EARLY STAGES IN INFANT SPEECH DEVELOPMENT

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ABSTRACT

In this study infant vocalizations have been described by means of a phonetic system based on the anatomical and physiological capacities of the child.

Two male infants were recorded weekly from birth until the sixth month, and thereafter bi-weekly.

Two groups of phonetically trained listeners analysed the phonatory patterns and articulatory traits of all vocalizations.

Categorization of the data in these ways revealed three stages in early infant speech development, and provided the basis for a satisfying definition of babbling.

INTRODUCTION

In the past decennia there has been an increasing interest in the acquisition of language in young children. A great deal of the research has concentrated on syntax and semantics, often starting

at the moment when children begin to use their first one-word sentences. Apart from this several studies have been devoted to the child's development of a phonological system, whatever this may be in infancy.

Infant sound studies fall into two groups:

a) Those which describe infant cry sounds, (e.g. Truby & Lind, 1965; Wasz-Höckert, Lind, Vuorenkoski, Partanen & Valanné, 1968; Müller, Hollien & Murry, 1974; Murry, Hollien & Müller, 1975).
b) Those which deal with early vocalizations.

Despite the larger number of descriptions of early sound production Delack's conclusion that precious little can be said about infant vocal behaviour during the first year of life which does not derive from unreliable, or at least equivocal, research results (1973 : 483) still holds, especially with reference to the phonological studies. Delack, (1973 : 479) notices, that most investigations have concentrated on the segmental structures of infants' vocalizations in the attempt to correlate early phonetic (or prelinguistic) repertoire with later linguistic behaviour. A good example of this is the study of Oller, Wieman, Doyle & Ross, (1976) on infant babbling. Their descriptive tools proved to be too limited to describe the whole range of infant utterances (see page 9 : Other elements) because their method is derived too directly from the adult linguistic system.

The use of unsuitable methods of analysis has probably led to the conflict between the notion of continuous development from early vocalizations to language. (Lewis, 1936; Mowrer, 1952; Skinner, 1957) and the notion of discontinuous development, in which babbling bears no relationship to later pronunciation of words (Jakobson, 1941; Lenneberg, 1967). We think that infant speech development starts from the very first day of life and that it is necessary to describe the early vocalizations by means of a phonetic system which will reveal the continuity in development. This

system must be based primarily on the child's anatomical capacities. Sound development is largely anatomically and physiologically determined, e.g. the tongue of the newborn is massive and fills the whole mouth, the nasal tract cannot yet be closed very well (Fletcher, 1973; Bosma, 1967).

Sensori-motor development causes continuous changes in production and perception abilities.

Describing infant vocalizations in terms of an adult phonological system ignores the fact that the infant's perceptual system may be very different from the adult's (Fourcin, in press). For example only frequencies below 500 Hz elicit the startle respons from neonates (Fourcin, in press, quoting Ruth Weir), and latency periods for stimuli of 500, 1000, 2000, 4000 and 8000 Hz are much longer in infants than in the adult and only diminish gradually in the first year of life (Holm & Stange, 1973). These data fit in well with the hypothesis that myelinization, which is not complete until puberty, influences the high frequency transmission characteristics of new fibres (Fourcin, in press). The importance of low frequency energy makes Fourcin (in press) suppose that the first interactive communication of the baby with other members of his family is solely on the basis of voice pitch. This justifies a suprasegmental approach to early speech development. We may suppose that the infant gradually comes to perceive phonatory patterns as well as articulatory traits in his mother's and his own sounds. This pattern and trait recognition (e.g. intonation, duration, rhythm) must be linked with production in order to achieve verbal communication. Delack (1973) is one of the few researchers who describes the aspects of early infant vocalizations without relating them to phonemes. He is mainly concerned with suprasegmentals, analysing his data with respect to duration and to contour and range of fundamental frequency, in various situations (Delack, 1973 : 491). These suprasegmentals turn out to play a role at a very early point in infant speech development (Delack, 1973; Delack & Fowlow, 1975).

Bullowa, Jones & Bever, (1964) set up an interesting investigation, but up to now only a small part of the material has been analysed. Apart from these studies no phonetically reliable research on early infant vocalizations is known to us. Nevertheless, it is necessary to describe early infant sounds without relating them to phonemes. We have developed therefore a system based on phonatory patterns and articulatory traits in the infants' vocalizations.

METHODS

Since it is impossible to make X-ray film registrations weekly, we tried to analyze infant sound productions in terms of articulatory movements and in manner of phonation without relating them to phonemes, merely by listening thoroughly. We realize that it is disputable as to how far one can hear in what way sounds are produced but a categorization is needed before one is able to subject articulatory movements and phonatory patterns to acoustic analysis.

Because of the great confusion in terminology with respect to early infant sounds we will use the term 'vocalization' for all non-crying, non-vegetative sound productions of infants.

Subjects

For our data collection we used the vocalizations of two full-term infants, both boys, born in hospital, with an Apgar-score of 9 or 10 after spontaneous delivery. The one (A) has two elder sisters (6 and 2 years old), the other one (B) has one elder sister (5 years old).The parents of infant (A) received vocational training after primary school; the parents of infant (B) both have a university degree.

Data

Tape recordings of the infants' vocalizations were made weekly during the first six months and bi-weekly during the second six months, starting at age 0; 0.6. Each tape recording lasted about half an hour and was made at home in situations in which the mother believed the baby felt happy (e.g. after feeding, during changing, reclining in a baby-chair). The parents were allowed to interact with and stimulate their babies if they wished.

Coding system

Every non-crying, non-vegetative sound was analysed for various aspects of manner of phonation and of articulation. The scoring was done by two groups, each consisting of three phonetically-trained listeners. One group scored the vocalizations of infant(A), the other those of infant (B). The groups worked independently. Phonation patterns are varied in accordance with the infant's respirational and laryngeal activities, manner of articulation is varied by the movements of different parts of the vocal tract.

Manner of phonation was scored in terms of high fundamental frequency, creaky voice, short phonation, prolonged phonation, flat, falling intonation, rising intonation, combinations of rising and falling intonations, glottal stops, series of phonations during one expiration, aspirated, vigorous phonation, rhythmic phonatory movements.

Manner of articulation was scored by noting movements of pharynx, velum, back, middle and tip of the tongue, uvula, jaw, lips. This coding system is described more fully in a working paper (Koopmans & Van der Stelt, 1977).

RESULTS AND CONCLUSIONS

Phonation

The phonation of both infants during non-crying, non-vegetative sound productions was nearly always expiratory, only incidentally inspiratory.

week 1-5: Most vocalizations were short, flat, and creaky, although some falling intonations were found for both infants right from the first week; in week 3 the high fundamental frequency of the vocalizations of both infants was striking.

week 6-9: Both infants started to make series of phonations during one expiration, only by interrupting the vibrations of their vocal cords (glottal stop), in combination with an abrupt onset; these series were always made in a 'conversational' situation. Infant (A) had been making glottal stops incidentally from the first week. Aspirated phonation and rising intonation occurred for the first time in both infants.

week 10-14: The intonation of both infants showed striking amounts of variation, such as rising-falling, falling-rising, falling-rising-falling. Vocalizations stopped being creaky.

week 15-19: Great variations in loudness were the most marked characteristic of this period.

week 20-26: Especially the last weeks before they were six months old, both infants produced a large scale of very long screams, glissandos, vocal fry, and diplophone vocalizations alternating with short, gentle, relaxed sounds.

week 27: When both infants were nearly six months old their phonation became more rhythmic; this was related to their production of repetitive articulatory movements, discussed below.

In summary we can say that there is a steady development in manner

of phonation from simple, flat, and short to rhythmic series. This development involves the progressive mastery of all kinds of intonational, dynamic and durational variations. At about six months of age both children were able to use their respirational and laryngeal activities, approximately in the way adults produce phonatory patterns.

Articulation

week 1-5: The only articulatory movement of the infants was made by means of the pharynx. There was no closing of the nasal tract; the mouth was normally open as well.

week 6-9: Velum activity occurred in both infants, together with incidental movements of the jaw.

week 10-14: Both infants started to make a single articulatory movement, either at the beginning, the middle or the end of a phonation. These movements were made first by means of the back of the tongue, the larynx, the uvula or the velum, and sometimes by means of the jaw.

week 15-19: The middle of the tongue (week 15) and two weeks later also tongue tip and lips became involved in articulation. From here on both infants made articulatory movements in all parts of the mouth, increasingly in combination with intonational and dynamic variations.

week 20-26: Both infants showed much 'front' activity: movements of tongue tip, lips, jaw. Progressively more rapid little closing movements were made during one phonation. Total closure was not yet achieved, but the beginning of a rhythmic articulatory movement could be observed.

week 27 (for infant B), week 29 (for infant A): Both started to to produce chains of repetitive articulatory movements during prolonged phonation in one breath unit. Now complete closures were made by lips, jaw-lip, tongue tip alveolus, tongue tip-palate, middle of the tongue-palate. This production of repetitive chains continued in the following weeks, alternat-

ed by uvula trills. Phonation could be either continuous or interrupted during these repetitions; dynamic and intonational variations were also introduced during the repetitive chains.

week 33 (B), week 39 (A): The infants started to use the articulators in the back part of the vocal tract as well for making repetitive chains. They also made alternating front-back movements in one continued or interrupted phonation.

Summarizing the course of articulatory development, we can say that during the first six months of their lives the infants map their vocal tracts as it were. In the control of the vocal tract, as in other maturational processes, gross movements come first, and the fine movements of tongue tip and lips occur last.

After about six months when repetitive rhythmic chains start to be produced, the rapid movements in the front part of the vocal tract develop before the rapid movements in the back part; this fits in well with the fact that lip and tongue tip movements are easier and more rapid than movements of the back of the tongue (Van der Stelt, 1976).

Table I

Speech and language development

In table I an overview of the development in both phonation patterns and articulatory traits for the two infants is presented. We think there are three land-marks of speech development in these first months:

1) the production of series of glottal stops in one expiration,
2) the onset of articulatory movements in continued phonation,
3) the production of repetitive chains.

These three types of sound production all display a syllable-like

character in which 3) is partly a combination of 1) and 2).

Lenneberg, (1967 : 128) describes the onset of babbling at about six months; in his view babbling resembles one-syllable utterances. This is in accordance with the definition given by Oller et al. (1976 : 3).

These descriptions of babbling, however, are comparable to the vocalizations of stage 2) in our analysis.

In view of our results babbling can be defined as the production of chains of repetitive articulatory movements during continued or interrupted phonation in one breath unit.

The alternating front-back movements in one continued or interrupted phonation is a further step in the development of babbling.

DISCUSSION

The results of this study confirm that speech development consists of a steady maturation of respirational and laryngeal activities together with a progressive 'mapping' of the whole vocal tract area and mastering of the articulators from gross to tiny movements and from single to rhythmically repeated movements. It now becomes necessary to relate the phonatory and articulatory categorization used here, especially the three 'land-marks', to an acoustic categorization. Furthermore, it must be determined how general these results, based on two babies, are. If maturational processes do play an important role, and if the phonatory and articulatory development is for the greater part anatomically fixed, the order of sound development must be the same for all babies. This suggests that a cross-cultural investigation of the order of development should be carried out. In the third place we have to determine the amount of variability in timing, and the influence of sex, social class, and motor development on the course

of speech development, especially with respect to the three 'land-marks'. We are currently carrying out a study of 50 Dutch infants, to determine at what age they start babbling, i.e. producing rhythmic repetitive chains. We chose to investigate first the age of babbling instead of the other 'land-marks', since babbling was the most easily recognizable, striking moment. It has been mentioned often in descriptive literature (Lewis, 1939; Nakazima, 1962; Lenneberg, 1966; Sedláčková, 1967).

A further area for research is the question which of the infants' sound productions evoke the most reactions in the adults. Which vocalizations are picked up by the parents and which are ignored? Parental responses may be an important factor in the development of communication. We are carrying out an analysis of adult responses to infant vocalizations as part of the investigation of 50 infants mentioned above. This study is being done in cooperation with A. de Blauw, C. Dubber and C. Snow from the linguistic department of the University of Amsterdam. It is not unlikely that a relation exists between reactions of parents on hearing the repetitive chains of their infants and the origin of first infant words like papa, mama, nana, dada, tata. Besides it has been shown that in deaf infants the sound productions decrease abruptly at the age of about six months (Mavilya, 1970), suggesting that development after that age depends to some extend on adult responses. A final research question is whether sound productions during the first months of life is the same in deaf and in blind infants as in normal hearing and seeing infants. What is the influence of auditory, visual and kinesthetic memory on the development of speech during the early stage? It would be very useful to apply our method of analysis to the early vocalizations of children with different pathologies, in order to answer some of the questions which arise about the autonomy of motor development.

weeks	1-5	6-9	10-14	15-19	20-26	27
PHONATION						
high fundamental frequency	x					
creacky voice	x	x				
short	x	x	x	x	x	x
flat	x	x	x	x	x	x
falling intonation	x	x	x	x	x	x
rising intonation		x	x	x	x	x
glottal stops		x	x	x	x	x
series by glottal stops in 1 expiration		(x)	x	x	x	x
complex intonation patterns			x	x	x	x
aspiration			x	x	x	x
loud				x	x	x
long					x	x
rhythmic series						(x)
ARTICULATION						
pharynx	x	x	x	x	x	x
velum		x	x	x	x	x
uvula			x	x	x	x
back of the tongue			x	x	x	x
jaw			x	x	x	x
articulation in continued phonation			(x)	x	x	x
middle of the tongue				x	x	x
tongue tip				x	x	x
lips				x	x	x
repetitive chains						(x)

TABLE I

Overview of the development in phonation
and articulation of two infants.
Circles indicate possible land-marks.

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