THE DEVELOPMENT OF SPEECH COMMUNICATION IN NORMAL AND CLEFT-PALATE BABIES: STATE OF THE ART OF A PROJECT

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1. INTRODUCTION

Four years ago a research project* was started concerning the speech development and interaction in the first years of life of normal and cleft-palate babies (Koopmans-van Beinum et al., 1984). This project, originally set up in cooperation with the Department of Otolaryngology (E.N.T.) and the Cleft-Palate Team of the Free University in Amsterdam, was expanded in an early stage with the cooperation of the Department of Otolaryngology and the Cleft-Palate Team of the University of Amsterdam. Moreover we got support of two regional Cleft-Palate Teams (Haarlem and Alkmaar) and of a number of specialists from various departments of both Academic Hospitals (the Free University and the University of Amsterdam). With respect to the execution of the project we worked during four years with the help of two research assistents, Mariken Blom and Arnold Dijkstra, attending the video-recordings and performing data management and processing, both appointed on a part-time basis.
Although the project will be continued for at least another year, we feel the necessity to render an account of the state of the art, since meanwhile some of the research aspects have been changed, as compared to our plans at the start of the project. Moreover several results are achieved already, some of them with respect to the development of a system for micro-analyses of mother-child interaction, some with respect to the development of special programs for processing the analysis data, and some preliminary results concerning speech development and interaction of part of the subjects involved in the project.

2. AIMS OF THE PROJECT

The aim of our cleft-palate research project as formulated four years ago (Koopmans-van Beinum et al., 1984, p. 66), was 'to analyse and compare longitudinally the development of the proto-conversations between mothers and normal children, and between mothers and cleft-palate babies, in order to arrive at an optimal treatment and guidance for these latter babies'. The grant was provided in order to answer four specific questions:
- Will early placing of an oral plate, covering the upper jaw and primary palate, yield any positive effect on the development of speech, both for the speech motor system and for the speech interaction?

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* This research project has been granted in 1984 by the Netherlands Prevention Fund for a period of four years (project no. 28-1042). Recently this granted period was extended within the limits of the budget until 1-1-1990.

- If so, how far will a normal development of speech be approached in case of early placing of an oral plate, apart from the usual surgical treatments (closing of the lip at about 3 months, closing of the velum at about 9 months)?
- Are there any negative side-effects in the early placing of an oral plate?
- In what way will we have to instruct the parents of cleft-palate infants in order to make the speech development of their children an optimal one, taking into account the eventually remaining disabilities for the cleft-palate children?

Apart from answering these specific, prevention-oriented questions, this project provided us with a perfect opportunity to study possible systematics in the development of mother-child interaction, in order to support understanding of the development of (speech) communication just from the very beginning. In our view the onset of speech production is embedded in the coordination of respiratory, phonatory, and articulatory movements (Koopmans-van Beinum & Van der Stelt, 1986). Sound production in infants, probably controlled physiologically at first, is even in that stage liable to mutual influences within the mother-infant system. And since it results from more or less coordinated body movements, and body movements are perceived proximally and distally, speech development is embedded in the development of total communication (so vocal and non-vocal) in the mother-infant system in relation to every-day situations (Van der Stelt, 1987). The infant is intended to belong to the community surrounding him or her, sharing the same world of living, so it is of vital interest to get in touch with the other members of this community and to learn the encoding and decoding rules within the group the infant is born in. The main care-taker, in our project the mother, and the infant make up a mutually modulating system with their own program. Internal and external feedback play an important role within this system. It becomes more and more likely that the mother regulates and adjusts her program to the capacities of her child at that time (see also Van der Stelt, 1988: this volume). Nevertheless each child is supposed to have arrived at a certain communication level at a certain age, in order to be able to communicate adequately with a more extended surrounding world, e.g. in a nursery class. Although the tests measuring the children's linguistic and cognitive skills provide us with only incidental pictures, these results are extremely important for comparing the results within and between the various groups of subjects in our project as well as with results collected in other projects in progress (Jansonius-Schultheiss, 1988; Beers, 1987).

3. DATA COLLECTION

3.1. General remarks

In our project we intended to follow the (speech) communication development of the infants from birth onwards, with a focus on the interaction process in the total communication of individual mother-infant pairs, for normal born as well as for cleft-palate children. In the first instance we would therefore study each mother-infant pair individually within their own learning program and subsequently explore whether identical stages can be traced within the interactional processes.
At the time we wrote our project proposal and applied for the grant, only a restricted number of cleft-palate infants were provided with a oral plate soon after birth, normally done only in order to guide the growth of both parts of the upper jaw into the direction of a more or less normal arch and additionally to avoid probably too severe sucking and swallowing problems. Although mainly medical and orthodontical aspects determine (surgical) treatment, the importance of an early optimal speech development is accepted more and more. In this respect the Cleft-Palate Team of the Free University was

interested in possible positive effects of the oral plate and planned within the scope of our project proposal to apply it to some more infants. This would give us in our project a good opportunity to compare cleft-palate infants with an oral plate to cleft-palate infants without one. However, at the time we actually started the project, both Academic Hospitals in Amsterdam meanwhile had changed their standard procedure so that almost all cleft-palate infants were provided with an oral plate as soon as possible. To cover this we contacted two regional Cleft-Palate Teams who, as a standard, did not provide the infants with an oral plate. Although these teams approved their cooperation, the number of infants announced there was rather limited. This compelled us to look for an other design in order to answer the questions as posed in our research proposal and as quoted in section 2.
An acceptable solution was to include in our project the recordings of a group of two-year-old cleft-palate children, for the greater part without oral plate, as well as another group of two-year-old, normal born children. This could be realized thanks to the cooperation of the E.N.T. Department of the Academic Hospital of the University of Amsterdam. In this way a larger group of children being recorded once-only at the age of two years, could be compared retrospectively in a number of tests with our longitudinally recorded group when these children would be at that same age of two years.

3.2. Selection of the subjects

3.2.1. Cleft-palate infants

According to the proposal the project would last four years, and children were to be recorded during two years from birth onwards owing to the expectation that at the age of two years all children in the project would produce at least a number of words, understandable for their surrounding. So new-born cleft-palate babies could be entered in the project up to one and a half year after the start of the project at the latest, so that we would be left with enough time for analysing the tapes. With these limits in time we were able to record twelve cleft-palate infants, that fulfilled the criteria described below, and whose parents were willing to be involved in the project. These infants are classified as in Fig. 1.

		unilateral complete cleft	bilateral complete cleft	cleft palate only
boys	with oral plate	4	3	
	without oral plate			1
girls	with oral plate	1	1	
	without oral plate	1		1

Fig. 1. Composition of the longitudinally followed cleft-palate group of 12 infants.

The infants and their parents had to fulfil a number of social and medical requirements in order to be accepted in the project:

Social criteria regarding the background of the parents:
- both parents (if two) should have Dutch nationality;
- they should biologically belong to the Caucasian type;
- they should have received minimally primary education;
- they should not have any speech-, language- or hearing-disabilities;
- they should live within a radius of fifty kilometers from Amsterdam;
- one of the parents (the main caretaker, preferably the mother for reasons of uniformity of the reasearch) should be reasonably disposable for the video-recordings.

Medical criteria regarding the history of mother and infant:
- duration of pregnancy should be between 37 and 42 weeks;
- weight of the infant at birth should be between 2750 and 4250 g.;
- Apgarscore (numerical value indicating the condition of a new-born just after birth) after 5 min. should be between 8 and 10;
- no kern-icterus (affection of the kernels with jaundice, resulting in permanent cerebral damage) should be stated in the infant;
- the infant should be born with a unilateral or bilateral cleft lip, jaw, and palate, or with a cleft palate only;
- the cleft palate should not be part of a syndrome;
- no other severe deviations should be present in the infant.

As soon as a cleft-palate infant, coming up to these requirements, was seen by one of the participating Cleft-Palate Teams, we checked the history, contacted and visited the parents at their homes, explained aim and procedure, and asked them to cooperate in the project. Only in one or two cases parents refused.

3.2.2. Normal born infants

In order to compose a control group of normal infants, we defined the notion 'normal' in such a sense that the medical history on pregnancy and labour had to be normal to optimal. Furthermore the selection criteria for the normal born infants and their parents were identical to those applied to the cleft-palate infants, of course apart from the specific cleft-palate criteria.
Although we intended to have the normal born infants announced by the obstretic department of the Academic Hospital, it turned out that seldom, or at least not frequently enough for our project, normal or optimal children answering our criteria were born in this hospital. Probably this is related to the preference of most parents in the Netherlands to give birth to their children at home if possible.
With respect to our project two normal born infants were born in the hospital, four other infants were selected from those ones born within a group of accidental acquaintances, neighbours, and colleagues. The finally selected group of six normal born infants consists of two boys and four girls.

3.2.3. Two-year-old cleft-palate children

The 'retrospective' group was composed of 18 cleft-palate children, born in the two years preceding the start of our project. At the age of two years they are seen by the Cleft-Palate Team, just in accordance with the normal procedure. Their parents were

asked to take part in the project with a once-only video-recording. Twelve of these children had not received an early orthodontic treatment in the form of an oral plate.

3.2.4. Two-year-old normal born children

Apart from the longitudinally followed normal born children, five normal born two-year-old children with their mothers were involved in the project for a once-only video-recording and the same tests that all other children in the project had to perform at that age.
The once-only recorded children, normal born as well as with cleft palate, provided us furthermore with the possibility to control for the effect of the longitudinal attention and the effect of being video-recorded from birth onwards.

An overview of the total subject design is given in fig. 2.

		CLEFT PALATE						NORMAL BORN	
		longitudinally recorded			once-only recorded			longitudinally recorded	once-only recorded
		unilateral complete cleft	bilateral complete cleft	cleft palate only	unilateral complete cleft	bilateral complete cleft	cleft palate only		
boys	with oral plate	4	3		2	1			
	without oral plate			1	2	2	5	2	2
girls	with oral plate	1*	1*		1				
	without oral plate	1		1	1	2	2	4	3
TOTAL		6	4	2	6	5	7	6	5

Fig. 2. Overview of the total subject design of all 41 subjects within the project; * indicates an early complete closure of the palate at about 11 months, whereafter no oral plate is used anymore.

3.3. Video- and audio-recordings

All infants to be followed longitudinally, were recorded naturalistically at home as soon as possible after birth, always together with their mother, and subsequently at four-week intervals. During their first year of life three of the normal born infants (one boy and two girls) were recorded at two-week intervals, in order to obtain fine-meshed recordings. On behalf of the recordings a shooting-script was made to the effect that during the first year recordings were made of about 7 min. in feeding situation and 10 min. in free-play situation, and of about 20 min. freely playing and interacting with their mother during the second year. The mothers were informed about our pre-occupations with sound production and our need to have good view of both mother and infant in play and in feeding situation. There were no further instructions about feeding or play situations: mother and child were free to do what they liked.
The video-recordings were made by means of two high-quality cameras feeding a mixer-whiper unit. Sound was recorded initially using lapel microphones, and later on using standard microphones. Since in our project the development of the total communication and interaction was object of research, priority is given the attempt to obtain optimal video-recordings over optimal audio-registrations. Although we intended to make also registrations of respiration movements separately, we were obliged to give up these attempts because of the inappropriateness of the instruments, either reacting already to the faintest physical movements or neglecting almost all respiratory movements.
The longitudinal video-recordings were made at the infants' homes. Two extra video-recordings at the age of 12 and 24 months were made in a laboratory setting of the hospital in an interaction situation of mother and child together, slightly instructed with regard to the set of toys available. This is done for all longitudinally followed children, in order to be able to compare them at that age with the once-only recorded children, especially to assess the state of speech development in interactional situation, mainly with respect to phonology, syntax, and semantics.

3.4. Medical data

A number of medical data on the normal born infants as well on the cleft-palate infants were collected at various intervals over the two years of study. Specialists of both Academic Hospitals were involved in these examinations, concerning:

- Ethiology (at 0 - 1 month)
- Child-neurological examination (at 12 and at 24 months)
- Hearing tests, viz. Ewing test and tympanography (at 8 and at 14 months)
- Otorhinolaryngological examination (at 8 and 14 months)

Apart from these medical examinations all relevant medical background information, was registered by the parents and collected four-weekly at each recording session. This concerned information such as on illnesses and surgeries, number of days that the child was ill or had been hospitalized, type of illness and its seriousness, etc.
Eruption of teeth and possible complications were registered likewise.
It should be kept in mind that most of these data reflect what is filled in by the parents themselves, often without any medical checking.

3.5. Sensori-motor and cognitive developmental data

In order to collect as completely as possible a number of sensori-motor, psychological, social, and linguistic developmental data, several questionnaires and tests were used. These tests were administered and inquiries filled in during a visit at the children's homes, for the once-only recorded children too.
All these data together with the medical ones provide us with the possibility to relate results from the video-analyses to the developmental stages of the children, giving background information about the mother-child interaction and communication.

- A loose-leaf inquiry book was developed in a boy's and a girl's version with a large number of questions on psychomotor development regularly to be filled in by the parents. Moreover at each recording session orally information was given by the mother with respect to her observations concerning new aspects in her child's sound productions.
- A questionnaire on the sensori-motor development of the mouth area of the child was filled in by the parents.
- A questionnaire on infant and toddler temper, being a Dutch translation of the Infant Characteristics Questionnaire (Bates, 1982) was filled in by the parents at the infants' age of 6, 13, and 24 months in case of the longitudinally followed group, and at 24 months for the 'retrospective' group.
- The mental part of the Bayley Scales of Infant Development (Van der Meulen & Smrkovsky, 1982) was used at the age of 12 months for the longitudinal group and at 24 months for all subjects. For nearly all children the test at 24 months was done at home.
- At the age of 24 months the articulatory and phonological skill of all subjects was determined by means of FAN (Beers, 1987), being the Dutch adapted version of the English PROPH (Crystal, 1982). The grammatical developmental stage of each of the children was determined by means of GRAMAT (Bol & Kuiken, 1988), which is a Dutch adapted version of LARSP (Crystal, 1982).
- At the children's age of 12 and 24 months the parents were asked to fill in a questionnaire on their way of bringing-up their child in relation to the behaviour of the child (Leenders, 1984).

4. MICRO-ANALYSIS OF THE VIDEO-RECORDINGS

Since speech communication is part of the total social interaction, we think it necessary to analyse the development of this total interaction system. As for the 18 longitudinally followed children in our project their mothers were the principle caretakers, we always analysed mother and child together.
This required an extended coding system that makes it possible to study aspects of mother and child separately, their interaction, and combinations with other aspects. For this purpose we developed a multi-channel coding system, transcribing changes in the gaze direction, facial, tactile, speech-, head-, arm-, leg-, and body movements, and proximity of mother and infant.
Fig. 3 presents an imaginary example of a possible interactional situation, coded by means of the multi-channel coding system. Within each channel a number of codes is used to describe the various possible behaviours for mother and child, according to a transcription book of about 200 well-defined behaviours. Per channel only one code could be applied at a certain time, so codes per channel are mutually exclusive.
Within this coding system some channels, as e.g. 'speech movement' can be empty for some time (discontinuous channels), whereas in other channels, as e.g. 'facial

movement' or 'proximity' always any code is indicated (for the sake of clearness omitted in the example of fig. 3), changing after a period of time in another code (continuous channels). More details on the coding system are given by Van der Stelt (1987, 1988: this volume).

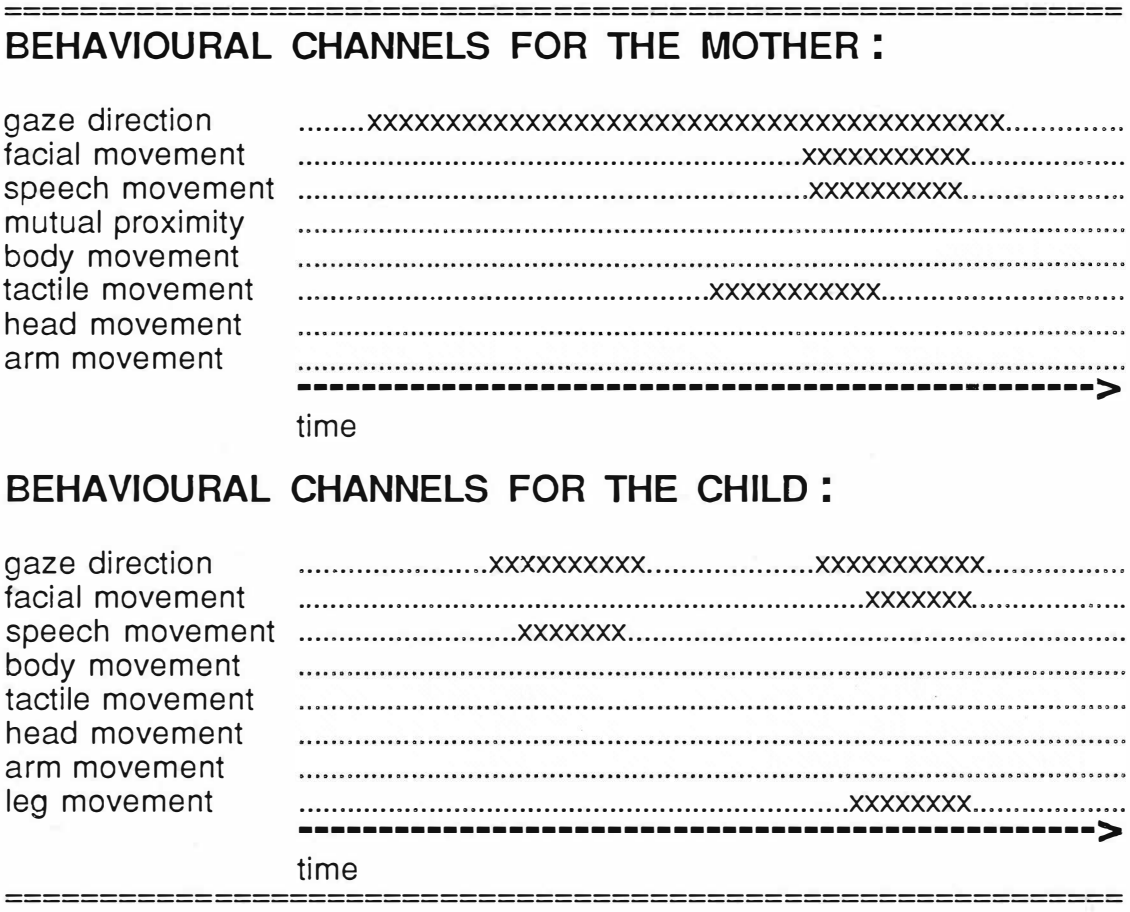

Fig. 3. Imaginary example of coded mother-child interaction within a multi-channel coding system. In this example the mother might be looking at the infant's face, the infant turns two times to the mother: during the first time the infant makes speech sounds, whereas during the second time while touching the infant the mother smiles and talks whereas the infant e.g. smiles and tramples.

5. DATA PROCESSING

In order to process the coded behavioural data a number of computer programs have been developed:

- PROTIN (Dijkstra, in progress), a program for automatised input of behavioural codes. Concurrently with the copying of the original video tapes, each video frame is provided with a frame number on a time base of 0.02 sec. by means of a hardware coding system. When transcribing a tape the first frame number of the selected video-fragment is linked up with the time indication on the screen. Subsequently time is

automatically connected to the coded input data. Each created file contains in its header information on mother-child pair, date of recording, channel to be transcribed. The grammar of the program reports input errors as e.g. codes not permitted in a certain channel, controls for double-coding and for correctness of subsequent codes in discontinuous channels. Correction of the input data afterwards is always possible and the read time code can be increased or reduced with a desired number of seconds. Moreover a comment column with editing provisions is provided, as well as the possibility of input of hand-coded data. All separate files (coded data stored per channel) can be merged on desire, by means of the time codes, whereas merged files can be separated as well by selecting a specific channel.

- FP, an adapted frequency program providing frequencies of codes within the various channels, percentages of total number of codes as well as percentages of time that a certain code behaviour occurs (maximum duration, minimum duration, etc.).

- CFP, a conditionally counting program giving sequences of codes per channel with two possibilities:
  1) for the directly following code, again with frequencies, etc. (step size 1);
  2) for the secondly following code, when one code is skipped (step size 2).

- HIST, an interactive program providing histograms and tabels of behavioural duration of the selected code within a certain channel.

- PROGRAAF (Kerkhoven, in progress), a program for analysis and representation of data collected and stored as described in the PROTIN program. The program provides for three forms of representing the transcriptions:
  1) a histogram, in which behaviours are represented cumulatively on the basis of previously selected channels with previously selected codes in there, and a time window stated on desire. This provides the possibility to trace episodes of relatively many changes in the behavioural flow;
  2) a 'staff' with (for each line) a time base stated on desire for previously selected channels and codes. This staff precisely visualizes the transcriptions, combined with a column of written codes if wanted.
  3) a graphics, displaying the durations of the selected coded behaviours with initial and final instance, in the order as occurring in the transcription.
  The PROGRAAF program furthermore commands the possibility to process specific search tasks. By stating two criterium components certain combinations of behaviours can be traced, e.g. if we want to know when mother and child are looking at each other, and what happens within the other selected channels during these episodes. Moreover the program provides an overview of absolute durations and percentages of the time these criterium components continue.
  It will be clear that this program provides very attractive possibilities with respect to the detection of patterns within the interaction of mother and child (Van der Stelt, 1988: this volume).

All data of the medical, sensori-motor, and cognitive tests and questionnaires are processed by means of standard statistical programs.
The results of the articulatory and phonological skill tests are processed in a computer program to be developed especially for FAN-analyses (Beers, 1987). This program allows for processing the articulatory and phonological skills of normal and language disturbed young children.
In the same way also the GRAMAT-analyses (Bol & Kuiken) concerning grammatical skills could be computerized and processed recently.

6. RESULTS

At this point in time all video-recordings of the longitudinally followed group and of the two-year-old 'retrospective' group have been collected. In our opinion one of the most striking aspects of the project is, that none of the eighteen longitudinally followed mother-child pairs gave up during the course of the project. Of only one pair (normal born child) the recording in laboratorium situation at the age of 24 months is missing, since this family moved abroad when the child was 20 months. Nevertheless the parents proposed to make the last recordings by themselves, so that the two years of video material could be completed.
Of two normal born and two cleft-palate children periods of five minutes per recording of the free play situation, in interaction with their mother, are micro-analysed. From the results of the data processing a number of aspects will be selected to be explored in the data of the other longitudinally recorded children. We have so far reported on subsets of the results in oral presentations, furthermore in contributions in our Institute's Proceedings (Jansonius-Schultheiss, 1985, 1987; Van der Stelt, 1985, 1987 and 1988: this volume), and in reports (Reichart, 1986; Overes, 1987; Jansonius-Schultheiss, 1988; Van Haaren, 1988).

Concerning the speech developmental state of the longitudinally followed group of cleft-palate children we found on the basis of the video-recordings in the laboratory setting at the age of two years, that overall language development was retarded in comparison to the group of normal born children. We also found that in the cleft-palate group normal phonological patterns within word formation could be identified as well, but that far more frequently specific and atypical processes (given the language developmental stage of a child) were to ascertain due to articulatory disabilities. With ongoing growth in language skills, the amount of specific or incorrect phonological processes increased in the cleft-palate group, whereas in the group of normal born children the amount of these processes diminished. With better exerted language skills the normal born children got better articulatory proficiency over time, whereas the cleft-palate children seemed to get more speech problems.

Concerning interactional aspects (mother input in relation to child speech) the mothers of the cleft-palate children at the age of two years, seemed to use in their interactions less language facilitating aspects and more language-learning inhibiting aspects, as compared to the mothers of the normal born children at the same age. These results are based upon analysis of spontaneous speech collected in the home situation as well as in the laboratory setting (Borgers-de Haan, 1988; Van Gasselt-Nobel, 1988). However, these results are preliminary, since the language developmental age of the children in relation to maternal language input was not sufficiently controlled yet. Based upon these preliminary results we may tentatively suggest, that the cleft-palate children and their mothers are more at risk for communication problems.
But also within the group of normal born children we found one mother-child pair with speech interactional problems. Although the results are not completed yet, it is at this moment already clear that one of the cleft-palate children as well as one of the normal born group needs special help since they both are overtly retarded compared to the standardized norms, as well as in comparison with all other children within the longitudinally followed group.

The data of the speech skills in the various groups of two-year-old children combined with the results on the questionnaires are partly processed and will be completed and reported on in the near future. The data concerning illnesses have been processed recently and will be used in relation to the results of the micro-analyses.
Finally, at the conclusion of the project it is the aim to compose an instruction movie, based upon the video materials of our recordings and the results of the analyses. The movie is intended to be used for the information of parents of cleft-palate infants.

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