THE INFLUENCE OF "MOTHER'S SPEECH" ON THE CHILD'S PHONOLOGIC DEVELOPMENT DURING THE FIRST SIX MONTH OF LIFE.

SPA - Speech procesing and Acoustic of the Communication PACS - 43.70.-h

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ABSTRACT.

Dynamic of acoustic characteristics (F1, F2) of the signals produced by mothers and children during vocal-speech interaction was shown from 3 to 6 month of child's life. Mothers had articulated more clearly to the child's 6 month. For the mostly often-used mother's vowels [a], [e] the meanings: F1 [a]-F1 [e] for child's 3 month less then for 6 month. Children approach sound's characteristics to the mothers one with the age: F1, F2 for vowel-likes at 6 lower then at 3 month. The meanings F1, F2 closed for mother's and children's "imitation" sounds at 6 but not at 3 month.

INTRODUCTION.

The first year of child's life is the most important one in the development of different functions of human organism. The speech function is one of them. Exactly in this preverbal period the phonological system of "family language" begins to master (Lyakso e.a.., 2001). According to the data of cross- linguistic studies, sounds which are specific for child's native language appear in his vocalisations in the beginning of the second half of the first year (Vihman, 1991; Lyakso, Silven, 2001).

The nervous system maturation process, changes in the anatomical structures of voice tract during the first months of life lead to the expansion of child's vocal repertoire (Bauer, Kent 1987). Children train they articulation apparatus by "vocal play" (Oller, 1980; Stark,1980) that is they produce varied sounds when they are in content statement. Such process begins approximately at the 4 month of child's life. From the very beginning infant gets many types of acoustic stimulation. One of them is the mother's voice which makes the significant contribution in child's speech development (Jusczyc, 1997, Kuhl et al, 1997, Fernald, 1984). Mother's speech (motherese) is characterised by following features: increasing of the main frequency, raising of the quality and the quantity of amplitude modulation, increasing of the number of pauses and decreasing of the time of utterance, prosodic repetitions and the exaggerating of melodic contour. Different authors (Fernald, Simon, 1984; Stern et. al., 1983) note changes in semantic, syntaxes, phonology in the motherese when compare with the speech directed to adults. The attraction of child's attention and its focus on the speech signals are discussed as the functions of motheres (Fernald, 1984). The point of view exists that "reinforcement of the concentration of speech signal" is in the mother's speech (Jusczyc, 1997). "The hyperarticulate prototypes" of every phoneme category are found in mother's utterances (Kuhl, et. al., 1997)

that is vowels are pronounced more clear then usually. A baby prefers to listen motherese (Fernald, 1985), but it also can produce different sounds dependent of the type of sounds which adults address to him. First it was shown (Bloom, 1998) that 3-month-old infants produce more complex speech-like sounds when interact with the adult who talk with a child but not when the adult smiles or touches the child. Then researchers discuss the imitation as other aspect of infant's answer on adult's stimulation. It was shown (Kuhl, Meltzoff, 1991), that children already before 6 month of life can imitate and this ability increases with the age. As for Russian children it was established (Lyakso, 2002) that they imitate mainly "key words" in spontaneous mother's speech directed to children. Key words – are the words with the main exaggerated melodic contour. This fact was reflected in the resemblance of acoustic characteristics of child's and mother's vowels.

So the processes of maturation of vocal tract and nervous system, acoustic environment with changing with child's age mother's speech and the ability of child to react on mother's speech and to imitate mother's voice – all these factors result in the acquiring of specific sound's sequences of native language by children. But the question about special contribution of every of the noted factors on different stages of speech development is not very clear now.

This investigation's main goal was the description of spectral characteristics of vowel-like sounds produced by children during they first six months of life and spectral characteristics of vowels mother's speech directed to children. We tried to discover the possible age dynamic of the acoustic characteristics of child's vocalisations and to find the most important factor which causes such dynamic. So we proposed that the spectral characteristics of some child's vowel-like sounds approximate to spectral characteristics of vowels of adults, particularly to spectral characteristics of vowels of mother's speech.

First we compared the parameters of striking vowels from mother's speech directed to children of third month of life with the parameters of striking vowels from mother's speech directed to children of sixth month of life. Secondary we compared the parameters of vowel-like sounds produced by three-month-old children with the parameters of vowel-like sounds produced by six-month-old children and parameters of infant's vocalisations produced in situation of mother-child vocal-speech interaction with parameters of infant's vocalisations produced when infant played alone. Then we took vowel-like child's signals which were described as imitation of mother's speech signals particularly mother's vowels, and we tried to trace the age dynamic of characteristics of these signals.

METHODS.

The registration of sound signals of 8 Russian healthy children and 6 mother-child dyads was made when children were 3 and 6 months old. The recordings were released at child's home in situations of natural interaction in dyads mother-child and in situation of child spontaneous play without mother. At the same time the protocol of the process of signal's registrations was carried out. The goal of such protocol was to reflect changes in emotional and physiological state of the child (Was he angry or happy, wet or dry?) and the particularities of interaction process in dyads (Does the child look on the toy or on the mother's face or imitate mother's voice?).

For the recording the tape recorder "TIAC W-800R" was used with the mike LOMO – 82A.02. Five minutes parts of recordings were analysed then with help of software "COOL PRO" (Syntr. Software Corporation, USA). The PC IBM Pentium (32 Õ max) with 16-class sound- card was used. The analogue-to-digital conversion was carried out with the frequency sampling 2400 Hz. Spectral analysis was made on the base of quick Furie transformation, Hemming window. When mother's speech was estimated the "key words" were selected in mother-to-child utterances (Lyakso, 2002), strike vowel in key words. The value of the first and second spectral peaks (F1, F2, Hz), value of the base frequency (F0), length of this vowels (t, ms). The pauses between mother's key word and child's next vocalisation were noted. The types of child's vocalisations were selected during auditory analysis according emotional state of a child. Cry signals and delight vocalisations – so called highly emotional vocalisations and the

"physiological sounds" - cough, sneezing were excluded from the analysis process. Neutral signals produced by children in calm comfort state were divided into fragments with the stabile type of a dynamic spectrogram and stabile sounding during whole the fragment. Statistic was made in the programms – "Excel 7.0", "ANOVA" (the Mann-Uitny criteria, Median test were used).

RESULTS AND DISCUSSION.

1)The characteristics of vowel-like signals of the children of the third and sixth months of age.

The instrumental analysis of acoustic signals produced by 8 children at the age of 3 and 6 months was carried out. Signals were produced in interaction situation and in spontaneous play situation in mother's absence. For three-month-old children were 690, for six-month-old children – 739 vocalisations. Sounds which were like Russian vowels [à] and [ý] ([e]) were used for the further analysis because this sounds were dominating in the repertoire of children of this age (Lyakso e.a., 2002).

In the tables 1a è 1b are the average values of F1 and F2 and standard deviations for [à] – (1a) and [e] –(1b) vowel-likes for every of 8 children of the 3 and 6 month of they life. These signals were produced by children in interaction situations.

Table 1à.

Child	Parameter	Child's age			
		3 month		6 month	
		F1	F2	F1	F2
1	Average mean	1080	2085	927	1339
	St. deviation	341	719	127	215
2	Average mean	998	1586	759	1242
	St. deviation	341	661	235	359
3	Average mean	1031	2027	1111	1959
	St. deviation	262	550	343	579
4	Average mean	1161	2227	997	1677
	St. deviation	375	661	235	359
5	Average mean	1164	1925	930	1773
	St. deviation	341	661	235	359
6	Average mean	948	1828	1107	1765
	St. deviation	341	661	235	359
7	Average mean	794	1766	730	1424
	St. deviation	122	468	188	404
8	Average mean	664	1313	721	1065
	St. deviation	107	334	180	172

Table 1b.

Child	Parameter	Child's age			
		3 month		6 month	
		F1	F2	F1	F2
1	Average mean	846	2250	860	1758
	St. deviation	108	572	72	567
2	Average mean	912	2009	694	1212
	St. deviation	82	547	312	335
3	Average mean	923	2124	871	1965
	St. deviation	162	375	182	510
4	Average mean	920	1900	910	1874
	St. deviation	107	546	186	465
5	Average mean	794	1775	839	2045
	St. deviation	82	548	157	335
6	Average mean	859	1989	870	1951
	St. deviation	163	536	369	612

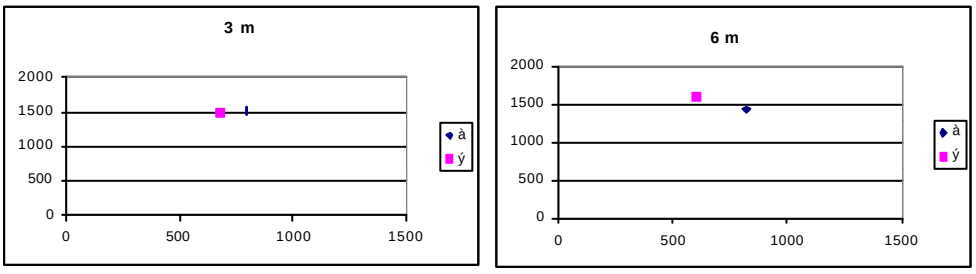
7	Average mean	672	1682	760	1533
	St. deviation	61	495	187	529
8	Average mean	807	1649	639	1065
	St. deviation	165	598	69	369

Reliable differences for F1 and F2 between 3 and 6 months were revealed for [à]-like: for child 1 – F2 decrease ($p<0,01$), for child 2 – F1 è F2 ($p<0,01$), for child 7 – for F1 ($p<0,01$), F2 ($p<0,05$); for [e]: for child 2 – F1 ($p<0,01$) , for child 8 – F1 ($p<0,05$). For all children there is the tendency to decrease the values of the first and second spectral maximums. F0 don't change with the age of children and has the from 220 Hz to 737 Hz for [à]-like and from 205 Hz to 622 Hz for [e]-like. This data are in accordance with the data of previous investigations for children developed in Russian-speaking environment (Kulikov e.a., 1999; Lyakso, Galunov 2001, Lyakso e.a., 1999). Authors discuss that more remarkable growth dynamic takes place in the second half of the first year.

Spectral characteristics of this vowel-likes of children in signals produced in interaction situation and in separate play situation do not differ clearly of each other. Some authors noted the dependency of quality and quantity of child's signals on the quality of adult's addressing for (Bloom, 1998) or from environment at all – that is laboratory environment or home (Lewedag e.a., 1994) But they don't discuss phonetic characteristics, but only complexity of signals. As to the phonetic characteristics they say that they are caused by possibilities of articulation apparatus.

2) Mother's speech adressed to children of 3 and 6 months.

We had analysed 215 and 207 vowels from key words of 6 mothers for 3 and 6 months-old children accordingly. The most frequently vowel was [a] – for three month it was 36-55% from all key words, [e]-3-25; for 6 month: [à]-29-60%, [e]-0-14%. The difference in the frequency of using of different vowels in different age levels was not noted. The length of strike vowels from key words, F0 for this vowels don't change with child's age. The values of F0 in this investigation are higher then values which are usual for women voice. This fact is like in literature (Fernald, 1985; Shimura, 1992; Lyakso, 2002). There is an opinion in literature about acoustic exaggeration of phonetic units in mother's speech (Kuhl e.a., 1997). So the area of formant triangle on coordinate plot (the angle of which are values for Russian vowels [à], [è] ([i]), [ó] ([u])) increases in mother's speech opposite the common such triangle area. In this research we used vowels [a], [e] according child's vowel-likes discussed early. F1 and F2 for them don't change with the age of child (according statistic). There are average values for F1 and F2 for these vowels on coordinate plot. You can see that the distance between average values of F1, F2 for [à] and [e] increases. It could be the way for better articulation, for emphasizing the acoustic distinction. But on this level of investigation this is only a hypotheses.



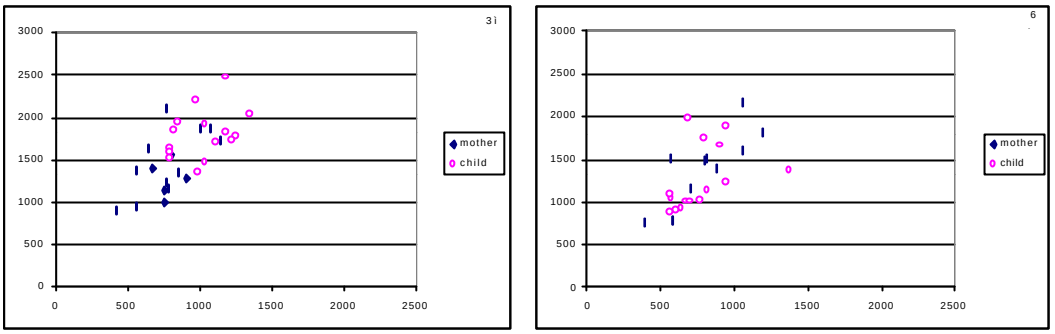
a b

Figure 2. The average values of F1, F2 (Hz) for vowels [a], [ý] from mother's key words, addressed to children in 3 (a) and 6 (b) months.

3)The vocal imitation.

The child's vowels which are followed for the mother's key word on a distance 450 ms and more (to 6895 ms) are discussed as vocal-speech imitation by children of mother's vowels from key words.

We studied the imitation of vowel [a]. 3 month old children imitated 14% from all mother's [a] in key words and 6 month old - 13%. There are values of F1 and F2 on coordinate plot for mother's and child's [a] for imitation (See figure 3.) in 3 (a) and 6 (b) month. The values of F1, F2 in imitation situation decrease to 6 month of child's life ($p<0,001$). As a result the areas on which the number of values for F1 and F2 for child's and mother's [a] are situated on coordinate plot become the same when child is 6 months old.



a b

Figure 3. The values of F1 and F2 for [a] vowels for mother and child in imitation situation; a- 3 month child's life, b- 6 month child's life.

CONCLUSION.

In this way all of the tendencies in the dynamic of child's signals acoustic characteristics become more clear in imitation situation. So we can say that imitation plays a great role in process of child language development and in common in provision of realisation of evolution potential of developing speech tract of child (Lieberman, 1975).

The work is carried out with financial support of RGNF (N 01-06-00090à).

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