NEWBORN'S CRY FROM RISK AND NORMAL PREGNANCIES

Mirjana Sovilj, Tatjana Adamovic, Misko Subotic, Nikoleta Stevovic
Institute for Experimental Phonetics and Speech Pathology, Belgrade, Serbia and Montenegro

***Abstract*. Previous researches of the prelingual period indicated that primal cry and the first cry represent the inception of verbal communication.**
The aim of this work was to study qualitative characteristics of crying of newborns from risk pregnancies and newborns from regular pregnancies in the function of prediction of verbal communication development.
The research was carried out on the sample of N=10 babies divided into two groups, aged 15 days. E group (N=5) comprised newborns from risk pregnancies, and C group (N=5) comprised newborns from normal pregnancies. Crying in the examined sample was digitally recorded and spectrographically analyzed.
The research results point to the possibility that certain acoustic characteristics of crying can be used in the prediction of verbal communication development and that the researches in this area should be intensified and continued.
***Key words*: newborn's cry, verbal communication, prelingual period, spectrographic analysis**

1. INTRODUCTION

Newborn's cry, as an elementary particle of the development of verbal communication, was the topic of numerous scientific researches aimed not only at broadening the knowledge of controlling the process of crying production and brain organization itself, but only at examining the possibilities of crying as a diagnostic-differential instrument.
The firs baby's cry, as stated by Kostic (1991), appears as a spontaneous physiological reaction that does not depend on its communication with the social environment [2]. The same author thinks that, during the first two months of life, a newborn reacts to hunger, discomfort and pain by crying. Physiological needs of a child's organism are the means of sound expressed through crying and thus they lie in the basis of communication between a child and his parents (Kostic, 1980) [3].
Researches of Sovilj and Djokovic (1993) support the fact that the development of speech communication is commenced by the first cry. Proceeding from the standpoint that the first cry contains all acoustic elements of the speech acoustic structure: formant forms, noise forms and combined formant-noise forms of acoustic structure, which are normally present in speech (Kostic, Stosic 1963) [4], Sovilj and Djokovic analyzed the first cry-(ing) from birth until the end of the first month, reaching the results that indicate the existence of phases in the development of cry-(ing), from the first cry to crying (30 days), which are significant not only for the monitoring of the development of hearing, and future speech and language, but also for the development of methodological procedure for early detection of speech and hearing impairment and speech habilitation of hearing impaired children, which is carried out from the first month, in the prelingual phase [6].
Sovilj (1995) [7] also emphasizes that the first day after birth global control connection between hearing and voce is established. On the basis of spectrographic analyses, Truby and Lind (1965) established three important types of crying: basic phonation cry, turbulent, dysphonic cry, and strongly expressed hyperphonation cry [9].
The most complete model for the production of these types of cries was developed by Golub (1980), separating crying production into subglottal, glottal and supraglottal production zone connecting muscle activity with each type of crying [1].
Proceeding from the assumption that crying of hearing impaired children differs from crying of their normally hearing peers, due to the lack of auditory feedback, Moller and Schonweiler (1997) reached the results that coincided indicating that crying of normally hearing babies differs from crying of those with profound hearing impairment. Main statistically significant differences were found in the distribution of energy in different frequency ranges, duration of crying, and some melodic parametres [5].
In this paper, which is a pilot research, crying was studied through the analysis of ranging of the movement of the basic laryngeal voice in newborns' crying as the carrier of the quantitative monitors of speech (QMS): intensity, frequency and duration. QMS are the carriers of suprasegment speech structure and their variation forms the matrix. In the later period of speech-language development, sounds, syllables, words and sentences, followed by the development of accents of words, accents of melodies and melody sentence are built into this matrix. Previous researches at the Institute

Models and analysis of vocal emissions for biomedical applications. 4th international workshop. October 29-31, 2005 – Firenze, Italy.
Edited by C. Manfredi. ISBN 88-8453-320-1 (online)

for Experimental Phonetics and Speech Pathology (Sovilj, 2002) as well as the results of foreign researchers, indicated that suprasegment structure of mother tongue develops as early as in the fetal period [8]. This fact points even more to the necessity and significance of researching the cry as a nucleus of verbal communication and finding ways of its use in early detection and diagnostics, i.e. early prediction of hearing, speech and language development.

2. AIM

The aim of this research was to study qualitative characteristics of crying of newborns from risk pregnancies and newborns from regular pregnancies in the function of prediction of verbal communication development.

3. METHODOLOGY

For the needs of spectrographic analysis of a newborn's cry, crying before nursing was digitally recorded in home conditions, on the 30th day after birth, because of the clear stabilization of the acoustic field of crying when a child has physiological needs, compared to the inception of vocalization, when a child is in homeostasis. The research was carried out on the sample of N=10 newborn babies, 15 days of age, divided into two groups. The experimental group (E) comprised N=5 newborns from risk pregnancies, and the control group (C) comprised N=5 newborns from normal pregnancies. Newborns from E group were born from the pregnancies with the risk of a miscarriage from 6-7 month. All newborns were born normally in the 9th month.

During the recording, we used the directed microphone that was positioned near newborn's mouth on the defined distance of 10 cm. The recording lasted for about 3 minutes, which was a sufficient time period for obtaining the repeated stable characteristics of crying. Digitalized recordings were transferred into COOL program, from which the trained researcher, by means of auditory control and visual control of the recording, selected the signal (cry) that occurred most frequently, and transferred it to PRATT program for spectrographic signal analysis. The recorded cry was digitalized by the speed of choice 22050 Hz, 16-bit resolution, and it was recorded on one channel (mono). Spectrographic analysis obtained: minimal, maximal and mean values and their standard deviations of duration (Du), intensity (I) and frequency (FFo) of basic laryngeal tone.

Besides crying, for the psyhophysiological assessment of newborns we provided the data on body size at birth (body weight – BW and body length - BL).

The obtained data were statistically processed by the application of T-test significance of the differences between the examined groups.

4. RESULTS AND DISCUSSION

In order to obtain more reliable and objective indices of crying characteristic in the monitored groups, we proceeded from the fact that newborn's voice in the monitored period (15 days) is not connected with the control of the movement of speech organs meant for speech production, but solely with its general physiological state and needs.

In that sense, newborn's body was observed from the aspect of the complete resonatory and energy space, whose influence on the voice (crying) can be represented by longitudinal mass (LM), which represents the relation of BW and BL given in the formula

$$LM = \frac{BW}{BL}$$

Having on mind that constitution plays an important role in voice impostation, we normalized intensity and frequency values on crying duration and newborn's longitudinal mass.

Normalized IFo and FFo values were calculated according to the following mathematical formulas:

$$CIFo = \frac{\text{x IFo}}{DU \bullet LM}$$

(coefficient of crying intensity) (average crying intensity)

$$CIFo = \frac{\text{x FFo}}{DU \bullet LM}$$

(coefficient of crying intensity) (average crying frequency)

Intensity

Table 1 Crying intensity in E and C group

Statistical parametres	dB-min	dB-max	dB-average	dB-SD
Experimental group				
X	73.37	83.12	79.79	1.97
SD	4.87	3.90	5.45	0.95
Control group				
X	78.83	88.22	83.94	2.20
SD	7.26	2.03	5.39	1.60

Results of the movement of the laryngeal tone intensity in newborns' crying (Table 1) indicate that mean value of Fo intensity in C group is 83.94 dB, and 79.79 dB in E group, which indicates that newborns' crying from normal pregnancies (C group) is 5% more intense.

Average value of Fo minimal intensity in C group is (78.83 dB: 73,37 dB) 7% higher than in E group, whereas average value of maximal intensity of Fo crying in C group (88,22 dB: 83,12 dB) is 6.8% higher than in E group.

Frequency

Table 2 Frequency of Fo crying in E and C group

Statistical parametres	Average Fo frequency			
	Hz min	Hz max	Hz average	Hz SD
Experimental group				
X	245.26	500.99	369.17	71.18
SD	93.59	31.53	58.70	39.01
Control group				
X	223.50	498.08	361.80	75.69
SD	79.80	44.01	72.20	24.79

Table 2 presents the results of laryngeal voice frequency in newborns' crying. Mean value of FFo crying in C group is 361.80 Hz, and in E group it is 369.17 Hz, i.e. laryngeal voice of newborns' crying from risk pregnancies is 2% higher compared to newborns from regular pregnancies.

Average minimal value of frequency in C group is (223.50Hz : 245.26Hz) about 9% lower compared to E group.

Average value of maximal frequency in C group (498.08 Hz: 500.99 Hz), is about 0.6% lower compared to E group.

Duration

Table 3 Crying duration in E and C group

Statistical parametres	DU in group	
	E group	C group
X	1.08	1.70
SD	0.26	0.73

Results of laryngeal voice duration in newborns' crying (Table 5) in the examined sample, indicate that average duration of crying in C group is 1.7 sec, and in E group it is 1.08 sec. i.e. that crying of newborns from normal pregnancies is 36.5% longer.

The analysis of average BW values (Table 4) indicated that newborns from C group had 19% higher BW compared to E group, but the differences between he groups are not statistically significant.

Table 4 Body weight in E and C group

Statistical parametres	BW	
	E group	C group
X	2790	3440
SD	803	305

Table 5 Body length in E and C group

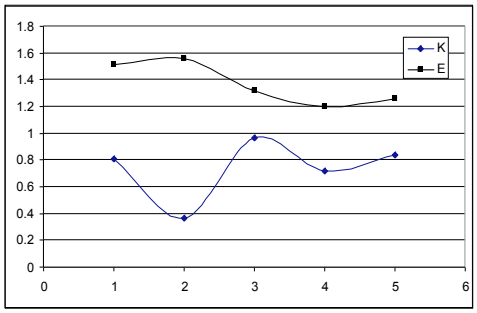
Statistical parametres	BL	
	E group	C group
X	48.00	51.40
SD	5.15	2.97

Results of the average value of BL (Table 5) indicate that newborns from C group had about 7% greater BL compared to E group.

Table 6 C- IFo E and C group

T-Test C-FFo C and E group		
	C group	**E group**
X	3.375906279	6.508190577
df	4	
Tab._ test	-5.574036129	
p(T<=t)	0.002538411	
_ critical	2.131846486	

Graph 1 C IFo in E and C group



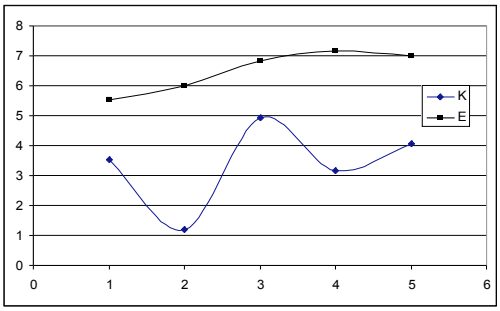
Data in Table 6 and Graph 1 indicate that C-IFo average value in E group is 1.373, and in C group 0.741. Comparing mean C-IFo values in E and C group, we obtained statistically highly significant difference on the level p = 0.007, which indicates that this coefficient can be a reliable parametre for assessment of newborns' crying characteristics and further researches, on a larger sample, will enable their use not only for the early detection of difficulties in speech and language development, but also for the assessment of the general psychophysiological development.

Results in Table 7 and Graph 2 indicate that average value C-FFo in E group is 6,508, and in C group 3,375. Comparing mean values of C-FFo E and C group, we obtained statistically highly significant difference on the level p = 0,002, which indicates that this coefficient can be a reliable parametre in the assessment of newborns' crying characteristics, and further researches will enable their use not only for the early detection of difficulties in speech and language development, but also for the assessment of the general psychophysiological status of a newborn child.

Table 7 C-FFo in E and C group

T test C- IFo E and C group		
	C group	E group
X	0.7417	1.3733
df	4	
Tab._-test	-4.1408	
p (T<=t)	0.0071	
_ critical	2.1318	

Graph 2 C-FFo coefficient in E and C group



On a more precise level, C-IFo and C-FFo indicated the presence of regularities in the connection of three parametres: intensity of crying frequency, duration, and newborn's longitudinal mass i.e. their interdependence, as the expression of psychophysiological state of a child, which classifies them as rather precise measures for the prediction of speech development and psychophysiological status.

CONCLUSION

The results obtained in our research, when comparing the values of QMS parametres in newborns' crying on the 15th day after birth from E and C group, indicate the following:

- C-IFo and C-FFo represent valid parametres for the assessment of newborn's crying characteristics
- when the characteristics and tendencies of the characteristics of laryngeal voice in newborns' crying are perceived globally, it is noted that crying of newborns from normal pregnancies (C group) has the tendency of: larger intensity, lower tone and longer duration compared to crying of newborns from risk pregnancies, whose crying, according to the movement of QMS, can be characterized as crying of the shorter expiratory fork, hypotonic and hypertensive.
- the obtained tendencies of crying characteristics indicate that newborn's crying can be relevant parametre for the prediction of not only speech and language development, but also of the psychophysiological status of a newborn child.

Further researches, on a larger sample, will enable defining of limit values of coefficients for population of newborns from normal and risk pregnancies.

This research was financed by the Ministry of Science and Environment Protection of the republic of Serbia, within the project of basic researches, N° 1784.

LITERATURE

[1] Golub H. L. (1980): A physioacoustic model of the infant cry and its use for medical diagnosis and prognosis, Thesis, Massachusetts Institute of Technology, Boston.
[2] Kostic Dj. (1991): Cooing and Babbling, Notes and discussion, No 2, IEPSP, Belgrade.
[3] Kostic Dj. (1980): Speech and the Hearing Impaired Children, Indian Statistical Institute, Calcutta.
[4] Kostic Dj., Stosic M. (1963): Acoustic Structure of a Newborn's Cry, IEPSP, Belgrade.
[5] Moller S., Schonweiler R. (1997): Analysis of Infant Cries for the Early Detection of Hearing Impairment, in: Proc. 5th European Conf. on Speech Communication and Technology (Eurospeech `97), Europ. Speech Com. Ass. ESCA, GR-Rhodes.
[6] Sovilj M., Djokovic S. (1993): Development of Newborn's Cry-(ing) from Birth Until the end of the First Month, Defectological theory and practice, Belgrade.
[7] Sovilj M. (1995): The Development of New-born Infant`s Cry(-ing) from Birth Until the End of the First Month, European Decade of the Brain, Amsterdam, 1995.
[8] Sovilj M. (2002): Children's Speech – Quantitative Monitors of Speech, *Zaduzbina Andrejevic*, Belgrade.
[9] Truby, H. M., Lind, L. (1965): Newborn Infant Cry, Almquist & Wiksells, Uppsala.