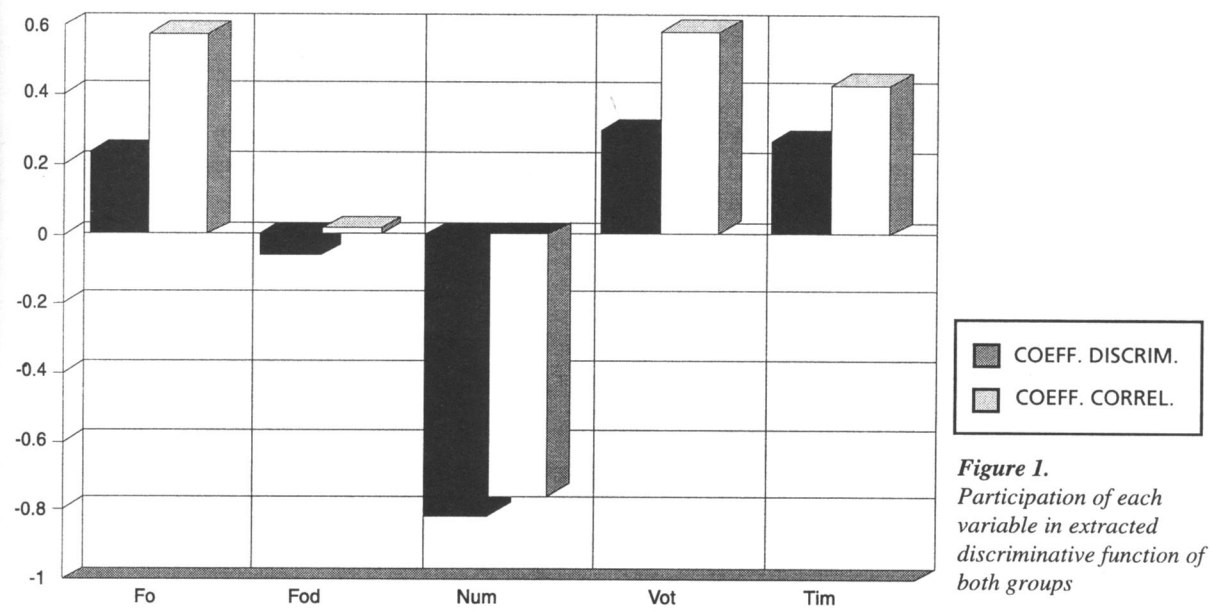


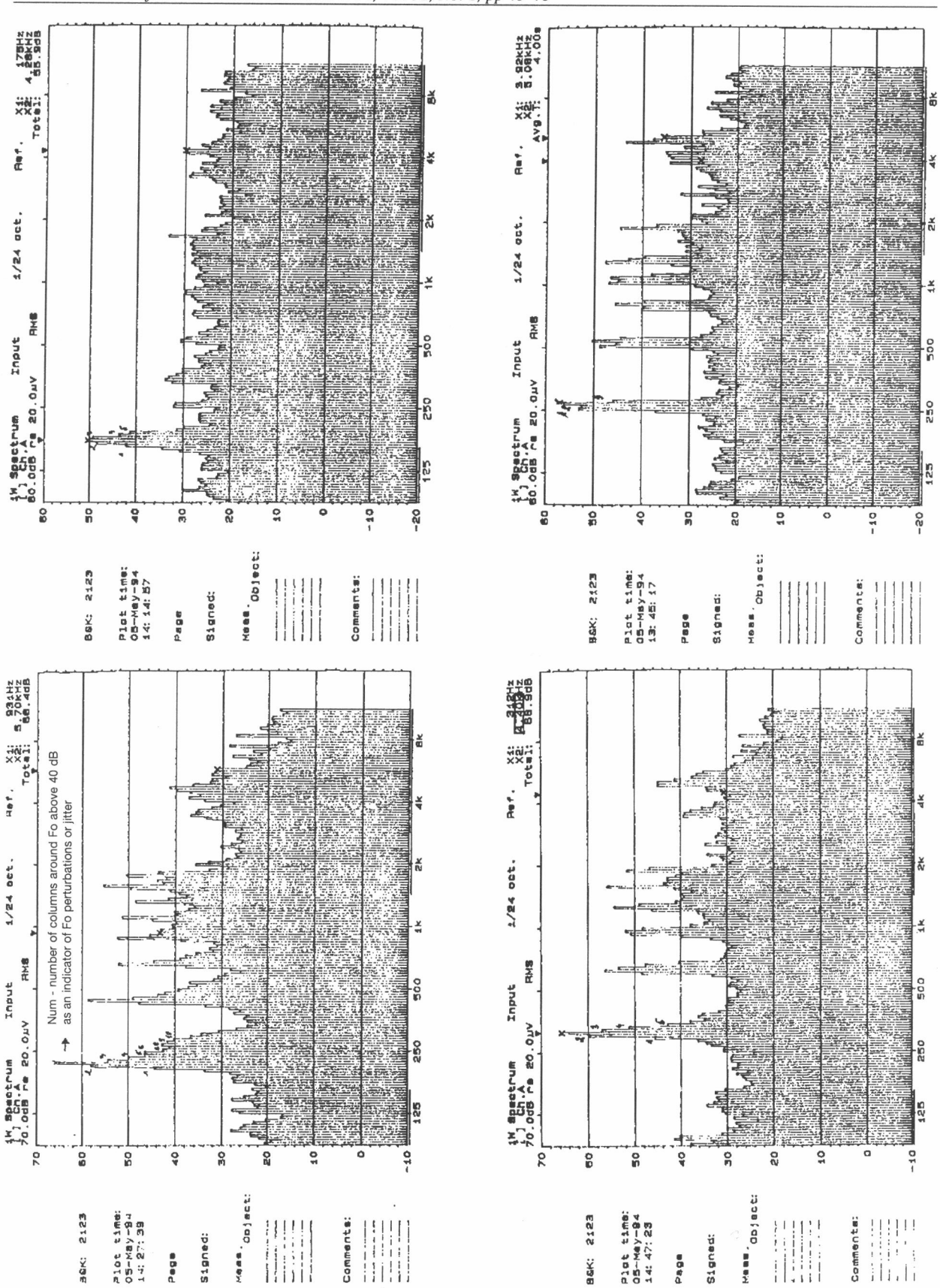
Figure 1.
Participation of each variable in extracted discriminative function of both groups

noisy component that manifested itself as hoarseness, but this was not the case with the children without voice disorders. The results of the robust discriminative analysis (Table 2) confirm the results obtained. One discriminative function was extracted that had a strength of discrimination (Wilks' lambda) that was statistically significant at the 0.05 level.

The Num variable contributes most to the strength of the discriminative function and clearly gives the best results in respect of greater or lesser distortion of the voice (Figure 1). The results obtained for other coefficients of discrimination and correlation are more or less confirmatory of the previously explained results of the variance analysis.

DISCUSSION AND CONCLUSIONS

Using the methodology of Lisker and Abranson (according to Aronson, 1980) who in 1964 were the first to define voice onset time VOT as a difference in time between the relaxation of the articulatory tension and the beginning of the vibration of the vocal cords, we obtained a voice onset time for children with hoarse voices that was shorter than for children with no voice disorders. The greater the laryngeal tension, and the more excessive and harder the onset of phonation, the shorter the Vot is. Further, we expected that children with voice disorders would have greater perturbations of pitch and intensity of voice than children without voice disorders. Johnson (according to Aronson, 1980) considered that inadequate variability of voice causes possible changes in the pitch and intensity of the voice. The definition of hoarseness of voice includes every deviation from the normal features of pitch, intensity, and voice quality, so these values were measured. Griffiths (1989) stated that the most common causes of disturbed phonation are excessive use of the voice, vocal injuries, laryngitis and endocrine diseases. The results obtained from research in Zagreb kindergartens found 36 children whose voices were accompanied by greater oscillations of the fundamental laryngeal tone (the statistically significant differences between the groups with respect to the Num variable - number of columns; this variable most strongly creates the discriminative function). The statistically significant difference obtained between the groups with respect to the variable Tim (maximal time of sustained consonant /s/) is explicable by possible disturbances in resonance and respiratory control in the group with voice disorders. Measuring the time of sustained consonant /s/ is a good way of measuring the economy of time and the muscular tension of the articulator that are necessary for good friction (assuming by this the state of the resonator itself). On the basis of such data, we have confirmed the hypothesis that there is a difference between the groups in voice onset time with the syllable /sa/ (P=0.03), in Fo frequency and intensity perturbations (P = 0.00), and the maximal time of sustained consonant /s/ (P= 0.05). The problems of children's voices are neglected here in Croatia, but also in foreign literature. There are relatively few works describing research into children's laryngeal pathology as compared with research into the same problem in the adult population. The research in Zagreb was done with the aim of subsequently starting a preschool preventive program to encompass the discovery, recognition, and determination of this kind of vocal disturbance in children at a very sensitive age. We found that 7.1% of 502 preschool children had voice disorders. The results of Dobres (1990) indicated that 42% of 731 preschoolers had vocal nodules. Powell (1989) said that in a mass screening of children ages 6-10 in a rural school division, 203 children were identified as having a voice deviation.



These 4 spectrograms represent voice characteristics of group with voice disorders

REFERENCES

1. Armitage, P. (1973): Statistical methods in medical research, Blackwell Scientific Publications, London.
2. Aronson, A. E. (1980): Clinical voice disorders, An Interdisciplinary Approach, Brian Decker, N. Y.
3. Boone, D. R. (1989): The voice and voice therapy, Prentice Hall, Englewood Cliffs, N. Y.
4. B"hme, R., Rosse, E. (1969): Incidence, age distribution, therapy and prognosis of vocal cord nodules, Folia Phoniat., 21,121-126.
5. Brackett, I. P. (1971): Parameters of voice quality (in) Travis, L. E., (ed.) Handbook of speech pathology and audiology, pp. 441-465, Appleton - Century - Crofts. Inc., N.Y.
6. Bryan, J. G. (1951): The generalized discriminant function: mathematical foundation and computational routine, Harvard Educational Review, 21, 90.
7. Dembitz, A. (1987): Mehanisms of obtained vocal nodules in children, Faculty of Medicine, Master thesis, Zagreb.
8. Dobres, R. (1990): Description of laryngeal pathologies in children evaluated by otolaryngologists, Journal of Speech and Hearing Disorders, 3, 526-533.
9. Griffiths, C. (1989): Neurologic diseases and their effect on voice, Journal of Voice, 3, 148- 156.
10. Krom, G. (1993): A cepstrum/based technique for determining a harmonics-to-noise ratio in speech signals, Journal of Speech and Hearing Research, 36, 254-266.
11. Milenković, P. (1987): Least mean square measures of voice perturbation, Journal of Speech and Hearing Research, 30, 529-538.
12. Powell, M. (1989): A Longitudinal study of the prevalence of voice disorders in children from a rural school division, Journal of Communication Disorders, 22, 375-382.
13. Titze, I. R. (1993): Comparison of Fo extraction methods for high-precision voice perturbation measurements, Journal of Speech and Hearing Research, 36, 1120-1133.
14. Wilson, K. (1979): Voice problems of children, The Williams/Wilkins Company, N. Y.
15. Wolfe, V. (1995): Acoustic prediction of severity in commonly occuring voice problems, Journal of Speech and Hearing Research, 38, 273-279.