Jeannette Mathilde
van der Stelt

FINALLY A WORD

A sensori-motor approach of the mother-infant system in its development towards speech

STUDIES IN LANGUAGE AND LANGUAGE USE

4

Jeannette Mathilde van der Stelt

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A sensori-motor approach of the mother-infant system in its development towards speech.

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Jeannette Mathilde van der Stelt

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Je schedeltje tegen
mijn schouder gelegd
hoeft niets meer verzwegen
en niets meer gezegd.

(Onmogelijk geluk, J.P. Rawie, 1992, p. 37.)

Voor
Anne Marlein,
Jasper Roeland *en*
Hester Eline, die
PaJan en Oma Sija
niet gekend hebben.

CURRICULUM VITAE

Jeannette Mathilde van der Stelt is op 14 september 1943 geboren te Zwolle. Zij bezocht middelbare scholen te Amsterdam, Bandung, Zwolle en Emmeloord, en behaalde in 1961 het HBS-B diploma. Daarna werkte zij enige jaren in Engeland en Frankrijk.

In 1963 begon zij met de opleiding Logopedie te Utrecht, liep een stage Foniatrie en behaalde in 1966 het diploma Logopedist. In oktober 1966 werd zij aangesteld als logopediste met een onderzoekstaak bij het Instituut voor Fonetische Wetenschappen van de Universiteit van Amsterdam. Bij dit Instituut is zij, als universitair docent, nog steeds werkzaam.

In 1967 behaalde zij het diploma Akoepedist en begon met de studie Pedagogiek. Onderzoek naar vroege spraakontwikkeling, in nauwe samenwerking met Florien Koopmans-van Beinum, maakte vanaf 1973 deel uit van het fonetische werk.

Het doctoraalexamen Orthopedagogiek (afstudeeronderwerpen in Historische Pedagogiek en Fonetische Wetenschappen) werd in 1977 afgelegd.

Vanaf 1979 heeft zij zich ook met de vroege spraakontwikkeling in praktische zin bezig gehouden.

Zij was als uitvoerder betrokken bij een door het Nederlands Praeventie Fonds betaald onderzoek (1984-1990) naar de spraakontwikkeling en -interactie in de eerste levensjaren van kinderen met een gehemeltespleet. De data, die gebruikt zijn in dit proefschrift, vormen een onderdeel van dit Schisisproject.

Zij neemt momenteel tevens deel aan een project, dat gefinancierd wordt door de Stichting Kinderpostzegels Nederland. Daarin worden ondermeer de verworven inzichten in de vroege spraakontwikkeling onderzocht op hun toepasbaarheid voor een groter publiek.

VOORWOORD

Wie moet je bedanken als je, met rijke levenservaring, uiteindelijk een proefschrift schrijft?
De mensen om je heen hebben hun plaats verworven. Ze staan verderaf of wel min of meer nabij. Je geeft ze hun plaats in je verleden, in het heden, of in je toekomst. Wildvreemden kunnen familieleden van je zijn geworden, terwijl sommige familieleden heel erg van je zijn vervreemd. Vriendschappen volgen deze bewegingen.
Het 'lab' is mijn wetenschappelijke familie. Net als mijn biologische familie is het een verzameling "Eigenheimers". We scherpen elkaars denken en waarderen die wederzijdse inspanning meestal zeer. Ik voel me in beide families thuis.
Dankzij het Nederlands Praeventie Fonds is de kring om me heen uitgebreid met gezinnen zonder wie dit proefschrift niet geschreven zou zijn. De afgelopen periode van stilte is het gevolg van het asociale gedrag dat bij het schrijven van een proefschrift hoort.
De vele betrokken-anderen, van buiten het lab en mijn biologische familie, hebben mij vaak gesteund en gestimuleerd, soms zonder dat zij zich dat zelf bewust waren. Hun zeer diverse inbreng is niet in simpele zinnen te vatten.
Ik dank allen dan ook zonder woorden.

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INTRODUCTION

Abstract

By the time the infant is two years of age, mother and infant usually have sufficiently specialised their initial communication system to produce 'grown-up' conversations. Some children have speech-communicative problems, for which no physical or mental cause can be found. In that case, the interaction with the mother is often blamed.
In the literature on early communicative interaction, it is suggested that, after birth, mother and baby are occupied with less obvious aspects of their communication system, which have evolutionary bases.

In this thesis an approach is chosen in which mother and infant are seen as a system that exchanges movements. Intersubjectivity and intentionality, expressed via the visual and auditory modalities, are fundamental characteristics of 'being in communication'. The infant gradually comes to understand speech as 'just' an audible message. The mother's reactions towards the infant's sounds are thought to represent turntaking which is basic in communication systems as well. Intersubjectivity, intentionality, and turntaking by the mother upon sound productions of the infant are the three main topics of this thesis.

These three topics have been studied in two mother-girl pairs who were video-taped monthly in naturalistic home situations during the first two years of the infant's life. The interactions of both mothers and their infants were considered to be quite different already when the infants were four weeks old. Also, the levels of speech development at the age of two were different for the infants. By the time they were six years old, one of the girls was an eager and good speaker, while the other girl's speech was difficult to understand. She still needed speech therapy which already had started when she was about three years old.
The interaction of these pairs is described micro-analytically by means of a multi-channel transcription system for movements. The sound productions of the infants are coded with a system for the description of speech motor landmarks, and, likewise, the mother's sound productions with regard to their sensori-motor functions. This analytic approach of the mother-infant system was chosen because it is fairly independent from the interpretations of an observer.

1.1 General introduction

"One cannot hope to understand the child's acquisition of any system of behaviors without observing the acquisitive process from the beginning."

Locke (1983, p. 1)

"A speaker may speak as sloppily as the listener permits him to speak". This is not only a good phonetician's dictum covering a world of phonetic problems (e.g. Koopmans-van Beinum, 1980, p. 1), but it could be a parent's saying as well. It certainly refers to the parent's world for quite some time after the birth of a baby who will be introduced to that speaking world.
Most new primiparous parents do not worry about their infant's 'sloppy sound production' and rely upon the child's future ability to speak understandably. Their children will speak, and sooner or later they will speak as full members of society.
The parental expectations are not always met; e.g. the newborn can have an obvious defect. Parents who have a handicapped baby go through a grieve process in which several stages can be recognised (e.g. Kübler-Ross, 1969). It is of major importance for parents to gather more knowledge about the future consequences of the handicap of their baby. When the future procedures and therapies are explained, the parents can try to anticipate upon their tasks (e.g. Stensland Junker, 1979). With cleft palate infants, the parents should be informed as soon as possible on specific matters related to the handicap of their baby (Koopmans-van Beinum, Jansonius-Schultheiss & Van der Stelt, 1990).

Problems in speech communication which originate from obvious causes such as a cleft palate, hearing loss, or a severe brain injury are not the topic of this study. The basic curiosity behind this thesis is directed at the developmental processes that risk to deviate. The parental histories sometimes can explain their difficulties in building a relationship with their child, while the problems may have their origin in the baby as well. A handicap of the baby is not always obvious soon after birth; the infant may, for instance, have a mild hearing loss. In due course, as the infant is not developing as expected, parents become concerned and look for either denial or confirmation of their worries. These worries can become an obstacle to treatment, when the parents remain in the first stage of their grieve process for too long. The denying of their infant's problems and the parents' following isolation blocks the mastering of their new roles as parents. An evaluation as early as possible of the developmental problems is preferable for both the parents and the child.
Speech therapists and clinical linguists often see children because of 'delayed' speech development. The first step in the treatment is the exclusion of obvious causes, for example, a mild hearing loss. There is, however, a group of children with a clean medical history, but having communication problems. The parents then realise that for such a child

with speech-communicative problems, even the kindergarten may become a tough place already.
An easy explanation for the communicative problems can be given by blaming an abnormal early mother-infant interaction, and assuming the problems to originate from certain interaction styles during the first years of life. Speech therapy for the child and hometraining (i.e. explaining the parents how to interact) is then normally offered as a remedy.
However, prevention of speech-communicative problems would be much better, both for the parent and the infant. The first step that must be taken to prevent these 'interactional' speech-communicative problems, is the recognition as early as possible of interactions at-risk.
This is not an easy task, as many ways of mother-infant interactions lead to the 'Rome forum', where people do speak up. Mother and infant pairs can use a variety of overt communicative behaviours. These behaviours must be evaluated upon their contribution to underlying continuing processes in speech development. These processes probably have a multi-layered character, in which the social affect system is thought to be basic (e.g. Bullowa, 1979; Bloom, 1993). The development of such a communication system, initially, is probably largely language-independent and related to interactional structures. Early mother-infant conversations are a universal human phenomenon with, probably, evolutionary roots in the prosodic aspects (e.g. Levelt, 1989; Fernald, 1992). Infants learn these structures of conversations in their interaction with their parents, who already know how to time their actions during conversations with another adult.

1.2 The approach

The chosen approach, i.e. considering *mother and infant as a sensori-motor system*, is presumed to be valuable for the detection of early speech-communicative problems. This study aims at the construction of a method that could signal, soon after birth, that a mother-infant interaction is at-risk with regard to speech development. In apparently normal mother-infant pairs, the interaction can deviate from a broad normal path. Many causes can explain an abnormal or problematic interaction, among them the mother's family history, or perinatal incidents (e.g. Price, 1989). In such instances the method could indicate that an interaction is indeed at-risk, and that mother and infant need some intervention. The diagnosis must be made as early as possible in *single mother-infant pairs*. Clues for intervention, then, can be found in the communicative behaviours of the individuals. The preliminary outline of a diagnostic method is presented in the final chapter of this thesis.

I will follow two main lines of approach in my description of the mother-infant *interaction system* with regard to speech communication.

(1) Literature data on early mother-infant interaction and speech development are reviewed and evaluated.

(2) Observations of interactions during the first two years of six mother-infant pairs are evaluated with regard to communicative aspects of their behaviour, and the development in behaviour. Of these six pairs, two were chosen for a more detailed study because of their clearly different interaction patterns.

With regard to the first line, the literature will be reviewed as far as it belongs to the following areas related to early speech development:

- psycholinguistics and sociological sciences,
- primate biology, evolutionary biology, and communication, and
- anatomy, physiology, and neurology of the infant's speech mechanisms.

This first line has contributed to my approach by means of the selection of behaviours, a library of concepts, research results, and methods in these fields that will be presented over the period of mother-infant development that we studied.

The second (ethological) line is based on many hours of our previous observational research on mother-infant interaction by the Amsterdam group (e.g. Koopmans-van Beinum & Van der Stelt, 1979, 1986; Koopmans-van Beinum et al., 1990; Jansonius-Schultheiss & Van der Stelt, 1990a, 1990b; and Van der Stelt & Jansonius-Schultheiss, 1990). That research has led to:

- some working hypotheses on styles of mother-infant interaction,
- working hypotheses on development changes in interactions,
- knowledge about preferential individual behaviours, and
- ideas about recommendations to prevent problems.

This second line, based on ethological methods, is further formalised in this study, enabling to obtain certain more objective descriptions of mother-infant behaviours during the first two years.

The mother and infant as a system

Mother-infant interaction is often studied with questions in mind about the 'contribution of the infant' as compared to the 'contribution of the mother' in the ongoing shifts in their behaviours. For certain disciplines the questions about the individual changes are important because their interest is only the development of the person in question. The 'obvious difference in age and experience' between mother and infant then is a returning topic in research which disregards their relationship. This structuralist approach regards development as a matter of sequential stages, probably in both mother and infant if the dyad is considered (e.g. Beek & Hopkins, 1992). The functionalist approach

> "... assumes the presence of age-appropriate actions imbued with specific adaptive functions, such as communication and exploration, and a mutual fit between organism and environment at all times in development."
>
> (Beek & Hopkins, 1992, p. 425)

This functionalist line of thinking about social development makes two ends meet: environment (mother) and organism (infant) develop as *a system* (e.g. Asch, 1952), and not as two separate sequences of actions which is already difficult to imagine in relation to the development of *communication.*

In *speech* communication, two other developmental approaches that are sometimes diametrically oriented towards each other can be recognised in the literature and in the (age-related) categories chosen for mother-infant studies. These 'top-down' (meaning-sound realisation) or 'bottom-up' (sound-meaning) lines clearly are attractive in scientific linguistic thinking, but the philosophy behind them is quite different (e.g. Bloom, D'Odorico & Beaumont, 1993). As for early mother-infant systems, the approaches 'borrow' terms and theories from the many disciplines that are concerned with development and with speech communication (see section 1.4 for background information).

A popular approach is the one in which *adult* communicative behaviour offers the leading theoretical model for speech development. A second approach starts from the *infant,* explaining speech acquisition as a general developmental process. With information lately accumulating about the infant's capacities as a socially well-prepared human being, the adult's 'legitimate' predominance in the interaction process studies is decreasing. The behaviours of mother and infant, however, are rarely described using the same system or described with the same categories. These differences in description 'invite' conclusions about inequality in the behaviours, which distracts the attention from more equal aspects in their behaviours (e.g. the fundamental frequency in infant sound production and in motherese, which is the caretaker's way to talk to children, Papoušek & Papoušek, 1991).

In the present study, the *mother and infant behaviour as a system* is the most important topic, and not so much the behaviours of the individuals. When mother and infant are 'measured with the same measures' a 'system characteristic' can be discovered, which neglects judgements about a (subtle) cooperation or a non-cooperation of mother and infant in terms of the development of their communication system (e.g. Fernald, 1992). If we regard mother and infant to be a system-in-development, the dilemmas about 'individual contributions' in the development must be solved within the system (e.g. Asch, 1952; Fogel, 1992a, 1992b; Beek & Hopkins, 1992). Often, an outside observer cannot decide about the value which individual behaviours have for the partners, but the *system* can still be evaluated with regard to its functioning.
It is supposed that the partners negotiate their relation in the system at any moment in the development. The mother changes her behaviours to infant levels and the infant is ready to mirror the adult's behaviour as far and as complexly as possible. The mother mirrors too; certain infant behaviours are sometimes exaggerated because of cues in the infant's

behaviour (e.g. Fernald, 1992). In this way, mother and infant are of the 'same age' in their relationship which started at the same moment for both partners. With regard to speech communication which is in its ultimate form a social phenomenon, the mother knows best which direction to choose. In order to arrive with this particular child at a normal speech-communicative system, she can intervene at crucial moments, already early in their cooperation.

1.3 Constraints of my approach

1.3.1 Considerations

In view of the complexity of the topic of this study, constraints are in line with those in literature and with previous research results. Several aspects of the normal interactional processes present in the development towards speech communication must be considered. These aspects are discussed further as background information (section 1.4).

The period studied

My approach aims at an evaluation of mother-infant interaction 'as early as possible' which means that the onset of the evaluation should be soon after birth. The offset of the period is related to the possibility to give a qualified judgement about the speech developmental process at that moment. This can be the occurrence of the first word recognised by the parents (Bullowa, 1972) or perhaps the first cues of grammar.
In this study the *first two years* after birth are chosen. By then, children normally are well on their way to developing speech (in the realm of linguistics) and they usually have become fluent speakers at the age of three (Pinker & Bloom, 1992). On the other hand, if the developmental process is not quite as expected, the chance upon spontaneous progress is given the benefit of the doubt during the first two years. Speech-communicative abnormalities or delays without obvious explanations are rarely treated before the second birthday. An early diagnosis, i.e. in that period, can prevent more severe problems in the future of the mother-infant pair (e.g. De Ridder-Sluiter, 1990).

Changes in behaviour

The mother's and the infant's behaviours show considerable changes during the period between birth and two-years-of-age, for example, with regard to the *type* of behaviour, the *smoothness*, and the *timing*. The interaction primarily seems to aim at survival (i.e. to function as a life-line) during the first months. Later, a variety of social behaviours

(important for either one of the individuals of a pair) will be gradually shown during the interaction, both by the mother and the infant.
In this study, early and later behaviours of the individuals are described by means of a *micro-analytic transcription system* for movements (see Appendix II). This system enabled us to make comparisons on aspects of the interactional behaviours over the entire period observed. The selection of only some specific behaviours permits an *objective* evaluation of the interactional development over time.

The interaction in the system in general

The development towards communicative behaviour is a matter of *selection* of the behaviours present *within* the interaction of the partners at different moments. The partners select their specific 'triggers' for a specific interaction to occur. The occurrence of these specific behaviours can go back to the (near-past) experiences within the mother-infant system. Therefore, and because of the dynamics of the system of mother-infant interactions, an outside observer of communication processes cannot make an a priori selection of behaviours that must be used in the description of the mother-infant system.
In this study, a transcription system for movements is used which describes *all* observable behaviours of mother and infant separately. With regard to timing of behaviours, the transcription system employs a micro-analytic way (see Appendix II). In sixteen simultaneously present channels, related to sound productions and to the body parts involved in the behaviours, mutually exclusive codes are given to specific movements. Subjective interpretation of behaviours and the attribution of meaning by an outside observer of the mother-infant interaction is thus eliminated as much as possible.

The context of interaction in a system

Experimental conditions may interfere in the interaction as these can e.g. elicit specific behaviours of mother and infant. The presence of toys increases the chance that 'goal'-words are produced or that specific interactions occur (e.g. Bloom, 1993). Normally, speech develops in the daily routines of mother and infant at home where they are free to do as they like. In contrast, more or less experimental situations (such as a lab-setting) are likely to force the interaction in a specific direction.
In this study, mothers and infants were observed monthly in their *naturalistic home situation*. Free-play situations were chosen, so that both mother and infant (within the range of the cameras) were as free as possible to do what they liked at that moment of their communicative development. Another reason to record the home situations is the possible therapeutic aspect in this study. Recommendations based on observations

during lab-settings are more difficult to integrate in the daily routines of the home situation.

The observation in naturalistic home situations

A longitudinal study of mother-infant interactions in the normal home situation has consequences for the collection of data. It is likely that the presence of the observers interferes with the situation for both mother and infant. When the infant grows up and becomes mobile, and is familiar with the regular visitors, it is an illusion for the observer to maintain an 'outside' attitude. The mothers, too, may or may not feel at ease during the home visits.
In this study, the observers had a non-interference attitude while recording mother and infant engaged in play. Behind the cameras, they became part of the distant context. The study is limited to the *distance channels of the mother-infant system,* as the (video) registrations of the mother-infant interaction had to be as naturalistic as possible. Soon after birth, in play situations mother and infant are mainly engaged via the visual and vocal-aural channels, making the observation method fairly reliable.

The unique processes

In principle, the interactions of the mother-infant pairs are unique, as each pair has its own history. Their overt behaviours are related to their individual histories and shared experiences, and have their biological constraints (e.g. Fernald, 1989, 1992). Yet, the postnatal interaction in mother-infant pairs can be seen as an evolving system which accounts for certain constraints. The interactions in different pairs must have certain underlying characteristics in common, because (some form of) speech communication develops in the majority of the pairs. The process is astray in some pairs.
The approach chosen in this study, was expected to discriminate between two normal *pairs that differed extremely* in their development towards speech communication. If the approach would not discriminate between these apparently different pairs, the underlying characteristics of a developmental process towards speech would neither be revealed. Therapeutic intervention must be based on a correct insight in the differences and their influence upon speech development in general.

Common characteristics

Although the actual interactions within a mother-infant system are taken to be unique, it is likely that certain common characteristics are present in all human communication systems. The communicative behaviours can

vary along several lines, i.e. as related to context, timing, and types of the behaviours of individuals. The sender-receiver model (Denes & Pinson, 1973) has been successfully applied in research on adult interactional behaviours.
In this study, the model was applied to mother-infant interaction, for which a *sensori-motor transmission model for movements* of mother and infant was formulated. This model enables the description of three basic characteristics of communication systems -intersubjectivity, intentionality, and turntaking- in terms of co-occurring movements in the partners. These movements are expressions of mother and infant operating *as a system* and are related to their preferences shown in their communication system during development.

Intersubjectivity stands for the mutual orientation towards each other: two individuals first have to notice each other before they can transmit messages. This basic aspect of communication systems is described in Chapter 3.
Intentionality is present when specific movements are transmitted to the partner during the periods of mutual orientation. In mother-infant interactions, these movements can be interpreted as intentional or meaningful. The transmission of intentions, which is treated in Chapter 4, is possible only during moments of intersubjective tuning.
Turntaking in its simplest form is present when one person reacts upon a previous movement of the other person. The reaction is expected to occur within a certain time. In Chapter 5, turntaking by the mother upon sound productions of the infant is studied.

These three common characteristics are interrelated in each speech communication system. Intentions presuppose intersubjective tuning, and a transmitted intention awaits a response. The person-in-focus is expected to take a turn upon the partner's movement because the movement was perceived by that person. The three characteristics still must become integrated in the mother-infant system. If they fail to do so, the development of a communication system is at-risk and disturbances in the speech communication are to be expected.

1.3.2 The construction of an evaluation method

A proposed method to assess mother-infant interaction with regard to their development towards speech communication which is presented in its outline in Chapter 6, is constructed with the constraints presented in section 1.3.1 in mind. Such an assessment must be performed in single pairs in naturalistic situations, and be started as early as possible.

An important element in the construction of our objective method is the *transcription system* which permits a continuous description of the movements without an a priori and, likely, subjective interpretation of the

movements. The period of the first two years of life is covered by the transcription system (see Chapter 2, section 2.3.2).

Next, the *sensori-motor transmission model* for movements permits an objective evaluation of the interaction of mother and infant as a system. Not all movements of the individuals are perceived by the partner, and some of the movements can thus be neglected in our analyses: the transmission model presents the selection (see Chapter 2, section 2.4.1).

By means of this transmission model, the *three common characteristics* are translated into certain movement patterns of the mother and the infant. Thus, the three common characteristics are also described in an objective way. The unique movements in the interaction patterns need no further interpretation by an outside observer.

With regard to the literature data, lines of thought are presented in section 1.4 as *background information,* which has contributed to the constraints chosen in our approach.

1.3.3 The mother-infant pairs

Two mother-infant pairs were followed during the first two years of their 'partnership' (See Koopmans-van Beinum et al., 1990). They belonged to a group of infants with near optimal medical histories at birth (Prechtl & Beintema, 1964).
The two pairs were chosen because their *interaction patterns appeared to be quite different* which was clear already soon after birth. The presence of this difference was subjectively judged by the observers.
In view of further data on their development during the first two years, these pairs can be regarded to differ on the interaction patterns only. As such, these pairs can be considered the test cases for our approach. The pairs were free to communicate in their own way. At two years of age, the levels of speech communication were found to be quite different.
At that age, one of the girls showed speech-communicative problems which were treated for at least three years afterwards. These problems were still present when she was six years old, though her behaviour in school was constructive and aimable.
The other child was a fluent and eager speaker at the age of two. When she was six years old, the teacher in kindergarten judged her even to be too talkative which interfered in class situations.
Further information about these pairs is given in Chapter 2.

1.4 Background information

In this section, the idea that parent and infant must learn to communicate by means of sounds only is based on and illustrated with literature data.

Learning to speak is a task for both parent and infant. To understand that process is a complex task as well for scientists from the various disciplines related to the subject. Often the individual aspects of behaviour in the development of communication prevail in research.

1.4.1 Psychobiological aspects

Taking care of a baby changes the adults' lives: the baby evokes new and yet familiar feelings and behaviours that were not known to the new parents in their complex intensity (e.g. Price, 1989). The new human being is equipped to adapt to new situations and has a built-in alarm system. New, intersubjective behaviours emerge among the care-givers and 'care-consumers' who are prepared to orient towards each other (Schaffer, 1977; Foster, 1990). This adds to the survival chances of the newborns (e.g. Fernald, 1992). These behaviours "can have long-term regulatory effects on the infant's physiology and behaviour far beyond the period of infancy." (Fernald, 1992, p. 422).

Initially, mothers (and, increasingly fathers) are primarily concerned with the *physical well-being* of the foetus and later on the infant. The parental ear is very sensitive to the quality of the newborn's cries because these can provide indications as to the state of well-being of the baby (Mann, 1992). For quite some time during the first year of life, a crying infant gives a penetrating signal to adults and other children (e.g. Morath, 1979). Usually someone reacts to (soothe) the baby (Leach, 1986). The baby is touched, caressed, picked up, changed, or talked to melodically with a 'prosodic' tune, or with at least musical elements in the voice of the caregiver or mother (Papoušek & Papoušek, 1981). To see if the tension decreases, the baby is visually inspected as well. In her preterm twin study, Mann (1992) found that more positive maternal behaviours were directed to the healthier baby of the two, even when this child showed 'negative' behaviour (cry) and the other child smiled. Cues for this preference of the mother appeared present already when the babies were four months old. Mother-infant systems are thus subtle constructions of two homeostatic systems forming a new organisation, as a 'symbiosis' at the biological level (Hofer, 1987). In normal mother-infant interactions, warmth and affection provide the effective care which the infant needs for further development into a 'nice person' (MacDonald, 1992).
The psychological and biological approaches of development are not yet readily separable in the early mother-infant systems (Hofer, 1987). In due course this complex sensori-motor relation will evolve into a *signalling-perceiving system* between the two individuals. It shows adaptations to various situations of the adult-baby pair. Turn-taking, as one of the basic aspects in the communication between giver and receiver, is recognisable in many forms like looking-and-looking-away (Stern, 1974), speaking-in-alternation (Ginsburg & Kilbourne, 1988), give-and-take, and playing together. The two players learn to shift and 'time' their roles in the games.

They are informed simultaneously about the intentions and the inter-subjective orientation. These affective aspects in communication systems clearly appear before the content of the linguistic 'message' itself (Bloom, 1993). The affect system can be seen as the underlying motivation for infant behaviour that concurs with the parents' affective behaviour and with their cultural values in many different situations later in life (MacDonald, 1992).
The ability *to bridge a distance* in time and space between two persons is, also from an evolutionary point of view (Wind, 1983), one of the most important characteristics of the human primate communication systems.
Human society has now become to rely upon *audible* signals for complex communication, and is doing so more and more: sounds can be recorded and sent away by mail and listened to later on. We have radio sets, telephones, and other signalling machines. The newborns that are to become members of our western society have to produce sounds as well because the infants are, most of the time, not 'in close contact with the mother' (e.g. Weir, 1962). The mother relies on her sound productions directed towards her infant, which are unusual in adult conversations (Fernald, 1992) in order to bridge the (initially) small spatial distance. Nowadays, the distance between parents and infant can even be increased: e.g. sounds 'follow' the wires of a 'baby-phone' system to the parents residing elsewhere.
For persons who wish to communicate, *vision* bridges the interpersonal gap as well: gestures and rituals, and pictures, photographs, television, and video recordings can transmit images all over the world.
In their interaction, the mother and infant learn to use the information transmitted by the sensori-motor system in general and they develop specialised applications.

1.4.2 Psycholinguistics and Ethology

To scientists, investigating the *development of speech* in a human individual the world of parent-and-baby communication is full of problems to be tackled. Considering the complexity of the behaviour, children master speech communication relatively quickly, even without formal instruction (e.g. Pinker & Bloom, 1992).
Studies on speech development often rely on linguistic or psycholinguistic theories, relating psychological concepts, and linguistic categories and aspects. However, linguistically oriented descriptions of infant sounds cannot cover the scala of sound productions (e.g. Oller, Wieman, Doyle & Ross, 1976), and cannot explain why infants produce sounds that are not part of their mother tongue. The fact that newborns do make these sounds (any kind of sounds, in interaction with the mother) has been disregarded as a cue for later communication, probably for reasons of sound quality.

In search of the *precursors of speech communication* (Bullowa, 1979; Lindblom & Zetterström, 1986), the onset of (aspects of) language use is

gradually laid closer to the moment of birth of the infant. When focusing on mother-infant interaction, precursors are sought even before birth (Tietze, 1985). According to Fernald (1992), the evolutionary approach to mother-infant speech communication offers evidence that motherese aspects in speech to infants must be seen as a specific human way of caretaking which facilitates speech-communication in the offspring.

The *infant's age* at the onset of specific behaviours often represents an important factor in the research. Weir (1962) actually listened to the "Language in the Crib" of a two-and-a-half-year-old, and she related sounds and words linguistically to the structures of the mother tongue. The 'cradle of language use', according to Bruner (1983), was found in the turntaking during conversations between mother and infant. Bullowa (1972) considered speech development to have started when an adult recognises a word in the sound stream of the infant. The baby's ability to produce a phonetically consistent sound intentionally (Gillis, 1986), was another solution to the problem of defining the onset of speech and language development.
Research in the field of developmental linguistics concerns itself with child grammar, the acquisition of specific aspects of speech sounds, intonation patterns, and meanings of children's words in relation to the input from the mother (cf. a cross-section of publications in the *Journal of Child Language*). Developmental psycholinguists study topics like affective expressions, intentions, cognition, and communicative acts in normal or deviant mother-infant pairs (cf. a cross-section of publications in the journals *Child Development* and *Infant Behavior and Development)*.
As long as adult characteristics of communication are not yet met, often the prefix 'pre' or 'proto' is added to the overt behaviour of the infant (e.g. Bateson, 1979). In my opinion, this indicates only a theoretical gap between early infant and later adult behaviour: the infant's behaviour is not yet readily comparable to the adult's standard.

For centuries now, the *beginnings of adult communicative behaviours* can easily be placed in the early period of adult-child interaction. Of course, an infant is able to develop behaviours under circumstances that fairly adequate adult caregivers create. In more recent research on speech development there is a tendency to focus on both the mother's and the infant's behaviours in the first years of life (Morath, 1979; Papoušek, Papoušek & Bornstein, 1985; Bloom, 1993). Gradually, the interactions of mother and infant during the first six months are focused upon, revealing patterns that underlie the development of speech (e.g. Fernald, 1992).
In the decades of scientific 'dyadic' thinking (previous to the interactional approach), the mother was expected to inform the experts about the infant's sounds. And the experts proved her to be right or wrong (e.g. Murry, Hollien & Müller, 1975). As the naturalistic context of the mother-infant pair was neglected, the results of these studies have but a limited value for our approach.

Now, methods are accepted for research on the *interaction system* of mother and infant in a general sense (e.g. Bullowa, 1979; Fernald, 1989, 1992). Disciplines like evolutionary biology and neuroscience try to integrate their concepts with the social sciences, including linguistics (Cosmides, Tooby & Barkow, 1992). Again, the observation of human behaviour is given a place in research (e.g. Wind, 1983, 1986). The outside observer liberates the mother from her two-fold role (in dyadic research) as actor and observer of her child in actual situations. Instead of being asked to label sounds and the infant's behaviour in scientific terms, the mother is free to act according to her impulses, habits, or parental judgements. The observer is expected only to collect the data crucial to the theory. This approach of mother and infant as a social interaction system (e.g. Bell, 1977) with an outside observer has become fully accepted in the seventies.

The interactional approach invites questions about *socio-cultural aspects* which contribute to but also complicate psycholinguistic theories on speech development. Father and mother behave differently towards their infants, as do siblings (e.g. Fernald, 1989). As the infant's behaviour is no longer the only subject of research, a research topic could be the 'speech-teaching attitudes' of lower-class and higher-class mothers because of a difference in prompt reactions. The hypotheses can become very complex, in many ways far removed from what is going on in the actual home situations.

It is quite possible to *communicate with an infant that is speechless*, as all mothers know (Greene, 1963; Bullowa, 1979; Fernald, 1992). For linguists of today, this notion has enlarged their concepts in research of speech and language development. The focus is on communication in general, of which speech is one ultimate form of human behaviour. It is the result of interaction which gradually specialises (e.g. Bullowa, 1979).

According to Söderbergh (1986), body language can be seen as a part of linguistic communication, but she restricts body language to purposeful communicative behaviour. With this restriction, we are back to the adultomorphic approach (See section 1.2) which creates a discrepancy between infant and adult behaviour, e.g. 'early *infant* sounds and later *adult* speech'. I usually name the 'prelinguistic' period of infants in their development to speech communication *the period of the 'linguistic gap'*; for Söderbergh (1986) it is "the latent stage of language" (p. 11).

In my opinion the indication 'prelinguistic' results from the above mentioned adultomorphic approach of infant development (section 1.2). Although researchers have frequently and in many different ways pointed out this theoretical trap (e.g. Tronick et al., 1979; Donaldson, 1983), it appears to be very difficult to imagine how the world of young children is structured in a different way from the adult's and what the role of the mother's behaviour in that structure can be (Fernald, 1992).

Bullowa's book (1979) debated the habitual researchers' attitudes towards infant behaviour, by means of her own contribution and those of others. My approach evaluates the basic aspects of communication systems as much detached as possible from the languages used. The evaluation is restricted to the descriptive behavioural level, in an attempt to explain

complex developmental phenomena "in the simplest terms possible" (Hofer, 1987, p. 634). Because it is difficult to describe infant behaviour before the age of four months in terms of *events* (Plooij, 1984), which ask for an adultomorphic terminology, an ethological approach of the mother-infant system should best be rendered in terms of movements.

1.4.3. Evolutionary origins of speech

In search of the *origins of the unique human ability to speak,* scientists have studied the premises and conditions for speech-communication in the human primate. The French banning of the topic (in 1866 by the Paris Society for Linguistics) seems to have worked like a modern controversial advertisement.
Because speech sounds are volatile, the complex sound production system is evaluated upon its morphology and functioning. This often is done by studying ancestral hominid remains and conditions in the closely related human and non-human primates (Leakey, 1981; Johanson & Edey, 1981; Wind, 1970, 1988; Gardner & Gardner, 1974; Premack, 1974).
The inferences about the brains and the vocal tract (often not the ear!) as well as the use of tools and evidence of culture are mentioned in the discussion (e.g. Wind, 1983). As language is gradually placed in wider social contexts, an evolutionary biological approach in different disciplines (e.g. Barkow, Cosmides & Tooby, 1992) has come to be focused on the development of speech in the human primate and particularly in infants.
Caregiving adult behaviours (e.g. Jacobson, Boersma, Fields & Olson, 1983; Fernald, 1992; Pinker & Bloom, 1992) and infant characteristics (see a review by Nelson, 1987) are thought to be reflections of a biological basis for the developmental processes towards speech, having phylogenetic roots of attachment (Hofer, 1987). Fernald (1984, 1989, 1992), for example, stresses the evolutionary impact of prosodic features in motherese with regard to the infant's three A's: Attention, Arousal, and Affect in interaction, which are basic to further infant development in many directions. As is argued by Pinker and Bloom (1992), a child is a fast language learner (with a wink to the *Language Acquisition Device*, e.g. Lenneberg, 1967). Clearly, biology gains increasing importance in the study of speech development and language acquisition.
Wind (1983) proposes about a *hundred processes having occurred in primate evolution* that have contributed to the origins of speech. Many of these apply to ontogenetic speech development as well (Figure 1.1), since the infant changes physically at a fast rate during the first years (e.g. McCall, 1979; Caplan, 1971). Wind's diagram (1983) offers links between various behaviours and the occurrence of speech which is still regarded as the most impressive ability of human primates. It is very well possible that the Pleistocene mother-and-infant in their 'homely' interaction developed speech-communication further by means of a basic intonation system (e.g. Fernald, 1992). This might explain why the female is, on the average, the more verbally gifted than the male.

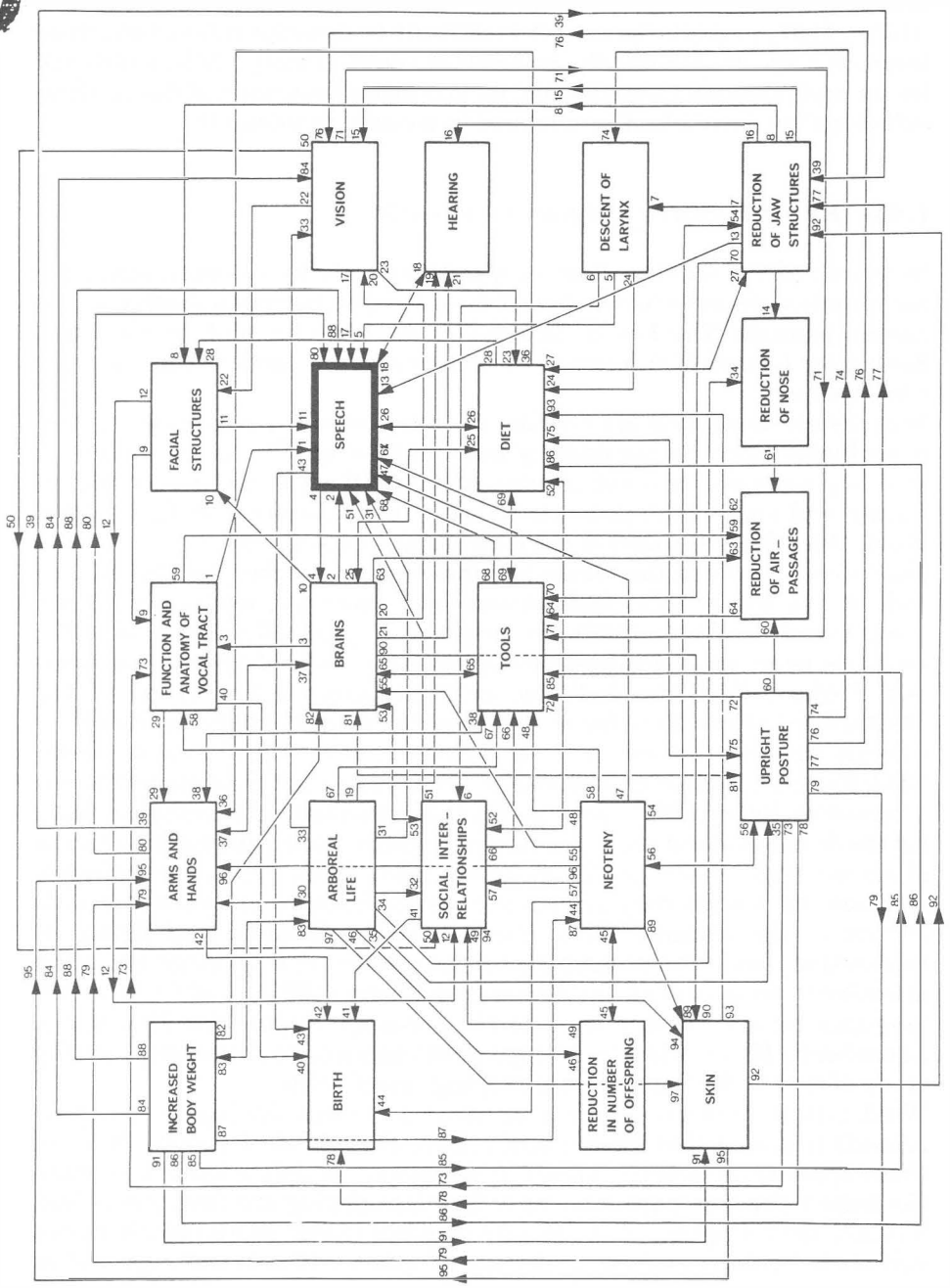


Figure 1.1
Processes that, during primate evolution, have contributed to the origins of speech (reproduced with kind permission, from Wind, 1983).

Of course, human ethology and evolutionary psychobiology (e.g. Morris, 1968; Eibl-Eibesfeldt, 1989; Barkow, Cosmides & Tooby, 1992) have largely neglected the detailed study of human speech behaviour, possibly because it would further complicate the study of human social behaviour. The evolutionary success and the uniqueness of the human primate, in a social sense, is reflected in the number of them on earth as well as in the efficiency of their social behaviour like, for example, speech communication.
Humankind is only on the edge of a new age following the Pleistocene period of hunter-gatherers which lasted for several hundred-thousand years (e.g. Cosmides, Tooby & Barkow, 1992). It is often suggested that speech as a system developed in relation to hunting and the following festivities (with sounds of joy, Critchley, 1967).

In my opinion, the complex socio-psycholinguistic aspects and evolutionary approaches of speech development touch upon each other in the *interaction between mother and infant*. The mother knows (unconsciously) the desired direction of the developmental processes and the infant shows the innate developmental power. Together, they form and mould the emerging product of their interaction resulting in speech communication.
In many ways, I have to navigate between Scylla and Charybdis, which is inherent to research concerned with complex behaviour (e.g. Zuithoff, 1971). In my ethological approach to mother-infant interaction, aiming at a method to evaluate, in the distance channels, the communicative development in early childhood, I have not taken into account the majority of Wind's processes (1983) as related to the origins of language. Rather, I have paid more attention than usual in psychobiology to specific behaviours related to the development towards speech communication.
Out of the large field covered by psycholinguistics, I have only touched superficially upon words and the topics in the conversations. Certain interactional processes must come 'before the sound messages' (e.g. Bullowa, 1979; Fernald, 1989), and these processes then facilitate the mutual understanding between mother and infant in a broader sense.

1.4.4 Anatomy, physiology, and neurology of the speech mechanism

The *anatomy and physiology of infant sound producing mechanisms* have extensively been studied (by e.g. Kent, 1976; Koopmans-van Beinum & Van der Stelt, 1979; Netsell, 1981; Van der Stelt, 1979, Van der Stelt & Koopmans-van Beinum, 1981). Previously, this 'organic' biological approach has proved useful in the description of infant sound production (Koopmans-van Beinum & Van der Stelt, 1979, 1986; Roug, Landberg & Lundberg, 1989). Much in line with the biological approach, researchers have studied *the infant's physical capacities* for speech production. Fletcher (1973), Kent (1976), and Netsell (1981), for example, have focused upon the neuro-anatomical development of the speech mechanism which is

the basis for the production of sounds. Several authors have described the development of sound production from birth onwards, and defined corresponding stages in motor coordination or sound quality changes (Koopmans-van Beinum & Van der Stelt, 1979, 1986; Roug, Landberg & Lundberg, 1989; Stark, 1978; Stark, Rose & McLagan, 1975; Proctor, 1989).

Measuring *acoustically* the infant's sounds (Lind, 1965; Wasz-Höckert et al. 1968; Stark, 1978; Kent & Murray, 1982; Oller, 1986; Robb, Saxman & Grant, 1989; Masataka, 1992) in the various stages may further support the categorisation of the cry and non-cry sounds by their different characteristics. In early interaction, however, there is no reason to believe that the mother or the infant need these precise acoustic 'definitions' of their sounds.

Because of the early sound productions of infants, scientists raised questions about *the infant's hearing* abilities. The difference between early sound production and (later) speech sounds could be explained if an infant simply did not hear the linguistically important differences in speech sounds in those early months. This explanation is supported by neurological evidence and is also able to link primary-auditory analysis (depending on the ear's mechanics) and speech-motor output. The infant's ear must analyse sounds in order to reproduce correctly the perceived speech sound (see an overview by Locke, 1983).

The overwhelming amount of research on infant perception of (speech) sounds (e.g. DeCasper & Fifer, 1980; Kuhl, 1981; Jusczyk & Bertoncini, 1988) reveals that the normal newborn human is able to discriminate sounds that belong to different categories of the mother tongue as well as other languages (Eilers, 1980; Aslin, Pisoni & Jusczyk, 1982; Fifer & Moon, 1989). Even before birth the infant becomes familiar with aspects of the communication system and the sounds of the society that will be his (e.g. Verny & Kelly, 1981). The limits for perception are set by the *construction of the ear* as a sensitive organ (Aslin, Pisoni & Jusczyk, 1982; Kuhl & Miller, 1978) rather than by the (communicative) sounds that function among equally equipped individuals of the species. The (non-human) mammalian cochlea quickly becomes sensitive to specific sounds (Echteler, Arjmand & Dallos, 1989). Surely, humans would be biological miracles if they could make sounds which another member of the species could not perceive. Soon after birth the infant's ear is capable to attend to sounds that occur in the society he is born into.

In the course of the individual's development hearing becomes more and more selective towards the complex (speech) sounds of the environment. This growing sensitivity for aspects in speech production, like those of the prosodic tunes (e.g. Papoušek & Papoušek, 1981, 1989, 1991; Fernald, 1992), is likely to be of a transitional character (e.g. Plooij & Van de Rijt-Plooij, in press). The mother's speech as far as it is directed at the infant is usually very 'rich' and 'exaggerated'. Along with the change of its perceptive abilities, the infant will 'select' and process sound patterns from its mother's speech, and react to these patterns according to its age

(Papoušek & Papoušek, 1991). Mutual attuning in the mother-infant system gradually shapes their vocal-aural interaction such as to obtain normal, i.e. fairly monotonous, adult speech.

For the development of infant *vision* a similar line of explanations has been proposed, e.g. assuming that initially the infant is not capable of seeing properly (see a review by Nelson, 1987) with regard to contrast and scanning of visual input. A newborn baby, however, can already discriminate and imitate mouth and tongue movements (e.g. Meltzoff & Moore, 1977), which until recently was incredible considering the state of knowledge about the infant's visual system and its development. The infants, observed by Meltzoff and Moore (1977), had never before seen movements of their own face, yet they were able to link visual perception with appropriate motor patterns, i.e. imitating the movements seen. A moving (talking) face attracts the infant's attention to the eyes of the speaker, probably because changes are most clearly expressed in that region (Haith, Bergman & Moore, 1977). Furthermore, during sucking the infant is capable to adjust the visual contrast within certain limits. Not seeing a speaking mother's face clearly is no longer an explanation for the discrepancy between early sound production and the later use of speech. This insight has triggered research into the earliest periods of communication, as approached from many angles. Psycholinguistics and other disciplines focusing on an analysis of human behaviour have introduced new (ethological) methods as well.

1.4.5 Sensori-motor mother-infant communication

From a strictly linguistic point of view speech development can be seen as a discontinuous process (Jakobson, 1941, 1968) because early sounds are seemingly not related to later speech production. The young infant is in a 'prelinguistic' stage, there is no 'notion of the alphabet', nor pragmatics. Rather, the infant is involved in 'proto-conversation' with the mother (Bateson, 1979). Yet, if this developmental process is seen in the *context of the general communicative behaviour* of mother and infant (Bullowa, 1979), preparing the baby for future speech communication and language use, the process can, in fact, be labelled as continuous and be seen to show hierarchically organised stages (e.g. Powers, 1973; Plooij & Van de Rijt-Plooij, in press), even though purely linguistic categories are not present in the earliest communicative behaviours.

Sullivan & Horowitz (1983) reviewed the literature on the subject of *intermodal perception in infancy in relation to language development and multi-modal maternal stimulation.* Infants explore the environment by means of five (in time) overlapping perceptual systems: looking, listening, smelling, tasting, and touching. These systems simultaneously provide different information about the same thing. Thus, infants can listen to language and 'see' language in relation to mouth movements, smiles, facial

movements, gestures, and body movements. They are able to perceive these movements, as shown in experimental studies on asynchronous and spatially distorted stimuli, causing discrepancies in that stimulation (e.g. Trevarthen, Murray & Hubley, 1981). Multi-modal perception of naturalistic verbal and non-verbal events gradually enables the infant to construct meaning in language use. The infant comes to know perceptual changes which are informative since they are related to environmental changes as well.

Research on human communication has benefited greatly from the *sender-message-receiver model* of information theory (Denes and Pinson, 1963). In fact, that model is fundamental in phonetic research. However, the audible strings of speech sounds are arbitrary symbols for their meanings and only possess a value because they are socially agreed upon (e.g. Foster, 1990). Humans are equipped with sensory and motor organs, and humans can communicate only because they employ these organs.

> "Signal or message production requires ability to produce change. A continuous and undifferentiated state produces no signal. That requires contrast. Usually this change is produced by motion. It could be by change in something which appears static, e.g. blushing, but this too is due to motion at a more microscopic level. What moves may be sound waves set in motion by the 'vocal apparatus' or it may be some visible part of the body.
> The possibilities for human-to-human communication are limited only by human motor and perceptual capacities."
>
> (Bullowa, 1979, p. 23)

Bullowa clearly shows that the sender-receiver model applies to the message-aspect of human communication and not to the state of *'being in communication'*, to which she refers on several occasions.
In my opinion, she pointed at the roots of the developmental linguistic 'gap' (section 1.4.2) with regard to the relation between early sounds and later speech already in 1979. Linguistic approaches of speech development focus in many ways upon the audible signal and the 'what, how, and when', rather than on the ways parent and child come to know each other.

> "However, we must pay attention *not only to the coded message* and the details of transmission and reception but also to the overall properties of the system which make interpersonal communication possible. This has more to do with being 'in communication' than with the what and how of communication, and pertains to fundamental properties of animal and human communicative systems, properties *less obvious than the nature of the codes and how they are used*."
>
> (Bullowa, 1979, p. 16, my italics)

In the beginning of their interaction, mother and infant are probably occupied with the less obvious properties of their communication system. They establish their notion of being in communication and their mutual sensory orientation upon the movements of the other.

According to Bullowa this process is visualised by '*tuning to a carrier wave of a radio station*' (p. 16). Speech signals are imposed upon the carrier wave, and the receiver has to separate the carrier wave from the minor fluctuations that represent the 'spoken message'. As an acoustic phenomenon (in the air), the spoken message has a complex form over time. Only when the receiver is able to detect the minor fluctuations as separated from the tune, the "sharing of time forms in multiple levels of behavioral organisation" (Bullowa citing Byers, 1976; p. 160) between humans is possible. This can be described as a biological process related to rhythm in movements in human-human communication.

In speech production, the 'carrier wave of phonation' is modified by vocal tract movements, and it is the task of the ear to separate and analyse that simultaneous information. Yet, the eye has its task too. Condon's work (Condon, 1979; Condon and Sander, 1974) demonstrates the synchrony of movements in communication of neonates and adults. In line with this approach, Van der Stelt (1979) suggested that early speech development is not primarily concerned with the transmission of 'meaning' but with 'movements'. When the two participants are in tune for sending-receiving speech sounds, a coded audible or visible message can be transmitted.
The choice of the coding systems is limited with regard to the manner of tuning between two persons. During the development of a communication system, the manner of tuning is still open, and the movements that will be transmitted await their attribution of meaning.

Of course, movements can be *perceived by different sensory modal*ities which are often interrelated, like seeing and hearing a speaker. In early mother-infant interaction the other senses are usually involved as well, and their multi-modal tuning is then a very complex matter to study for an outsider. That is one reason to limit the study of mother-infant interaction to observable ways of tuning over a distance between the persons.

1.4.6 Conclusions

The approach of the mother-infant system in this study, formalised in a transcription system for movements and a transmission model, is on the sensori-motor level.
The evolutionary basis for mother-infant interactions is incorporated in this study in the assumption that mother and infant form behaviourally a symbiotic system. As Hofer (1987) has put it quite clearly, the neuroscience approach has its presuppositions: ecological adaptation, control theory, neurological organisation, and an epigenetic theory on development.

Lacking a complete theory (which will thus be a very complex one) on development, research proceeds with ad hoc questions and inferences, thereby relying on current pragmatic insights. The evolutionary approach of human behaviour (Cosmides, Tooby & Barkow, 1992) offers new ways to study the infant's acquisition of speech by adding biology to psycho-linguistics, like in this study. Thus research of infant development can get away from the adultomorphic constraints often present in complex theories (e.g. Hofer, 1987).
A baby can hear and see his mother speak to him, she speaks to him consistently using the 'babytalk' or motherese register. Yet the baby himself initially produces sounds that do not fit in with the mother's language, his mother tongue. Why or for what reason would an infant do that?
Of course, this formulation of the problem is a bit of a caricature, but caricatures have their function in showing us an exaggerated picture of ourselves. We have to leave behind us our prejudiced ideas about human speech communication and turn to observing how the mother and infant communicate. Many aspects are still not clear in that process, but some are and will be summarised below.

The infant

We know that *infants are socially 'pre-prepared',* in regard to sensori-motor functions, for interaction with moving persons (Schaffer, 1977; Sherrod, 1981; Brazelton, Koslowski & Main, 1977), and that they have an evolutionary basis.
Trevarthen (1977, 1979, 1989) considers the newborn infant's behaviour to be intentional in relation to the mother's behaviour, thus creating a dispute about the 'meaning of goal-directedness in behaviour' with the more adult-centred approaches of intentionality (e.g. Harding, 1984). Trevarthen's point of view is supported by other infant-centred researchers: the infant is drawn to voices and faces in his environment (Meltzoff & Moore, 1977; Haith et al., 1977; Brazelton & Tronick, 1980; Eisenberg, 1979; Fernald, 1992). The contours of suprasegmental aspects, like intonation, duration, and loudness in the infant's sound production, are dependent of the situation an infant finds itself in during interaction with objects or persons (Delack, 1974; D'Odorico & Franco, 1991; Masataka, 1992).

The mother

As for the mother, we know that she changes her speech to the *'motherese' register* (babytalk or caretaker's speech) when interacting with the baby (Sullivan & Horowitz, 1983; Fernald, 1989, 1992). This use of motherese is thought to lie in its explicit and exaggerated forms, and Fernald (1992) points at the

evolutionary basis for this behaviour. It keeps the infant's attention directed at the mother and introduces the infant to the affective world. The mother feels that she can communicate with her baby (Bullowa, 1979; Foster, 1990) and that her attitude and behaviour is 'understood' (Greene, 1963) because the baby pays attention to her and can be aroused. Likewise, the mother is prepared to interpret the infant's vocal and non-vocal behaviour (Coates & Lewis, 1984; Bloom, D'Odorico & Beaumont, 1993) as meaningful and intentional in the context of their interaction. These aspects (here designated further as intersubjectivity, intentionality, and turntaking) are considered to be basic to communication systems. The aspects are related to the mother-infant affect system (Fernald, 1992; Bloom, 1993). In a less obvious way these aspects are continuously present in the development of speech towards language (Bullowa, 1979).

The distance bridged

We know that *infants make a 'map'* of their speech mechanism fairly systematically, re-organising movements of primary functions as respiration, sucking, and swallowing into new movements for sound production (Koopmans-van Beinum & Van der Stelt, 1979, 1986; Van der Stelt, 1979; Bosma, 1976; Fletcher, 1973; Hendrickx, de Breucker, Lambert, Switten & Vrijens-Quintens, 1976; Netsell, 1981). Most infant sounds, like for that matter adult ones, are produced during the expiration phase of the respiration cycle. Because of the silent period during inspiration, sound production is interrupted enabling turns between the partners (Trevarthen, 1979). Phonation is, after a period of physiological disorders (such as vocal fry, and aspirated phonation; Crystal, 1969) usually under control at the age of two months approximately. Even the infant's earliest articulatory movements may result in sound productions that are, at times, 'meaningful' in adult speech. Mothers focus pre-, peri- and postnatally, on their infant in their behaviour and thinking.

The *infant's gaze behaviour* (scanning) is, observed superficially, comparable to the adult's behaviour (Haith et al., 1977). The gaze of the infant at the mother's face increases her responsiveness dramatically (e.g. Stern, 1974). Infants change their facial expressions selectively, triggered by visual stimuli such as the mother's facial movements (e.g. Papoušek & Papoušek, 1977; Trevarthen, 1985; Bower & Wishart, 1979). They show distress when the mother does not act as usual (Genta, Tartabini, Costabile & Zamberlan, 1986). In research on sound perception of infants, a detailed study of the child's facial expressions has been made (it can already show attention or rage; Eisenberg, 1979), thus refining the methods in sound perception experiments. The infant pays

attention to sound, sight of and touch by another human being (Stensland-Junker, 1979).
Infants prefer to hear their mother's voice, orient towards it and are capable to discriminate speech sounds (e.g. DeCasper & Fifer, 1980; Fernald, 1984; Papoušek, Papoušek & Bornstein, 1985; Jusczyk & Bertoncini, 1988).

Thus, important *ingredients for the development of a communication system* appear to be present. Two humans orient towards each other, using a more or less predictably set of movements (in timing and in situational aspects), which is transmitted and responded to. These aspects differentiate and increasingly become specific to the persons in the interaction. But initially, and assuming that the signals are present,

> "It is vital for the infant to develop the ability to recognize these signals to which it is important for him to pay attention, if he is to survive."
>
> (Stensland-Junker, 1979, p. 307)

This thesis is concerned with that gradual *specialisation in the mother-infant system towards communication* in the first two years, which results in the child's earliest abilities for speech communication and the use of language: words exchanged with the mother.
My focus will be on the three fundamental characteristics that play an important role as agreed upon by research on communicative systems (Bullowa, 1979; Bruner, 1983), although the definitions may vary with the researcher's field involved:

- intersubjectivity,
- intentionality, and
- turntaking or alternation of the roles of the participants.

The first two are usually considered to belong to the less obvious properties of the mother-infant communicative system (their tuning and readiness to interpret behaviour) and are closely related to their affect system. Turntaking in this thesis comes in the realm of linguistics, especially when the infant's sound production is coded as a word.

The above three fundamental characteristics are treated in different chapters, even though they are present simultaneously at any time in the development of mother-infant communication. Their form, content, and function, as well as their overt contribution to the communicative process, change over time in relation to spatio-personal characteristics of the participants (Levelt, 1989). These aspects in the communication system should distract us as little as possible from the movements in the mother-infant system.

1.5 Organisation of the thesis

The first chapter thus was meant to explain the approach chosen in this thesis. The outline of a method for the evaluation of mother-infant interaction is presented in the final chapter.
Chapter 2 introduces the two mother-infant pairs, the video recording procedures, and the micro-analytic transcription system for movements in mother-infant interaction from the video recordings. The constraints chosen with regard to transmission of the movements between the partners are presented in the sensori-motor transmission model. Data processing, visualisation of transcription data, and simple statistics are discussed also in that chapter.
The next three chapters -on intersubjectivity (Chapter 3), intentionality (Chapter 4), and turntaking (Chapter 5)- each have a short introduction focusing on the literature on that topic. The chosen movements or combination of movements of mother and infant, representing the fundamental characteristic treated in that chapter, are discussed. The results and their possible impacts on speech communication are presented, together with the discussion about the approach.
The final chapter discusses my approach in general and offers suggestions for further research. The outline of the method devised to evaluate the development of mother-infant speech communication in a sensori-motor way, is given in a final section of that chapter.
Summaries in English and in Dutch precede the references that have been used. These are listed before the appendices that contain recording schedules, the transcription system for movements, and the overall numbers of movements per recording per person. Percentages and numbers per recording per pair on the three fundamental characteristics treated in the three 'topic' chapters are given as 'raw data' in appendices as well.

2

DATA COLLECTION AND PROCESSING

Abstract

Speech communication is considered to develop in the mother-infant system which gradually selects the communicative movements from the individual repertoires. To assess the value of this approach as presented in the first chapter, two mother-infant pairs were selected from a group of six because of the differences in their interaction patterns.
The two mothers and their infants are introduced in this chapter. With regard to pregnancy and birth the infants had near-optimal histories. The mothers were healthy and were the main caregivers. Medical, psycho-social, as well as linguistic data were collected by means of examinations, questionnaires, tests, and video recordings.
Soon after birth already, the pairs appeared to differ with regard to their style of interaction. When the children were two years of age, their levels of speech development were quite different and this persisted when they were six years of age.

Monthly direct observations of mother and infant in free play situations were made in naturalistic home settings by means of two cameras and split-screen video recordings.
Separate micro-analytic transcriptions were made for mother and infant of five minutes of each monthly-made video recording, during the first two years of the infants' lives. A multi-channel coding system for movements was used. Transcriptional data collection was computer-assisted.

In the mother-infant system the transmission of the movements is limited, because not all movements of the individual are perceived by the partner. A sensori-motor transmission model is presented in which the constraints for transmission of movements are formulated.
PROGRAAF is a computer program for the selection and processing of the transcribed movements, which can account for the limitations set by the transmission system. A counting program FP for frequencies and durations of specific movements per recording and per person was used as well.

2.1 Introduction

In this chapter we introduce the reader to basic aspects of our approach which is based on the assumption that interaction patterns are related to the outcomes of developmental processes like, for example, the process towards speech communication.
First of all, the *two mother-girl pairs* will be introduced. These pairs were chosen to be the test cases for analyses related to the approach. They were initially considered to differ only in their interaction patterns, which, however, appeared to be followed by differences in language- and intelligence-measures at the age of two of the infants. An evaluation of speech-related developmental factors will be given for the first two years as well as an evaluation by the parents and by the kindergarten teachers when the children were six years old. The collection of the background data during two years by means of medical examinations, questionnaires, tests, and the video recordings will be described in relation to the development registered.
Second, a *description* is given of the interaction patterns which are usually thought to be crucial in the development. These descriptions vary in relation to the research topic. I have chosen to describe all the behaviours of the individuals that occurred over the period of two years by the same micro-analytical system. This operationalisation of interaction patterns deals with the differences in behaviour between adults and infants. The transcription system for movements of mother and infant is given in an appendix.
The third discussion concerns the mother and the infant *as a system.* The individuals move and perceive in time and space. Many more changes than those apparent in the system are present when we regard the individuals. The restrictions formulated in the sensori-motor transmission model, are introduced.
Finally, the software programs for further processing of the transcriptional and transmitted data are presented.

2.2 Subjects

Claire and EVE and Fanny and SUSAN are the two normal infant-mother pairs that participated in this longitudinal study. (The names have been changed for privacy reasons. The mothers' names are given in capitals). Out of a group of six pairs, these two were chosen because of the differences in interaction patterns found during the first two years. These pairs functioned as the test cases for the description of mother and infant as a sensori-motor system.
The 'normality' of subject-pairs is discussed in respect of their general medical history at birth. Even when problems in the development arose in the following two years, the infants were not eliminated from the study.
The pairs are introduced in general and with regard to psychological aspects and to their level of speech development. This background

information is needed, together with the data from the direct observations, to obtain a picture as complete as possible of the developmental processes.

2.2.1 Normal mother-infant pairs

The subject pairs in this study thus were *two female full-term infants* and their mothers. As members of a control group of six normal mother-infant pairs, they had cooperated in a project that was financed by the *Netherlands Prevention Fund*, focusing on the influence of an oral plate on the speech development and speech interaction during the first two years in the life of cleft-palate infants (Koopmans-van Beinum, Jansonius-Schultheiss & Van der Stelt, 1990; Jansonius-Schultheiss & Van der Stelt, 1990a; Jansonius-Schultheiss & Van der Stelt, 1990b; Van der Stelt & Jansonius-Schultheiss, 1990).

a. *The infants*

The two infants studied in this thesis belonged to the *normal* group (4 girls and 2 boys) in the sense that the medical history of pregnancy, labour, and birth had been 'near optimal' on the criteria given below (see Prechtl and Beintema, 1964).

- Gestational age was between 38 and 42 weeks.
- Birth-weight was between 2750 and 4250 grams.
- Apgar scores (after 5 minutes) were between 8 and 10.
- Postnatally the infants did not develop severe icterus.
- The infants had no obvious somatic abnormalities.

As soon as possible after birth the infants were seen by an experienced paediatrician, H. de Kleine, of the Neonatal Department of the Academic Medical Centre, University of Amsterdam. He examined these newborns neurologically, observing their general appearance, the muscle tonus, the presence of asymmetries, etc.

b. *The mothers*

The two mothers were Caucasian, native Dutch-speaking women and they were respectively 31 and 36 years of age when their daughters were born. Both mothers have had professional training after primary school for at least four years. They had normal speech and hearing, and were the primary caregivers of their baby at that time. Furthermore, they were willing to participate in the study which had a fairly tight schedule of video recordings (biweekly during the first year). One family lived in Amsterdam, the other in a village nearby.
The pairs are further introduced in section 2.2.4.

c. *Normality*

In this thesis *'normality'* means that the two mother-girl pairs have had *a fair chance of a normal development* at the start. Under the condition that the infants were normal at birth after a normal pregnancy, we had decided (as in the Netherlands Prevention Fund project, Koopmans-van Beinum, Jansonius-Schultheiss & Van der Stelt, 1990) that none of the mother-infant pairs should be excluded from the study, even if illnesses or other disturbances of the 'normal' process would emerge later on. The infants were followed during the next 24 months and disturbances which occurred were regarded to be part of a developmental process. Slight medical problems are quite normal in mother-infant systems, and do not necessarily interfere with the development toward speech.
In longitudinal studies, the researcher can rarely afford to exclude a pair from the study because of an illness at the age of, for example, 16 months; disregarding the collected material and starting again with another pair would raise serious practical problems. Furthermore, these two mother-infant pairs were chosen from the six normal pairs because of their quite different interaction patterns (see 2.2.4 c).
We preferred to consider eventual developmental delays (e.g. in psycho-motor aspects or in speech communication of in-principle-normal mother-infant pairs) as possible (by)-products of the developmental process in the system itself. Both mother and infant may have difficulties in coping with each other's behavioural characteristics. Normally, mother-infant pairs go through the infant's "major reorganisations in the nervous system at quite specific ages" which may be difficult periods for a family (Plooij & Van de Rijt-Plooij, 1989, p. 279; Plooij & Van de Rijt-Plooij, in press; Van de Rijt-Plooij & Plooij, 1992, 1993). Deviations from the 'normal' process (whatever that may be) are possibly related to the maternal history, which affects her coping with the infant behaviours (e.g. Engfer, 1986; Engfer, Gavranidou & Heinig, 1986). These factors, however, are no reliable predictors for speech-communicative problems.
The interactional characteristics in mother-infant pairs evolve from these personal backgrounds, but serious problems arise in the interactions themselves.

2.2.2 The parents and infants cooperated fully

A researcher sometimes worries about the intrusion of 'science' in the lives of the subjects, especially when the period of home visits is a considerably long one. Can one somehow motivate the parents not to drop out when they are confronted with the amount of paperwork, the medical examinations, and the tight recording schedule? The colleagues consulted by us at a first presentation of the Netherlands Prevention Fund project were pessimistic about the design for data collection.

Therefore, the parents were promised a copy of all video recordings after the second birthday of the children. Furthermore, they would have a kind of 'developmental diary' of the babies on many aspects (because they filled out our questionnaires for each recording session) and the background data (Jansonius-Schultheiss & Van der Stelt, 1990b).

Towards the end of the Netherlands Prevention Fund project, the parents, the children, and the observers had difficulties to face a final good-bye which we did not have to do. After the second birthday both pairs were willing to participate in a follow-up study of another two years with recordings every three months (Kuijpers, 1987, 1993). Remarkably, these families are still part of my social life.

2.2.3 Questionnaires, tests, and illnesses

Because speech communication touches on many aspects of human life, video recordings clearly only show part of the picture, and certain additional data were needed to support the idea that the pairs mainly differed with regard to their interaction. Therefore, the parents were asked to fill out questionnaires about the development of their infant, with various intervals during the two years. This is the 'background information' on our children.

The parents were given the motivation for using the questionnaires as well as instructions how to fill them out by means of example situations and answers (e.g. Koopmans-van Beinum et al., 1990; Jansonius-Schultheiss & Van der Stelt, 1990b). These data were gathered to enable a comparison of the single cases with data on larger (normalised) populations.

Parents reported about *the infant's temperament* (Bates ICQ Dutch version; Duyvelaar, 1983), *illnesses* (from the onset to the offset, and the severity by means of our own questionnaire, adapted from Touwen, 1976), and the *psycho-motor development* (adapted from Pevenage, 1978). Their own *educational attitudes* were evaluated by means of two questionnaires about their 'control of the situations' and their 'tendency to seek further information' about raising children (Leenders, 1984).

The infants were tested by means of the mental scales of the *Bayley test* (Bayley, 1969; adapted for the Netherlands by Van der Meulen & Smrkovsky, 1983). The level of speech acquisition at the age of two was tested in a *laboratory setting* by the clinical linguist of the Netherlands Prevention Fund project, K. Jansonius-Schultheiss, using a fixed set of toys (e.g. Koopmans-van Beinum et al., 1990). These mother-infant play sessions have been recorded on video in the lab-setting, which showed that the two pairs performed differently (see 2.4.2).

2.2.4 Two single cases

The two mother-infant pairs were chosen because of their behavioural differences being the most pronounced of the six normal pairs that participated in the Netherlands Prevention Fund project (see 1.2).

a. ***EVE** and Claire*

EVE during this study, raised her *daughter Claire* alone. She lived in close harmony with her parental background which functions as a support system. Claire is her only child (after a previous abortion). EVE preferred to go to a hospital for childbirth because she was living alone. Claire was born at a gestational age of 39.4 weeks in one of the university hospitals in Amsterdam. Her weight was 3560 grams and she had an Apgar-score of 10 after 5 minutes.
EVE was globally informed by a senior staff member of the ward about participation in the Netherlands Prevention Fund project and appeared interested to cooperate. On the fourth day after she gave birth, I visited her in the maternity ward. She was given more details, and I explained that she and Claire were selected because the baby was perfectly normal and healthy. EVE decided to cooperate in the project, her family- and educational history was noted, and we made an appointment for the first recording session in her home.

During that first session (Claire was 2 weeks and 1 day old and just had a visit of EVE's parents and grandmother), we had the impression that EVE's interaction with Claire was very sensitive. She reacted alertly upon minor changes in her baby's behaviour, she hardly diverted her attention from the baby, and she often told us how wonderful her baby was. In the following weeks, Claire soon was aware of our presence and engaged us in her play, initially by gazing. With regard to our equipment with 'nice' lighting indicators, we came to a compromise about the duration of the manipulation of the equipment. Later on, she would sit on the look-out when EVE had told her that it was 'our day'.

Claire's temperament at the age of two was scored by EVE to deviate from the mean on four items on both the negative and the positive side, on two items even extremely positive. She was judged to be an infant of distinct 'likes and dislikes'. When she was six years old, the kindergarten teacher and her mother regarded her behaviour as 'independent'.
Claire was reported (by her mother) to be ill thirteen times during the two years, in total during 318 days, mainly because of colds. Her hearing was tested in the Academic Medical Centre of the University of Amsterdam when Claire was 8 and 14 months old and reported as normal. A neurological check-up at the age of 12 and 24 months by Dr. H. de Kleine, who had seen Claire perinatally and was informed about the parental

report on psychomotor development, indicated that she was, within the normal range, a fast developing child.
EVE observed Claire's psychomotor development quite precisely, informing us about new behaviours in the form of a diary. EVE, aware of her role as a mother, tended to collect more information about raising a child, although she had the feeling that she could cope with the situation as well as any other parent. Additional questionnaires on, for example, daily routines, eruption of teeth, and nourishment, were used to collect complementary data on developmental aspects. No major events occurred.

At two years of age, Claire's performance on the Mental Scale of the Bayley test was comparable to a 29 months old child. With regard to the non-verbal items, she was three months ahead of the mean population.
Claire's mean length of utterance (MLU) when two years old and in the lab-setting was 3.2. She produced 130 utterances during the 20-minutes recording, and 106 of these were transcribed as words. The mean length of the ten longest utterances (MLUL) was 6.0. In a group of ten normal children, she came first in the grammatical aspects, but not with regard to the number of utterances or words. These background data are reported more extensively in Koopmans-van Beinum et al. (1990).

b. *SUSAN and Fanny*

The other *mother, SUSAN* in this study, is married to John. *Fanny is her second daughter*. The eldest daughter Karen is four years older than her baby-sister Fanny, and was attending kindergarten at that time. SUSAN had heard about the Netherlands Prevention Fund project from an acquaintance and was interested in the possibilities for participation. We informed the family about the selection criteria.
SUSAN and John consented to cooperate (although the birth of their child had not yet taken place), knowing our conditions: pregnancy, labour, and birth (planned to take place at home), and the state of the infant after birth had to meet our criteria. They also knew about the goal of the project concerning speech development and mother-infant interaction of normal and cleft palate babies. Fanny was born at a gestational age of 40.5 weeks, her weight was 4000 grams, and she had an Apgar-score of 10, five minutes after birth.

During the first recording session (Fanny was 2 weeks and 4 days old), we noticed that Fanny would sometimes suddenly become tense and jerky, and then started to cry as in anger. SUSAN had trouble in handling this behaviour and experienced it as negatively directed at herself. We experienced this interaction as difficult too, "as a relationship at risk" (Thoman et al., 1979), but we did not interfere the interaction. Of course we had a willing ear for SUSAN's worries afterwards and during the following visits. Fanny clung to her mother during a large part of the first year. For not upsetting Fanny, we also had to keep a distance of at least

one meter. SUSAN coped with this behaviour very comprehensively, and later Fanny used to help us to install the equipment. When her baby-brother was born (she then was about eighteen months), she was obviously very proud, and welcoming to us. She replayed everyday situations with her doll during several sessions afterwards.

Fanny's temperament at the age of two was scored by SUSAN to deviate from the mean on six items on the mild-negative side, which indicated that she is a more 'easy going' child. Behaviourally, she was judged to be a normal infant. When she was six years old, the kindergarten teacher and her mother regarded her behaviour as 'cooperative in the group'. She then has had speech therapy for about three years, but her speech was still difficult to understand, and she needed therapy again.
Fanny was reported to be ill three times during the two years, with a total of 17 days. Once she vomited for four days, and she was hospitalised twice because of pneumonia around the age of 15 months (which is why the planned recording in week 65 is missing, Appendix I). Her hearing was tested at 8 and 14 months, in the Academic Medical Centre of the University of Amsterdam, and no abnormalities were found. A neurological check-up at the age of 12 and 24 months old by Dr. H. de Kleine, who had seen Fanny perinatally and was informed about the parental report on psychomotor development, indicated that she was a normally developing child.
SUSAN and John, regarding their own roles, did not tend to collect more information about raising a child. They had the feeling that they could cope with the situation as well as any other parent. Additional questionnaires on daily routines, eruption of teeth, and nourishment for example, were used to collect Fanny's complementary data on developmental aspects. No major events occurred.

When two years old, Fanny's performance on the Mental Scale of the Bayley test was comparable to a 19 months old child. With regard to the non-verbal items, she was four months behind the mean. She was making a game of the test, by smashing the test-objects around.
The number of utterances of Fanny in the lab-situation was 354 during the 20-minute-recording, with a mean length of utterance (MLU) of 1.1. The mean length of the ten longest utterances was 2.2. and the number of words 276. In the group of ten normal children, she was last in class with regard to the grammatical measures, but not with regard to the numbers of utterances and words (communicative attempts).
These background data are reported more extensively in Koopmans-van Beinum et al. (1990).

c. *Comparison of the two pairs*

When we started this study of mother and infant as a system, dealing with fundamental aspects in the development of speech, we already knew that

Claire and Fanny had developed quite differently with regard to speech communication. Fanny had speech therapy for three years after we had finished the project. This, however, was not expected in the beginnings of the Netherlands Prevention Fund project, because Claire and EVE, like Fanny and SUSAN, had fair chances to develop normally towards speech communication. Of course we have seen differences in interaction between the two infants. These differences were difficult to label in a general sense. The unexpected fact (considering the body of knowledge at that time) that Fanny at the age of two years was an infant with problems in speech communication, whereas Claire had no problems, is the topic of this thesis.

The background data, gathered during the two years that the two pairs participated in the Netherlands Prevention Fund project, can further illustrate the subjectively perceived differences in interaction. Temperament of the children was not clearly different, as judged by the parents. With regard to the educational attitude, EVE on her own, and SUSAN and JOHN together, judged themselves in control of the situation, and only EVE tended to seek more information about raising children. The medical histories of the children during the two years were different. Fanny twice had a severe pneumonia, and Claire was a child with near-continuous colds, risking glue ears perhaps. In both children hearing was examined twice, but no abnormalities were reported. Neurologically and psycho-motorically both children were in the normal range.
The Mental Scale of the Bayley test resulted in a difference of ten months between the two children. A considerable difference is found in the MLU and MLUL too, Claire being far ahead. Fanny produced more utterances, but Claire's were more complex.

The two mother-infant pairs differ in various ways on the scales presented above, and certainly in their vocal communication. These interactional differences were present during the entire period studied, and were 'formalised' by the questionnaires and tests. Many background data were gathered when the children were two years old and can thus be regarded to have resulted to a large extent from the (observed) differing interaction patterns. The children's records for illnesses are different; these illnesses may have resulted from more or less severe mother-infant conflicts during the transition periods (Van de Rijt-Plooij & Plooij, 1992, 1993; Plooij & Van de Rijt-Plooij, in press). Extra stress experienced in those transition periods imbalances the immune system (e.g. Plooij & Van de Rijt-Plooij, 1989), sometimes with serious effects on infant health. The results on the Bayley Scales and the Language Sample from the lab-setting (Jansonius-Schultheiss, forthcoming) reflect the influence of a normal speech development on such performances. As such the test results are quite logical.
In my opinion, the above background data show that *the interactions within the two pairs* have further accentuated the different patterns which we noticed already during the first recordings. The differences between the two pairs appeared to have been present throughout the two years, which

made them good test cases. The approach (chosen in this thesis) of mother and infant as a sensori-motor system is expected to differentiate between these two ways to speech communication.

2.3 Data collection

In this longitudinal study data have been collected in two qualitatively different ways. The *indirect* collection of data by means of questionnaires, tests, and medical examinations has been summarised above in the presentation of the two pairs. Now we get to the *direct* observation using the home video recordings which form the main body of this study. The collection of these data is further explained below.

2.3.1 Video recordings

In this study naturalistic, non-instructed, mother-infant interactions in free play situations were recorded during the first two years of the infants' life. Recording procedures resembled those of Tronick et al. (1979). The 'non-interfering' attitude of the observers towards the ongoing mother-infant interaction was maintained during the recordings (even though sometimes, we had a hard job to keep off laughing).

a. *Equipment*

As the recordings were to be made in a naturalistic setting, two cameras with professional lenses for low-light intensities (Panasonic WV 3990) were used. They were either placed on a tripod or hand-held, depending on the situation. On several occasions extra film light was needed: Dutch winters can be very grey.
The images were recorded by means of a mixer-whipper unit from Panasonic (WJ 5500) and a portable video recorder (Sony Vo 4800) enabling a split-screen display (JVC TM 22 monitor) for mother and infant at the same time. The Sony recorder accepted 20-minute-tapes only, which became the duration of the recordings, as interruptions for a new tape were regarded as a break in the interactional flow.
The date and time (from a video timer, VTG 22) of the recording were mixed in together with the two camera pictures. The timer was set on the stopwatch modality, displaying minutes, seconds, and hundredths of seconds.
Claire was one of the first babies to participate in the Netherlands Prevention Fund project. She and EVE were equipped with small clip-on microphones. Soon, these became the topic of mother-infant conversations, and we switched to a pending microphone. Fanny and SUSAN were not given the clip-on microphones at all.

b. *Frequency*

During the first year of the infants' lives the visits were made with approximately *biweekly* intervals, and in the second year with *monthly* intervals. In this thesis 24 monthly recordings, matched as much as possible for the two pairs, are used for further analysis (see Appendix I).
The recordings are considered to represent the normal, e.g. for that period usual, mother-infant interactions, which the mothers confirmed initially on a questionnaire.
Before each session, we telephoned to have the date and hour in question confirmed. Additionally, we reminded the mothers about questionnaires to fill out, and we informed them about tests and medical check-ups that we had planned in the weeks to come. In case of illnesses, an off-the-schedule recording would be planned.
When two years old, Claire and Fanny were recorded on video in a *laboratory setting* with their mothers in a semi-instructed play situation. A standard set of toys was used to assess linguistic abilities like articulation, phonological aspects, and grammar from a spontaneous speech sample (Jansonius-Schultheiss, in preparation).

c. *Procedure*

The home visits were made by a fairly consistent duo of observers, except during their holidays or illnesses. After an explicit greeting of mother and child, the equipment was installed in the habitual place in the room. The situation to be recorded was briefly discussed with the mother (e.g. "What is favourite now?"). Then mother and child began to play, and the recording started.
The mothers were allowed to do as they wished. Initially, mostly *face-to-face* -, or *held-by-the-mother* situations were recorded. Later on 'object manipulation', 'book reading', or 'games' were recorded, as well as interactions in between these activities. Interruptions were kept as brief as possible.
The two observers behind the two cameras developed a kind of sign system for switching between the mother and the infant, depending on changes in the situation. At times just one camera was used, when mother and infant watched a book, for example.

2.3.2 Transcription of video recordings

The transcription system (developed in 1984) describes in a micro-analytical way the vocal and non-vocal movements of mother-infant systems in the first two years. This level of description has been chosen because body movements are basic in human communication systems (e.g. Bullowa, 1979; Van der Stelt, 1979) and these can be described fairly objectively. The movements are transcribed for the two persons separately

with regard to the sound productions, and to the body parts involved. In 16 simultaneously present channels, the codes are categorised per channel in a mutually exclusive way (see section 2.4.2 a, Figure 2.2a for an example, and Appendix II for the system's channels and the codes per channel).
Per recording (except in week 12, when both infants fussed) five minutes of uninterrupted mother-infant interaction have been transcribed by one transcriber.
Micro-analytic transcription of the movements has been computer-assisted using hard- and software, developed for the Netherlands Prevention Fund project (Dijkstra, 1989; Koopmans-van Beinum et al., 1990).

a. *The first two years*

By recording mother-infant interaction from birth to two years old, an extensive period is covered in which major changes take place. When early and later behaviours must be compared, the description system should not have changed during that period.
Codes for similar movements of a newborn, a two-year-old, and a mother have to remain the same. Timing differences are accounted for in the micro-analysis of the recordings. An infant may need some time to visually find its mother's face, whereas a toddler can do so in a second. The duration of the infant's sound productions will also vary considerably. Combining the onset- and offset-time (duration of the sound) with a code for the type of sound production can reveal important changes in the channels for sound production of mother and infant.
Certain movements (such as walking) develop only later on, while earlier movements (as a 'shaky head') disappear completely. The movements of a neonate differ from those of a two-year-old child with regard to smoothness, timing, coordination, and direction of a movement. Also, the movements of the mother in interaction with an infant change during that period: 'care-taking' is replaced more and more by playing and by providing instructions.

b. *The movements*

The transcription system (Appendix II, based on Van der Stelt & Jansonius-Schultheiss, 1990) has codes for all movements of mother and infant that are likely to occur in naturalistic interactions during the first two years. It is not limited to a priori communicative movements as greeting or nodding affirmatively.
Usually, adult communicative movements are composed of well-timed simpler movements (e.g. Condon, 1977; Stern, Beebe, Jaffe & Bennett, 1977) as sound production, smile, gaze shift, touching hands and cheeks in the 'greeting ritual'. These simple movements (see below, section c.) are not necessarily communicative as such (e.g. a gaze shift). In the interaction

with a known human being, a communicative function is attributed to that movement.
In some pairs only half a word can mean as much as a long speech in another pair. The meanings of these particular interactions have to do with the mother-infant *'love affair'*. Stern et al. (1977) employ the term 'maintained engagement', and Bullowa (1979) refers to the relation as 'being in communication'. The affect system is regarded to be basic to the further development of an infant, including its speech development (e.g. Fernald, 1992; Bloom, 1993). In this context of emotional engagement, certain movements can become more specifically related (acquiring a meaning), and thus gain in communicative importance, since both partners know that the other is familiar with the meaning of the movements. The quality and timing of movements may gradually approach those of the standard adult communicative system or remain part of a *private system* of communication in that pair.
Beforehand, and as an outsider, it is difficult to know which movements are 'working or going to work' and which are not: this is for the mother-infant pair to decide. Therefore, the transcription system takes into account all movements in the recordings made during the two years. The possibility to compile simple movements of mother and child into 'new interactive behaviours' is considered a prerequisite in any analysis of mother-infant relations and their developmental processes. Certain compilations of simple movements may remain present in the interaction, while others fade away as their relevance disappears.
Initially, a mother may react audibly by means of a glottal-stop sound at the beginning of her utterance upon a purely vegetative sound of her young infant (as a hick-up). The function of this auditory interaction may be transposed to *new infant sounds* as soon as vegetative sounds are neglected by the mother.

c. *The movements per channel*

The transcription system consists of 16 channels in which approximately 200 codes for simple movements are categorised (Appendix II). The word 'simple' does not refer to the cybernetic coordination of the movement as such: certain codes in the transcription system result from complexly coordinated movements (e.g. sound production). A movement is called *simple* when it is transcribed by means of *one code in just one channel.* The channel stands for a *category* of movements. In the channel for *head* movements, for example, different codes are used for movements in the horizontal and vertical planes, as well as for the smooth combination of these movements. Many human behaviours consist of combinations of simple movements: greeting each other is at least composed of 'looking at each other', 'smiling', and 'vocalising' or 'shaking hands'.
One channel is used for the coding of mother-child *proximity* changes. Of the remaining 15 channels, eight are available for the child and seven for the mother. One channel per person is used to transcribe the *sound*

productions. The non-vocal movements are transcribed with regard to the body parts involved in the movements, and in the same manner for mother and child: *gaze direction, touch, and mimical, head, hand/arm, and body* movements. *Leg* movements are coded for the child only. Per channel the coded movements are mutually exclusive, which means that at one moment only one movement can occur in that channel.

The *sound productions of the children* have been coded in concordance with our previous work on respiration, phonation, and articulatory movements (e.g. Koopmans-van Beinum & Van der Stelt, 1979, 1986, Koopmans-van Beinum, 1990).
The *speech motor landmarks* in the developmental mapping of the speech mechanism are adapted in this transcription system with regard to aspects of phonation and articulation during one respiration cycle. Number and place of movements in the oral cavity are combined with aspects of phonation like perceived rising and/or falling intonation. For *reduplicated babbling,* separate codes are reserved for frontal movements ("papapa") or back-of-the-tongue movements ("gagaga"). The codes for these sound productions are thus mutually exclusive in the group of babbling sounds. Codes for vegetative sounds, crying, and laughing are added, and of course 'mono-, bi-, and tri- or more-syllabic-words' have different codes as well. Infant imitations of (parts of) the mother's sound production are indicated by specific codes or by codes used for the mother's utterances.
The *utterances of the mothers* are coded with regard to their communicative function, for example 'reacting upon the child's sound production' or 'focused upon body movements'. The content of the mother's utterances is written down in a column reserved for comments and is not used in the analysis as such.

The transcription system results in a kind of *orchestration of all the movements that occur in mother-infant interaction.* This manner of describing mother-infant interaction in terms of simple movements in different channels has several advantages.
By breaking down complex movement patterns into simple movements, the number of codes is reduced (comparable to phonetic acoustic analysis). Essential movements that make out the greeting-ritual may be the *gaze plus sound production plus touching hands*, with at times a smiling face as an addition. If a transcription system focuses on complex movement patterns, the greeting-ritual-*with-smile* has to be coded differently from the greeting-ritual-*without-smile*. Breaking down the complex patterns to simple movements also has its advantages during the transcription itself. Training is a prerequisite with the system, but during the coding of movements in the channel 'gaze direction', the transcriber can just concentrate upon the seven codes of that channel.
Another advantage of this system is, that the choice of movements to be described can be related to the aim of a study. If a researcher is only interested in face-to-face contact, the codes for other gaze directions can be deleted.

d. *Transcribers*

In this study I have chosen for *one transcriber* for the recordings of Claire and EVE, and of Fanny and SUSAN. Initially, the first six recordings of Claire and EVE have been transcribed by means of a paper-and-pencil method by two independent, trained transcribers (c1 and c2, see Table 2.1), because at that time the computer-assisted transcription was not yet available. These written transcriptions were fed into the computer afterwards and were checked while watching the video recordings.

Comparison of the transcriptions of these two transcribers showed differences especially with regard to the number of movements that were indicated, and not so much to the chosen codes. Some examples can explain these differences.
When the infant is looking into the direction of the camera, a transcriber may notice the difference in gaze direction between 'looking at the object' or 'looking at the person behind the object'. For the channel *sound production* a comparable example can be given. If an infant is producing a series of audible respirations, a global transcription will link the series. A 'narrow' transcriber, interested in the rhythm of respiration, indicates a series of codes for the onset and offset of each 'vegetative sound'.
Certain movements were 'not-seen' in one transcription, but were 'seen' in the second one, and vice versa. For the comparison, coded movements were regarded to have happened in either one of the transcriptions. The narrow transcriptions, indicating more movements than the broad transcriptions, ended up with a low percentage of consistency. Broad, more global transcriptions had indicated the major part of the 'obvious movements' and thus had a higher percentage.

Table 2.1
Comparison of the number of codes in four channels as indicated by two different transcribers in a recording of Claire and EVE. The number of *codes in common* (cic) is given per channel, as well as the number of codes per transcriber (c1, c2), and the percentages for consistency of codes in the two transcriptions. Gaze direction: IV (Infant Visual), MV (Mother Visual). Mimical movements: IM (Infant Mimics). Sound production: IS (Infant Sound).

channel	cic	c1	%	c2	%
IV	38	41	95	52	73
MV	35	35	100	51	69
IM	38	42	90	56	68
IS	26	30	87	47	55
Mean	34	37	93	52	66

Table 2.1 gives an illustration of the differences between the two transcribers. The more global transcriber (c1) reached a higher percentage of codes-in-common than the narrow transcriber (c2), but the movements that were not noted by the broad transcriber can play a role in the interaction between mother and infant. The percentage is not decisive as such. It was decided to have the second transcriber (c2, the author of this thesis) transcribe all recordings in a narrow way.
Transcription (over the sixteen channels) of a five-minute session of mother-infant interaction (per recording) took approximately eight hours, and proved to be depending on the quality of the video recording as well.

The *consistency in the narrow transcriptions* of the recordings of Claire and EVE, and of Fanny and SUSAN was checked in a second transcription of certain recordings (see Table 2.2 in which c2 was checked). Per channel an interaction segment of at least two minutes was selected within the five minutes that were transcribed previously. The recordings were chosen in quite different age periods to check the transcriber's accuracy upon different, age-related types of movements. In total, 44 channels over 7 recordings were transcribed a second time. These second transcriptions were made by me (c2) about two years after the first ones. The selected channels are used in the chapters on intersubjectivity, intentionality and turntaking. In Table 2.2 the mean percentage and range per compared channel are given.

Table 2.2
Mean percentage and range for consistency in number of codes per transcription over eight channels, transcribed narrowly by c2 from seven different recordings of Claire and EVE, and Fanny and SUSAN over the first two years. Gaze direction coded in the visual channel is indicated for infant (IV) and mother (MV), sound production as IS and MS, mimical movements as IM and MM, and head movements as IH and MH.

channel	mean %		range %
IV	78		72 - 88
MV	81		62 - 96
IS	89		72 - 97
MS	86		75 - 96
IM	83		73 - 93
MM	87		75 -100
IH	78		72 - 84
MH	89		87 - 91
Mean	84	Total	62 -100

The comparison of the two sets of transcriptions was made (per segment) with regard to the number of codes and their approximate time-indications in the channels. In either transcriptions, the missing codes were regarded as 'possible events', which had gone unnoticed. The comparison was made manually, which accounts for likely mistakes in onset and offset time and for obviously missed codes.
The *second transcription* has been consistent with a mean percentage of 84% for the number of movements per recording, representing the codes in common versus the total of possible codes (including the 'unseen movements' in any of the transcriptions). This percentage is acceptable in view of the variation in quality of the recordings. The range in the consistency of transcription is 62% to 100% for the 44 transcribed channels. Fluctuations in the number of movements and codes for mother-infant interactions per transcription were within the range of fluctuations of the interactions over the two years (see Appendix III).

e. *Five minutes*

Except for the third recording (week 12), the mother-infant play situations lasted about 14 (during the first year) to 20 minutes. Among these episodes it has been possible to select five minutes of uninterrupted, engaged mother-infant interaction. Transcription of five minutes per recording offered an acceptable equilibrium between the number of movements, the different codes, and the consumption of time for the transcription.
The mean number of changes (onsets and offsets over the sixteen channels) per pair and per recording is calculated, as well as the mean number of different codes. These numbers give an indication of the amount of movements per five minutes, transcribed in the sixteen channels.

Table 2.3
The mean number of changes and the mean number of different codes as well as the total numbers in the five-minute transcriptions of the 24 matched recordings, given for the two pairs.

		changes		different codes	
	recordings	mean	total	mean	total
Claire	24	467	11215	44	1064
EVE	24	464	11124	48	1154
Claire+EVE	24	931	22339	92	2218
Fanny	24	491	11776	45	1073
SUSAN	24	367	8811	45	1089
Fanny+SUSAN	24	858	20587	90	2162

Certain recorded interactions were quiet ones, while others were full of movement. Within one recording the number of movements per channel and the different codes varies according to the kind of interaction. A book-reading situation may show a relatively quiet child, compared to the hand/arm movements of the actively pointing, page-turning mother. In object-manipulation the reverse can be found. When either of the two was fairly active, the partner may remain somewhat more quiet or may join the activities (see Table 2.3, and Appendix III).

The *choice of five minutes* of uninterrupted naturalistic mother-infant interaction in a recording is fairly arbitrary, in view of the fluctuations in the number of movements in mother-infant interaction over the two years. In that period the play situation changes considerably, whereas one single semi-structured situation, like book-reading, is not occurring in all recordings of that period. In my opinion the transcription of five minutes naturalistic mother-infant interaction per recording offers a fair chance to find examples of 'selective' mother-infant interaction, considering the number of movements that occurred. Table 2.3 gives an overview of the changes that occurred in the transcriptions of the recordings over the two years (see Appendix III).

f. *Micro-analysis*

In the example below which comes from the literature, a complex movement pattern of mother and baby is given by Halliday (1979). The sequence of movements of the body parts involved does not necessarily represent their timing. It is not clear whether the mother's movements are simultaneous to the child's, nor to which ones they are.

> "The child is moving his face, his lips and tongue, his arms and hands and his whole body, and the movements are directed towards his mother: he is addressing her, and she is 'receiving' him. Simultaneously, she is addressing him with sounds and gestures of her own and he is receiving her."
>
> (Halliday, 1979, p. 171)

A micro-analytic description of the simple, mutually exclusive movements per channel opens the way to analyse interaction with regard to the timing of simple movements in different channels. Then, the 'responsibility' for the establishment and the termination of face-to-face contact in the given example can be laid by either one of the persons. In a deviating interaction one person then can be blamed, and the question remains whether that is a correct conclusion.
In the approach presented in this thesis, the *system* is held 'responsible', not the individuals. The individuals, in their mutual engagement, are expected to deal fairly adequately with the behaviours of their partner and the effects on their own behaviours.

g. *Computer-assisted transcription*

The initial paper-and-pencil-manner of transcription was later on computerised to reduce the amount of time needed per recording. A data base was constructed to facilitate the analysis of the data. A hardware device enabled encoding and decoding of the unique frame numbers, while a software program linked the QWERTY-keys of an Olivetti PC and the frame of the video recorder.
Per recording, per channel, and per person a 'protocol' file was constructed, with onset- and offset-times of each code. These were found by means of slow motion display. The resulting sixteen files per transcription can be transformed to ASCII files. These serve as input for other programs, like FP for counting and PROGRAAF for visual data representation or processing (see section 2.4).

Hardware
While copying the original tape to a tape for transcription, each video frame was given a unique *frame number* by means of a Video Code Generator/Detector device (VCGD). This system has been developed at the Institute of Phonetic Sciences, University of Amsterdam, in cooperation with the TNO Institute for Perception in Soesterberg, the Netherlands. Every video frame is built up in 0.02 seconds and the frame number thus changes in synchrony while watching the recording. By linking the recorded stopwatch time from the screen to the frame number, the latter could serve as a time indicator. The transcription input program (PROTIN) used the frame number to calculate the onset- and offset-times of codes.
The video tapes were played back on a Sony Vo 5800 recorder with a continuous forward and backward search mode for frame-to-frame analysis, and were displayed on a colour monitor (Grundig, 63 cm). The VCGD was connected to the Sony recorder and to an Olivetti M24 PC, modified with an interface card for the VCGD-input. The PC could read the time per frame automatically as soon as a QWERTY-key for a code was touched.

Software
The modifications of the PC have been accompanied by a software program PROTIN, written in Turbo-Pascal 3.01A (Dijkstra, 1989) to store transcription data from (micro-analytical) event studies. The program leads the user through various levels of data input (e.g. identification of the pair, date of the recording, channel to be coded). At the protocol level, representing a channel with the codes, a choice must be made for input from paper-and-pencil transcriptions or automatic input of the frame time from the VCGD system. Merging and splitting up of protocol files in their correct time sequence, or transformation of the data into ASCII-files is also possible.
The program has an edit function for the comment column, in which an orthographic notation of sound productions (a mother's utterance), a comment about a situation or an action can be given. Apart from some

special function keys, all QWERTY-keys can be used for coding per channel.

Onset- and offset-times of codes
As five minutes per recording were analysed in sixteen separate protocols, the start of the transcriptions had to be exactly similar for all protocols. Only then, merging of the files for mother and infant would not violate the sequences of the coded movements.
When the protocol was given its identification, the actual transcription of the chosen channel had to start with the frame number that marked the onset of the five minutes. That first frame number had to be linked to the recorded stop-watch time of the tape displayed on the monitor.
When the mother started to look at the face of the infant, the F-key for 'looking at Face' was pressed, followed by a return. Then, PROTIN searched automatically for the frame number and calculated the time in seconds and hundreds of seconds: the code F appeared in the channel for Mother-Visual together with a time indication.
By means of the search mode of the video recorder, the tape could be advanced very slowly until a change in gaze direction occurred. This change could be seen from a rather blotted image of the eye. Within a fraction of a second the next code for gaze direction could be chosen. A final check of the 'logic' of the transcription per protocol, with regard to the codes and their sequence and with regard to the increase in time was then executed upon request by PROTIN.

2.4 Data processing

The approach of mother and infant as a sensori-motor system must also account for movements of the individuals which seemingly have no function in that system. Therefore, a sensori-motor transmission model was formulated together with constraints per channel for transmission of movements between the two persons. The reduced data set is analysed further by means of software programs.

2.4.1 Sensori-motor transmission model for mother-infant interaction

The movements (in this study transcribed for the five minutes of mother-infant interaction per recording and per person) represent the basic material from which mother and infant select, privately, their communicative movements. The choice to react or not upon a movement changes with the ongoing development, and with personal and with situational aspects, which applies to the mother as well as to the infant. Getting to know *mutually audible signals and facial expressions* must be important in the development of communication.

A *model for the transmission of movements between mother and infant* is presented in Figure 2.1. The *'output' movements* by both partners are coded by means of the transcription system (Appendix II): eye movements, mimical movements, head movements, hand and arm movements, body movements, leg movements of the infant, and speech movements.
The *sensory information ('input')* in mother-infant interaction in this study is processed primarily by the visual (eye), the acoustic (ear), and tactile (touch) senses of the partners.
The sensori-motor transmission between two individuals usually is limited, since not all movements of both partners are constantly being perceived by both partners. In adult human communication systems, certain movements function as a signal in the 'noise' of other, simultaneously present movements. Certain communicative movements, such as an eye wink, likely occur when the receiver is looking at the sender's face from a certain distance. Other movements result in more than one sensory perception, like 'looking at' and 'feeling the caressing hand', or looking at a speaking mouth.

Constraints on the transmission of movements were in my study described at a fairly simple level, since memory for previous movements is not taken into consideration. The infant may turn his gaze away from the smiling face of his mother, and when returning his gaze to her face see a neutral expression. This would be regarded by the model as a completely new situation. Thus, movement patterns displayed in time during mother-infant interaction are not linked. Furthermore, the *sequence of movements* perceived by the partner is also neglected.

Not all sixteen channels for mother and infant interaction are taken into account in this thesis, since the compilation of simple movements into more complex patterns has been restricted. In the transcription system (Appendix II) the movements which a person makes are categorised per channel. In Figure 2.1 the grey triangles and blocks indicate the selected transmissions. For each channel the constraints for transmission of the movements to the partner are indicated below. The asterisk before the channel names indicates that those channels are used in the approach of the mother-infant system as studied in this thesis.

* *Eye movements*, i.e. changing the direction of the gaze (coded in the channels MV and IV for mother and infant respectively), are important in mother-infant interaction as they may indicate that attention is focused elsewhere. An eye movement is regarded as transmitted only when the partner is looking at the face of the 'sender'.

* *Mimical movements*, i.e. changing the facial expression of mother or infant (coded in the channels MM and IM), are considered to be transmitted only when the movements were seen by the partner. This is the case when that partner is looking at the other's face while the movements occur.

* *Head movements* (coded in the channels MH and IH) are thought to 'work' in mother-infant interaction only when gaze direction is towards the face of the partner while the distance is relatively small. A very young infant can focus between 20 and 50 cm, so when sitting on the mother's lap and looking at her body, her head movements are not seen by the infant. The mother who is looking at the body or hands of the baby can see the infant's face only peripherally. The focus of attention is not upon the infant's head movements and these are therefore regarded as *not-seen* by the mother.

* *Sound production movements* (coded in the sounds channels for mother MS and child IS), resulting in audible utterances, are perceptible for the partner in all circumstances since all recordings were made when mother and child were interacting in the same room. The auditory channel is a very 'sure' medium in this transmission system.
The segmentation of the (speech) sound stream into utterances making up a conversational turn by mother or infant is based on the physiological limits of the respiration cycle; this holds for mother *and* infant. The pauses between the utterances, resulting from the inspiration or from intended silence, are regarded to be transmitted as surely as the utterances themselves.

Tactile information is supposed to be transmitted in mother-infant interaction whenever the partners somehow touch one another in a changed way, which was visible for the observer (coded in the channels MT and IT). When the mother kisses the baby on the cheek, the moment that she touches the baby with her mouth is coded in the IT channel. The head movement and probably the smile of the mother will have started shortly before and are coded in the mother channels. Touching oneself is coded in the personal hand/arm channel by means of certain codes.

Hand and arm movements (coded in the MA and IA channels) are considered to be perceived by the partner when the gaze is directed at the *body* of the actor. When looking at the face, hand or arm movements may be seen as well, but more peripherally. Certain movements are clearly tactile, like caressing, and are thus coded in the tactile channel of the partner who is touched. Apart from speech sound production, other movements, like hammering, are audible as well. These audible aspects of movements (a touching hand) have been disregarded in our transmission system.

Leg movements of the infant are coded in channel IL. The infant's leg movements are regarded as visible to the mother when she is looking at the body of the baby. Walking has been coded in this channel as well as in the channel for 'body movements'. The movements of legs were not coded for the mother, since the lower part of her body usually was not visible in the recordings.

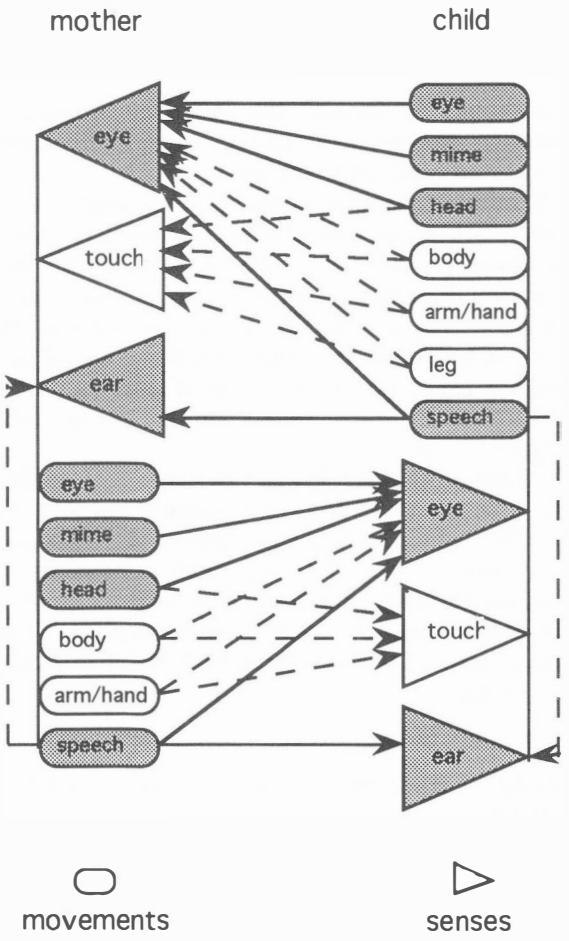


Figure 2.1
Sensori-motor transmission model for movements and perception of the movements by the partner. The movements are indicated in a rounded block, and the perception systems in a triangle. The grey ones are used in this thesis. Constraints for the transmission of movements between mother and infant are described in section 2.4.1.

Body movements (in the channels MB and IB) are transmitted when gaze is directed either at the face or the body of the partner, which may occur in situations when the distance between mother and baby is large. Changes in posture can also be transferred via the tactile channel, when the mother is holding the baby.

Proximity changes have been coded relative to the mother in channel MP in three categories: body-body contact, within arm distance of the mother, and outside that distance. The constraints for this channel are expressed relative to other channels, such as the tactile one, for example.

In these sixteen separate channels the coded movements of mother and infant in interaction can be combined to form more complex patterns, keeping the formulated constraints in mind.
An individual 'behavioural score' of movements that occur only in a few selected channels, such as gaze direction and mimical movements, can be obtained. With some practice it is possible to 'read' the score and to reconstruct the actual situation in which a person's movements occurred. A compilation of movements into an 'interactional score' is also possible, by selecting channels of both persons, like gaze direction of both persons and mimical movements, representing the flow of their movements. At times, mother and infant act simultaneously in the same channels, or they alternate their movements.
The behavioural score is comparable to the score of a musical composition, which prescribes what must be done at a certain moment. The transcribed movements have their place in time, they have a duration, a position in the sequence of movements per channel, and a position in relation to movements in other channels as well. The sensori-motor model for the transmission of movements in the different channels (such as actually seeing certain movements) is thought to be helpful in finding patterns in the mother-infant system.

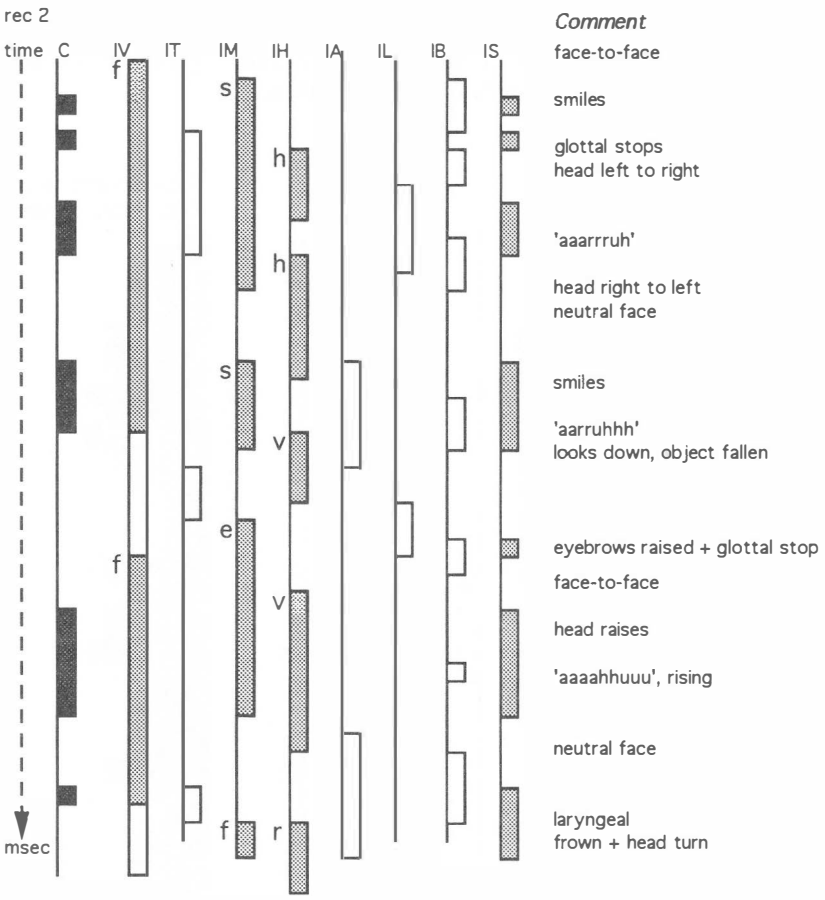
2.4.2 Movement pattern definition and detection: PROGRAAF

A software program PROGRAAF (Kerkhoven, 1989) was written to assist the definition and detection of patterns. The program is written in Turbo-Pascal and is used for MS-DOS computers.
PROGRAAF has three main functions:

1. a graphical representation of the transcribed data to enable a visual inspection,
2. the possibility to select specific channels and codes from the data base, and
3. a simple calculator for duration and frequency of a selected movement pattern.

The *first function* of PROGRAAF, graphical inspection of the micro-analytic data, is useful for the detection of movement patterns. In PROGRAAF the 'pictures' can be given in various ways:

a. As a score, in which the channels are represented as vertical lines like in Figure 2.2a . The codes in the channels are indicated on the lines, like blank or dotted blocs. The time base can be changed to obtain a more extended or a more dense version of the score.



C = criterion file, created by PROGRAAF: sound + looking at face
IV = infant visual channel, code f = looking at the face of the mother
IT = infant being touched (not used in this study).
IM = infant mimical movements, code s = smile, e = eyebrows raised
f = frown; neutral face is suppressed in score.
IH = infant head movements, code h = horizontal, v = vertical, r = h+v
IA = infant hand/arm movements (not used in this study).
IL = infant leg movements (not used in this study).
IB = infant body movements (not used in this study).
IS = infant sound productions, codes described in comment column.

Figure 2.2a
The score over eight channels for an infant in the second recording. Per channel the different codes are indicated as blocks, the filled ones have been used in this study. In the comment column, extra information can be given about the codes or the situation. The C-channel has been created by PROGRAAF from the visual and the speech sound channels.

b. As a cumulative histogram of the number of movements that occur in the (selected) channels during a given time lapse (see Figure 2.2b). This manner of data representation gives an impression about the density of actions per time unit.

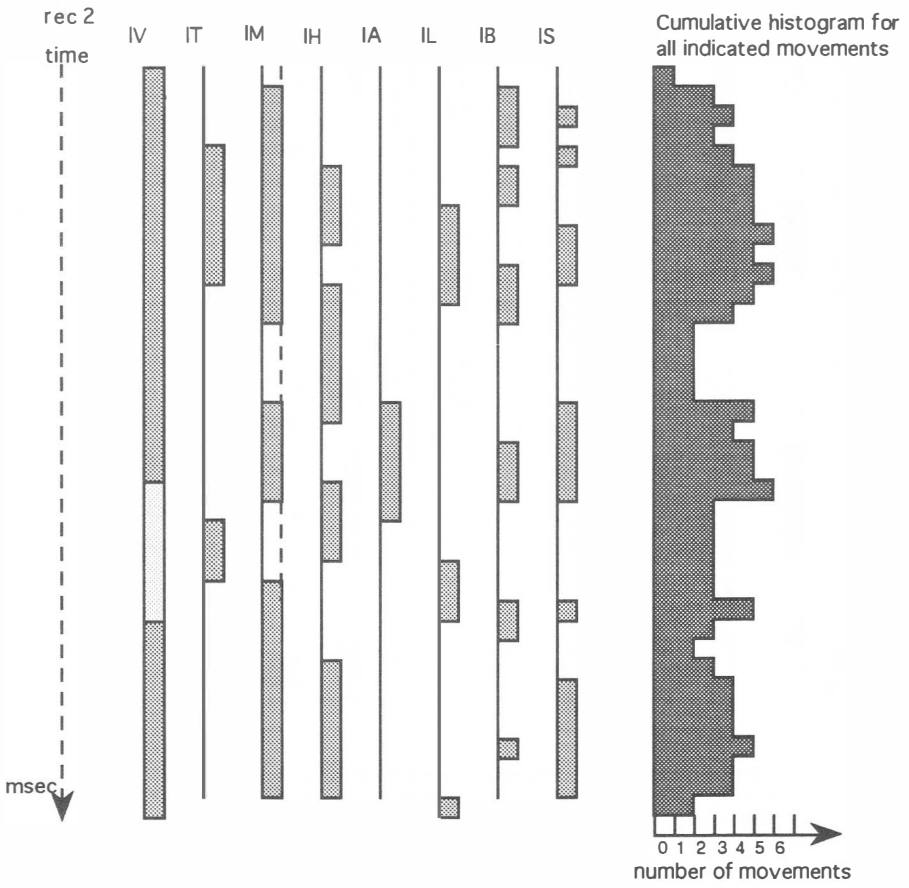


Figure 2.2b
A score over eight channels for an infant, constructed by PROGRAAF from the original transcriptions of the second recording. Per channel the different codes are indicated as blocks. In a cumulative histogram of the eight channels, the number of codes present per time unit are given.

The *second important function* of PROGRAAF is the selection of the micro-analytic data, to check upon the occurrence of specific patterns of movements. Channels and specific codes can be selected, copied to a new channel, or skipped altogether. Furthermore, just the onset of a movement can be selected, the codes then lose their duration and thus are given as spikes only. This function has been very useful, especially for the research discussed in the chapters to follow.

The 'movements on the infant's face', coded in the mimical channel, that occur during 'looking-at-the-face-of-the-mother' in the channel for gaze direction can be selected, for example (see Figure 2.2a). The program will then indicate these patterns in the score-mode (with the onset- and offset-times). This 'criterion' pattern can be saved as a 'new' file, to be used in further pattern search. Combining this file of the baby with 'looking-at-the-face-of-the-baby-by-the-mother' can then indicate the moments when the mother actually sees the baby smile, or frown, or raise his eyebrows, which point at an interactional pattern (Infant-smile during face-to-face contact, etc.). These patterns must be defined with regard to the simple components (movements) of the two individuals. In Figure 2.2b, for example, the neutral facial expression (not-filled blocks) is indicated in the infant's mimical movement channel (IM), but can be suppressed in the analysis.
Manipulation of the onset- and offset-times of the codes is also possible. When a pattern is selected, PROGRAAF gives an option to add (fractions of) seconds to the onset- or offset-time of a code, even when the code is changed to a spike-code. In this manner the program can be used in a more tolerant way, accounting for 'timing-errors' in a pattern. If it is expected that the mother will smile and talk almost immediately after 'face-to-face contact', the pattern detection can also be used more strictly in time. On the other hand by adding time to the offset-time of specific infant movements, the baby's coordination difficulties can be accounted for.

Finally, PROGRAAF gives some statistics on the *patterns,* like, for example, the number of times a pattern has occurred in the transcription, information on duration in seconds of the pattern, and the percentage of time of the pattern in relation to the total duration of the transcription. When the selected pattern consists of 'mimical movement' during 'face-to-face contact', PROGRAAF indicates the duration of mimical movements in the total recording and that of mimical movements during face-to-face contact.

2.4.3 Frequency Program: FP

FP is a program for straightforward counting in the PROTIN-files which are constructed during the actual transcription of the video recordings. The files contain information about the number of different codes per channel and about their durations. A slight transformation (suppressing

comment and header information for example) is necessary to use the files as input for the FP program. This statistical program has been adapted by R. van den Horst of the Centre for Mathematics and Informatics, in a cooperation of that Centre, the Paedological Institute of the City of Amsterdam, and our Institute of Phonetic Sciences of the University of Amsterdam. It now gives an overview of the various codes for movements per channel and per recording with regard to their occurrences and their *durations*. This last aspect was useful for our purpose, as this was impossible in the previous version of the FP program.
Per code the frequency is given per transcription, together with that code's contribution to the total number of codes in that channel as a percentage.
The overall durations of the different codes are given in seconds and as percentages of the total duration of the transcription. Of each code the mean, median, minimal, and maximal durations are calculated. The amount of time that no codes occur in the channels is given as well.
The program can do these calculations for the PROGRAAF-files, i.e. representing specific *patterns* of movements in a similar way. A simple overview of the amount of time of face-to-face contact as well as the number of the contacts in the subsequent recordings can be given by computing the results from FP.

2.5 The following chapters

In the following chapters, *intersubjectivity*, *intentionality*, and *turntaking* are defined as compilations of simple movements of mother and infant. Specific movement patterns are chosen to represent the three fundamental characteristics of communication systems. These are analysed in a quantitative way along the lines of the transmission system, in order to decide about their possible communicative value. In this operationalisation the qualitative difference between adult and infant behaviour is disregarded. Per chapter the consequences are discussed. The possibilities of PROGRAAF are used to search for the movement patterns in the original data base which covered the recordings over the two years. FP is used for quantitative aspects of the movements.
For intersubjectivity, mutual visual orientation and vocal-aural tuning is important (Chapter 3). Intentions are transmitted by means of movements only when mother and infant are attuned towards each other (Chapter 4). Turntaking of the mother upon sounds of the infant must occur within a certain pause at the end of the sound production (Chapter 5).
The first outline of a method to objectively evaluate movement patterns in the mother-infant system in relation to speech development (see Chapter 6) is mainly based on the *quantitative measures like amount of time and number of movement patterns.*

3

INTERSUBJECTIVITY

Abstract

Communication in humans assumes intersubjective tuning between at least two individuals who have both noticed each other. This tuning is regarded to be one of the common characteristics of communication systems. The approach chosen in this thesis focuses on the description of the movements of the individuals conforming to the sensori-motor model which formulates the constraints for the transmission of movements.
In the mother-infant system, the tuning is initially a multi-modal phenomenon with affective pre- and post-natal roots. Tuning via the two distance channels is also related to this basic aspect of communication systems. Speech development is at-risk if a gradual uni-modal tuning is not established during the second half of the infant's first year.

An initial asymmetry or inequality between the mother and her infant with regard to specific behaviours is well-known. Yet, the mother and the baby orient towards each other in a unique way. As such, they can be regarded as a closed system. With the growing physical distance between mother and infant, developmental processes proceed in the direction of adult behaviour.

In this chapter, the development of intersubjective tuning is described as objectively as possible for the two mother-infant pairs throughout the first two years. Early intersubjective tuning is considered to be expressed during mutual gazing at the partner's face, during simultaneous sound production, and during simultaneous vocal-aural together with face-to-face communication. The movements for the compilation of the patterns are presented and discussed.

The intersubjective tuning of the two pairs, which were selected as test-cases for the approach of speech development, is analysed for the three forms of tuning during the first two years. Already during the first five months, the pairs appeared to differ in the bi- and uni-modal use of the visual and auditory channels for tuning.
Results are discussed in view of their possible impact on early speech development, and with the following chapter (on intentions) in mind.

3.1 Introduction

"The ethics of all civic and practical messages depend on such emotional sharing utterly."

(Trevarthen, 1990, p. 690)

Intersubjectivity, the mutual notion that another important creature is present, is the focus of this chapter. This very basic aspect of human communication systems can make use of the various sensory-motor modalities. With our approach (introduced in the first two chapters) of early speech communication in mind, we explored how the two mother-infant systems gradually tune in via the visual and auditory modalities.
Literature on mother-infant interaction will be presented with regard to developmental aspects of intersubjectivity and intersubjective tuning in relation to speech development.
The compilation of simple movements for intersubjective tuning is discussed. The results for the two mother-infant pairs are presented and discussed.

3.1.1 To reanimate 'intersubjectivity' for the adult reader

Stage:	elevator in a skyscraper.
Actors:	two sensible ones.
Attributes:	none.

Elevator goes up, one insider.
Stops at floor nine, door opens.
Outsider comes in, door closes.

Actors tune in (or not) their sensibility

In the above reanimation, there probably is a comfortable distance between the sensitive actors and a score of intersubjective sensations, experienced from positive to negative by the individual actors. The sensations change with the modalities, like the smell or the visual impression of the co-actor. To many people, intersubjectivity has to do with feelings and is therefore not regarded as a suitable topic for exact description and analysis.
The approach chosen in this thesis delimits the notion to observable simultaneous behaviours of two persons, excluding the observer's intuition about the meanings of the behaviours, because these intuitions usually are too subjective. Intersubjectivity, here taken as the interpersonal mental engagements, supposes an effort of, in this case, mother and infant to

make mind-to-mind links. Mother and infant must bridge a distance, which is often indicated as an inequality in behaviours of the two persons involved. When actually observing a mother-infant pair in free play situations, the differences, however, seem less prominent. The distal intersubjective tuning between mother and infant is described as objectively as possible, as is the co-occurrence of certain simple movements of the two persons.
Another pitfall is that, for adults, *intersubjective situations* soon touch upon their knowledge of normal intentions of individuals (thus, the interpretation of behaviours of the partner). In adults, the mere sensation of someone present is often appreciated only subconsciously. In the presence of someone (and even in the absence) we act 'meaningfully', and 'spontaneous' movements have a fair chance to be interpreted as an intention. We can not imagine a world without intentions, without a goal-directed motive for our movements.
In the literature, intersubjectivity and intentions are rarely treated separately in the actual description of early interactions. In this chapter of the thesis, however, the reader is kindly requested to disregard the intentions, and rather focus on the underlying forms of intersubjective tuning, or the ways that mother and infant pay attention to each other.

3.1.2 Literature and definitions

In this section, the literature date are presented with regard to intersubjectivity and to the way that tuning is found in early mother-infant interaction. The intersubjective tuning in a system may cause tensions because of the individuals' preferences, and may divide the two persons, resulting in interactions-at-risk. Special attention is given to the use of distance modalities for intersubjective tuning, since these may show in an observable way an underlying characteristic.

a. *Positive feelings*

In general, the term 'intersubjectivity' in literature refers to positive feelings like togetherness, emotional bonding, mutual attraction, empathy, and the intermediate, mutual, and reciprocal aspects of perceptions and actions of affection between two persons (e.g. Trevarthen, 1985; Beebe, Jaffe, Feldstein, Mays & Alson, 1985; Foster, 1990). Subjectivity stands for aspects like belonging to one person, stemming from that person, or to aspects related to the mind of that subject. The behavioural streams are connected by the term 'inter', as a method or a manner for the two persons to express their relation in the time-space dimension.
Intersubjective tuning, affective bonding, and interpersonal empathy are regarded as basic phenomena that even can be described from a biological point of view (Trevarthen, 1985; Wind, 1986), crucial for the quality of interpersonal contact, and a prerequisite for human-to-human speech

communication and human social interactions (e.g. Murray & Trevarthen, 1985; Trevarthen, 1989; Messer, 1986; Myers, 1987; Stern, Hofer, Haft & Dore, 1985; Toda, Fogel & Kawai, 1990; MacDonald, 1992; Mann, 1992).
Intersubjective tuning as part of the affect system between mother and infant sets the stage for the infant's further development towards speech communication as well (e.g. Bloom, 1993). This affective relation is seen as a fundamental motive to communicate with another human being, and the speech communication system has such motive as well.

b. *Problems in intersubjective tuning*

The literature often evaluates intersubjectivity between mother-and infant as 'only positive', or the seemingly 'natural' manifestations of intersubjective development in normal mother-infant pairs. The accent on the positive feelings seems to result from a socially forced picture of mother-infant relationships (Price, 1989), which may neglect the difference in interests of the two persons involved and their contrasting situations. Child abuse or worse by caretakers is reported regularly (e.g. Mann, 1992), yet, caretakers are also able to sacrifice their personal opportunities in favour of their infant's.
Because of difficult and painful labour, some mothers may feel *anger towards the child*, which is not easily accepted socially (Price, 1989). Other sources of negative feelings are, for example, the disappointment with the sex of the baby, or the fatigue caused by the day-and-night-caring schedules (Price, 1989). The quality of intersubjective tuning may depend on these positive or negative feelings by the mother towards her infant. A more jerky handling of an inconsolable baby, sometimes together with an increasing tolerance for the infant's crying, exemplifies negatively coloured intersubjectivity. Also, vocally tuning to the baby's sound production by means of soothing sounds is difficult to implement for a mother with a basic anger.
Intersubjective tuning is an interactive process between the adult and the infant. Fraiberg (1979), comparing her own interactions with a blind and a severely neglected, unattractive but sighted infant, expresses her feelings towards the blind infant as follows:

> "..., but always I had the sense of something missing, something that should be coming back to me from Toni. There was of course no fixation of my face. And something else was missing. Although Toni smiled frequently in response to her mother's voice, she rarely smiled in response to the voices of us as observers."
>
> (Fraiberg, 1979, p. 150)

The sighted, unattractive child, however, sometimes gave the adult reinforcing 'return'-messages that were interpreted as expressions of their intersubjective relation.

The newborn, looking at the mother's face, and the mother's scanning of the infant's face is thus an important factor for interpersonal attachment and for getting to know and to recognise each other (Fraiberg, 1979). Adults, at certain moments and due to certain feelings, are at times less ready to express themselves by means of these channels, and thus they are programming the baby differently.

c. *The onset*

For scientists, early intersubjectivity can be difficult to define because of its emotional aspect. For some it is thought to develop before birth between mother and infant. For others, the concept is linked with 'self-awareness' of the infant, comparable to an adult 'self-concept', which develops much later in infant life.

For the family, the pre- and post-natal period is a period of emotional and social change. The mother perceives the baby after birth as a, really present, new person. On the whole, it is not clear whether the baby perceives the mother as a person. She was the baby's world before birth, and he will develop gradually a notion of intersubjectivity after birth.

From birth onwards, *an infant is clearly engaged in a process of enculturation*, as transmitted by at least one adult of that society. Only some, the wolf children, seem to have survived without an adult (e.g. Malson, 1972). Newborns give their visual attention more easily to animate than to inanimate objects (e.g. Newson, 1977) and have a preference for and react to faces (e.g. Bower & Wishart, 1979; Meltzoff & Moore, 1977). Probably quickly attuned to the mother as a primary caregiver, infants show preferences for her signals, which could be demonstrated within a few hours after birth (e.g. DeCasper & Fifer, 1980; Trevarthen, 1990). The infant is biologically pre-prepared for this social interaction (e.g. Schaffer, 1977; Wind, 1986), in which the caregiving adults, in their readiness to interpret the infant's behaviour as social, play their role as well (e.g. Brazelton, Koslowski & Main, 1974).

Most *adults cannot resist reacting upon an infant* because of certain infant features which are biological determinants for their actions. Appearance and vocalisations elicit specific, programmed, unintentional behaviours (Morath, 1979; Lewis, 1979; Papoušek et al. 1985). Not all parents are prepared for their role, but usually mothers quickly adapt themselves to the urgent needs of this new baby person (Price, 1989). The mother exhibits behaviours that are elicited only in the presence of the infant (Stern, 1974), like *babytalk* or motherese.

In this study, intersubjectivity in a sociobiological sense is taken to be observable from birth onwards as certain visible and audible behaviours. The early forms of visual and acoustic communication set the stage for adult speech communication, since constraints are not yet set primarily by the context or the message. Without those barriers, mother and infant can express their affection through the channels preferred for intersubjective tuning. Approximately after the fifth month mothers start to use the two

channels selectively for affective tuning (Stern, Hofer, Haft & Dore, 1985). The individual preferences for specific senses subsequently lead to the diversity of human communication systems.

d. *Tuning over a distance*

Initially, mother and infant engage in *multi-modal* intersubjective behaviour because they are in relative close contact. Infants probably can perceive very complex forms of maternal care and stimulation (Trevarthen, 1990). The other senses of infants -like smell, taste, and touch (Montagu, 1972)- are also prepared for social exchanges right after birth. It is important that, at an early age, the input for infant perception systems is of a multi-modal quality, which enables the infant to connect distal perceptions and proprioceptive changes (Powers, 1973; Plooij, 1984; Plooij & Van de Rijt, in press; Sullivan & Horowitz, 1983; Meltzoff, 1985). In the course of the development the use of the different modalities will become more specialised. In about the third month, infants are reported to focus on the partner's face and talking mouth, and to imitate mouth movements, although without vocalisation (see section 3.2.3 a). Trevarthen (1979, 1985) has called this oral behaviour 'prespeech', as it resembles articulatory movements used later in life. In this respect, the timing of the perceptions is also contributing to the developmental process. Condon (1977, 1979) points at a temporal synchrony of speech and body movements during mother-infant interaction.

Although there is every reason to accept multi-modality in interaction, in naturalistic situations early tuning is, for practical reasons, mostly described with regard to the distance modalities. As an outsider of a mother-infant system, it is difficult for an observer to measure and to decide about a change in muscle tension, for example. The description of tuning through the distance channels only (as in this chapter) may appear 'premature' in the mother-newborn pair.

Yet, it is acceptable to regard distal changes as the representatives of the multi-modal tuning in general. First of all there is the synchrony in behaviours in an individual (Condon, 1977, 1979) and between individuals (Condon & Sander, 1974). Furthermore, the modalities must be linked in a way, if later on, one of the perceptions (say, a picture of an apple) may elicit the odour and the taste (of an apple which is not present). A third point is that the infant's abilities to send or to receive distal messages cannot be assessed with adult norms for the quality of perception. Perhaps the mere use of the modalities is informative enough. Furthermore, there is the infant's 'prespeech' behaviour which can be interpreted as the onset of selective use of the visual and auditory modalities, already present in the third postnatal month.

The distal representative of intersubjective tuning may be misleading during the earliest period, that is, if we consider mother and infant as individuals. If, however, we observe them as a *system*, the intersubjective readiness of the adult to interpret infant behaviour as communicatively

intended (Foster, 1990) likely corrects such mistakes. The mother's tuning is expressed through movements in the visual and auditory channels, which programs the baby to communicate intentionally (Newson, 1979). Soon, the infant's capacities to pay attention to, and to prefer social interactions (e.g. Schaffer, 1977; Fernald, 1992) are also taken to be reflected in behaviour in the 'distance' channels. In the literature, various types of intersubjective tuning are discussed, especially during the first five months of mother-infant interaction.

The visual channel is clearly very important in the communication between human individuals. In many situations the focus of attention of a person can be deduced by looking at the eyes of that person.
Face-to-face communication occurs mainly during the first four to five months of mother-infant life. This 'intense eye contact' is an expression of visual attention for the other person and is basic to perceiving the partner's emotions. Face-to-face communication is initially embedded in the multi-modal complex of interpersonal exchanges, the realm of the 'unobservable senses'. The infant's gaze at the face of his mother is interpreted by the mother as 'showing attention', and this infant behaviour increases the mother's responsiveness dramatically (Stern, 1974). Gaze aversion of the infant is considered to end an interactive exchange. It is likely that the usual decline in face-to-face communication (at the age of four to five months) is related to the infant's interests in the world of objects which is introduced to the infant by a cooperative mother (e.g. Fogel, Young Dedo & McEwen, 1992).
Infants change their facial expressions selectively according to visual stimuli, such as the mother's face, and in relation to different experiences (Bower & Wishart, 1979). They show distress when the mother does not act as usual (blank face experiments, e.g. Papoušek, 1979; Genta, Tartabini, Costabile & Zamberlan, 1986). Research on sound perception of infants has used a detailed study of the child's facial expression, since it can show 'attention' or 'rage' (Eisenberg, 1979). Nelson (1987) suggested that only around the fourth month the mother's face is "perceived as a special class of stimuli" (p. 890). A younger infant cannot perceive the mother's facial expressions because of its lack of perception of contrast in the visual system. These reports accentuate the mother's interpreting role early in the development of the system. Visually an infant will need a facial scheme which probably is constructed during the first four months from a *moving* face because then perception may be better than from a still face (Nelson, 1987). The infant's dependence upon secure, intersubjective relationships (e.g. Bowlby, 1969, 2nd edition; 1984) has been underestimated for quite some time.
It is reported that *the face of the mother* easily elicits infant 'attachment' behaviour, such as attentive watching, smiling, and vocalising (Blehar, Lieberman & Ainsworth, 1977). In turn, this touches the mother, eliciting her exaggerated facial expressions and vocalisations (Stern, 1974). A prolonged gaze at her face is interpreted as an "intention to *engage* in an interaction" (Stern, 1974, p. 189, my italics, pointing at *inter*-subjectivity).

This results in smiles and homogeneous types of vocalisations to the baby (Papoušek, Papoušek & Bornstein, 1985). Adults slow down the tempo of their facial expressions and simultaneously exaggerate them, enabling the infant to acquire that face scheme (Stern, 1974). Later in the first year, mothers are reported to switch between the two distance channels for affective tuning (Stern, Hofer, Haft & Dore, 1985) which is a modification of early intersubjective tuning, as such directing the developmental process towards adult behaviour.

The vocal-aural channel between mother and infant is different from the adult one in emotionally neutral speech communication. In early vocal-aural communication, i.e. taken as the production of sounds and as hearing these sounds, vocalisation in unison (simultaneous sound production) by mother and infant (Stern, 1974) can be regarded as another expression of their intersubjective tuning and unique relationship. It is likely that vocalisation in unison is also related to affect attunement (Stern, Hofer, Haft & Dore, 1985), which is basic for the acquisition of self-awareness. This overlapping vocalisation, like overlapping gaze in face-to-face communication, usually disappears after the first four to five months of mother-infant life (Ginsburg & Kilbourne, 1988).

The newborn *infant's vocalisations* are usually interpreted as a message with a physical meaning. The birth cry of a newborn is a reassuring sound for the adults, as it signals that the infant will live and has started to breathe. The early sound productions of infants, of which the cries are the most prominent ones, activate the parents to check the physical well-being of the baby (Morath, 1979). This is an adequate caregiver reaction, for the newborn cries are more or less linked to specific internal states (Wasz-Hockert, Lind, Vuorenkoski, Partanen & Valanne, 1968). Sooner or later parents are able to recognise hunger or pain cries of their infants (e.g. Murry, Hollien & Müller, 1975), which of course is related to their knowledge about the infant's daily routine and feeding schedule. The non-cry sounds of the young infant are often seen as reflexive, diffuse bodily reactions, 'unarticulated sounds' as a by-product of bodily movements (Wind, 1970). Yet infant sound productions differ in various situations in their supra-segmental or prosodic aspects (e.g. Delack, 1974).

Most *caregivers* don't consider the infant's 'inability to speak' (e.g. Bullowa, 1979) to be any reason to be silent to their children, but they await the time that they can talk together. Apart from the preoccupation with the infant's well-being, almost all parents engage in sound production with the infants. They talk 'nonsense' to their infants. At the same time, however, they contribute to parent-infant tuning by means of the vocal-aural channel, probably especially in certain *prosodic* characteristics of speech (Papoušek, Papoušek & Bornstein, 1985; Fernald, 1989) facilitating later social behaviour (Fernald, 1992). Utterances of the mother to the infant ('how sweet you are'), often in the motherese register, stimulate the young infant to vocalise more frequently and for prolonged periods (e.g. Fernald, 1985; Cooper & Aslin, 1990; Masataka, 1992). Mother and infant are said to synchronise their vocalisations, and after the first three months mothers

begin to fill in the turns that are 'missed' by the infant (Schaffer, Collis & Parsons, 1977).
This vocal alternation in mother-infant sound exchanges is reported to follow upon a period in which vocalisation in unison occurred more often (Ginsburg & Kilbourne, 1988). These authors found an onset of vocal alternation early in the fourth month for two male infants, and in the third month for one female infant. Overlapping sound production seems to occur more prominently in affective situations.

e. *Concluding remarks*

From birth onwards, the *combined* use of vocal-aural and face-to-face tuning is present and appears initially related to multi-modal tuning. The observable bi-modal tuning through the distance channels is regarded to be an important representative of the *development of early affect in a mother-infant pair*. The way in which mother and infant initially express their affect may relate to communicative behaviours via the visual and auditory channels, later on in the development. According to the literature data, the use of the distance channels in the mother-infant system gradually increases during the first five months. The bi-modal use, like a remains of the multi-modal tuning, normally disappears after the fourth to fifth month and the channels function more selectively in the processing of information. In the mother-infant system, overlapping (i.e. mutually directed) behaviours of the individuals also disappear at that time.
Vocalisation in unison, an expression of affect during the first four to five months, is reported to disappear to a large extent when alternating sound production becomes more prominent in the fourth month. In later speech communication, the alternating sound production must be practised. In turntaking, mother and infant can expand their mutual experiences beyond their affections. *Early alternating* sound production (during the first three to four months) possibly hinders the development of an affective base for human speech communication because sound production then is no part of the synchronous multi-modal tuning.
Face-to-face contacts become shorter after about the fifth month and increasingly meant to check the gaze direction of the partner rather than for transmission of affect. Mothers follow the gaze direction of the infant and talk about the object which they think is in focus. The infant, orienting upon the environment, can then learn to relate actions, objects, and sounds labelling the experiences.
If, after approximately the fifth month, mother and infant continue to use the bi-modal way of intersubjective tuning, the speech development of the child is probably at-risk to be delayed. As the mother usually deduces the focus of attention from the child's gaze direction, she interprets a shift from an object to a long gaze at the face of the mother as a shift in the child's attention. Labelling during object-manipulation or book-reading via the vocal-aural modality alone (the child continues to look at the object) is

quite efficient in communication. Shifts in gaze from one object to another usually elicit an immediate naming of the object by the mother.

In our approach of mother and infant as a sensori-motor system, intersubjective tuning was studied first. In this chapter, three themes for intersubjective tuning (mutually looking at the face of the partner, simultaneous sound production, and their bi-modal occurrence) are treated. These interactional patterns are present in many forms and timings in infant-adult communication. The period of two years was chosen in order to early detect any speech communication at-risk. It can be concluded from the literature that for *intersubjective tuning* the first five months establish a critical period. Certain *persisting* early behaviours may contribute to the risk, but so do also behaviours that *occur too early*. The changes around the fifth month are possibly related to the quality of speech communication later on, because of the tuning in a mother-infant pair.
After about the fifth month, mother and infant already use the distance channels in a way more similar to adults. In normal adult conversations rules for gaze behaviour and sound production are fairly strict. As the infant depends on conversations for his further social and mental development, it is of major importance to learn the rules.

3.2 Intersubjective tuning as co-occurring movements

Our approach employs the transcriptions of movements of mother and infant recorded on video (see section 2.3.2). The transmission of the movements between the two persons is regarded to be restricted since not all individual movements are perceived by the partner in the system (see section 2.4.1).
Although single pairs are unique, certain common characteristics must be present in their progress towards speech communication (see 1.3.1 g.).
Intersubjective tuning is regarded to be the first fundamental characteristic in the development of speech communication.
In the distance channels, the intersubjective tuning is made operational by

- face-to-face contact, or mutual gaze,
- vocalisation in unison, or simultaneous sound production, and
- the bi-modal tuning, or vocalisation in unison during mutual gaze.

In the next section, these three forms of intersubjective tuning are 'translated' into co-occurring movements of mother and infant, with a summarised introduction to the variety of forms and timings of these three types of behaviours in mother-infant interaction. Differences in intersubjective tuning are expected to be found in quantitative measures like the numbers and the amount of time per recording. The sign-test for non-parametric data is used to estimate the differences between the pairs (Grooteboer & Luyten, 1978; Nijdam & Van Buuren, 1980; Marascuilo &

Serlin, 1988). Below, in section 3.3, the sign test and the distribution of signs over the matched recordings is explained by means of an example.

3.2.1 Uni-modal tuning: mutual gaze

Prolonged mutual gazes at each other's face have been noticed by observers of early mother-infant interaction. In the course of the development towards speech, the use of the channels for mother and infant gaze direction changes.

a. *Introduction to intersubjective movements*

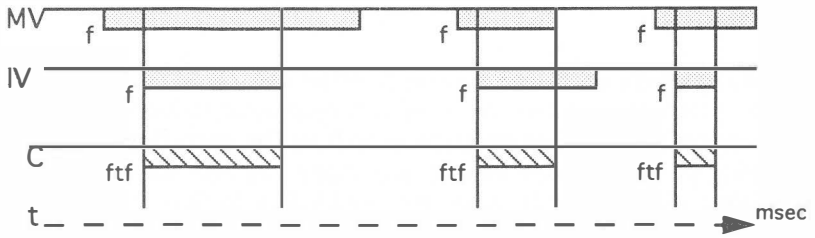
Mothers and infants may develop fairly systematic preferences during face-to-face communication, which depends on their other means for intersubjective tuning. The infant's prolonged gaze at the mother's face usually keeps the mother's attention also directed at the infant's face. Most of the time, the mother of a young infant is 'framing' the infant's gaze (gazing at the infant's face, awaiting the infant's gaze at her face; Fogel, 1977). Once face-to-face contact is established, she can choose from her repertoire available to the pair at that time: affective displays, speech instruction, or a mutual orientation towards an object which is indicated by means of an eye movement.
The early prolonged mutual gazes will largely disappear at the fourth or fifth month, when the infant will probably become more interested in the manipulation of the inanimate environment. Then, the number of short glimpses at each other's face in familiar situations will increase and the overall duration of mutual gazes will decrease. When words take over, mutual gazes can even disappear altogether. The longer mutual gazes can re-occur, of course, probably in affective situations. In adult conversations, the short glimpses are still used, among others, to indicate a shift in turns. In due course, the mother-infant systems develop this kind of tuning in a glimpse.

The many ways of visual intersubjective are thought to be reflected in *simple quantitative measures* of interpersonal behaviour. Clearly, the frequency of face-to-face contacts as well as the overall amount of time per recording per pair varies, also in this study, because these data result from *individual* characteristics of mother and infant in that specific recording.
Prolonged mutual gazes at the face of the partner correspond to a small frequency of face-to-face contacts in a fixed time span of observation. Accumulating the durations of the contacts, a long overall duration of mutual gaze then is expected in the first five recordings. Later on, the gazes usually change to short glimpses at the partner's face, quickly scanning the situation. The frequency of face-to-face contacts may then be higher than before, while the overall duration per recording is not necessarily changing.

The percentage of time of face-to-face contact and of framing per recording, as well as the frequency of face-to-face contact and of looking at the partner's face per recording are thought to reflect different ways of intersubjective tuning. These data were chosen in relation to expected differences in visual tuning during the development of speech. Between the two pairs, these differences must be fairly systematic over the two years, if we want to draw any conclusions about two interaction styles. The results of the comparison of the two pairs with regard to mutual gaze are presented in section 3.3.1, also explaining the sign-test with an example.

b. *Searching for intersubjective visual tuning*

In the search for moments of face-to-face contact, PROGRAAF (see section 2.4.2) is instructed to select from the original transcription of the visual channels only the code 'looking at the face of the partner' with the corresponding onset- and offset-times (code F in the channel for mother and infant gaze direction, see Appendix II). Not all gazes of the individuals at the partner's face per recording result in the establishment of face-to-face contact between mother and baby.
The onset of face-to-face contact starts, when one of the persons is looking at the face of the partner, and the partner, who is not yet looking, looks at the face of the other. The end of face-to-face contact occurs when either one of the persons breaks off face-to-face contact.
Below an example is given of the establishment of face-to-face contacts between Fanny and SUSAN. The mother is already looking at the infant's face, when the infant establishes face-to-face contact by looking also at the mother's face. The overlaps in time of the codes for mother and infant represent the actual face-to-face contacts in that recording. This 'criterion'-file C is saved as a new PROGRAAF-file with onset- and offset-times of each face-to-face contact in that recording.



Example 3.1
Establishment of face-to-face contact (ftf) in a mother-infant pair. In the channels MV (Mother-Visual) and IV (Infant-Visual), the occurrences of code f ('looking at the partner's face) are given for mother and infant. In channel C (Criterion) the actual moments of face-to-face contact (ftf) are indicated. The time-base is dashed, and the duration of a 'dash' can be chosen in PROGRAAF.

The overall amount of time per recording of face-to-face contact is the accumulation of the duration of the actual moments that face-to-face contact took place, and per recording the percentage of time for face-to-face contact is calculated. The frequency of contacts is given by PROGRAAF in the C-file.
The percentage of time per recording and the frequency of gazes at the partner's face for mother and infant have been calculated by FP (the Frequency Program; see section 2.4.3) from the original transcriptions in the MV and IV channels. The amount of 'framing' is found by subtracting the percentage of time that the infant was 'looking at the mother's face' from the mother's percentage of time. The percentage of framing-time represents the mother's investment in face-to-face contacts.

3.2.2 Uni-modal tuning: vocalisation in unison

In the available literature vocalisation in unison has received less attention than face-to-face communication, which is likely to be the result of a predominant focus on just one of the persons in the system and of the quality of the infant's sound production. In the course of the development, mother and infant will start to alternate their sound production for conversational reasons.

a. *Introduction to intersubjective movements*

The mere production of sound does 'work' intersubjectively because it informs both partners about their mutual presence. Sound production by mother and infant is quite free from conventional adult rules and it can occur simultaneously.
Vocalisation in unison is an exception in normal adult conversations. Adults separate the onsets of sound productions in time, preferably even by an interpersonal pause. This is a fairly strict and universal rule in speech communication. Initially, mother and infant disregard this rule more or less. Towards the end of the first five months, vocalisation in unison usually decreases, and *alternating* sound production is going to predominate. A dialogue with neat pauses and only slight interruptions occurs more and more often.
The establishment of vocalisation in unison or alternating sound production is also influenced by the duration and the quality of sounds. A newborn's sound production exists of cry-sounds with a longer duration than the vegetative sounds (like a hiccup), and an occasional 'effort' sound or grunt. These sounds, with a short duration (e.g. Koopmans-van Beinum & Van der Stelt, 1979), are less likely to occur during sound production (soothing) by the mother than the longer cry-sounds. Another motive to vocalise in unison is given by the quality of the sounds. A more or less emotional message (a happy or a cry-sound) may 'invite' the partners to join in, but that is a matter of individual preferences.

The frequencies of sound productions of the mother and the infant likely result in various vocal interaction patterns. For example, the child is not vocalising very frequently in a specific recording. The mother may interrupt promptly when a sound is produced by the infant, after which the child is silent again. The number of vocalisations in unison of the mother-infant system then equals the number of infant sound productions. This relation can also be found under different conditions. A mother who talks a lot and who has a quiet infant may produce a number of vocalisations in unison that approaches this (quiet) infant's number of utterances as well. The infant is likely to interrupt the mother's sound productions since she leaves no pauses.

Mother and infant construct a vocal scheme of each other's sounds in different situations. In due course, the perceived relation between sound production and situational changes expands towards new sounds. The combination in our study of the four individuals in the two pairs, together with the duration and the quality of sounds, resulted in a range of different patterns. The details of these different interaction patterns, however, are disregarded in this study. The mere presence of vocalisation in unison during the first four to five months, changing to alternating sound production, demonstrates that the vocal-aural channel is used. This is important for further speech development.

Intersubjective tuning in the vocal-aural channel is present during simultaneous sound production, regardless of the quality of sounds produced by the partners in the vocal play. The percentage of time and the frequencies of vocalisation in unison depends on different individual patterns in the two pairs in that recording. These outcomes on vocalisations in unison are taken to be related to changes in the vocal-aural tuning during the development of speech.
During the first five months the longer cry-sounds and 'pleasure-cries' to which the mother (vocally) reacts correspond to a low number of vocalisations in unison per recording. The accumulated duration is then related to the presence of simultaneous sounds made by the mother. Later on, the number of vocalisations in unison does not necessarily decrease, as slight interruptions may persist. The accumulated duration per recording, however, usually is smaller than during the first five months.
The differences between the two pairs in this study must be fairly systematic over the two years, if we want to make any distinction between two styles of vocal-aural tuning. The results of the comparison between the two pairs on vocalisation in unison are presented in section 3.3.2.

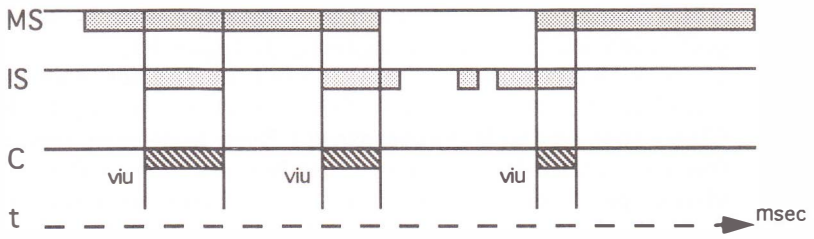
b. *Searching for intersubjective vocal-aural tuning*

All codes in the channels for sound production of the mother (MS) and the infant (IS) are acceptable in the PROGRAAF-search for simultaneous occurrence (see Appendix II). This implies that vocalisation in unison may

occur during crying, fussing, audible laughing, and all other sounds (usually less 'normal' for adults).
When one partner is producing a sound and the other joins in, the onset of that moment of vocalisation in unison is calculated by PROGRAAF. The end of vocalisation in unison is given when one of the persons stops producing sounds. Very short moments of vocalisation in unison appeared mainly to occur during alternating sound production, because of prompt interruptions of the partner's turn, not awaiting the turngiving signal ("Oh yes, you are quite right!").

In Figure 3.2 an example is given of the establishment of vocalisation in unison for Claire and EVE, searched for by PROGRAAF. The individual roles of mother and infant with regard to the initiative for vocalisation in unison is disregarded in this study. The overlaps in time of sounds produced by mother and infant represent the actual durations of the moments of vocalisation in unison in that recording. This 'criterion'-file C, with onset- and offset-times of each simultaneous sound production in that recording, was saved as a new file.

The overall amount of time per recording of vocalisations in unison is the accumulation of the durations of the actual moments, and is presented in the percentage of time per recording. The frequency of vocalisations in unison is given by PROGRAAF in the C file, as the number of criteria-moments. The percentage of time per recording and the frequency of sound productions of mother and infant per recording is calculated by FP from the original sound production channels.



Example 3.2
Establishment of vocalisation in unison (viu) by Claire and EVE in week 12. The sound productions and the pauses between the sounds of mother and infant are given in the channels MS (Mother-Speech) and IS (Infant-Speech). No sound productions are deleted from the transcriptions per recording. In channel C (Criterion) the actual moments of vocalisation in unison are indicated. The time-base is dashed, and the duration of a 'dash' can be chosen in PROGRAAF.

3.2.3 Bi-modal tuning: vocalisation in unison and face-to-face contacts

In young infant-mother pairs vocalisation in unison usually occurs in face-to-face situations. The bi-modal intersubjective tuning will disappear to a large extent in the first five months. For speech communication a more specialised use of the visual and vocal-aural channel will be used.

a. *Introduction to bi-modal intersubjective movements*

Early in infant life intersubjective tuning through the two distance channels is embedded in the multi-modal interaction which uses all senses and movements. This multi-modal form of intersubjective tuning is disappearing when the distance between mother and infant becomes larger. Bi-modally, certain sounds are then 'visible', while sounds may set the rhythm or beat for visual movements like hammering. In a way the two distance channels support each other.
Usually, the bi-modal form is present up to about five months of infant age, gradually changing to a more uni-modal use of the distance channels. When the infant starts to break down the bi-modal complex, the two channels sometimes hinder each other. One form of input seems completely suppressed, which is illustrated below for Claire and EVE in week 16.

> Claire is becoming aware that there are two different channels towards her mother. That interaction has been recorded by chance in week 16. In the recording of week 15 (not used for further analysis) Claire and EVE are engaged in long 'proto-conversations', while looking at each other's face. Nine days later, in week 16, the proto-conversations have completely disappeared.
> In week 16 Claire, without a sound but moving her mouth and lips, fixes her gaze at her mother's face in such a way that EVE says to Claire that she feels embarrassed ("Even little girls can make me feel embarrassed"). EVE continues her monologue, demonstrating visual speech movements. When Claire turns her gaze away from her mother's face, she starts to move her body and limbs, and then vocalises in a, for her age, rather complex way. The gaze back at her mother's face 'immobilises' Claire's body and sound production again, as if she can only pay attention to the visual aspects of her mother's speech.

After the fifth month, mother and infant still may use bi-modal tuning from time to time. When the child tries out a new sound, looking at the mother's face, the mother may react 'explicitly' by means of the two channels. Thus, bi-modal tuning offers an affective link in new developments. The changes in bi-modal tuning result from changes in face-to-face contact and from changes in vocalisation in unison. Persistent

visual tuning with only incidental vocalisations in unison corresponds with a decrease in number and overall duration of moments of bi-modal tuning. For persistent audible tuning, together with few face-to-face contacts, comparable results will be found.
Uni-modal specialisation is efficient for speech development. Mutual visual attention for an object can be checked quickly, while the auditory channel transmits information like the name of an object or the word for the colour or the form of the object. In this way visual and audible characteristics of the more and more complex environment can become related.

b. *Searching for intersubjective bi-modal tuning*

Bi-modal intersubjective tuning supposes bi-modal movements in one person to occur simultaneously with bi-modal movements in the other. These moments are present in mother-infant interaction when they both look at the face of the partner while vocalising together as well. Looking at the face of the mother during crying is, partly, occurring simultaneously with the mother's soothing sounds, while she looks at the infant's face.
In the previous sections, moments of uni-modal intersubjective tuning (face-to-face contact, and vocalisation in unison) are searched by PROGRAAF and saved as two criterion files. The moments of bi-modal tuning occur when uni-modal moments in these files overlap in time. The onset of a bi-modal moment is thus related to either the onset of face-to-face contact or to the onset of vocalisation in unison. The end of the moment co-occurs with the end of either one of the uni-modal moments.
The changes during the first two years are reflected in simple quantitative measures of the bi-modal interpersonal behaviour and are calculated in PROGRAAF as the percentage of time and the frequency of bi-modal contacts per pair and per recording. The calculations depend largely on the data on uni-modal tuning, although these data may stand on their own.
The results on the comparison of the two pairs with regard to bi-modal tuning are presented in section 3.3.3.

3.3 Results

Our approach of the mother and infant as a sensori-motor system is expected to lead to results that indicate that the two pairs differ in their intersubjective tuning. This tuning through the distance channels is measured like the percentage of time and frequency of face-to-face contact, vocalisation in unison, and the combination of these into bi-modal tuning. The intersubjective tuning is expected to change around the fifth month.
Face-to-face contact is established when both mother and infant have turned their eyes to look at the face of the partner. As this behaviour is a central theme in this thesis, the actual percentages of time in the recordings over the two years are given for the two pairs per recording in Appendix IVa, and in Figure 3.1.

Per aspect the two pairs are compared over the two years on these quantitative measures by means of the sign-test, which is also used in the following chapters. The distribution of signs is explained by means of the data presented in Figure 3.1.

The *sign-test is used for the comparison of the two sets of data.* This test indicates if there is a (non-)difference in a measure of a central tendency in two groups of data. Each point for comparison must be matched for the two groups, in our case the recordings and the ages of the infants. The first recording of Claire and EVE is compared to the first recording of Fanny and SUSAN, etc. (See Appendix I). In view of the period between birth and the age of two years, the matching of the concurrent recordings is considered satisfactory.
The statistical null-hypothesis in the sign-tests is that, over the 24 recordings, the pairs *do not differ systematically* in their ways of intersubjective tuning by means of the different channels. This null-hypothesis can be rejected when the distributions (the percentages or the frequencies) appear systematically different. This is the case when in one pair the percentages and frequencies are (nearly always) higher than in the other pair. It is very likely that the two pairs will then differ in uni-modal and/or bi-modal intersubjective tuning (Marascuilo & Serlin, 1988).

Table 3.1
Distribution of signs between Claire and EVE, and Fanny and SUSAN for the percentages of face-to-face contact per recording over two years. The percentages per recording are given per pair (% ftf), together with the sign (the + or - sign, see text).

	% ftf				% ftf		
rec. nr.	EVE Claire	SUSAN Fanny	+/-	rec. nr.	EVE Claire	SUSAN Fanny	+/-
1	34.2	65.6	-	13	2.3	2.6	-
2	52.5	45.0	+	14	3.0	0.3	+
3	5.2	17.6	-	15	2.0	8.2	-
4	85.3	13.7	+	16	1.8	4.4	-
5	6.7	3.1	+	17	1.3	6.0	-
6	10.8	30.7	-	18	6.2	9.1	-
7	5.6	19.1	-	19	4.3	13.4	-
8	7.4	11.5	-	20	12.3	12.9	-
9	0.3	41.0	-	21	4.0	4.6	-
10	1.0	2.0	-	22	3.9	0.3	+
11	1.6	15.8	-	23	2.3	1.0	+
12	3.3	0.3	+	24	0.0	15.0	-

The distribution of signs was implemented following the same procedure throughout this thesis. A positive sign was given to a recording of Claire and EVE whenever their percentage or frequency was higher than that of Fanny and SUSAN. A negative sign was given to Claire and EVE in the inverse cases. When the percentages or the frequencies were the same for the two pairs the recording was disregarded because no sign could be given to either one of the recordings. In Table 3.1, the sign distribution is given for the percentage of face-to-face contact in the 24 matched recordings of Claire and EVE, and Fanny and SUSAN (see also Figure 3.1). Claire and EVE received a positive sign 7 times and a negative one 17 times, and Fanny and SUSAN the inverse
The chance that a decision about a difference in tuning of the pairs over the period of two years is wrong is given in a decimal number ($p < 0.05$) which depends on the distribution of signs and the numbers of matched records (see section 3.3.1).

3.3.1 Intersubjectivity and mutual gaze

In this section the results on face-to-face contact, looking at the partner's face by the individuals, and visual 'framing' behaviour of the mother (e.g. Fogel, 1977) are presented. The percentages of time per recording, and the frequencies describe the interaction patterns in general.

a. *Percentage of time of face-to-face contact*

The data for the two pairs show (in Figure 3.1, for example) how mutual gaze can change from one recording to another because of external and internal variation in the observation over the two years. The observation context was naturalistic and not structured for mother and infant. These inter-observation differences are expected to occur in both pairs randomly. The sign-test disregards these fluctuations, registering only the difference between the pairs per recording: the higher scores of one pair receive a positive sign (or the inverse), and only the signs are counted.

The mother's *framing behaviour* is calculated because it represents her estimation of the predictability of the infant's 'looking at the mother's face'. Once the mother knows how the infant reacts (upon her calling his name, for example), she relies on that interaction, and her framing will decrease. This framing has been calculated by subtracting the percentage of time the child looks at the mother's face (% c laf) from the percentage of time the mother looks at the child's face (% m laf). In none of the 24 recordings this subtraction turned out to be negative (see Appendix IVa.), which means that both mothers have looked at the face of their child for a higher percentage of time per recording than their children at the mother's face .
Face-to-face contact, framing, and individual behaviours (looking at the face of the partner) are related to and probably of influence on visual

intersubjective tuning. The comparison of the pairs was done in terms of the percentages of time per recording that:

-the child was looking at the face of the mother (% c laf),
-the mother was looking at the face of the infant (% m laf),
-the mother is framing (% fram), and
-the pair establishes face-to-face contact per recording (% ftf)

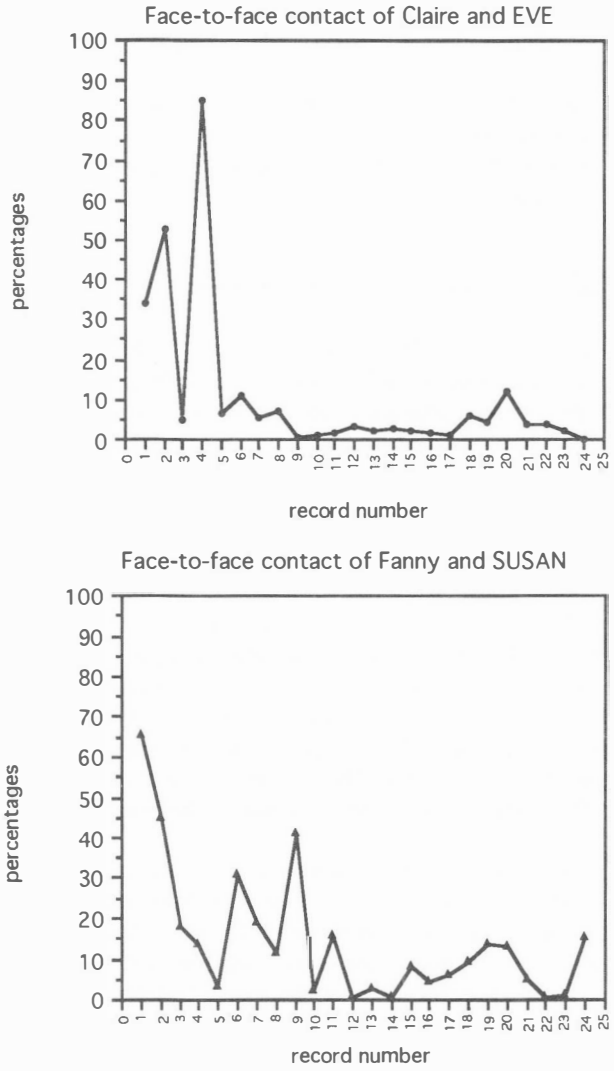


Figure 3.1
Percentages of time of face-to-face contact per recording for the two pairs, Claire and EVE, and Fanny and SUSAN over the two years.

For the sign-test the null-hypothesis is set, namely that the two pairs do not differ systematically with regard to these percentages per recording over the two years. This means that the distributions of the percentages per recording are assumed to be at times higher for Claire and EVE, and lower at other times. The signs per recording are thus expected to be about equally divided over the pairs. When this null-hypothesis cannot be accepted, the alternative hypothesis is accepted, stating that the pairs are likely to differ in the percentages of time of framing, of face-to-face contact, and of gaze at the partner's face over the two years. In view of the literature data, the recordings before and after the fifth month are compared as well.

Comparing the two columns (1-24) and (6-24) in Table 3.2, it can be concluded that the visual intersubjective tuning in the recordings over the two years in the two pairs was different; and after the fifth month (recordings 6-24) the difference was even more clear. The distribution of signs in the first five recordings (1-5) was not significantly different: two recordings of Claire and EVE received a negative sign (17 minus 15), and three recordings a positive sign (7 minus 4).
The establishment of face-to-face contact is closely related to the child's gazing behaviour. The distribution of signs in % ftf and % c laf is similar (see Appendix IVa. for a comparison of the percentages), which is also reported in the literature. The mother frames the infant's gaze, and when the infant turns his gaze to the mother's face, he is very successful in establishing face-to-face contact.

Table 3.2
Distribution of signs for percentages of face-to-face contact (% ftf), the child looking at the mother's face (% c laf), the mother looking at the child's face (% m laf), and framing (% fram) after the comparison of matched recordings of the two pairs, Claire and EVE (CE), and Fanny and SUSAN (FS). The first columns represent the distribution on all 24 recordings, while the second columns disregard the initial five recordings. The asterisks indicate the different levels of significance.

	% ftf		% c laf		% m laf		% fram	
recordings	1-24	6-24	1-24	6-24	1-24	6-24	1-24	6-24
CE<FS(-)	17	15	17	15	18	16	17	15
	*	**	*	**	*	**	*	**
CE>FS(+)	7	4	7	4	6	3	7	4
	24	19	24	19	24	19	24	19

* p <0.05
** p <0.01

As to the percentage of time for looking at the face of the child, EVE received a negative sign in 18 out of 24 recordings. After the first five recordings she has been looking at Claire's face in only three recordings for a higher percentage of time than SUSAN has looked at Fanny's face.

Framing behaviour was also different for the two mothers, since in 17 out of 24 recordings Claire and EVE scored lower than Fanny and SUSAN. After the first five recordings this was the case in 15 out of 19 recordings, which is also significantly different.
In the first two years, visual intersubjective tuning and framing per recording were different ($p < 0.05$). The differences between the two pairs were even more significant after the first five recordings ($p < 0.01$), indicating a change around that age.
In the *first five recordings* Claire and EVE scored higher on face-to-face contact than Fanny and SUSAN in three out of five recordings. This was not predicting the future: over the two years this figure was seven out of 24 recordings, because in only four recordings out of the 19 after the fifth recording Claire and EVE scored higher than Fanny and SUSAN. This pointed at a tendency of inverse patterns in the two pairs after the fifth month: before that time Claire and EVE scored higher, and thereafter mainly lower Fanny and SUSAN did.

b. *The frequency of face-to-face contacts*

The frequency of face-to-face contacts varies along with the individual gaze behaviours, but the infant is usually more successful than the mother in the establishment of the contact. In view of the percentages of time and the signs, given in Table 3.2, the frequencies were also expected to be systematically higher for Fanny and SUSAN than for Claire and EVE on face-to-face contacts, and for gazes at the face of the partner.
The null-hypothesis again assumed a more or less equal distribution of positive and negative signs over the 24 matched recordings. The second columns (6-24) disregard the first five recordings. The distributions of signs are given in Table 3.3; the actual numbers are given in Appendix IVb.

The two pairs differed significantly over the two years with regard to the frequencies of face-to-face contacts as well as for the frequency of gazes at the partner's face. The mothers showed a larger difference than the children.
The frequency of face-to-face contact after the fifth recording differed more significantly for the pairs than for all 24 recordings, which is a sign of a change in the infant's gaze behaviour around five months for the frequencies which was also found for the percentages of time. Claire looked less than Fanny at her mother's face in the recordings six to twelve (see Appendix IVa,b).

Table 3.3
Distribution of signs for frequencies of face-to-face contact (n ftf), the child looking at the mother's face (n c laf), the mother looking at the child's face (n m laf) after the comparison of matched recordings of the two pairs, Claire and EVE (CE), and Fanny and SUSAN (FS), over the 24 and over the final 19 recordings after the fifth one. The asterisks indicate the different levels of significance.

	n ftf		n c laf		n m laf	
recordings	1-24	6-24	1-24	6-24	1-24	6-24
CE<FS(-)	18	15	17	14	19	15
	*	**	*	**	*	**
CE>FS(+)	6	4	7	5	5	4
	24	19	24	19	24	19

* $p < 0.05$
** $p < 0.01$

A comparison of the two pairs as to the median duration of the moments resulted in a non-significant distribution of signs over the recordings. Claire and EVE did not look at each other's face in a systematically different timing than Fanny and SUSAN did.

3.3.2 Intersubjectivity and vocalisation in unison

In this section, the results on vocal-aural intersubjective tuning, together with sound production of the individuals are presented. The percentages of time and the frequencies of vocalisations in unison and of sound production of mother and infant are considered to represent the developmental changes in vocal-aural tuning over the two years.

a. *Percentage of time of vocalisation in unison*

Vocalisation in unison occurs when both mother and infant produce sounds simultaneously. In Figure 3.2 the percentages per recording over the two years for both pairs are given (see also Appendix IVc).
Naturally, the percentage of time of vocalisation in unison varies for both pairs in the recordings over the two years. For Fanny and SUSAN, the first five recordings are not very different in this respect from the recordings in the following period. In the first six recordings of Claire and EVE, vocalisation in unison occurs for a higher percentage of time than in the later recordings (then about 5 %). The sign-test disregards these fluctuations within a pair because signs are attributed only by comparing the percentages of the pairs per recording.

The percentages of time per recording are compared for the two pairs on the following data:

-vocalisation in unison (% viu),
-sound production of the child (% c s), and
-sound production of the mother (% m s)

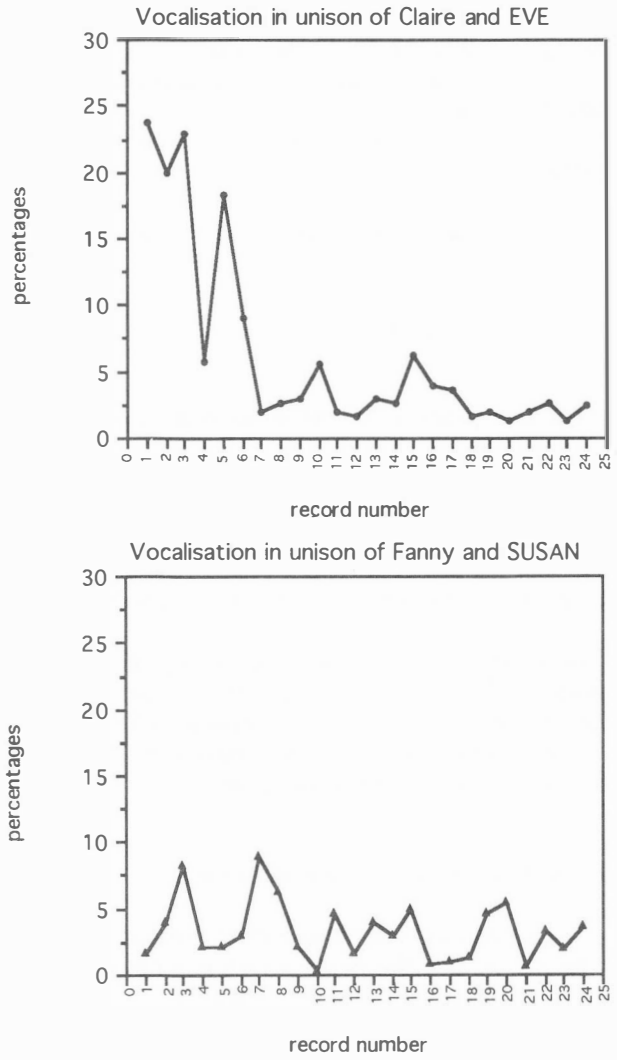


Figure 3.2
Percentages of vocalisation in unison per recording for both pairs, Claire and EVE, and Fanny and SUSAN over the two years.

Table 3.4
Distribution of signs for the percentages of time for vocalisation in unison (% viu), the child's sound production (% c s), and the mother's sound production (% m s) after the comparison of matched recordings of the two pairs, Claire and EVE (CE), and Fanny and SUSAN (FS) over all 24 and over the final 19 recordings. The asterisks indicate the level of significance.

	% viu		% cs		% ms	
recordings	1-24	6-24	1-24	6-24	1-24	6-24
CE<FS(-)	10	10	12	11	0	0
					**	**
CE>FS(+)	13	8	11	7	24	19
	23	18	23	18	24	19

** p <0.000

The null-hypothesis for the sign-test is assuming that the pairs do not differ systematically with regard to these percentages of time per recording over the two years, nor after the fifth recording. The distributions of the percentages are expected to be sometimes higher for Claire and EVE, at other times lower than for Fanny and SUSAN. The signs are thought to be distributed about equally over the recordings. When this null-hypothesis cannot be accepted, the two pairs are likely to differ in their use of the vocal-aural channel for uni-modal intersubjective tuning.

It is concluded that the pairs did not differ with regard to the amount of vocalisation in unison in the recordings over the two years. After the fifth month the distribution of signs was also comparable for the two pairs.
By comparing the two columns, the signs for the first five recordings can be extracted. In the first five recordings, Claire and EVE always had a higher percentage of time of vocalisation in unison than Fanny and SUSAN which is a significant difference ($p < 0.05$).
As to the percentages of sound production of the infants, over the two years and before or after the fifth month, the pairs did not differ. Claire tended to have lower percentages of sound production after the fifth month than Fanny. In all recordings EVE was more vocal than SUSAN. With respect to the percentages of time of the mother's sound production, the two pairs were very different.

b. *The frequency of vocalisations in unison*

The frequency of vocalisations in unison varied along with the individual sound productions per recording which is probably also related with the development towards alternating sound production. In view of the

percentages of time for vocalisation in unison and the signs, given in Appendix IVe and Table 3.4, the two pairs were expected not to differ with regard to the number of vocalisations in unison over the two years. Possibly they only differed during the first five months.

The null-hypothesis for the sign-test is assuming that the distribution of signs is divided equally over the matched recordings, for the frequencies of vocalisations in unison, and for the frequencies of mother and infant sound productions. The distribution of signs is given in Table 3.5, and the frequencies in Appendix IVd.

As was expected the pairs were not different with regard to the frequencies of vocalisations in unison over the two years, including the period after the fifth month.
As EVE was very vocal, her sound production could have caused slight interruptions of Claire's sounds. This did not drastically increase the percentage of time, but increased only the frequency of vocalisations in unison. The timing of their sound productions, however, has not increased the frequency of vocalisations in unison to become significantly different from Fanny and SUSAN.
The frequencies of sound productions for the two children differed significantly after the fifth recording (column 6-24, $p < 0.05$), because in only five recordings out of 19 Claire produced more sounds than Fanny. The children did not differ with regard to the percentages of time for sound production (Table 3.4), but they did for the frequencies. Quantitatively speaking, Fanny was clearly more vocal than Claire.

Table 3.5
Distribution of signs for the frequencies of vocalisation in unison (n viu), the child's sound production (n cs), and the mother's sound production (n ms) after the comparison of matched recordings of the two pairs, Claire and EVE (CE), and Fanny and SUSAN (FS) over the 24 recordings and the final 19 recordings after the fifth one. The asterisks indicate the different levels of significance.

	n viu		n cs		n ms	
recordings	1-24	6-24	1-24	6-24	1-24	6-24
CE<FS(-)	11	10	15	14 *	5 **	4 **
CE>FS(+)	12	8	9	5	19	15
	23	18	23	19	24	19

* p <0.05
** p <0.01

As was to be expected, the mothers' frequencies of sound productions differed significantly over the two years as well as after the fifth recording. Claire has thus perceived significantly more sounds from her mother than Fanny did from SUSAN. In four of the first five recordings, the frequencies of vocalisations in unison were higher for Claire and EVE than for Fanny and SUSAN. This difference is not significant, but can be interpreted as a tendency to vocalise in unison *during* the first five months, and to alternate sound production *afterwards.* For Fanny and SUSAN alternating sound production seemed a rule already during the first five recordings as well as over the two years.

3.3.3 Intersubjectivity and bi-modal tuning

The results on simultaneous intersubjective tuning by means of two channels are presented in this section. This bi-modal tuning is regarded to represent the multi-modal tuning of the earliest stage of mother-infant interaction (see sections 3.1.2 d and 3.2.3). During the first five months a gradual uni-modal tuning by means of the distance channels is expected. The percentage of time and the frequency of instances that bi-modal tuning is present in the interactions of both pairs describe the initial multi-modal tuning as well as the later bi-modal tuning.

a. *Percentage of time and frequency of bi-modal tuning*

Merging the two uni-modal criterion files (face-to-face contacts and vocalisations in unison) resulted in the bi-modal moments. The percentages of time of bi-modal tuning per recording are small. An overview of the percentages of time per recording of the two pairs (see also Appendix IVe) is given in Figure 3.3 .
The percentages of bi-modal tuning per recording over the two years fluctuated in the pairs, for Fanny and SUSAN more than for Claire and EVE. These percentages of time and the frequencies of bi-modal tuning were compared for the two pairs.
The null-hypothesis for the sign-test assumes that the two pairs do not differ systematically over the recordings made during two years. If the signs are not distributed about equally over the 24 and the 19 recordings, the alternative hypothesis is accepted, and the two pairs will be considered to differ systematically with regard to their bi-modal tuning.

The pairs did not differ in the percentage of time for bi-modal tuning when the recordings over the two years were compared: in the column (1-24) the signs were not distributed in a significantly different way.
Comparing the two columns of the percentages (1-24) and (6-24), a systematic higher percentage was found for Claire and EVE in the first five recordings (10-8 and 10-3, $p < 0.05$). After the fifth moth Claire and EVE's percentage was higher than Fanny and SUSAN's percentages in

only three recordings. Obviously, in the percentage of time for bi-modal intersubjective tuning a shift was found around the fifth recording, from initially higher for Claire and EVE to lower than Fanny and SUSAN later on.

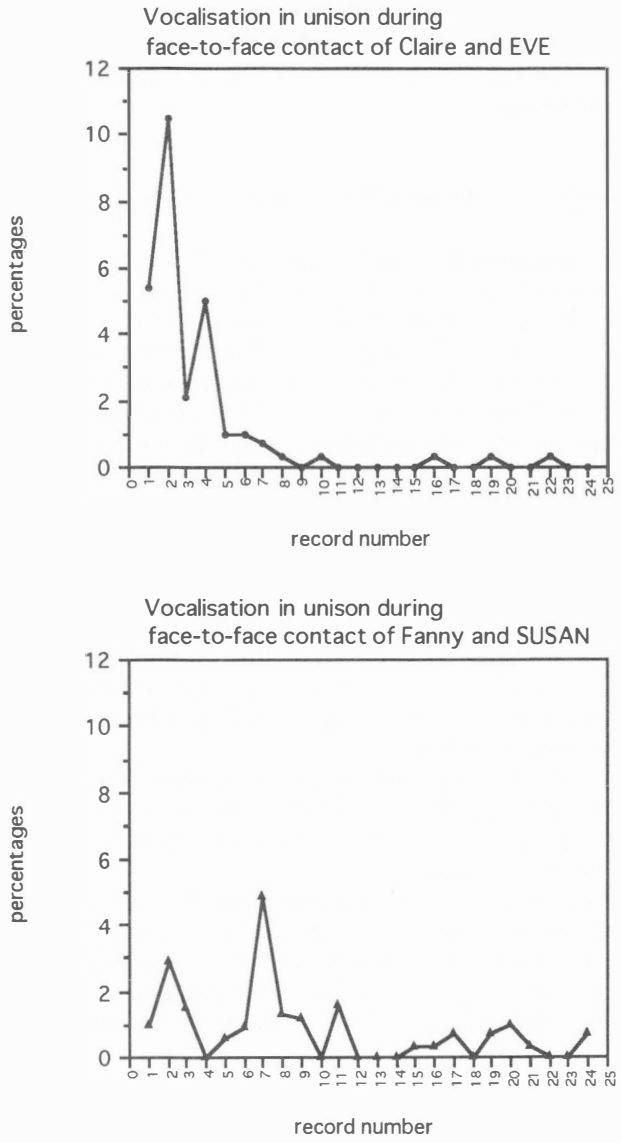


Figure 3.3
Percentages of bi-modal tuning moments per recording for both pairs, Claire and EVE, and Fanny and SUSAN over the two years.

Table 3.6
Distribution of signs for the amounts of time (% viu/ftf) and the numbers of bi-modal intersubjective tuning moments (n viu/ftf) after the comparison of matched recordings of the two pairs, Claire and EVE (CE), and Fanny and SUSAN (FS) over all 24 recordings of the two years, and over the final 19 recordings. The asterisks indicate the different levels of significance.

	% viu/ftf		n viu/ftf	
recordings	1-24	6-24	1-24	6-24
CE<FS(-)	10	10	14	13
	*		**	***
CE>FS(+)	8	3	4	1
	18	13	18	14

* p < 0.05
** p < 0.025
*** p < 0.005

With regard to the frequency of bi-modal tuning, the pairs also differed. For Fanny and SUSAN the frequency, as taken over the two years and after the fifth recording, was usually higher than for Claire and EVE. Fanny and SUSAN used the two distance channels more often simultaneously for intersubjective tuning than Claire and EVE, but not necessarily as long as Claire and EVE did.
For the development of speech, prolonged bi-modal tuning (after about the fifth month) can be regarded as less contributory.

3.3.4 Summary of results on intersubjective tuning

Mutual gaze (face-to-face contact), vocalisation in unison, and the co-occurrence of mutual gaze and vocalisation in unison have quantitatively been described in section 3.3. The pairs are compared over the two years and over the period before (not in the tables) and after the fifth month, partly because the literature data pointed at a change around that age. The data on the two pairs also indicate a difference around that age. The intersubjective tuning of the two pairs is summarised as follows:

The percentage of total time and the frequency of *face-to-face contact* per recording are systematically lower over the two years and after the fifth month for Claire and EVE than for Fanny and SUSAN.

With regard to the percentage of total time and the frequency of *vocalisation in unison*, the pairs do not differ over the two years.

For Claire and EVE the percentages are higher in the first five recordings.

The bi-modal *intersubjective tuning* is different for the two pairs after the fifth month: there is a lower percentage of time and frequency for Claire and EVE than for Fanny and SUSAN. Before the fifth month the pairs also differ, because the percentage of time is then higher for Claire and EVE than for Fanny and SUSAN.

3.4 Discussion

Mother and infant come to know each other after birth in a particular way. Visual and vocal-audible patterns developed in that early period may influence later behaviours to a yet unknown extent. This has been the reason to represent the available data covering the two years, and not, for example, just the first year. Emotions are basic motives for intersubjective movements which transmit information between humans, thus developing their communication system in naturalistic situations. The contribution of the individuals to the actual ongoing communication is different, i.e. according to temperament, age, and preferences. Human communication systems apparently permit a multitude of styles.

3.4.1 Our approach

An analysis of mother-infant systems that is focusing on their observable movements which is followed by a synthesis of selected movements seems to be a very technical approach of mothers and infants. It impresses as disregarding many very important other aspects of the interaction, of which I am well aware. My approach, however, does not aim at a complete representation of the complex reality of mothers and infants developing speech communication. The focus rather is on simple, easily overlooked behaviours in mother-infant systems on their way to communication, i.e. speech.

a. *Intersubjectivity*

In this chapter intersubjective tuning is distinguished from intentions in an explicit way, i.e. in order to evaluate the development of the mutual orientation as such, without complicated speculations about the intentions or even 'higher-order' meanings.
Furthermore, intersubjective tuning *without* intentional movements can objectively be assessed. Just looking at each other in the neonatal period is quite natural, but less so at a later age of a mother-infant system. The interpersonal physical distance is then probably bridged already.

Through the distance channels only a part of the intersubjective tuning can be observed, and free-play situations may show less of the affective behaviours of a mother-infant pair than e.g. bathing or nursing situations. Yet, the results presented in this chapter can be interpreted with some hope for an early detection of communicative problems. With regard to intersubjective tuning in human communication, the mother-infant system is perhaps less selective in different situations than we presume.

b. *Code selection*

Bi-modal tuning is composed of uni-modal tunings. In the visual channels of mother and infant we only selected the code for 'looking at the face of the partner'. This behaviour, which is prominently present in early mother-infant interaction, is likely to disappear in the course of development. Mothers have sometimes reported that their child hardly looked at them. Can we conclude that those interaction patterns predict a process of speech development which is at-risk?
At this moment I think that this is the case. If normal, healthy young infants do not orient visually upon the primary caregiver, that caregiver will have a difficult task in establishing an interpersonal relationship. The mother may give up her framing behaviour, and will not see her infant's glimpses at her face. Then visual tuning will be lost for further contact.
Only the distal vocal-aural tuning then remains. In our analysis, therefore, no codes were deleted from the transcriptions in the search for vocalisation in unison. Even sounds are included that do not belong to the mother tongue and that are vegetative or social, such as laughing. The sounds only have in common that they are produced by the speech mechanism. These sounds are equally human, and a young infant may orient towards these sounds. The selection of codes is put back in the mother-infant system, trusting that the individuals will be selective themselves.
We did not include the sounds that are produced by the human hands in the transcription. In a way that is a pity because these sounds are present in early interactions like the spoon in a plate or the caressing hand on your head. The infants world is full of social sounds, and we have selected only a few of them in our transcription system. The feeding spoon, for example, especially makes noise towards the end of the meal, i.e. when it becomes likely that the mothers will say: "Finished!". Some mothers realise that their infant knows already that the intake of food will soon end, because of the sound of the spoon in the plate. Their "Finished" is the sound of ultimate importance in that situation because it soon can be applied to other situations.

c. *Mutual and simultaneous*

Intersubjective tuning initially occurs distally during mutual gazing (though perhaps somewhat more in the form of 'wishful thinking' by the

mother). It certainly changes her behaviour, which the baby will notice. Intersubjective tuning during vocalisation in unison (which is regarded to be basic to speech development) is perhaps an unexpected choice because *alternating* sound production is used later on. Perhaps the 'tuning' between mother and infant must be taken literally here. Research on prosody in motherese and its effects points also in that direction. The earliest infant sound productions have but a very short duration. The pleasure cries in proto-conversations are longer. Mothers and other adults raise their voices and tune in (Papoušek & Papoušek, 1989). This may result in enhancing auditory perception by the infant, i.e. by being well above its hearing threshold. This possibly is 'noticed' by the infant, as such stimulating the infant's voice production. These are only speculations, of course, but early absence of vocalisation in unison did occur in the pair (Fanny and SUSAN) with speech communicative delay.

d. *Fluctuations in data*

In a four-week period the amount of time and the frequencies of intersubjective tuning appeared to change drastically. That is unpleasant for the researcher, because it is unpleasant for statistical analysis. Yet this is the reality of longitudinal studies. The sampling frequency for observations is usually chosen on the basis of practical arguments, and thus the frequency may be too low. The infant's development during the first two years is a fast process which needs very frequent sampling.
As we are interested in the underlying, common characteristics of the developing speech communication, the fluctuations are merely a handicap for 'powerful' statistical techniques.
But the sign-test does its job. The magnitude of the differences between the two percentages or frequencies, used in the comparisons, could be a point of discussion. If the differences between the two pairs are (very) small, and thus probably irrelevant, the chance to get a significant distribution of signs is small. The noise in the observations can further guarantee that.

3.4.2 Impact of intersubjectivity for speech communication

The intersubjective patterns in face-to-face contact and vocalisation in unison are quite different for the two pairs. A quick conclusion would point at the affect systems in the two pairs, forming the basis for the further development of speech.
There is more to the affect system than looking at each other and laughing together. There is every reason to believe that both Claire and EVE, and Fanny and SUSAN have built up their affectionate relationships. Certain relationships are probably constructed in a way that is less favourable for a normal development of speech communication.

For Claire and EVE the picture is quite clear: they are abundantly engaged in vocal play. The face-to-face situations were 'continuing stories' full of positive affect, laughing, games, and play. When Claire was fussy, EVE tried her repertoire of movements, songs, or new inventions. Books were introduced at an early age and she had many favourite ones. In a way, Claire had a playmate-caregiver during each stage of her precocious development.
For Fanny and SUSAN the picture is different. Only after the analysis of the recordings, we started to understand what may have been going on. Right after birth, Fanny seemed a child full of temperament and being further ahead than SUSAN probably expected in sound production and in visual attention. Karen, Fanny's older sister, had been an easy-going child. Fanny may have wanted different things than her sister in the first months and had unpredictable tempers. With a tiny infant, adults are at a risk of underestimating the infant's abilities.

> Fanny, for example, is looking at SUSAN's face in week 4 about 65% of the time (first recording in Figure 3.1, see Appendix IVa). For a four-week-old infant, it is quite an effort to pay attention to the mother's face for such a prolonged time. In three-week-olds, Van Wulfften Palthe (1986) reports a median duration of less than 10% of the time. In the five recordings up to week 20 of Fanny and SUSAN, the amount of time is decreasing quickly, a tendency which is also reported by Van Wulfften Palthe (1986). Perhaps the preference for the visual channel is present already in the first recording of Fanny and SUSAN. Perhaps the exceptional and early visual attention explains the re-occurrence of face-to-face contact in the further development of this pair.

Fanny's tempers had their effects on SUSAN who felt then at a loss and she backed out at times. She used to say that Fanny preferred her father, which was probably true. SUSAN and Fanny's early relationship has been 'cautious', at least in the distance channels. SUSAN often looked away from the face-to-face situation for fractions of seconds, to make sure that everything was o.k. When Fanny invited her with really sweet babbling monologues, SUSAN smiled about her obviously happy girl, but she hardly engaged in the play. When she introduced a book, she read the written story and did not keep Fanny's attention. So, Fanny did not like books. However, SUSAN and Fanny somehow came to understand each other, establishing a close and functional relationship, especially in the presence of strangers.

Moments of mutual gaze together with vocalisation in unison were more prominent over the two years in the interaction of Fanny and SUSAN than in that of Claire and EVE. Fanny and SUSAN continued to often use both the vocal-aural and the visual channel to express their mutual attunement. Claire and EVE did so too, but less often by means of the two channels simultaneously.

One 'explanation' for Claire and EVE's behaviours could be that they increasingly use the visual and the vocal-aural channels separately for all kinds of intersubjective tuning. This is reported in the literature too: the infant becomes more interested in the objects that are present in the environment which the mother introduces then in the interaction (Fogel et al., 1992). Earlier we have suggested that around week 16 Claire started to break up the bi-modal complex tuning (section 3.2.3 a.).

> In view of data from Van Wulfften Palthe (1986) on the time spent by infants looking at their mother's face during week 3 to week 21, the recording of Claire and EVE in week 16 can be qualified as 'exceptionally visual' (> 80%, see Figure 3.1). Van Wulfften Palthe reports a median duration of 45% of the time in week 15 (and a range of 20-60%). Claire and EVE are then already 'ahead' in their visual tuning than Fanny and SUSAN.

When the mutual tuning can be checked visually in a glance like Claire and EVE did, attention can remain on an object, for example, while 'extra information' about the object can be given through the vocal-aural channel. This is similar to a 'naming situation' which is favourable for learning a lexicon.

Fanny and SUSAN, less sure of each other, preferred the fairly intense bi-modal method of intersubjective tuning which is 'expensive', because of the many vocal-aural exchanges between the partners during which they must look at each other's face. At those moments the mutual visual attention for an object or a picture is interrupted, and labelling the object vocally is then more likely to be 'unsystematic'.

Intersubjective tuning starts off as the development of affect, also through the distance channels. If the affect system does not spread to uni-modal forms of tuning, the persisting early patterns can have their impact on the further development of speech. In this way the approach reveals early difficulties in speech development at a very basic level.

In the next chapter (on intentionality) the transmission of visual or audible messages to the partner during face-to-face contact and vocal-aural tuning is described. This aspect of speech communication is thought to accentuate further the intersubjective patterns in the two pairs.

4

INTENTIONALITY

Abstract

Human communication implies intentionality of the partners, which is based on intersubjective tuning. In this thesis three kinds of intentions transmitted via the distance channels, are studied from the fourth week onwards. The communicative intent of young infants is a topic for discussion among scientists. According to some scientists, the young infant is only moving reflexively or acting instrumentally. Others point at the infant's ability to stay in contact with an important other person, and they consider that to be intentional behaviour. Mother and infant, as a system, move and react upon each other's movements from birth onwards.

The initial asymmetry between mother and infant with regard to the expression of intent in a linguistic sense is clear. Imitation of facial expressions and mouth movements in infants are strong cues for a transmitted communicative intent to the caregivers. Compared to movements in the visual system, infant sound production develops only slowly to adult quality. Based on intersubjective tuning, however, mother and infant transmit, through the vocal-aural channel and supported by the visual channel, movements that may become meaningful in an adult sense in their later communication system.

In our approach, intentionality in the mother-infant system is described on the sensori-motor level throughout the first two years. Intentions are considered to be expressed by sound productions and by mimical plus head movements that are transmitted during mutual gaze. With this sensori-motor transmission system in mind, an intention is only received by the partner, when at least two simultaneous movements have occurred. For example, a sound production is only regarded as an intention during face-to-face contact.

Results on the visual, the audible, and the intense intentions are discussed in relation to efficiency in the speech communication system.

4.1 Introduction

"Such assumptions allow us to speak of intentionality in preverbal infants; the more interesting it is to observe that young infants do differently modulate vocalisations during individual stages of learning instrumental acts, and that parents do interpret those vocalisations as expressions of intentions as well."

(Papoušek & Papoušek, 1981, p 207)

Intentionality-in-development is related to the readiness of a person to perceive and interpret the movements of the partner. This characteristic, as present in mother-infant systems, is the focus of this chapter. Instrumental acts and goal-directedness will develop in the interactional context.
For transmission of intentions, intersubjective tuning must be present, which was discussed in Chapter 3. Intentions can be attributed to most human movements, or combinations of movements, that are perceived. In this thesis, a selection of intentions is made in line with the sensori-motor approach. Three kinds of intentions are studied, that are transmitted over the distance channels.
The literature will be presented with regard to the development of intentions of mothers and babies in relation to speech communication.
The compilation of movements, representing the transmitted intentions, is discussed as well as the comparison of the two mother-infant pairs.

4.1.1 To reanimate 'intentionality' during intersubjective tuning for the adult reader

Stage:	elevator in a skyscraper
Actors:	two sensibly moving ones
Attributes:	none

Elevator goes up, two insiders, one only recently.
Stops at floor ten, door opens and closes
No one comes in, elevator goes up again

Actors look at each other, one smiles

In the above reanimation the two actors have been in each other's presence since floor nine and have grown accustomed to each other in that situation when something happens. The smile of the actor can be interpreted by the co-actor as: "This happens more often, don't worry". Other interpretations are also plausible, but in this chapter the 'don't worry'-intention is leading.

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While the elevator goes up, the intention of the smile and the initial interpretation are probably negotiated.
To many people, intentions are related to goals, and quite correctly, nearly all human action can be translated into aiming at results or (subconscious) goals. Knowledge about and estimations of the intentions of other people make up a large part of adult life. Even in fairly private conversations, the transmission of intentions in adults can deviate quickly, mainly because the successive interpretations are selective or usually based on previous experiences. Training, discussion techniques, and assertiveness with their effects on *turntaking* can be seen as a means to correct such deviations. In mother-infant interactions intersubjective tuning is basic for the transmission of intentions and for further development.
In this chapter a selection of transmitted intentions between mother and infant is given, since only the distance channels are considered. One thing is certain: if no intentions are transmitted, the infant will have difficulties in becoming a normal communicator. Intentions expressed by movements which are not perceived by the partner are neglected in this chapter. This interactional constraint is chosen because the observer cannot know the previous experiences of the mother-infant system. He cannot decide about the intention of *a movement of an individual* which was used successfully towards the partner before. To interpret the movements in a quickly changing interaction pattern presents another problem which is usually solved in the mother-infant system. The continuity in intentionality between mother and infant is assumed to underlie the various overtly transmitted movements.

4.1.2 Literature and definitions

In the literature, the ability of infants to express intentions is usually discussed in relation to the interpretative function of the mother. Infant imitation can be seen as an interpretation of the mother's intentions. Movements and their interpretations are matters of personal preferences in mother-infant systems that can deviate into interactions-at-risk. There seems to be a 'natural selection' in the literature to study intentions in the *distance* channels. We have confined ourselves to the literature data on the development of intentionality during the first year.

a. *Meaning*

The term intentionality is related to implicit meanings in acts that aim in a certain direction and end at a certain goal (e.g. Tronick, 1981). Actions between persons can have many purposes. Determination, firmness, and concentration are elements of an 'intent' look which is directing a partner's mind towards a meaning. For adult intentionality, the 'object-person' does not need to be present. Intentionality in mother-infant interaction is

present in the actions of the persons involved when an aim or an implicit meaning is a necessary ingredient of that act.
Although intentionality is ascribed to one person, the presence of another person facilitates the interpretation. Intentions are thus mainly based on intersubjective situations. Persistent crying of even young infants is interpreted likewise: the infant 'wants to....', which at times is overruled because of an 'adult' interpretation (is tired and must go to sleep!).
In a positive sense, neonatal imitation (Meltzoff & Moore, 1977) is also seen as intentional behaviour of infants. The imitation as such is not precisely intentional on its own (causal, or goal-directed), but the purpose to stay in contact with an important other person, is clearly intentional (Butterworth, 1986).

b. *Onset*

The discussion about the onset of intentionality in infancy originates from the same source as the 'linguistic gap' (see 1.4.3 final paragraph): the adultomorphic approach of infancy. The initial *'inequality' in intentions* is present in individual mother-infant pairs, because *specific* behaviours are compared. The quality of life of these two individuals, however, is totally different. Thus the meaning of the word 'intention' is different. Research with a lead from adult theory and that using the infant-centred approach will dispute each other's position. Some topics are found in the grey area between intersubjectivity and intentionality, and others in the content of intentions.
Scientists agree upon the existence of intentionality when the infants have developed *more or less 'adult' behaviour*. Such an approach will miss the actual developmental process towards 'adult' intentionality.

> "..., the initial communication system does not contain language, although clearly it will develop in such a manner as to permit linguistic interchanges. Therefore, to look at the early development of the system solely in terms of its pre-linguistic properties would be to miss its current organization and the change of that organization."
>
> (Tronick et al., 1979, p. 349)

Generally, researchers in cognitive psycholinguistic do not ascribe communicative intent to infants younger than seven or eight months old. Infants are said to be prelinguistic at different levels of linguistic description (Gillis et al., 1988). Intentionality is related to measurable concepts and consciousness (Harding, 1984). Tronick et al. (1979; Tronick, 1981) has disputed this approach; recent psycholinguistic research is less restrictive with regard to the age of the infants (Murray et al., 1990).
Naturally, there is a difference between meaningful behaviour of a young infant and a near-toddler. Trevarthen (1977) has introduced the term *primary intersubjectivity* to indicate a young infant's meaningful behaviour

in the interaction with the mother, which for Butterworth (1986) is observable in mother-infant contact. Of course, *secondary* intersubjectivity (Trevarthen & Hubley, 1978) comes later, resembling 'real' intentionality. The distinction between primary and secondary intersubjectivity is usually explained by means of the infant's object manipulation which is initially just intersubjective with the mother as onlooker: the infant knows that the mother is present. Towards the end of the first year *a sharing of interest for an object* with another person develops, which is called 'intentional communication' (Kerkhoven, 1989) or secondary intersubjectivity (e.g. Foster, 1990).
In my opinion, this distinction between primary and secondary intersubjectivity partly disregards the vast field of emotional intentions shared with another person. If the 'object' is left out of the discussion, a sharing of interest and a sharing of movements can be said to be present right after birth.

> "She is using reaching no longer as a *direct* means of getting what she wants, but *indirectly* by using it as a request. She is apparently aware of the ineffectiveness of requests that go unnoticed or are not responded to, since she checks to see that her mother has noticed and is going to respond. This simultaneous attention to *something that is communicated about* and to *a person who is being communicated with* is secondary intersubjectivity, and true communication."
>
> (Foster, 1990, p. 22-23, original italics)

Bruner's approach (1975, 1981) to the problem is *already less adult-centred*: infant behaviours seem to be goal-directed and, as such, instrumental. Furthermore, he argues that intentional acts are not necessarily performed consciously. Even adults cannot claim to act consciously all the time, yet they can afterwards formulate a 'reason' for their behaviours.
Tronick (1981) points at the *neonatal ability* to coordinate endogenous and exogenous processes, and at the regulation of reciprocal exchanges with the mother. This ability is a proof of goal-directed, skilled performances, and demonstrates the meaningfulness of neonatal acts. In mother-infant interaction this ability evokes the usual behaviours, possibly because of their mutual predictability. Trevarthen (1979) also argues in favour of an early onset. He clearly identified distinct visual (yet non-vocal) lip and tongue movements in the third month. This 'prespeech' is perceived by adults in the face-to-face situation as "a rudiment of intention to speak to that person" (p. 327). The infant imitates adult speech by an increase in vocalisation frequency which can be interpreted as intentional i.e. to maintain vocal contact (e.g. Bloom, 1988). Differences in behaviours in 'animate' (with clear commitment to intentional communication) and 'inanimate' situations offer further support for an *interactional approach of intentionality* (Trevarthen, 1977, 1979; Trevarthen & Marwick, 1986). An innate intentionality in the infant's spontaneous acts is possible, but in

direct social interaction with the mother intentions and interpretation of intentions are inseparable (Asch, 1952; Butterworth, 1986).
The search for the ultimate infant behaviour which proves that the infant is capable of intentions 'at the age of ....' is futile. In mother-infant interaction soon after birth the system is in development via all modalities. While 'being in communication' (Bullowa, 1979), one person moves and the other attributes intentions, regardless of the conventional symbols or codes. Intentionality is present in a form that is not yet simply related to overt adult behaviours.

c. *Intentions via the distance channels*

During *face-to-face contact, visual and vocal-aural intentions* can be transmitted to the partner, as parts of a visual and audible communication system. Combinations of vocalisations and facial expressions are likely to occur simultaneously (e.g. Condon & Sander, 1974; Condon, 1977, 1979) in the individual and in interaction. It can vary from an intent gaze at the partner, followed by a burst of movements of the infant from eight months onwards, according to Kerkhoven (1989) to firm and determined behaviour of the mother, for example. A 'spontaneous, repeated social smile' of a ten-day-old baby to the mother, surrounded by a gathered family is for them a sign of happiness of the infant (personal observation). To parents, the attribution of meaning to imitated mouth and mimical movements is not difficult. The global structures of mother-infant engagements reflect rules of adult communication: face-to-face contact, mimical expressions, hand-arm movements, and a growing ability to time movements in turns.
The *parental interaction programs the infant* to act more and more intentional (Newson, 1979). Parents spontaneously attribute a communicative intention to the facial expressions, gaze, and head movements of infants (Trevarthen, 1977, 1985; Bullowa, 1979; Foster, 1990). It seems to be "a vocabulary of sign and signals" (Fraiberg, 1979, p. 152). The mechanisms in attribution of meaning are based on primary intersubjectivity, elaborating intentionality at the same time.
The *intent attributed to the infant's behaviour* is private in the mother-infant system. A frown upon a barking (unfamiliar) dog can be interpreted as: 'Baby does not like dogs', and thus the baby is kept away from dogs. The 'children's words', as /ka/ for aeroplane, have started in private and persist in the family circle (personal observation). In short: the infant and parents are ready for 'moving together'.

In *research,* differences in timing and quality of movements between infants and adults, and lack of 'infant intentionality' are theoretically more conclusive than an immediate recognition of infant's behaviour by the parents. Scientifically, the early smile is thought to be reflexive or to occur by accident. During face-to-face contact, however, the amount of time that an infant smiles and vocalises clearly increases in the first three months, which is not explained by an age-effect alone (Van Beek, 1993). Nelson

(1987) doubts the infant's ability to recognise and *understand* facial expressions because the visual system is not yet mature. He concludes that infant discrimination of visual intentions, like smiles and anger, is not likely before four months. The infants may respond to other features in the mother's face that will have a function later on.

It is very unlikely that this knowledge will limit the mother when using facial expressions. These are usually accompanied by audible cues in the vocal-play situations, in a contingent way related to the emotions. Mothers, before researchers, have been well aware of the bi-directionality in their interactions with infants (e.g. Van Beek, 1993), provided that the infant's communicative behaviours have become more or less predictable for the mother. In relation to speech communication, Bateson (1979) already points at the structure in the behaviour of both persons during the proto-conversations.

There is some disagreement about the use of the term 'conversation' for mother-infant vocal behaviour. The dialogue structure is present with clearly more syllabic than non-syllabic sounds (Bloom, 1988), but the sounds are meaningless (e.g. the discussion in Bloom, Russell & Wassenberg, 1987). For a long time, mothers were considered to be 'talking nonsense' (e.g. Bullowa, 1979) as the baby does not understand *the content* of what she says.

The function of the *mother's speech* changes with the age of the infant. Infants might pick up the (affective) message from the prosodic features in their parent's speech (Fernald, 1989). In six-months-olds, about 30% of the mother's utterances still have an affective (prosodic) value, in spite of the clear increase of referential utterances (Penman, Cross, Milgrom-Friedman & Meares, 1983; Snow, 1977). The adult's changes in their speech to infants is a widespread phenomenon and present in many different cultures. Among other explanations, this occurs to "facilitate speech processing and language comprehension" (Fernald, Taeschner, Dunn, Papoušek & De Boysson-Bardies, 1989, p. 495).

Babies distinguish and *prefer motherese* (Fernald, 1985). The affections as expressed in voice features can be discriminated by infants (Caron, Caron & MacLean, 1988). Young infants vary their vocalisations along with situations and specific maternal utterances in the first five months already (e.g. Delack, 1974; Bloom, 1988; Masataka, 1992).

When visual *maternal behaviours are manipulated* and are not expected by the infant (Papoušek & Papoušek, 1977), they trigger negative affect. The babies then aim at a re-establishment of normal communication (Genta, Tartabini, Costabile & Zamberlan, 1986; Stern, 1974). The effects of unresponsive infants upon adults has so far only been studied in non-human primates (experimentally controlled by anaesthesia, e.g. Rosenblum & Youngstein, 1974) and in blind infant-mother interaction (Fraiberg, 1979). If the infant does not react upon adult actions as expected, the adult will (to a certain extent, of course) try something else to comfort the baby.

Conflicts and clear 'misunderstandings' in human mother-infant interaction are generally regarded as 'incidental' by the mother. Mothers usually say that these deviations from normal routines are caused by a bad mood of the infant, or are explained by environmental effects. It is questionable if this is a correct assumption (Plooij & Van de Rijt-Plooij, 1989). Conflicts probably occur more often in mother-infant interaction than is admitted and their impact on the developmental process is underestimated (Van de Rijt-Plooij & Plooij, 1993). The 'misunderstandings' ask for renewed tuning and a new formulation of transmitted intentions, which can be in a form which is a step closer to the adult communication system.

d. *Imitations as special intentions*

Imitation of facial expressions, including mouth movements, certainly will be seen by skilled observers, certain parents included. The infant is capable of responding to meaningful parental behaviours in a systematic way. Mothers, opening their mouth while spoon-feeding their infant, rely on an unconscious intentional residue, based on infant imitation or empathy (Wind, 1986). The infant's attention for the mother's face is prolonged, when the mother imitates (Field, 1981).
Caregivers focus on these infant behaviours nearly automatically, as they resemble their own behaviour (Trevarthen, 1979). It facilitates the attribution of intention.
Imitation by infants of sound aspects is not easy to detect (e.g. Snow, 1981), as there is an anatomical and neurophysiological difference in the speech production mechanism (e.g. Koopmans-van Beinum & Van der Stelt, 1979; Bloom, 1988). Adult sound productions to infants elicit infant sound production, yet *what* has been imitated is not always obvious. Possibly an infant reproduces only seemingly unimportant aspects of the adult vocal model, in relation to the capacities at that moment of the development. Yet, infants are probably aware of many sounds that an adult has learned to suppress in perception.

> "...., since vocal imitation presumably requires such awareness. And, indeed, such evidence exists. Martin and Clark (1982) found that at 18 hr postnatally, infants react differentially to audio recordings of their own crying as opposed to that of other infants."
> (Locke, 1990, p. 628)

Imitation in infants is fascinating, since it proves that 'adult-control-systems' for movements are not needed for 'meaningful' movements of infants in interaction. Newborns can imitate facial movements, mouth and hand movements (Meltzoff & Moore, 1977).

Newborns recognise

> "(a).. isomorphisms between themselves and other humans, (b).. act on abstract, intermodal representations of things and people in the world, and (c).. organize and control their behavior on the basis of stored representations of perceptually absent stimuli."
>
> (Meltzoff, 1985, p. 3)

The explanation for these infant abilities (e.g. Powers, 1973; Plooij, 1984; Meltzoff, 1985) comes with 'intermodal perception in infants', which applies to other fields of infant behaviour as well. For Sullivan & Horowitz (1983) "the multimodal quality of the input provided by the mother is especially important during the first year of life." (p. 211.). Supramodal or intermodal perception in newborns and infants may explain how in imitation the link is made between a visual display and a proprioceptive change, like a 'sensory-motor control system', of which the developing hierarchical structures enable patterns of more or less unimodal behaviours (Powers, 1973)

e. *Concluding remarks*

The transmission of intentions to a partner is instantaneous and is not necessarily linked to earlier or later appearing abilities. It is based on an underlying mutual attitude to take each other's movements serious (e.g. Van Beek, 1993). This opens the door to the interpretation of really new behaviours meant to be intentional for the partner. As for future behaviours, the proportions of responsiveness and stimulation in interactions with young infants are probably more predictive for performances later on than the individual behaviours themselves (e.g. Coates & Lewis, 1984).
Overtly, the intentional behaviours of the individuals are very complex, complicating the study of underlying processes that may attribute to the development. The approach of mother and infant as a system has its advantages in the description of speech development (e.g. Fogel, 1992a, 1992b), because the outcome of the 'self-organising' interaction does not necessarily result from intended and conscious decisions of the individuals. Thus, discussions about the infant's (or the mother's) consciousness and the quality of movements can be avoided, if we are dealing with the *system's coping capacities* (see Chapter 6, section 6.3 c).

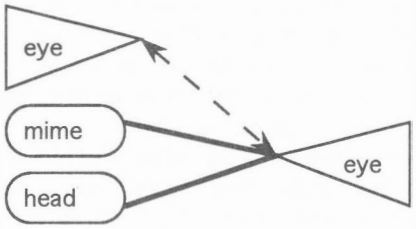
4.2 Intentions as co-occurring movements

In search for intentionality, movements are selected from the original transcriptions that are transmitted during face-to-face contact and vocal-aural tuning (Chapter 3). The selection of movements is in line with the sensori-motor model for mother-infant interaction (2.4.1). Although the

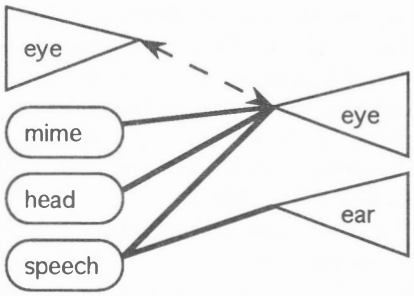
pairs are unique, certain fundamental characteristics must be present in their progress toward speech communication (see 3.1.1g.).
The transmission of intentions is regarded to be the second underlying characteristic in the development. Through the distance channels, certain intentions are transmitted during face-to-face contact and vocal-aural tuning like

- visual intentions,
- audible intentions, and
- intense intentions, combining the previous two.

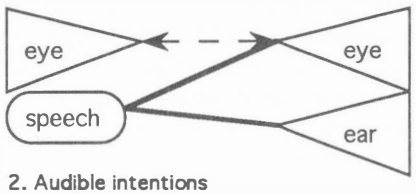
With the sensori-motor transmission model in mind, movements can be interpreted only when they are perceived by the partner. The occurrence of movements in one of the individuals thus must be related to the activities of the partner in order to conclude about interpersonal transmission. When *at least two simultaneous* movements occurred during face-to-face contact (for the intense intentions *four* movements are present simultaneously), we assumed that *intentions* were actually transmitted between the two individuals via the distance channels. By choosing two changes, a baseline is set for co-occurring movements to be intentional. In Example 4.1 the three kinds of intentions are represented in the channels of the transmission model.



1. Visual intentions
during face-to-face contact
mimical and head movements



3. Intense intentions
during face-to-face contact
mimical, mouth, head movements
together with sound productions



2. Audible intentions
during face-to-face contact
mouth movements and sound

Example 4.1
Three kinds of intentions, in which at least two changes occur simultaneously that are perceived by the partner (indicated by the bold lines).

As indicated in Example 4.1, the *visual* intentions are defined by the simultaneous mimical and head movements during mutual gaze. Two movements are then received through the visual channel.
The *audible* intentions are considered to be transmitted while *seeing* the mouth movements and simultaneously *hearing* the sounds, which should occur simultaneously as well. Two changes occur then, for the receiver via the two distance channels. The vocal-aural channel always functions, and face-to-face contact guarantees that the mouth movements (made during the production of sound) are received.
The so-called *intense* intentions combine the visual and the audible ones. Then, four changes occur simultaneously: three via the visual channel (mimical, mouth, and head movements) and one via the vocal-*aural* channel.
The three kinds of intentions must be 'translated' below to co-occurring movements in the two individuals of a tuned pair. The reader is introduced to a variety of possible intentions, which is considered to be reflected in quantitative data. The sign-test is used to compare the transmission of intentions between the individuals of a pair, and to compare the mothers of the two pairs and the two infants. The comparison *within* a pair gives an impression about the presence of the intentions with which the pair's communication system will be constructed. The comparison *between* the pairs shows whether a part of the differences can be explained by the quantity and the kinds of transmitted intentions.

4.2.1 Visual intentions

During face-to-face contact mothers and infants usually exhibit a variety of movements, partly interpreted as excitement, with the mutual expressions. When, in the course of development, face-to-face contact is about to disappear, the visual intentions can only be a small part of the communication system, which, however, says little about their function.

a. *Introduction to visual intentions*

The visual communication system in humans is complex because the eye can see *and* move. A visual intention, *as analysed in this chapter*, is transmitted when a mimical and a head movement co-occur during mutual gaze (Example 4.1). The eye movements themselves are regarded to be very communicative movements (Field, 1981), but these are disregarded here. When either one of the individuals is looking away, visual intersubjective tuning, a prerequisite for the transmission of intentions, is interrupted. The observer may start to 'interpret' the visual interaction and the meaning of the shift in gaze direction which then becomes a matter of taste. By disregarding the eye movements as intentions this pitfall is eliminated in the study.

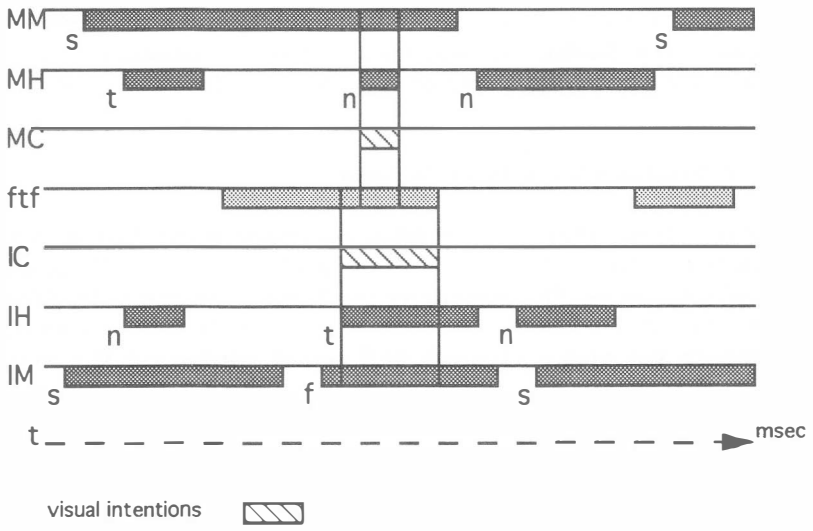
The infant and the mother are thought to be fairly equally equipped with abilities for the mutual transmission of visual intentions. Movements can gradually be better coordinated by the infant, interpersonal with the movements of the mother as well. Mothers may vary and repeat aspects of their movements patterns, while infants can repeat over and over again the same movements. Later on, the infant can combine specific movements that are interpreted by the mother in line with the 'conventions' of the developing mother-infant communication system. Here, I will focus on the infant's visual behaviour in that system.
Initially, the infant may see mainly mimical and head movements and only few of the mother's eye movements because the mother *frames* the infant's gaze (see 3.3.1a). If the mother keeps a fairly blank face during face-to-face contact, few visual intentions are transmitted to the infant.
At an early age, the visual behaviour of an infant *suggests,* however, 'adult' quality. Mimical movements or traces of these are interpreted by parents to reflect the internal state of the infant. A head movement of the infant usually implies a (previous) shift in gaze direction, but not so later on when head and eye movements are under control.

> In week 8, Claire 'found out' that her frowning movement 'changed' the smile on the face of her mother to a neutral facial expression, which EVE probably did unconsciously.
> This mimical interaction occurs about fifteen times in that recording of five minutes, with variation in the duration of the simple movements of mother and infant.

More or less short glances at a person can be interpreted as 'just checking' if the partner is paying attention. Then, a swift exchange of smiles may occur and a greeting head movement. The visual intentions are then transmitted very efficiently with regard to the timing of the movements.
The differences in the ways to transmit intentions during face-to-face contact are thought to be reflected in *simple quantitative measures*, such as the percentage of time of face-to-face contact in a recording. It is clear that visual intentions are *personal actions*. The frequency of visual intentions as well as the percentage of face-to-face time used for the transmission depends on the co-occurrence of mimical and head movements in a person.
The differences in intentionality originate from the development of the individuals as well as from their interaction with the partner in a pair. A comparison of the intentions of the individuals within a pair reveals the material with which they construct their communication system. The (infants and mothers of the) two pairs must also be compared amongst them in the search for the differences between them. These differences must be fairly systematic over the two years if the researcher wants to distinguish between different styles of intentionality in the development toward speech communication. The results on the transmission of visual intentions are presented in section 4.3.1.

b. *Searching for visual intentions*

The file with the onset- and offset-times of moments of face-to-face contact in the two pairs, constructed in Chapter 3, is used again here. A visual intention is indicated by PROGRAAF whenever a movement in the mimical channel co-occurs with a head movement during face-to-face contact. The code 'neutral face' is excluded in the mimical channel, as that is thought to represent a normal expression of the face (see Appendix II; MM:N, and IM:N). In the channel for head movements none of the codes have been deleted (MH: all codes, and IH: all codes).
Overlaps in time between face-to-face contact, and mimical and head movements represent the actual moments of visual intentions. Per recording and per person, these PROGRAAF-constructed files are saved for further analysis of the 'intense' intentions (section 4.2.3). The percentage of time per recording of visual intentions is the accumulation of the durations of the individual moments per person, calculated by FP and PROGRAAF. The frequency of intentions is given by PROGRAAF in the C-files of mother and infant.



Example 4.2
Visual intentions composed of simple movements in the mimical and head movements channels during face-to-face contact of EVE and Claire in the 8th week. Mimical movements are represented in the channels MM and IM (Mother-Mimic and Infant-Mimic). Head movements are given in the channels MH and IH (Mother-Head and Infant-Head). The ftf-line indicates the moments of face-to-face contact. In channel C (Criterion) the actual visual intentions are indicated, for mother (MC) and infant (IC). See the text for a verbal report of the situation.

Example 4.2 illustrates the search for visual intentions by PROGRAAF in a transcription of EVE and Claire. EVE's mimical movement (MM: s = smile) starts before face-to-face contact (blocks on the line ftf), as does a head movement (MH: t = turning). During face-to-face contact with a smiling face, only a very short head movement occurs (MH: n = horizontal head movement). This head movement is decisive for the duration of the visual intention.
Claire frowns (IM: f = frowning) and turns her head (IH: t = turning), breaking off face-to-face contact (ftf line: end of the first block). The transmission of a visual intention by one person is considered not to be hindered by possibly simultaneous use of the visual channel by the partner for the intentions of the latter.

4.2.2 Audible intentions

Sound production during face-to-face contact results in two changes in the mother-infant system: the sounds are heard via the vocal-aural channel, and the mouth movements are seen as well. The infant learns to relate sounds and mouth movements of the mother. When face-to-face contact disappears in the course of development, the audible intentions also disappear. The further development of speech communication permits transmission of intentions through the vocal-aural channel alone.

a. *Introduction to audible intentions*

In mother-infant interaction audible intentions occur during face-to-face contact, when the mother or the infant produces sounds. Then, the visual and auditory 'lines' for intersubjective tuning are open simultaneously. The movements that result in sound are transmitted in two ways: mouth movements via visual channel and sound waves via the vocal-aural channel. Vocalisation in unison may occur during face-to-face contact. These *overlapping* audible intentions are regarded to be transmitted to the persons involved as well, thereby relying on the selective ear of the partners.
If sound production movements occur while mutual gazing is absent, they are disregarded as transmitted audible intentions. A sound production is then only *one single* change via the vocal-aural channel and the 'baseline' was set for at least two changes. All sound productions (like calling the infant's name), however, are transcribed because they can become to belong to the category of 'audible intentions' whenever the infant turns to the mother visually during her calling. Many mothers interpret the sounds of their infants (even 'soundless' mouth movements) during face-to-face contact as 'speech', so they react to it.

In the fourth recording of Claire and EVE, the mother says: "You try to say the word, but the sound does not come out" to Claire who is making voiceless mouth movements during mutual gazing.

Children 'rehearse' their audible intentions in various ways. Fanny (in week 103) repeated the word "brother" over and over again when she saw a baby in a 'mother and infant care'-magazine, pointing at the baby's picture and then turning to her mother. The mother's interpretation of new infant sounds is perhaps easier when she is looking at the infant's face. The infant probably also looks at the mother's face, i.e. to check the effect, which results in an increase of audible intentions.

For several reasons, it was to be expected that the duration of audible intentions would decrease in the course of development. Firstly, mutual gaze decreases in duration. Secondly, cries disappear (usually!) and 'pleasure cries' decrease in duration as well. First words do not have a very long duration. Thirdly, when the development of speech communication proceeds, and both mother and infant alternate their sound productions, sometimes only a part of an utterance is transmitted in the form of an 'audible intention'. Only the onset or the offset of the utterances occurs during mutual gaze, like in adult turntaking.

In sound production, the infant is initially not an 'equal partner' for the adult because the sound production mechanism is cybernetically quite complicated and needs maturation. Furthermore, the role of the mother is a dual one as she is expected to react to the sound productions of the infant, and to do so in a selective way, 'reinforcing' the sounds that fit in with the mother tongue. This developmental process may derail in many ways. I will mention here only two extremes.

1. The infant does not produce any sounds for the mother to react to. Two choices are then open to the mother:
   (a) she may 'invite' the infant by means of her own audible intentions, or
   (b) she can wait for spontaneous sound productions of the infant that she can react to.

The latter is thought to be less favourable for the development of speech, because then the vocal-aural channel is not incorporated in their communication system as much as possible.

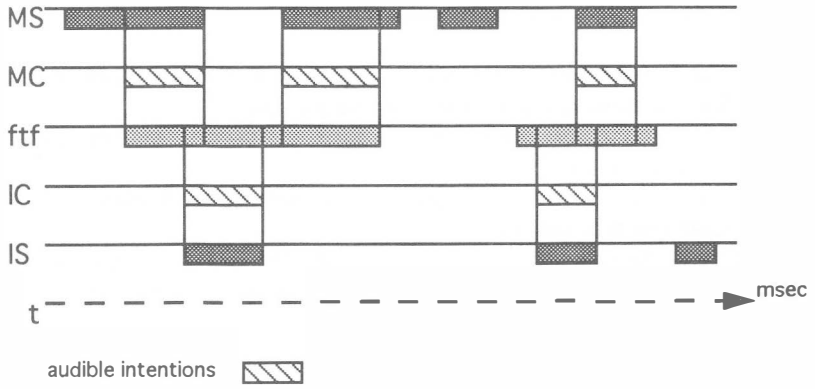
2. The infant produces sounds, but these do not resemble the sounds of the mother tongue. Again, two choices are open for the mother:
   (a) she offers 'models' by means of her own audible intentions, or
   (b) she waits for 'understandable sounds' to spontaneously appear.

The latter is thought to be unfavourable for the development of speech. Then, the incorporation of the vocal-aural channel in the communication system is likely to come after the period in which bi-modal tuning should already be maximally present (the first five months).

The more favourable choices of the mother (1.a and 2.a) result in relatively more readily audible intentions of the mothers than those of the infants, especially during the first five months.
The differences found over the two years to exist between the partners within a pair and between the two pairs are thought to be reflected in simple quantitative measures: the overall amount of time for the intentions is taken relative to the amount of time for face-to-face contact resulting in a percentage per recording. The frequency of sounds that are produced during face-to-face contact depends on the use of the vocal-aural channel. The results of the comparisons on audible intentions, presented in section 4.3.2, are discussed further in relation to the development of speech.

b. *Searching for audible intentions*

The file with onset- and offset-times of moments of face-to-face contact in the two pairs, constructed in Chapter 3, is used again here for the compilation of audible intentions. An audible intention is indicated by PROGRAAF when a sound is produced during face-to-face contact. All sound productions made by the partners are taken into account (Mother Sound production, MS: all codes, and Infant Sound production, IS: all codes; Appendix II, and Example 4.3) in the search for transmitted audible intentions.



Example 4.3
Audible intentions, compiled from sound productions during face-to-face contact of EVE and Claire in the 8th week. In the channels MS and IS (Mother Sound production and Infant Sound production) the sounds are represented. The ftf-line gives the moments of face-to-face contact. In the channel C (Criterion) the actual audible intentions are indicated for mother (MC) and infant (IC).

Intentionality is analysed separately for mother and infant, and the intentions are transmitted because intersubjective tuning through the visual and vocal-aural channels is present.
The onset of an audible intention of one of the partners can be the moment that face-to-face contact is established during sound production; also it can be the moment that that person starts sound production during face-to-face contact. The offset of the audible intention is calculated by PROGRAAF either when the mutual gaze is interrupted or a sound production ends. The vocalisations in unison, which occurred during face-to-face contact (the moments of bi-modal tuning, see section 3.3), are thus included in the audible intentions of the partners as (partly) simultaneous transmissions.
The duration of an audible intention is determined by the actual overlap in time of the files for sound production (MS, or IS) and face-to-face contact (see 3.3.1). These PROGRAAF-constructed files with audible intentions per person are further used for the synthesis of the 'intense' intentions (see 4.2.3).
The overall duration per recording is calculated by PROGRAAF. Per recording the frequency of audible intentions of a person is given in the C-files. The percentage of time for sound production (not necessarily during face-to-face contact) and the frequency of sound production are given by FP, as calculated from the original transcriptions. These sound productions are seen as investments of the partners in audible intentions.
Below an example is given of audible intentions by Claire and EVE, as indicated by PROGRAAF. No sound codes are given as the mere production of sound is enough to make an audible intention.

4.2.3 Intense intentions

The transmission of mimical and head movements together with sound production during mutual gaze ('intense' intentions) is the third kind of intentions, transmitted between mother and infant; this is discussed in this chapter. The intense intentions are regarded to be very obvious ones, even in early mother-infant interaction.

a. *Introduction to intense intentions*

The so-called intense intentions occur during face-to-face contact, i.e. when the mother or the infant combine visual and audible intentions. This intention was given its label because *three* more or less coordinated movements in *three* channels occurred during face-to-face contact, which is expected to be a 'quite obvious' phenomenon to the partner. Since visual and audible intentions (see section 4.2.1 and 4.2.2) can occur on their own, the intense intentions add a bi-modal aspect to the evaluation of the intentionality of the two pairs.

The intense intentions are present more often in the early multi-modal interaction, because mutual gaze together with vocalisations is more frequent then than after the fifth month.

> Fanny, in week 8, is sitting in a baby chair which is inclined backwards, looking at her mother's face. In correspondence with her age she vocalises fairly complex sounds of the laryngeal type. SUSAN, in front of her, touches the chair to check the straps, and she touches Fanny's body now and then. SUSAN smiles when mutual gaze is established, the smile freezes as she continues to look at Fanny in her vocal play. For fractions of seconds SUSAN repeatedly interrupts the mutual gaze to look at Fanny's body.
> Out of the blue, Fanny's body becomes tense, straitening her back, and she utters a short, loud cry sound. SUSAN immediately looks at Fanny's face with a frown, and asks: "What's the matter?", upon which Fanny vocalises again. This pattern re-occurs twice in that recording, and all cry sounds in that recording are produced when Fanny looks at her mother's face.

As the system's development proceeds, these intense intentions persist in certain situations, like in the game-situation ('peek-a-boo', for example). Towards the end of the first year, or until the infant has discovered the power of sound production, only simple laryngeal sounds (see Appendix II: code 41, or Figure 5.1a-b) are produced, usually with a questioning face and a head turn, to evoke a variety of desired actions in the mother. When playing alone at that age, a child can produce fairly long and complex vocalisations, sometimes mixed with 'babbled words' (observations made by Kerkhoven, 1989), but they cannot yet use these complex sound productions in a communicative situation.
The intense intentions are not always 'easy' to produce for infants. The mothers are considered to be 'experienced movers', so they are likely to produce more often intense intentions than the children. The intense intentions of mother and infant sometimes occur simultaneously. The transmission is regarded to be not hindered in those circumstances, comparable to situations in the transmission of the audible intentions. The fairly 'effortful' intense intentions will almost disappear when the speech communication system develops further.
The different ways to transmit intense intentions are thought to be reflected in simple quantitative measures, such as the amount of time of face-to-face contact. The percentage of face-to-face time and the frequency of intense intentions per person and per recording result from overlapping visual and audible intentions. The infant and the mother within a pair will gradually become more equal to each other by 'negotiating' these intentions, which is found by comparing the persons within a pair. The infants and the mothers of the two pairs were also compared amongst them to discover any differences between them. Results are presented in section 4.3.3 and will be discussed further in relation to the development of speech.

b. *Searching for intense intentions*

The intense intentions are searched for by PROGRAAF by analysing the two files constructed for visual intentions and for audible intentions that were produced by one individual. This results in a new file representing simultaneous moments of face-to-face contact and movements in three channels (MM: -neutral face plus MH: all codes, representing the visual intentions plus MS: all codes, representing the audible intentions, and similar for the infant IM: -neutral face plus IH: all codes plus IS: all codes). The onset of intense intentions results from the onset of a visual intention while an audible intention simultaneous had already started, or the other way around. The offset is calculated when either one of the simultaneously present intentions ends.
Per recording and per person the percentage of time and the frequency of intense intentions is calculated, to be used as measures in the description of the development of the intense intentions during the two years.

4.3 Results

The approach chosen in this thesis was expected to indicate that the two pairs differed in their transmission of intentions, relative to the intersubjective tuning, as presented in Chapter 3.
Intentionality via the distance channels is measured as the percentage of time of face-to-face contact, used for the transmission of intentions. The frequencies of visual, audible, and intense intentions are also presented, which is a more absolute comparison of the persons within a pair and of the two pairs.
Per kind of intention the persons within a pair and between the pairs are compared over the two years. Transmission of intentions is expected to change around the fifth month when face-to-face contact changes. Hypotheses will be introduced per kind of intention because these are related to the results obtained on intersubjective tuning (Chapter 3).

The sign-test is used again to compare the sets of data (mother-infant within a pair, and mother-mother, and infant-infant between the pairs); the attribution of signs is similar to the procedure in the previous chapter (see Table 3.1). The chance of a mistaken decision ('yes'- or 'no'-difference) is given in percentages.

4.3.1 Visual intentions

Results on the percentage of total time of face-to-face contact and the frequencies of visual intentions of the mothers and the infants are presented in this section. Both partners within a pair are compared, as well as the two infants and the two mothers of the two pairs.

Mother and infant *within a pair* are expected not to differ in this respect, as they can negotiate continuously about this kind of transmission in a more or less equal manner. The mothers and the infants of *the two pairs* are expected to differ because visual tuning occurred for a larger amount of time in Fanny and SUSAN than in Claire and EVE, not only during the first five months but over the two years as well.
Per recording the percentage of time of face-to-face contact used by a person for the transmission of visual intentions varies. The frequency of visual intentions thus varies too. Internal and external variation is of influence over the extended period of two years. The percentage of time of visual intentions and the frequencies of visual intentions are given in Appendix Va. for mother and infant per pair over the recordings of the two years. In Figure 4.1 (a-d) the percentages of time of face-to-face contact used for visual intentions of the four persons are given.

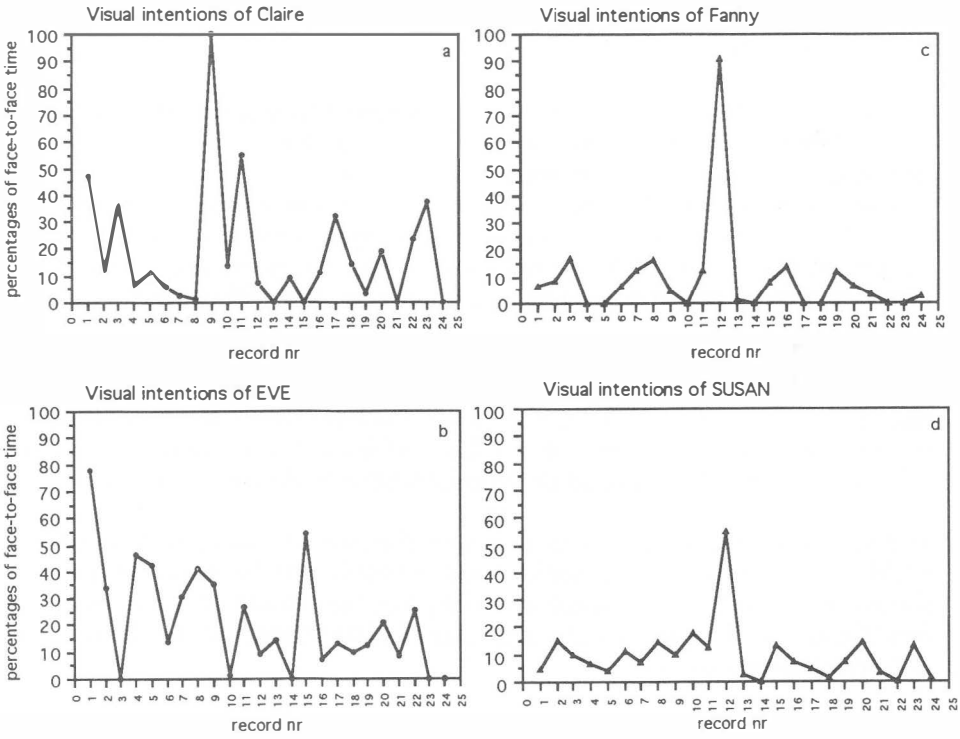


Figure 4.1 a-d
Percentages of the amount of time of face-to-face contact used for the transmission of visual intentions by Claire (a), EVE (b), Fanny (c), and SUSAN (d) in the recordings over the two years.

a. *Percentage of time and frequency of visual intentions within a pair*

I have assumed that visual intentions were transmitted when a mimical and a head movement of one person co-occurred during face-to-face contact with the partner. The partners in a pair could negotiate their transmission of visual intentions from an early moment in the first five months because the infant's visual behaviour appeared to be of adult quality.
For the sign-test the null-hypothesis is set as follows: the partners in a pair do not differ systematically with regard to the transmission of visual intentions over the two years.
The comparison of percentages and frequencies of visual intentions per recording is given a negative sign when the infants scored lower than their mothers (i<m: -). A positive sign is given in the inverse case (i>m: +); the recording is disregarded when the persons scored equal. This manner of sign distribution is used similarly in the following sections on audible and intense intentions (4.3.2 and 4.3.3 respectively).

Within a pair, mother and infant did not differ with regard to the transmission of visual intentions over the recordings of the two years. As the distributions of signs for the transmission of visual intentions was not different for the infants and mothers, the amount of time of face-to-face contact was used more or less equally by both persons for the transmission of visual intentions. The negative signs were more frequent in both pairs, indicating a tendency for the mothers to transmit somewhat more often visual intentions than the infants did.

Table 4.1
Distribution of signs for the percentages of face-to-face time used for visual intentions (% vi) and the frequencies of visual intentions (n vi) after the comparison of 24 matched recordings of *infant and mother within a pair* (Claire-EVE, Fanny-SUSAN). A positive sign is given to the recordings in which an infant scores higher than the mother (i>m), and a negative sign when the infant scores lower than the mother (i<m). Recordings in which mother and infant have equal percentages or frequencies are disregarded.

	Claire-EVE				Fanny-SUSAN			
	% vi		n vi		% vi		n vi	
n records	24	5	24	5	24	5	24	5
i<m(-)	14	4	11	4	12	3	11	3
i>m(+)	9	1	11	1	8	2	8	2
	23	5	22	5	20	5	19	5

In view of the number of disregarded recordings, Fanny and SUSAN tended to be more alike than Claire and EVE (see also the means in Appendix Va). Fanny and SUSAN ended with equal percentages (4 times) and frequencies (5 times) more often than Claire and EVE (1, and 2 times, respectively).
In the first five recordings, no difference was found within the pairs, which supports the idea of early visual equality between the partners of a pair.

b. *Percentage of time and frequency of visual intentions between the pairs*

The transmission of visual intentions of Claire and Fanny to their mothers, and vice versa, was compared to see if the infants or the mothers differed in this respect in the matched recordings over the two years.
In view of the percentages of face-to-face time used for visual intersubjective tuning over the two years (see 3.3.1), it was to be expected that Fanny scored higher than Claire on the percentage of time and frequencies of visual intentions. However, Fanny was expected to score lower than Claire during the first five months. Similarly, SUSAN was expected to score higher on the percentages of time and frequencies than EVE in the matched recordings over the two years, but lower during the first five recordings.

Table 4.2
Distribution of signs for the percentages of time for visual intentions (% vi) and the frequencies of visual intentions (n vi) after the comparison of 24 matched recordings, as well as the first five, for the infants (Claire-Fanny), and for the mothers (EVE-SUSAN), to make a between-pairs comparison.
A positive sign is given to the recordings in which Claire or EVE scores higher than Fanny or SUSAN, respectively (C/E>F/S). A negative sign is given when Claire or EVE scores lower than Fanny or SUSAN (C/E<F/S). Recordings in which the infants or mothers have equal percentages or frequencies are disregarded. The asterisks indicate the different levels of significance.

	Claire-Fanny				EVE-SUSAN			
	% vi		n vi		% vi		n vi	
n records	24	5	24	5	24	5	24	5
C/E<F/S(-)	10	0 *	13	2	5 **	1	10	1
C/E>F/S(+)	14	5	11	3	17	4	9	3
	24	5	24	5	22	5	19	4

* p <0.05
** p <0.01

These hypotheses have been tested by means of the sign-test, assuming in the null-hypotheses more or less equal distributions of signs over the first five recordings and over the 24 recordings. The results of the comparisons over the two years are given in Table 4.2.

When the percentage of face-to-face time for visual intentions or the frequency of intentions was lower for Claire than for Fanny, or for EVE compared to SUSAN, a negative sign was attributed to the recording. A positive sign was given when either Claire or EVE scored higher than Fanny or SUSAN respectively. Recordings with equal percentages or frequencies were disregarded. This manner of sign distribution *between the pairs* is similar in the next sections on audible and intense intentions (4.3.2 and 4.3.3, respectively).

Because of the *visual tuning* which was significantly higher for Fanny and SUSAN, it was expected that Fanny will score higher than Claire on the percentages and the frequencies of visual intentions over the two years. Yet, the distribution of signs over the 24 matched recordings was not significantly different for the infants on the two measures.

Likewise, and based on visual tuning, SUSAN was expected to score higher than EVE on the transmission of visual intentions. The distribution of signs for the comparison of the frequencies of visual intentions was *not* different for the mothers. In contrast to the expectation, it was *EVE* who was transmitting visual intentions for a higher percentage of face-to-face time than SUSAN ($p < 0.01$).

The comparison of the infants and the mothers amongst them over the first five recordings resulted in distributions that were significantly different ($p < 0.05$) for Claire and Fanny with regard to the percentage (not the frequencies) of face-to-face time that visual intentions were transmitted. As expected, Claire transmitted visual intentions during a higher percentage of time than Fanny in all five recordings. The distributions of signs for the mothers were not different for the percentages or the frequencies in the first five recordings.

These results indicate that, indeed, Claire and EVE initially used the visual tuning for the (mutual) transmission of visual intentions more often than Fanny and SUSAN did. Claire, with a higher percentage, differed from Fanny during the first five recordings. Even after the fifth recording when visual tuning with Claire was sparse, EVE continued to use the (small) amounts of face-to-face time systematically for a higher percentage of time than SUSAN for the transmission of visual intentions. Fanny and SUSAN were using a lower percentage of face-to-face time than Claire and EVE for the transmission of mimical and head movements, while the percentages of time and the frequencies of face-to-face contact were significantly higher (see 3.3.1). This means that Fanny and SUSAN looked at each other with 'blank faces' more often than Claire and EVE.

The onset of mimical movements

The above surprising result deserves some further exploration. As SUSAN was (visually) less intentional than EVE, it is possible that SUSAN used

just the onset of a smile as a visual intention, without a simultaneous head movement. This kind of visual intentions has been neglected in this chapter. For all individuals in the pairs, the number of actually noticed onsets of mimical movements per recording has been searched. The pairs, however, did not differ systematically with regard to the distribution of signs. This procedure was not done for the head movements, as a head movement can occur during face-to-face contact when the person is starting to look away, breaking off visual tuning.
The conclusion about the blank faces of Fanny and SUSAN seems correct.

4.3.2 Audible intentions

Results on the percentage of face-to-face time and frequencies of audible intentions of the mothers and the infants are presented in this section. The partners within a pair were compared (Claire with EVE, and Fanny with SUSAN), as well as both infants and mothers amongst them (Claire with Fanny, and EVE with SUSAN).
I assumed that audible intentions were transmitted during face-to-face contact, while the line for the transmission via the vocal-aural channel was also open: "see-what-you-say". This aspect of intentionality was analysed with regard to the percentage of face-to-face time used and the frequencies of audible intentions per recording for the persons involved.
An audible intention of the mother may have 'triggered' an infant 's which may partly overlap with the mother's. These audible intentions included thus the moments of bi-modal tuning (see section 3.3), but here the movements were counted per person only.

The mother and the infant *within* a pair were expected to differ in this respect. The mother showed the infant the 'models' for (later speech) sound production, and 'invited' the infant to produce (proper) sounds. Furthermore, sound production results from complex coordination of respiratory, phonatory, and articulatory movements, which the infant will master only gradually. Thus, a rather *unequal relationship* exists between mother and infant with regard to the transmission of audible intentions.
In view of the difference *between the two pairs* in vocal-aural tuning (3.3.2) and bi-modal tuning (3.3.3) in the first five recordings, the comparisons of the mothers and of the infants amongst them were expected to be different too. The transmission of audible intentions in the first five recordings was thought to be more frequent and lasting for longer periods of time for Claire or EVE than for Fanny or SUSAN, respectively. Over the two years, the pairs were expected not to differ.

The percentage of face-to-face time of audible intentions (% ai) and the frequencies of audible intentions (n ai) are given in Appendix Vb for mother and infant per pair for the recordings of the two years. In Figure 4.2 (a-d) the percentages of time of face-to-face contact used for the audible intentions of the four persons are given.

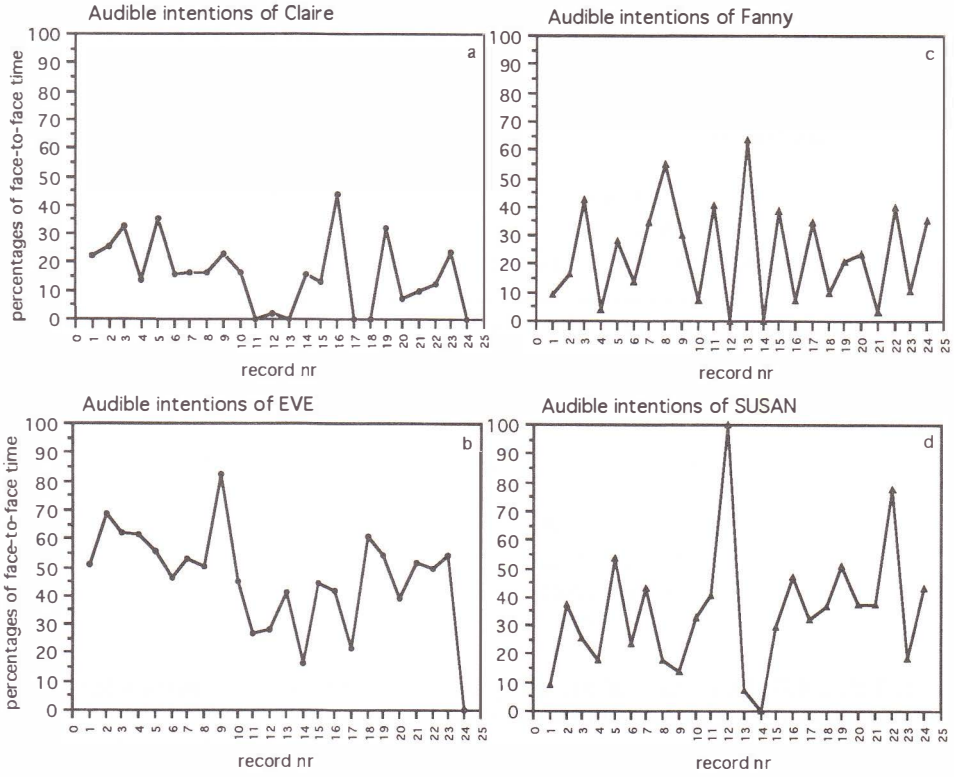


Figure 4.2 a-d
Percentages of total time of face-to-face contact used for the transmission of audible intentions by Claire (a), EVE (b), Fanny, (c), and SUSAN (d) in the recordings over the two years.

a. *Percentage of time and frequency of audible intentions within a pair*

It is assumed that audible intentions were transmitted to the partner when sounds were produced during face-to-face contact. Both mother and infant could (start to) produce the sounds, even simultaneously, because the ear of the receiver is probably selectively tuned. The mothers were expected to transmit more often audible intentions than their infants.
The null-hypotheses assumed that the mother and infant of a pair did not differ systematically with regard to the percentages and the frequencies of audible intentions. For the distribution of signs over the matched recordings the same method has been used as for the visual intentions *within* a pair (4.3.1 a).

Table 4.3
Distribution of signs for the percentages of face-to-face time used for audible intentions (% ai) and the frequencies of audible intentions (n ai) after the comparison of 24 matched recordings, as well as the first five, of *infant and mother within a pair* (Claire-EVE, Fanny-SUSAN). Distribution of signs to the infant and the mother is done similarly to the procedure described in Table 4.1 above. The asterisks indicate the different levels of significance.

	Claire-EVE				Fanny-SUSAN			
	% ai		n ai		% ai		n ai	
n records	24	5	24	5	24	5	24	5
i<m(-)	22	5	20	5	15	3	15	5
	***	*	***	*	*		**	*
i>m(+)	1	0	2	0	6	1	5	0
	23	5	22	5	21	4	20	5

* p <0.05
** p <0.025
*** p <0.01

In Table 4.3 the results of the comparisons for the persons within the pairs is presented for the recordings over the two years.
It is obvious that *within a pair* mother and infant differed significantly in sign distributions with regard to the percentage of face-to-face time and the frequencies of audible intentions that were transmitted in the recordings over the two years. Both mothers 'invited' and offered 'models' to their infants during mutual gazing.
Comparison of the first five recordings for mother and infant within a pair on transmitted audible intentions resulted in a difference for Claire and EVE ($p < 0.05$) on the percentage of time and the frequency of audible intentions, whereas for Fanny only the frequency of intentions was significantly lower than her mother's ($p < 0.05$).
During the moments of prolonged mutual gaze, early in the development, EVE and Claire engaged in sound production, which may occur simultaneously (see 3.3.2 on vocalisation in unison). Fanny and SUSAN engaged in sound production as well, but not as different from each other as Claire and EVE. Since Fanny and SUSAN did not differ systematically from each other with regard to the percentage of face-to-face time used for the transmission of audible intentions in the first five recordings, Fanny was likely to produce relatively prolonged sounds during mutual gaze in that period.

b. *Percentage of time and frequency of audible intentions between the pairs*

The two infants and the two mothers were compared amongst them upon the transmission of audible movements in the matched recordings over the two years. The amount of time for vocal-aural tuning (see 3.3.2) appeared to be different for the two pairs only during the first five months, when Claire and EVE scored higher on this form of intersubjective tuning.
During that period, the two pairs probably differed too with regard to the percentage of face-to-face time and the frequencies of audible intentions that they transmitted to the partner. It was expected that Claire scored higher than Fanny on audible intentions during the first five months, but not over the two years. Similarly, EVE was expected to score higher than SUSAN in the first five recordings, but not over the two years.
In the null-hypotheses no difference was expected for the comparisons of the measures on the transmission of audible intentions by the infants and by the mothers.
The results over the five months and the two years are given in Table 4.4. The distribution of signs has been executed in the same way as for the visual intentions between the two pairs (see 4.3.1 b).

As was expected, the infants appeared not to differ with regard to the percentage of face-to-face time and the frequencies of transmitted audible intentions in the recordings over the two years.
The mothers did differ over the two years, but only with respect to the percentage of time. EVE used more face-to-face time than SUSAN for the transmission of audible intentions. The signs for the *frequencies* of intentions were not distributed differently, which means that EVE's intentions had a longer duration: in the recordings over the two years her utterances are generally longer than the utterances of SUSAN.
It is not very surprising that the comparison for the first five recordings (significant for $p < 0.05$) showed a striking similarity to the results over the two years. During face-to-face contact EVE talked significantly more than SUSAN, right from the beginning of her interactions with Claire.
This talkative behaviour of EVE, however, has not resulted in differences in transmission of audible intentions between Claire and Fanny, not even during the first five recordings. Partly, this can be explained by EVE's behaviour: Claire did not get the chance to transmit audible intentions in alternation with her mother.
Another possible explanation is Fanny's behaviour: as her mother was fairly quiet, she had the chance (which she uses) to transmit audible intentions, distributed more or less like Claire's.
In Appendix IVd. support can be found for the above suggestions. Fanny has produced more utterances than Claire in the recordings over the two years, and she equalled her mother SUSAN in this. When Claire produces one utterance, EVE produces about two.

Table 4.4
Distribution of signs for the percentages of face-to-face time used for audible intentions (% ai) and the frequencies of audible intentions (n ai) after the comparison of 24 matched recordings, as well as the first five, for the infants (Claire-Fanny), and for the mothers (EVE-SUSAN), to make a between-pairs comparison. See Table 4.2 for manner used for the distribution of signs. The asterisks indicate the different levels of significance.

	Claire-Fanny				EVE-SUSAN			
	% ai		n ai		% ai		n ai	
n records	24	5	24	5	24	5	24	5
C/E<F/S(-)	12	1	15	2	6	0	11	1
					**	*		
C/E>F/S(+)	12	4	7	3	18	5	12	4
	24	5	22	5	24	5	23	5

* p <0.05
** p <0.025

4.3.3 Intense intentions

In this section the results on the transmission of intense intentions between mother and infant are presented. Intense intentions are defined as mimical and head movements together with sound productions during face-to-face contact and PROGRAAF has searched the transcriptions for these co-occurrences of movements. The persons within a pair, as well as the two infants and the two mothers are compared amongst them.

Since the pairs differed in bi-modal tuning before and after the fifth month (3.3.3), it was likely that the comparison of the mothers and of the infants amongst them would also result in differences in the transmission of intense intentions before and after the fifth month.
During the two years, the mother and the infant within a pair did differ in their transmission of audible intentions (4.3.2), but not in the visual ones (4.3.1). The transmission of intense intentions was expected to be different also, because of the 'weight of the audible intention' in the intense intentions.
The percentage of time of face-to-face contact used for the transmission of intense intentions (% ii) and the frequencies (n ii) are given in Appendix Vc. for mother and infant per pair in the recordings over the two years.
In Figure 4.3 (a-d) the percentages of time used for transmission of intense intentions are given graphically.

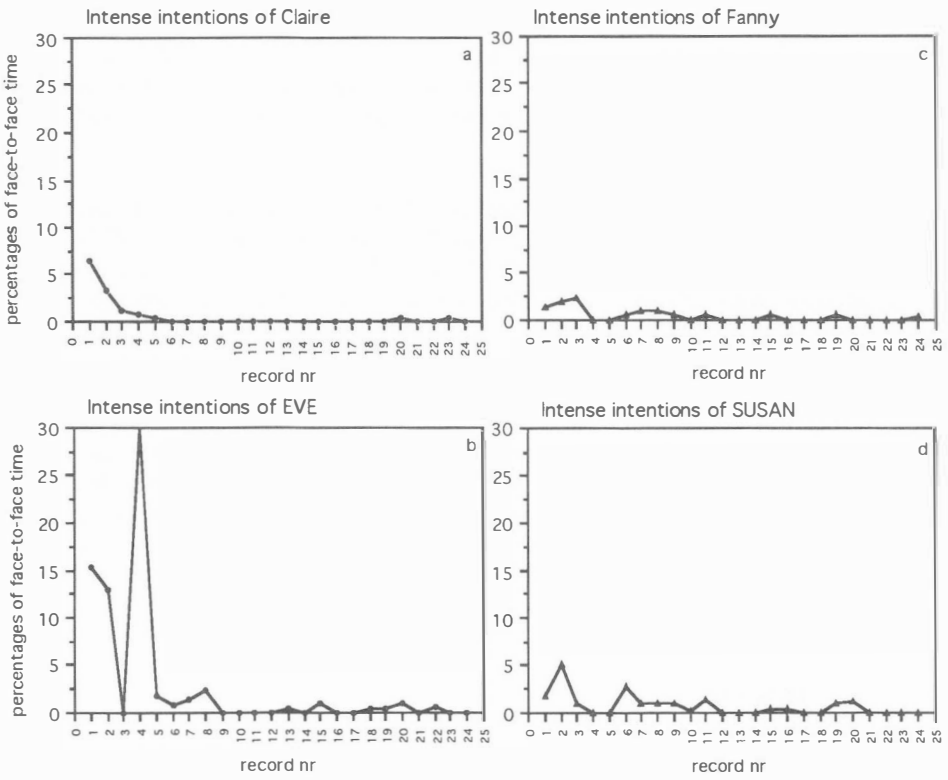


Figure 4.3 a-d
Percentages of the amount of time of face-to-face contact used for the transmission of intense intentions by Claire (a), EVE (b), Fanny (c), and SUSAN (d) in the recordings over the two years. For the comparison of the four individuals, the vertical axes are chosen in relation to the highest percentage (EVE's, in recording 4).

a. *Percentage of time and frequency of intense intentions within a pair*

This aspect of intentionality is measured by taking the percentage of face-to-face time in which mimical and head movements, and sound productions co-occur. Apart from the percentage of time, the frequency of these intentions per recording and per person is also used as a measure.

Because of results on the audible intentions, the mothers were expected to transmit more often intense intentions than their infants did, at least during the first five recordings.
For the sign-test we hypothesised that the two persons in a pair did not differ with regard to the distribution of signs in the matched recordings. The distribution of signs over the matched recordings is done using the same method used for the visual intentions within a pair (4.3.1 a).
In Table 4.5 the results of the comparisons of the mother and the infant are presented for the 24 matched recordings over the two years, as well as for the first five recordings.

The transmission of intense intentions from the mother to the infant in a pair appeared to be only systematically higher in Claire and EVE in the recordings over the two years. With regard to the first five recordings the tendency was already present. In the first five recordings Claire transmitted in only one recording more often intense intentions than her mother. This is likely to be related to the talkative character of this mother, obviously underlining her utterances with mimical and head movements.
The distribution for Fanny and SUSAN justified the conclusion that mother and infant did not use the intense intentions differently from each other. SUSAN differed systematically from Fanny with regard to the audible intentions (Table 4.3), but she did not put them in a context of mimical and head movements which would have resulted in intense intentions.

Table 4.5
Distribution of signs for the percentages of face-to-face time used for intense intentions (% ii) and the frequencies of visual intentions (n ii) after the comparison of 24 matched recordings, as well as the first five, of infant and mother within a pair (Claire-EVE, Fanny-SUSAN). Distribution of signs to the infant and the mother is done similarly to the procedure described in Table 4.1 above. The asterisk indicates the level of significance.

	Claire-EVE				Fanny-SUSAN			
	% ii		n ii		% ii		n ii	
n records	24	5	24	5	24	5	24	5
i<m(-)	13 *	4	15 *	4	9	2	9	2
i>m(+)	2	1	3	1	3	1	8	2
	15	5	18	5	12	3	17	4

* p <0.01

In view of the overall numbers of disregarded recordings (no sign attributed because of equal scores), both pairs seemed to mirror each others intense intentions.
Claire and EVE had equal percentages of intense intentions in nine recordings out of the 24, and for Fanny and SUSAN this was the case in 12 recordings.
Similarly, for the frequencies, Claire and EVE had equal numbers in six out of 24 recordings, and Fanny and SUSAN in seven recordings. This latter pair had already equal percentages and numbers in the first five recordings: two, and one recording respectively.

b. *Percentage of time and frequency of intense intentions between the pairs*

Comparing the mothers of the two pairs and the two infants amongst them with regard to the transmission of intense intentions, two-by-two they were likely to differ on this aspect, before and after the fifth month. Bi-modal tuning (see section 3.3.3) was different between the two pairs before and after the fifth month.
Claire was expected to score higher than Fanny in the first five months, and lower thereafter. For EVE a higher score than SUSAN was likely, as she talked (underlined with mimical and head movements) much more than SUSAN.
The sign-test was used again, assuming an equal distribution of signs for the matched recordings of both infants and of mothers. The distribution of signs has been executed as for the visual intentions between the two pairs (4.3.1b). The results are given in Table 4.6

Table 4.6
Distribution of signs for the percentages of time for intense intentions (% ii) and the frequencies of intense intentions (n ii) after the comparison of 24 matched recordings, as well as the first five, for the infants and for the mothers, to make a between-pairs comparison. See Table 4.2 for the manner used for the distribution of signs.

	Claire-Fanny				EVE-SUSAN			
	% ii		n ii		% ii		n ii	
n records	24	5	24	5	24	5	24	5
C/E<F/S(-)	9	1	10	1	8	1	9	1
C/E>F/S(+)	6	4	9	4	10	4	11	4
	15	5	19	5	18	5	20	5

Over the two years the two mothers and the two infants did not differ with regard to the transmission of intense movements. During the first five months, there was only a tendency for Claire to transmit more often intense intentions than Fanny. Similarly, EVE tended to transmit more often intense intentions than SUSAN in that period. These results were surprising in view of how talk-active EVE was. Possibly she thought it no longer necessary, later on in the development of speech communication, to underline her utterances explicitly (in many recordings the scores are zero).

4.3.4 Summary of results on intentionality

The results on the transmission of visual, audible, and intense intentions from one person to the other during face-to-face contact and vocal-aural tuning are described in section 4.3 for the two mother-infant pairs recorded during two years.
The development of intentionality is regarded to be based upon aspects of the intersubjective tuning described in Chapter 3. Both mother and infant come to know each other in a new way after birth. The transmission of the intentions via the distance channels is important for further development of speech. This has been a reason to present the data covering the two years.
The intentions of the mothers and the infants have been compared in the following ways:

- per recording with the other partner in a pair, and
- between the two infants and between the two mothers

With regard to the visual, audible, and intense intentions during mutual gaze, the development of intentionality can be summarised as follows:

The frequencies of transmitted *visual intentions* between the partners in a pair are not different. Claire and EVE, as well as Fanny and SUSAN transmit visual intentions to each other in about an equal way.

Comparing the two children over the two years revealed no difference in the transmission of intentions to the respective mothers. During the first five months, Claire transmitted visual intentions to her mother for a higher percentage of face-to-face time than Fanny to hers.

Comparing the mothers of the two pairs over the two years showed a significant difference between EVE and SUSAN with regard to the percentage of face-to-face time (higher for EVE) that visual intentions were transmitted to the respective children. In the first five months the mothers did not differ.

The *transmission of audible intentions* between the partners in a pair appeared significantly less frequent and showed a lower percentage of face-to-face time in the children than in the mothers over the two years. For Claire this pattern was already present in the first five recordings. In the first five recordings only the frequency of audible intentions was lower for Fanny than for her mother; the percentage of face-to-face time used for audible intentions was not different for Fanny and SUSAN.

Comparing the two children revealed that they did not differ in the measures used for the transmission of audible intentions.

The mothers differed from each other only in the percentage of face-to-face time, and not in the frequency of audible intentions, over the two years as well as during the first five recordings.

The *transmission of 'intense' intentions* between the partners of a pair was different for Claire and EVE only because EVE systematically underlines her utterances with mimical and head movements more often than Claire did.

The children and mothers compared with regard to the transmission of intense intentions did not differ over the two years, nor over the first five months.

4.4 Discussion

The transmission of intentions to an intersubjectively engaged other person is the most important part of an interpersonal communication system. Even very distortedly transmitted intentions usually find a 'willing ear' that will interpret the meanings, independent of age, time, or situation of the individuals involved. In human communication, intentions are, however, transmitted in very different ways.

4.4.1 Our approach

The evaluation of intentionality in mother-infant systems as implemented in this study, seems to disregard many important aspects, reasons, or goals in the interaction. Often these aspects are related to the personal motives in the intentions which are best expressed by the adult. In a way this approach focuses on the effects of intentions in the very small and special 'society' of a mother-infant pair. On its way to a larger human society mutual adjustments are often needed. Sometimes these adjustments are easy, sometimes they are not.

a. *Intentionality*

The affective basis for the development of (speech) communication is studied in this thesis with regard to the distance channels only. Intersubjectivity is present in all the intentions discussed in this chapter. Affect is just another intention, often transmitted together with other messages. This expression system of humans is already 'in place when word learning begins' in an infant (Bloom, 1993).
An objective evaluation of the basic affectionate aspects in the development of a communication system must better keep a distance to the actual transmitted meanings. In the first place, it is very important *that* movements are transmitted anyway between the persons, referred to as bi-directionality (e.g. Cohn & Tronick, 1988). As to the question *how* the meanings are transmitted, we only focused on the distance channels. *What* movements are transmitted, is third in line and will be discussed to some extent in the next chapter (on turntaking).
The chance that one single movement occurs during mutual gaze in naturalistic situations is high. The specific 'meaning' of the movement (or the absence of a meaning) is a matter of contextual interpretation. There is a fair chance that the movement first occurs 'at random', and is 'cultivated' only later in the development. In adult-adult communication one single transmitted movement may do the job, but during early infant development some exaggeration or explicitness may be needed. It seems an adequate criterion to compile at least two simultaneously transmitted changes in the channels under consideration. This quantitative solution is relying on Condon's (1977; 1979) observations: speech is accompanied by unconsciously made movements that, however, occur in synchrony.

b. *Code selection*

In our compilation of the visual intentions only one code was disregarded: neutral facial expressions (the pauses between mimical movements). It can be argued that a change towards the neutral facial expression is a clear intention in adults. In mother-infant interactions these arguments seem to imply too much 'consciousness'. The onsets of the other movements are apparently used about equally by all four persons involved.
The audible intentions include all sounds produced by mother and infant during mutual gaze (Appendix II), giving the benefit of the doubt to the infant. In mother-infant interaction even vegetative and 'nappy' sounds of the infant are responded to by some mothers. The infant learns that audible changes can make other people move!

c. *The measures*

The percentage of time of face-to-face contact used for the transmission of intentions is a relative measure. If face-to-face contact of one second is

completely used for the transmission of a visual intention, the score is 100% in that recording. The sign-test is not very sensitive to extremes. We may assume that both sets of data are subject to these processes.
The frequency of intentions per recording disregards the variety of the intentions. It is thus possible that all intentions in a recording are transmitted by means of just two movements during mutual gaze, that are repeated over and over again. Claire did that, while frowning to her mother, only showing variation in the duration of her movements.

4.4.2 Impact of intentionality for speech communication

The human system of speech communication can be used in an elaborated way: transmission of (visually and audibly different) information is possible by means of only the auditory and/or the visual channel. The emotional aspect of tuning and readiness to interpret the movements in either channel is then to be interwoven in timing, or in exaggeration of the movements, or in both.

In the course of development the child must learn to construct a meaning mainly from sound or mimics, together with information from the environment. The intersubjective tuning and the notion that certain changes (sounds) then are meaningfully related to actions like pointing, is usually employed in the further development of speech. When naming pictures in a book, for example, it is not efficient to look at the mother's face every time she pronounces the words.

Early in mother-infant interaction the simultaneous use of two channels is just a partial use of the multi-modal transmission system. The selective attention for the two channels and their simultaneous use can direct the infant gradually towards the synchrony of sound and picture. Then, either one of these 'informations' can, in certain situations, become redundant. But 'seeing-what-the-speaker-says' makes speech communication much easier, also for the (adult) listener and for the (adult) speaker.

The need for visual information may re-occur whenever the development of speech enters a new stage, like for the use of two-word sentences. The combination of visual and audible intentions into the intense ones during face-to-face-time can thus have a function in the initial period of a new stage in speech development. Intense intentions are expected more or less to disappear later in that stage.

Audible intentions can easily co-occur with the visual ones, but they can occur separately as well, in the form of 'pure' speech instruction. Transmission of (speech) sound productions just via the vocal-aural channel is thought to be based upon the audible intentions that gradually disappear once speech develops.

In the next chapter (on turntaking) the focus is on *what* is transmitted in mother-infant interaction. This aspect is explored with regard to exchanges of sounds in the simplest dialogues of mother and infant. The mother's role, influencing the direction of this process, is given special attention.

5

TURNTAKING

Abstract

Human communication systems are characterised to a large extent by a cyclic timing of behavioural patterns of two persons. In mother-infant interaction the cyclic form is recognisable in early face-to-face interaction. Mutual gaze, although related to the duration aspects in intersubjectivity and in intentionality, is established and broken off at times. It has been suggested in the literature that these turns in the visual channel set the stage for turntaking in the auditory channel, which becomes more prominent after about the third month of post-natal life.
In this chapter turntaking in sound production by mother and infant is described from birth onwards. Although vocalisation in unison is a characteristic of early mother-infant interaction, a part of the infant's sounds occur already in the alternated mode of sound production.

Infants systematically learn to use their speech mechanism and produce sounds in the course of time. Some of these sounds can be regarded as landmarks on the way to adult speech production. Mothers are supposed to take turns upon the landmark sounds of their infant, as if these are already sounds of the mother tongue. As the infant's sound production proceeds towards adult speech, the mother will increasingly neglect the landmark sounds of a previous stage. The dialogues are underlying the development of speech and of psycho-linguistic aspects of human communication.
Taking turns by the mother upon the infant's sound productions was studied here for four groups of landmark-sounds: laryngeal sounds, simple articulations, babbling sounds, and, finally, words. These groups of sounds usually have their onset in the first year of life.

The two pairs appeared to differ with regard to the frequency of sounds per group, with regard to turns taken by the mother, and with regard to the mother's turns upon specific sounds of the infant.

5.1 Introduction

> "It is suggested that rhythmicity organizes the behavioural dialogue, which is basic to the development of verbal dialogue between two human beings. If the child does not apprehend the turn-taking pattern of speech, no meaningful communication can occur."
>
> (Censullo, Lester & Hoffman, 1985, p. 345)

Turntaking occurs very early in development of the coordination of behaviours in the mother-infant system. It is the third fundamental characteristic of communication systems, and is also studied in our approach of speech communication in the mother-infant system. It is based on intersubjective tuning (Chapter 3) and on the transmission of intentions (Chapter 4). Turntaking (or turn*giving)* is fundamental to a variety of human interpersonal and intended behaviours. Early non-verbal, non-symbolic turntaking is related to later conversations around a participant-spatio-temporal topic (Foster, 1990; Levelt, 1989). The literature will be presented with regard to the development of turntaking of mothers and infants on their way to speech communication.
Considering turntaking in its most basic form, the quality of an infant's turn in sound production and the prompt occurrence of the mother's turn within an interpersonal pause (the simplest form of a dialogue) is discussed. This alternating sound production is seen as a further specialisation of the communication system around audible intentions described in the previous chapter.
The results for the two mother-infant pairs are presented and discussed in relation to speech development.

5.1.1 To reanimate 'turntaking' during intersubjective tuning with intention for the adult reader

---

Stage:	elevator in a skyscraper
Actors:	two sensibly alternating ones
Attributes:	none

Elevator still goes up, two persons inside

Actors still look at each other, one still smiles and says: "Mmm?"
The co-actor says: "Are you familiar with this?"

In this reanimation, the two actors have been in each other's presence going up quite a few floors. The co-actor has interpreted the smile-reaction to the 'door-opening' incident in the previous chapter, and takes a turn. In

their ongoing conversation, it appears that both actors are newly employed persons of a futuristic firm on the top floor of the building, producing auto-flying "Mary Poppins" umbrellas.
To many people, turntaking is a very natural and almost unconscious behaviour in certain situations: for instance, a talkative person in the waiting room of the dentist will evoke responses. The quality of the turns depends among others on the mood of the other persons present. Turntaking can direct a conversation to unexpected outcomes or it may result in a stereotyped conversation, like the weather. In mother-infant interactions, the intersubjective tuning and the transmission of intentions seems a guarantee for turntaking.
In this chapter, the simplest form of *turntaking by the mother upon selected sound productions of the infants* is studied. The role of this turntaking is interpreted didactically, since in taking her turns the mother is teaching the infant which sounds are effective for an ongoing conversation. The selection of the infant's sound productions is related to four landmarks in development: laryngeals, simple articulations, babbling sounds, and words. Any audible turn of the mother within a time limit after the infant's utterance is rated as a turn.

5.1.2 Literature and definitions

In the literature on infant development, the focus is usually on turntaking abilities of the infants. When 'turngiving' and 'filling in the infant's turn' are discussed in the literature, the mother's ability to time the action is given the benefit of the doubt. In the mother-infant system alternating sound productions are a matter of personal preferences. We know that extreme behaviours of both mother and infant, silence or too many sounds, can result in a deviant development. Are interactions at-risk when more subtle preferences are present?
The onset of turntaking, the quality of turns, their timing, and turngiving or turntaking are discussed in relation to the literature, mainly focusing on turntaking in sound production.

a. *Definition*

The term 'turn' refers to a behavioural change from one person to another, depending within certain time limits upon the type of communication system (cf. Foster, 1990). Turns can occur as (bursts of) movements in human interaction with a biological base for the regularity (cf. Stern, 1974; Kaye, 1977, 1979; Lester, Hoffman & Brazelton, 1985).
The timing of turns is an important factor in the flow of the two behavioural streams (Fogel, 1992a, 1992b; Van Beek, 1993). The onsets of behavioural turns can occur (1) synchronously, (2) as an interruption, or (3) sequentially. These variations in timing depend on the modality of the turn, the ability of the persons to time their turns, and the intended and

perceived meanings of the turns (cf. Bloom, 1988; Bloom, Russell & Wassenberg, 1987). Simultaneous laughing, for example, is an adequate form of vocal communication, while simultaneous speaking usually is not.
The aspect 'taking' is considered to belong to a 'give-and-take' game, and thus turn*giving* is considered to be an equivalent for turn*taking* in mother-infant interaction. The partners can signal to each other when a turn is expected to be a game of give and take, by a question-intonation or a shift in gaze direction.

b. *The onset of cyclic behaviour*

The social context of infant vocalisations has been neglected for a long time (Schaffer, Collis & Parsons, 1977; Bullowa, 1979). Probably because sound productions were regarded to be properties of the individuals, they were related to personal characteristics. The onset of studies on the social context of vocal behaviours is thus closely related to progress in the theory on individual development itself. Research on early speech development has demonstrated this (cf. Bullowa, 1979; Foster, 1990).
In newborns, control of eye and head movements in face-to-face situations is virtually non-existent, but the eyes can be closed to shut out the visual stimulation of the mother's turn. When the baby is visually alert, the mother usually takes her turn to communicate with the baby, and she will be attentive to minor changes in the infant's level of arousal in a variety of infant behaviours (cf. Kaye, 1977; Dunn & Richards, 1977).
Blehar, Lieberman & Ainsworth (1977) found that infants became more responsive (i.e. looked more at the mother) over the period from 6 to 15 weeks, whereas the mother's behaviour did not change, probably because she was already maximally responsive.

Developmental psychology suggests relations between early visual 'turntaking' (in patterns of mutual gaze and looking away) and vocal turns (cf. Stern, 1974). Although primarily simultaneous sound production is present from birth onwards (Ginsburg & Kilbourne, 1988), the timing of the onset and offset of utterances is not in perfect synchrony for mother and infant. When vocalisation in unison starts, both partners will notice the onset of the sound production that 'caused' the simultaneous sound production. Alternating sound production -replacing early simultaneous sound production- is said to develop noticeably after three to four months (Ginsburg and Kilbourne, 1988), and the effects are found of the mother's turntaking upon the infant's sound production (Bloom, Russell & Wassenberg, 1987).
In this thesis turntaking is considered to be possible from birth onwards in patterns of sound production in mother-infant interaction. Not all sounds of mother and infant occur simultaneously, and if they do, the onsets differ most of the time.

c. *Behavioural quality of turns*

In face-to-face communication, shifts from attention to non-attention are forms of social exchanges with an impact on other developmental processes (Brazelton, Koslowski & Main, 1974; Stern, 1974; Kaye, 1977, 1979; Tronick, Als & Adamson, 1979).
Turntaking in the form of an alternation in the movements of two people, who are emphatically in touch, is easily recognised in the visual domain (Stern, 1974) and in the sucking of the infant and intermediate movements of the mothers (Kaye, 1977). Hand movements in caressing is another form of cyclic behaviour (cf. Foster, 1990).
Sullivan & Horowitz (1983) point at the infant's sensitivity to temporal characteristics in stimulation, regardless of the modalities involved:

> "It is conceivable that this redundancy across modalities may help provide meaning to the auditory input. At the very early ages the meaning may be a very general one. Examples might be the infant's learning that the face and voice of the mother go together and specify the same stimulus complex."
>
> (Sullivan & Horowitz, 1983, p. 224)

Mothers usually mingle their own actions (face and voice) with those of the infant, adapting their behaviour to an initial inability of the infant to time a turn (Papoušek & Papoušek, 1979). Initiation, greeting rituals, and play dialogues can be detected (Tronick, Als & Adamson, 1979; Censullo, Lester & Hoffman, 1985) as well as a constant switch between a passive and an active role of the participants (Schaffer, Collis & Parsons, 1977). At the age of about three months, moderate stimulation in face-to-face interaction is preferred by infants. A more detailed perception of objects such as dolls (Field, 1981) and of the mother's mouth movements starts at that time. The infant's 'prespeech' movements are in line with these observations (Trevarthen, 1979).

Turntaking is prominently present when sounds are exchanged. The co-action mode (mother and infant moving simultaneously) appears in affectionate situations like laughing or crying. Simultaneous production of sounds hinders the transmission of more detailed information which is coded in sounds. Successive sound production -yet staying in tune by timing, and by prosodic and content cues (Beebe, Feldstein, Jaffe, Mays & Alson, 1985; Bloom, Russell & Wassenberg, 1987, Van der Stelt, 1983; Fernald, 1992)- is basic to speech communication.
The sounds produced by the sender in their spatio-temporal setting function as gradually more specific meanings, conveyed to a receiver (Levelt, 1989). If there is any doubt about the meaning, the receiver's turn may contain a question. In the narrow sense of speech communication, 'audible language' has then developed.
Studies on early speech development often operate on this linguistic level, describing sound properties of utterances in mother-infant interaction as

the lowest level of a top-down determination (cf. Bruner, 1981). The structure explains the term 'proto-conversation' (Bateson, 1979), but the content of the turns of the infants is not yet of adult linguistic quality (and consists of "coos and murmurs", p. 65). The infant's sounds are described as 'vowel-like' or as 'consonant-like' (Oller et al, 1976).

The *communicative value of the sound production*, as 'an audible complex of movements of the speech mechanism', timed and embedded in an interactional context, usually is not understood as a bottom-up line in the development of speech communication (Bruner, 1981), probably originating from evolutionary roots (Fernald, 1992). In the search of specific relations between specific behaviours of the individuals (which are difficult to find), the quickly changing process is the first to be designated (e.g. Van Beek, 1993). Smiling is a good predictor of other people's behaviour, but so are the 'less obvious' persisting roots in intersubjective tuning and affective intentions of this behaviour, which are easily forgotten.
Mothers and infants maintain turntaking in sound production, also once the sounds of the infants acquire 'prespeech' quality. In interaction with young infants, mothers usually change their 'normal *adult*' behaviours (Stern, 1974). Some mothers may not change *within* their 'motherese' register, even when the infants have started to babble (e.g. Van der Stelt, 1983). These infants will then less readily learn that *babbling sounds* have other interactional effects than laryngeal sounds and simple articulations! The alternating mode (action followed by action) gives the impression that the mother is 'teaching' something to the infant. The mother's use of the babytalk-register, in alternation with infant sounds, can be seen as a didactic method to support, echo, and stimulate the infant's vocal activities that later will be used in speech communication (Papoušek, Papoušek & Bornstein, 1985). Obviously, that method needs further evaluation.

d. *Timing of turns*

Even in highly engaged interactions with the neonate, behavioural rhythms are found (Censullo, Lester & Hoffman, 1985). Several interactions have different temporal levels, like lengthening or delaying turns (Kaye, 1977; Tronick, 1981). Infants control the instant of social visual contact by looking at the mother's face or away from it. They shift from attention to non-attention about four to five times per minute (Brazelton, Koslowski & Main, 1974). Field's study (1981) supports Stern's (1974) idea about an underlying biological control system for arousal (i.e. rate of heart beat) which is related to these turn-taking rhythms.
The infant of about 14 weeks "initiates and terminates 94% of all mutual gazes." (Stern, 1974, p. 206) and is responsible for a large part of the burst-pause cycle (Tronick, et al., 1979). Of course, the mother is giving about 100 % of visual framing time. Maternal behaviours towards 13- to 14-weeks-old infants have a characteristic rhythmic and temporal pattern (Stern et al., 1977), with more discrete and shorter phases and with more

clear pauses than in adult-adult conversations. The mother tries to be in tune with the infant's intentions.
From three to five months of age an increase in behavioural periodicity is found for both mother and infant (Lester, Hoffmann & Brazelton, 1985). The infant may fail to take a turn. Then the mother is seen to play the leading part (Blehar, Lieberman & Ainsworth, 1977), 'taking the infant's turn as well' to keep pace with the cyclic pattern of the (turntaking?) interaction in general. Schaffer, Collis & Parsons (1977) quite correctly point at the fact that the *interaction* is described in their study on turntaking, and that no conclusions should be drawn about the individuals. In the mother-infant system, 'looking at the mother' is related to the two-year-old's vocal activities.

> "Facial orientation toward a likely recipient will ensure that the sound is emitted in the most appropriate direction and, further, that facial signals which may augment the vocal ones are optimally apparent."
>
> (Schaffer, Collis & Parsons, 1977, p. 318)

These authors found a higher number of overlaps in the conversations of one-year-olds with their mother than for two-year-olds, and only some of the overlaps are seen as 'turntaking failures' ("true clash of roles", p. 303). In these age-groups the speaker switch-pauses are extremely brief, usually less than one second. Masataka (1992) considers the utterances of mothers and infants under six months as separate when the intra-personal pause is longer than 0.3 seconds. The duration of pauses seems a matter of arbitrary choice, as systematic data on this subject are lacking (e.g. Van der Stelt, 1991).

e. *Concluding remarks*

Turntaking is intersubjective, intentional behaviour in which the quality and the timing of the behaviours start to play a role. One person moves and another person, being present, can interrupt, pause and take a turn, or neglect the 'causing' move of the other person. The kind of movements the 'starting' person makes influences not only the timing of the other person, but the quality of the turns is usually related to the previous move as well. In early interaction, turntaking in the mother-infant system is not simply related to individual behaviours, and still needs further analysis. Perhaps turntaking can be seen as the first level in speech communication, where one of the individuals in the mother-infant system can take a lead, taking a chance with regard to the direction of the interaction.
Early in development, turntaking by the mothers upon sounds of their infants is not yet strictly 'ruled' with regard to timing and quality of turns. In view of the infant's developing speech motor control, the mother is expected to adapt to the process, assuming that she is sensitive to the

infant's expressions. Her timing will become more adult-like, as well as the quality of her (linguistic) turns.
In the following sections, the freedom in timing and in quality of turns of the mother-infant communicative system is discussed in relation to the infants' developmental stages in sound production.

5.1.3 Previous studies of infant sound production

The description of infant sound production presented here is largely based on previous work of Koopmans-van Beinum and myself, published since 1979. As speech is regarded to be a sensori-motor skill (Van der Stelt & Koopmans-van Beinum, 1981; Netsell, 1981; Kent, 1981), the maturation of the speech mechanism and the acquisition of speech motor control is assumed to be basic in the development of infant sound production (e.g. Fletcher, 1973; Netsell, 1981).
The 'speech mechanism' (Fletcher's term, 1973) is primarily used for vital functions like sucking, feeding, and breathing (McCarthy, 1952). In the course of its development the infant develops auditory and proprioceptive control and coordination of the movements of the larynx (Wind, 1970), the pharynx, velum, tongue, and lips (Bosma, 1967). Primary functions of the speech mechanism become reorganised into new functional movements of sound production (Hendrickx et al., 1976). Learning to talk is a continuous process in which the constraints come from the physiological changes of the developing brain (Gilbert, 1974; Plooij & Van de Rijt-Plooij, 1989).
In the manner indicated above, infants fairly systematically make a kind of a 'map' of the movements of their speech mechanism. In the course of time they produce sounds that can be regarded as landmarks on their way to adult speech production (cf. Koopmans-van Beinum & Van der Stelt, 1979, 1986, 1988; Van der Stelt & Koopmans-van Beinum, 1981; Koopmans-van Beinum, 1990). The stages in infant sound production are demarcated by new landmarks (e.g. Proctor, 1989), even though previous landmarks may also keep their communicative value. The mother's vocal reactions upon the sounds in turntaking guide her infant into the direction of adult speech motor control.

a. *Landmarks*

The landmarks indicated by other authors differ with their disciplines (Stark, 1978, 1980; Stark, Rose & McLagen, 1975; Roug, Landberg & Lundberg, 1989; Oller, 1980, 1986; Nakazima, 1962, 1966). Proctor (1989) offers a comparison of infant sound productions indicated by the above mentioned authors together with the stages mentioned in our work (e.g. Koopmans-van Beinum & Van der Stelt, 1986), encompassing five stages in the first year of infant life.
The codes for infant sound production used in the transcription system (Appendix II) are based on the landmarks defined by Koopmans-van

Beinum and Van der Stelt (e.g. 1979, 1986). Sound production is seen as resulting from a increasing coordination of *respiratory, phonatory, and articulatory* movements.

Basic is the *respiratory cycle* which physiologically determines the length of utterances and the intra-personal pauses. Speech is usually produced during the expiration phase of the cycle.
The infant initially learns to *coordinate respiration and phonation* which is not immediately optimal. Several 'physiological vocal disorders' can be recognised in the early period (Crystal, 1969). Yet the infant can produce sounds with a syllabic character from about six weeks on by making glottal stops during the expiration. This is regarded to be a landmark in speech motor development since it is basic in adult speech when producing voiceless stops. Its communicative impact is very clear: in Dutch "u!u!" is used when forbidding someone.
Articulatory movements during phonation occur from about twelve weeks onwards. In the group of the 'simple articulations' just *one* movement per utterance is made, usually with the back of the tongue. This is another landmark in speech motor coordination. With the occurrence of 'babbling', defined as a *repetitive* articulatory movement during interrupted or uninterrupted phonation, all basic aspects of adult speech movements are acquired. In Figure 5.1 the landmarks are given, together with a short description.
Usually the landmarks have their onset in the first year of life and are regarded as demarcations for stages in the speech motor development (see Proctor, 1989). There are, however, considerable individual differences between infants (Van der Stelt & Koopmans-van Beinum, 1986; Koopmans-van Beinum et al., 1990). Furthermore, infants differ with regard to the frequencies of sound productions in the successive stages (this chapter).

b. *Impact on interaction*

Mothers react differently upon early sound productions of their infants. Cry sounds can be penetrating and usually evoke reactions. The early, short non-cry sounds (aspirated or after glottal stops) are perhaps rarely recognised as 'landmark' sounds by the parents. Van der Stelt (1983) found that the infant's landmark sounds in dialogues had quite different effects on mothers. Usually, the dialogues started with an inviting utterance of the mother, produced with a rising intonation. After the infant's turn, in which early landmark sounds were produced, some mothers immediately shifted to utterances with a falling intonation, while other mothers did not change. The dialogues of the pairs in which the mothers changed the intonation pattern in their second turn were progressively longer over the period between 3 and 7 months of the infant's age. Possibly, the vocal reactions of some mothers are triggered only by the later, more readily understandable sound productions of the infant.

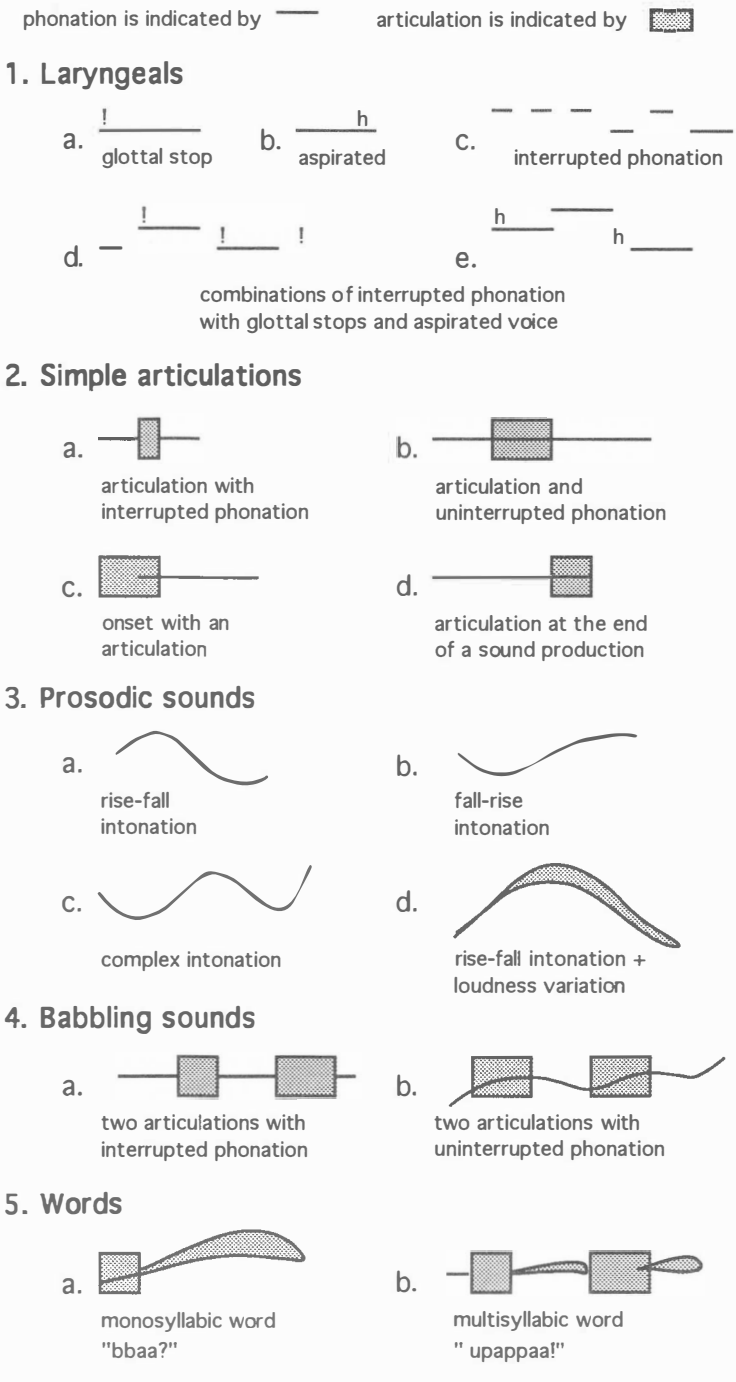


Figure 5.1
The six landmarks in speech motor development of the first year of life, described by Koopmans-van Beinum and Van der Stelt (e.g. 1979, 1986).

Babbling can be produced from week 18 onwards (Koopmans-van Beinum & Van der Stelt, 1981; Van der Stelt, 1983; Van der Stelt & Koopmans-van Beinum, 1986). The babbling sounds, clearly audible signals to parents, are easily interpreted as 'words' by the parents. In many languages of the world babbling sounds are words indeed: "mama"- and "papa"-words are nearly universals. Repetitive babbling develops further into more complex articulatory movements together with a variety of phonation patterns.
The onset of real words, produced in a phonetically constant manner (Gillis, 1986), can be recognised by the familiar listener (Bullowa, 1972). Private words of a pair are examples of the communication at this level.
These differences are of influence upon the mother-infant interaction. Mothers have different styles towards their infant's sound productions (Van der Stelt, 1983, 1990). The styles are probably related to later development of speech, the acquisition of the lexicon, and intonation patterns (Nelson, 1973).
In this chapter the vocal turntaking in mother-infant interaction is studied with regard to the mother's readiness to take a turn upon infant sounds.

5.2 Landmarks and turntaking

In this section, the selection of the landmarks in infant sound productions is presented. Turntaking upon these sounds is studied in its simplest form: the infant produces a sound, and the mother is taking her turn or not, by the production of an utterance. Only the onset of the mother's utterances is used to trace turntaking. After the infant's utterance, the inter-speaker switch-pause is not of a fixed duration, but is calculated per recording to account for developmental changes considered over the two years. In order to be regarded as a turn, the mother's utterance must start in that switch-pause at the latest.

5.2.1 The infant's sound production

In the transcriptions of five minutes mother-infant interaction per recording, all infant utterances were coded by means of the transcription system (Appendix II). Per landmark more than one code can be used in order to indicate differences in intonation pattern and in the manner or place of sound production. These phonatory and articulatory distinctions per landmark are not used in this thesis.
In this chapter on turntaking by the mother, the different codes are grouped per landmark. Since the 'prosodic sounds', with variation in intonation and loudness (see Figure 5.1, number 4), were rare in the recordings of the two girls, these sounds are disregarded (e.g. Koopmans-van Beinum et al., 1990).
The sounds made in the two first stages (e.g. Koopmans-van Beinum & Van der Stelt, 1986) -uninterrupted and interrupted sound productions (Figure 5.1, e.g. 1 a and 1 c)- are clustered as 'laryngeals'.

Finally, the remaining four groups of landmark codes (see below section 5.2.1 a-d) were selected for the description of turntaking in the recordings over the two years. The first occurrences of the sounds are spread in time over the first year, and thereby represent the speech motor development which is gradually a more complex coordination of respiration, phonation, and articulation.

a. *Laryngeals*

The *laryngeals* are always the first non-cry sounds that infants produce from an early age onwards by means of glottal movements during expiration only (Figure 5.1, number 1 a-e; Appendix II, codes 41-44). The sounds have a relatively short duration, and can be produced as a very weak sound. Some of them are mainly aspirated, the others are produced mostly around glottal stops. Claire and Fanny produced these sounds already in the first recording.

b. *Simple articulations*

The *simple articulations* occurred for Claire and Fanny from the second recordings onwards, and are characterised by one single articulatory movement during phonation (Figure 5.1, number 2; Appendix II, codes 45-48). The articulatory movement can be made at the beginning, in the middle, or at the end of an utterance. Phonation can be interrupted during the movement, or is not interrupted.

c. *Babbling*

Babbling sounds can be produced as early as week 18 (Van der Stelt & Koopmans-van Beinum, 1986), but for Claire and Fanny babbling was recorded for the first time in week 32 which is the mean age for the onset of babbling. The sounds are characterised by means of at least two articulatory movements per utterance, which are either repetitive or variegated. Phonation is either interrupted or not interrupted (Figure 5.1, number 4 a-b; Appendix II, codes 52-57).

d. *Words*

The words usually have their onset in the second half of the first year, and are mono-, bi-, or multisyllabic sounds with a fairly consistent form and meaning (Figure 5.1, number 5 a-b; Appendix II, codes 58-60). The first words occur in recording 11 for Claire, and 12 for Fanny. The contextual cues are initially used by participants for the interpretation.

5.2.2 The mother's sound production

The infant's sounds are regarded as the *triggers for turntaking* by the mother. In our previous research on verbal interaction (Van der Stelt, 1983), the dialogues became longer in relation to the interactional quality of the turns taken by the mother which represented her evaluation of the infant's sound production quality.
The *mother's reaction upon an infant sound* is one of her didactic means to direct the communicative process towards the mother tongue in the way she uses it in the mother-infant system. In the earliest period, when the infant's turns are unpredictable, her turns are the only chances of the 'playing-dialogue' game. When the infant is ready to adjust his turns, for example in their timing, to those of the mother, this pragmatic aspect of speech communication begins to resemble adult behaviour.
In this thesis, I have chosen to focus only on the mother's turntaking capacities. The sound production of an infant may seem a response upon a 'stimulating' mother's turn, but the mother's turn following upon the infant's sound is probably more important for further development of speech communication. Furthermore, in this manner the comparison over the two years is kept similar for the early and later recordings, since the mother is capable to react upon the infant's sounds throughout the period studied. The infant probably can do so only lateron.
The procedures of how to decide about a turntaking sequence in the mother's and infant's sound stream are explained below with regard to the quality of the mother's utterances, and the choice to consider only the onsets of her utterances.

a. *Code selection*

In the channel for maternal sound production all codes attributed during the transcription are considered to be possible reactions upon an infant sound. None of the codes for the mother's sound productions are disregarded by PROGRAAF. The mother can interpret a sound of the infant in relation to its 'speech' sound characteristics (coded as 01 to 06, see Appendix II) or in relation to the situation and their mutual activities, which is coded differently. The mother, thus, *is free to interpret the selected infant sounds as she wishes.* For turntaking, however, it is important that she somehow reacts audibly upon the infant's sound productions.

b. *Onsets of the mother's utterances*

Of the mother's utterances, only the onsets were used in the search for turntaking. In the early recordings simultaneous sound production appears to be more frequent than it is later on. The onset of an utterance, even during a sound production of the infant, is a clear change in the vocal-aural channel (see Figure 5.2).

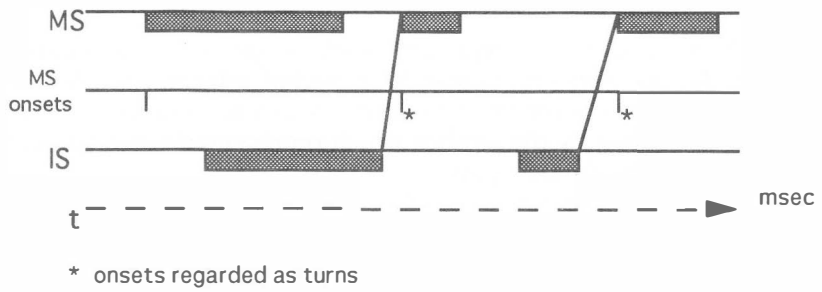


Figure 5.2
Examples of vocal turntaking in the mother-infant system. The mother's sound productions are indicated in the MS channel. The onsets of her utterances are used to decide about turntaking. The infant's sound productions are given in the IS channel. See the text for the inter-speaker switch-pause, which is the time between the end of the infant's utterance and the onset of the mother's.

A second reason to choose the onsets only is the vocal behaviour of the mothers themselves. The two mothers differed considerably with regard to the overall amount of time and frequencies of sound production compared to their child, and compared to each other. EVE talked considerably more than SUSAN per recording (see Chapter 4, the audible intentions, and Appendix Vb.). The chance that EVE's sound productions would occur simultaneously with Claire's thus is higher than for SUSAN's and Fanny's. EVE then would score more often on turntaking than SUSAN.

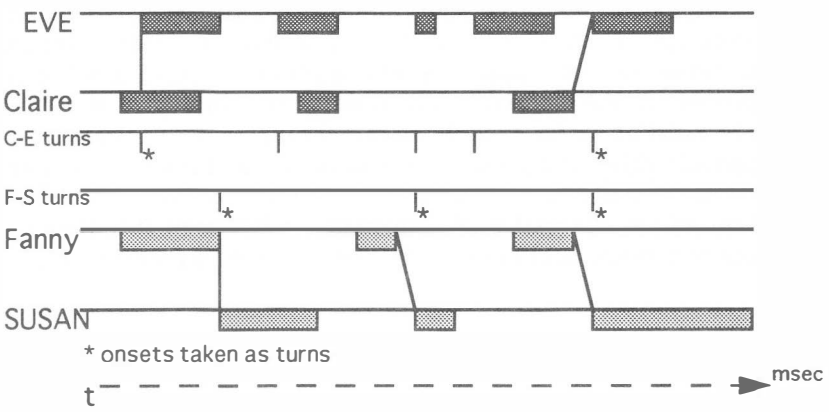


Figure 5.3
Examples of turntaking by EVE and SUSAN upon sound productions of Claire and Fanny, respectively. The mothers differ in this example with regard to simultaneous and alternating sound production.

For one sound made by Claire, EVE usually produced approximately two utterances. Fanny and SUSAN produced more or less equal numbers of sounds per recording, with a few exceptions. I reckoned that for the notion of 'turntaking upon sounds' just one utterance of the mother would do. The onsets of EVE's second utterances are likely to occur after the inter-speaker switch-pause (see section 5.2.3), except for the infant's sound productions with a long duration.
In this manner SUSAN's and EVE's turntaking behaviour has been evaluated in a more equal way. In Figure 5.3, the sound productions of the four individuals are depicted: a talkative EVE with two turns to Claire's one sound (the first one on the line), and SUSAN, alternating her utterances with Fanny, which results in three taken turns. The inter-speaker switch-pause, however, may have been different for the two pairs.

5.2.3 The time-lapse for turntaking

With regard to the timing aspect in turntaking, mother and infant may develop preferences. Usually, the pauses depend on many different aspects in human conversations, such as the topic and the situation, the duration of the conversation, and the interlocutor's moods. A normative duration for pauses cannot be given easily, since the language used and the individual characteristics of the speakers are also important factors. In the search for turntaking in the first two years of infant and mother, a duration for the inter-speaker switch-pause has been calculated per recording.
Turntaking in conversations takes place within a certain period of time after the turn of the speaker who gives cues that the turn will end. In highly engaged conversations this pattern can be violated, and a turn of a speaker is then interrupted by a premature turn of the listener-speaker, in which the timing has 'failed'. Vocalisation in unison can thus be seen as an interrupted turntaking because either mother or infant did not await turngiving signals.
Timing can also fail in the other direction. If the pause between the turn of the infant and the turn of the mother becomes too long, there is no dialogue and the two sound productions are, on that level, not related. The difficulty is how to decide what is 'too large' since that duration may change from recording to recording.
The durations of vocalisation in unison, seen as timing errors in turntaking (turns occurring 'too soon'), can be used as an indication for 'late' turntaking as well. Considering that between turns in adult-adult conversation a slight pause is normal, the mother must have some time to react too. Twice the median duration of the moments of vocalisation-in-unison per recording is taken as the inter-speaker switch-pause for the mother to react after the end of the infant's sound production. The mother is given some extra time to react by giving her *twice* the duration.
The median duration of these moments of vocalisation in unison has been calculated by FP during the analyses of intersubjectivity in Chapter 3, and

are given per recording and per pair in Appendix VI, together with the frequencies of vocalisations in unison per recording.

5.2.4 The PROGRAAF search

PROGRAAF has been instructed to consider the sound productions of the mother only with regard to the onsets of the utterances. PROGRAAF indicates per recording how many infant sounds per group were followed by a turn of the mother within the inter-speaker switch-pause. The *number of times* that the onset of a mother's utterance occurs in or shortly after an infant sound production is calculated by the program as well, but the actual duration of a possible overlap time is disregarded. In this way, a mother's utterance that began before the infant's sound production was not designated as a turn upon the infant sound (see Figure 5.2).
The total number of infant sounds in the four groups have been calculated per recording by FP. The PROGRAAF indications and the total numbers of infant sounds per recording are compared and presented in the next section. The discrepancy between these two numbers (FP versus PROGRAAF) represents the number of 'missed' turns of the mother. These results are presented for the four groups of infant sounds separately.

5.3 Results

Our approach to turntaking in the mother-infant system is expected to indicate some differences between the two pairs. The mothers will differ in their turntaking upon 'landmark sounds' of the infants (Figure 5.1).
Intersubjective tuning and intentionality, prerequisites for turntaking in general, were discussed in the previous chapters. Face-to-face contact was no longer a criterion (as it was for audible intentions, Chapter 4) in the search for the mother's turntaking upon the infant's landmarks.
Percentages are calculated for the *landmark sounds with turns* per total number of sounds of that group per recording for both pairs. At times, the number of sounds with turns is indicated by PROGRAAF to be higher than the total number of sounds produced in that recording. Especially when the sounds of the baby have a longer duration, more than one onset of the mother's sound production may occur during just one infant sound (see Figure 5.3). In these cases the percentage of sounds with turns is set at 100% because the mother has taken a turn upon all sounds produced by the infant.

The percentages of sounds with turns per group are compared for the two mother-infant pairs by means of the sign-test. The null-hypotheses assume that the distributions of signs for the four groups of sounds are not different for the two pairs. Like in our previous research items, Claire and EVE are attributed a positive sign when the percentages of their sounds with turns are higher than Fanny's and SUSAN's. A negative sign is given

to Claire and EVE when the percentages are lower. Recordings with equal percentages for the two pairs are disregarded. (Appendix VIIa-d, giving the number of infant sounds, together with the numbers of sounds with turns by the mothers per recording).

5.3.1 Laryngeal sounds

In this section the turntaking of the mother following upon the laryngeal sounds of the infant -mainly short sounds with aspiration or glottal stops- is described for the recordings that were made over the two years. The children produced these sounds in nearly all recordings, although less frequently in the second year. The frequencies of laryngeals of the two infants per recording, and the frequencies of laryngeals with turns are given in Figure 5.4.

In Table 5.1 the results of the comparison of the two pairs are given for the percentages of laryngeals in turns per total number of laryngeals in matched recordings. The difference between the total number of recordings (24) and the recordings with a sign (17) indicates the recordings with equal percentages for the pairs (7).

EVE has taken turns upon the laryngeal sounds of Claire significantly more than SUSAN has upon the laryngeal sounds of Fanny.
The total number of laryngeal sounds produced by the two infants in the recordings over the two years is 309 for Claire, of which 191 'caused' a turn of the mother (which is 61.8 % of the total number of laryngeals), while Fanny produced in total 299 laryngeals, and 68 caused a mother's turn (which is 22.7 %, see Appendix VIIa).

Table 5.1
Distribution of signs for the percentages of laryngeals with turns after the comparison of 24 matched recordings of the pairs Claire and EVE and Fanny and SUSAN. The asterisk indicates the level of significance.

	number of recordings
Total number of recordings	24
Claire + EVE<Fanny + SUSAN (-)	3
	*
Claire + EVE>Fanny + SUSAN (+)	14

* $p < 0.01$

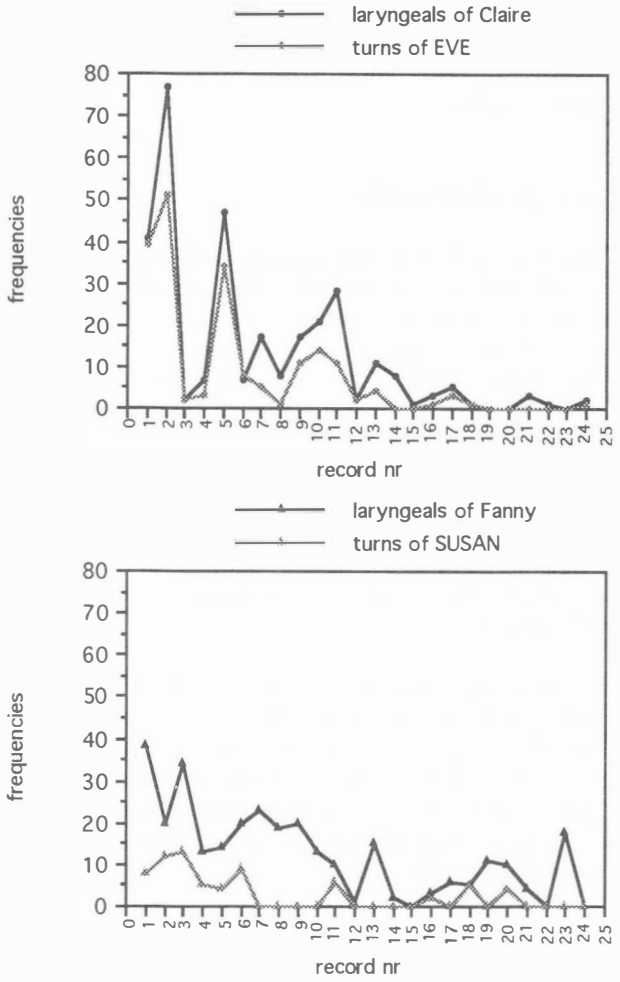


Figure 5.4
Frequency of laryngeals produced by the two infants Claire and Fanny (dashed line) and the frequency of laryngeals upon which the mothers EVE and SUSAN have taken a turn (continuous line) per recording over the two years.

Our observations thus show that the laryngeal sounds -the first landmark sounds produced in the speech motor development- can reveal a significant difference in turntaking between the two mothers already at an early age of the children.
Laryngeals were produced by both children in 21 out of 24 recordings. After the sixth recording, SUSAN took turns upon laryngeals in only four recordings out of the remaining fifteen with laryngeals. In contrast to SUSAN, EVE 'neglected' Claire's laryngeals in only four recordings in the second year.

The feedback upon these early landmark sounds of the infants has been quite different for Claire and Fanny.

5.3.2 Simple articulations

In this section the turntaking of the mother upon the simple articulations of the infant, such as "aarre", is described for the recordings over two years. The children appeared to produce these sounds from the second recording onwards, and face-to-face contact was then frequent ('proto-conversations'). The frequencies of simple articulations per recording of the two infants, and the frequencies of simple articulations with turns are presented in Figure 5.5.
In Table 5.2 the results of the comparison of the two pairs are given for the percentages of the simple articulations with turns per total number of simple articulations in the matched recordings.

The turntaking behaviour of the two mothers as a reaction to the simple articulations of the infants was similar to that following laryngeal sounds (section 5.3.1). EVE was significantly more active in taking her turns after Claire's simple articulations than SUSAN was upon the large amount of sounds produced by Fanny (e.g. recordings 7 and 8 in Figure 5.5).
The total number of simple articulations in the recordings over the two years was 115 for Claire, of which 87 caused a mother's turn (of the total number this represents 75.7 %). Fanny produced more frequently simple articulations than Claire: 432 in the two years, but only 24 of them (5.6 % of the total number) resulted in a turntaking pattern (see Appendix VIIb).
The simple articulations were produced for the first time by both infants in the second recording. EVE took her turns upon these sounds in all recordings but two (record number 20 and 23), when Claire was already over eighteen months old. SUSAN has taken her turns upon Fanny's simple articulations in four recordings (two in the first year and two in the second year), out of the 22 in which Fanny produced these sounds.

Table 5.2
Distribution of signs for the percentages of simple articulations with turns after the comparison of 24 matched recordings of the pairs Claire and EVE and Fanny and SUSAN. The asterisk indicates the level of significance.

	number of recordings
Total number of recordings	24
Claire + EVE<Fanny + SUSAN (-)	2 *
Claire + EVE>Fanny + SUSAN (+)	14

* $p < 0.01$

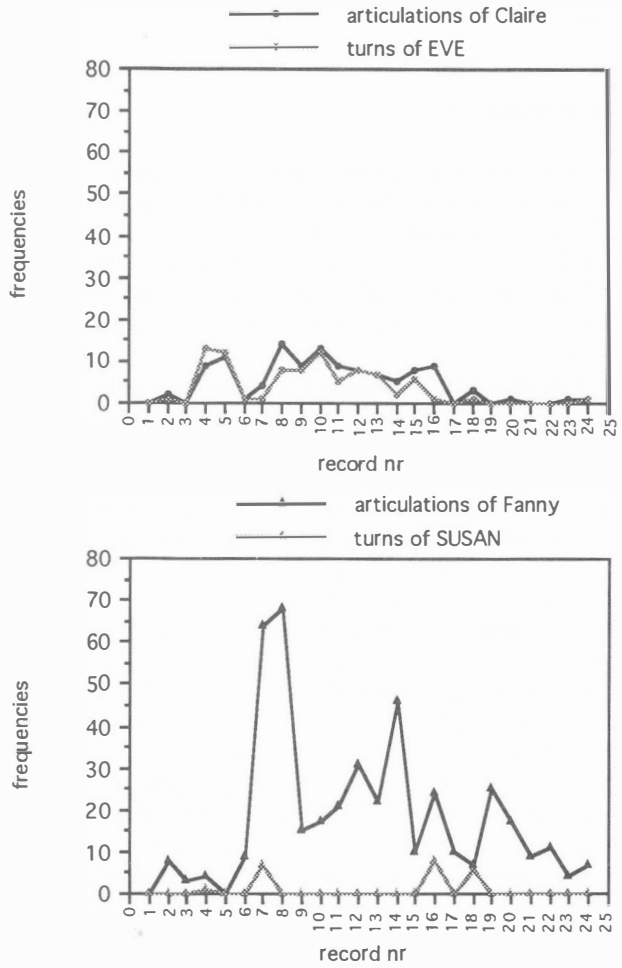


Figure 5.5
Frequency of simple articulations produced by the two infants Claire and Fanny (dashed line) and the frequency of simple articulations upon which the mothers EVE and SUSAN have taken a turn (continuous line) per recording over the two years.

The difference in the feedback on *sound productions with a beginning articulatory movement* between the two infants is obvious. Fanny seemed to 'overproduce' the sounds with one articulatory movement, but hardly got a 'comment' on them over the two years. Claire, in contrast, frequently received feedback more than once upon one simple-articulation sound in the recordings of week 16 and 18 (see Figure 5.5, upper graph, recording number 4 and 5). In those recordings of Claire and EVE, the number of articulations *with turns* is higher than the number of articulations itself.

Then the percentage of sounds with a turn was set upon 100 % in these recordings, and these percentages are used in the distribution of signs.

5.3.3 Babbling sounds

The turntaking of the mother following upon the production of babbling sounds by the infant (like "abababba") for the recordings over two years is described in this section.

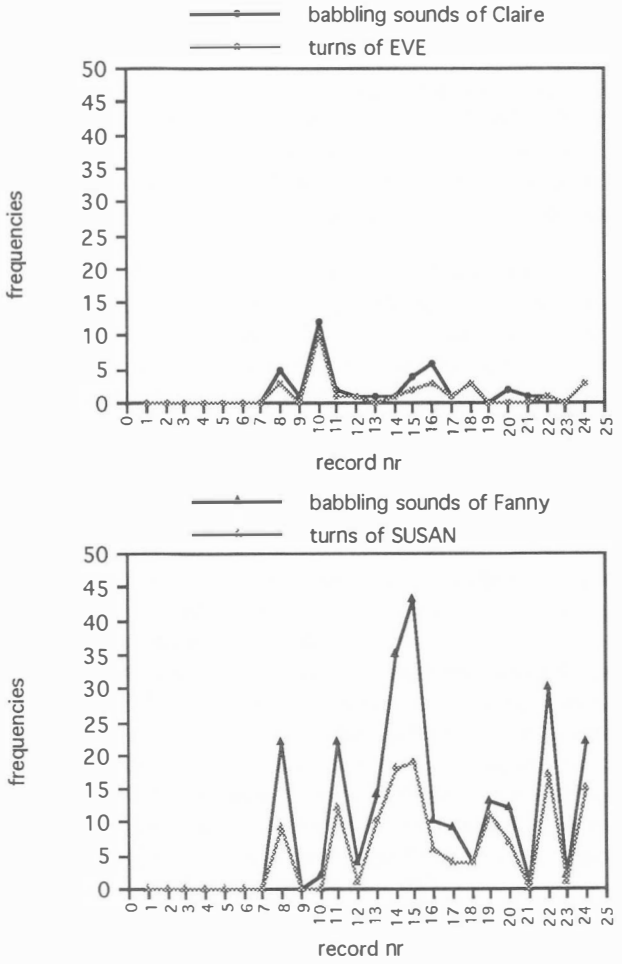


Figure 5.6
Frequency of babbling sounds produced by the two infants Claire and Fanny (dashed line) and the frequency of babbling sounds upon which the mothers EVE and SUSAN have taken a turn (continuous line) per recording over the two years.

Table 5.3
Distribution of signs for the percentages of babbling sounds with turns after the comparison of 24 matched recordings of the pairs Claire and EVE and Fanny and SUSAN.

	number of recordings
Total number of recordings	24
Claire + EVE<Fanny + SUSAN (-)	6
Claire + EVE>Fanny + SUSAN (+)	8

In Table 5.3 the results of the comparison of the two pairs are given for the percentages of the babbling sounds with turns per total number of babbling sounds in the matched recordings.
The distribution of signs is not statistically different for the two pairs with regard to the babbling sounds in turns.

Both infants produced babbling sounds in the recording eight for the first time. Claire produced five babbling sounds then and Fanny 22 already. Babbling sounds resemble 'first words' and the sounds appeared to be fairly adequate in drawing the mother's attention. The frequency of babbling sounds produced by the infants per recording, and the frequency of turns taken by the mother upon these infant's sounds are given in Figure 5.6.
The total number of babbling sounds produced by the two infants in the recordings over the two years is 44 for Claire, of which 29 (65.9 % of the total number of babbling sounds) caused a turn taken by the mother. Fanny produced 245 babbling sounds, and SUSAN took a turn upon 134 babbling sounds produced by Fanny (which is 54.7 % of the total number, see Appendix VIIc). These sounds clearly pushed SUSAN to take her turns. Although Fanny produced babbling sounds more frequently than Claire, Claire was more 'successful' in evoking EVE's turns upon these sounds than Fanny was with SUSAN.
The number of recordings that were attributed a positive sign (Claire-and-EVE's percentages above those of Fanny and SUSAN) is higher for Claire and EVE than for Fanny and SUSAN. Claire did not produce many babbling sounds in the recordings over the two years, and EVE reacted upon them as she did for the sounds productions in the other groups. SUSAN (finally) has started to take turns upon the (babbling) sounds of Fanny.

5.3.4 Words

Then, finally, the first words were produced, although they were not always easy to recognise as such. In this section the turntaking of the

mother upon the production of words by the infant is described for the recordings over the two years. The two children produced words for the first time in recording number 11 for Claire, and in recording number 12 for Fanny.

The number of words produced by the two infants per recording, and the number of turns taken by the mother upon these infant's sounds are given in Figure 5.7. In Table 5.4 the result of the comparison of the two pairs is presented for the percentages of words in turns per total number of words in the matched recordings.

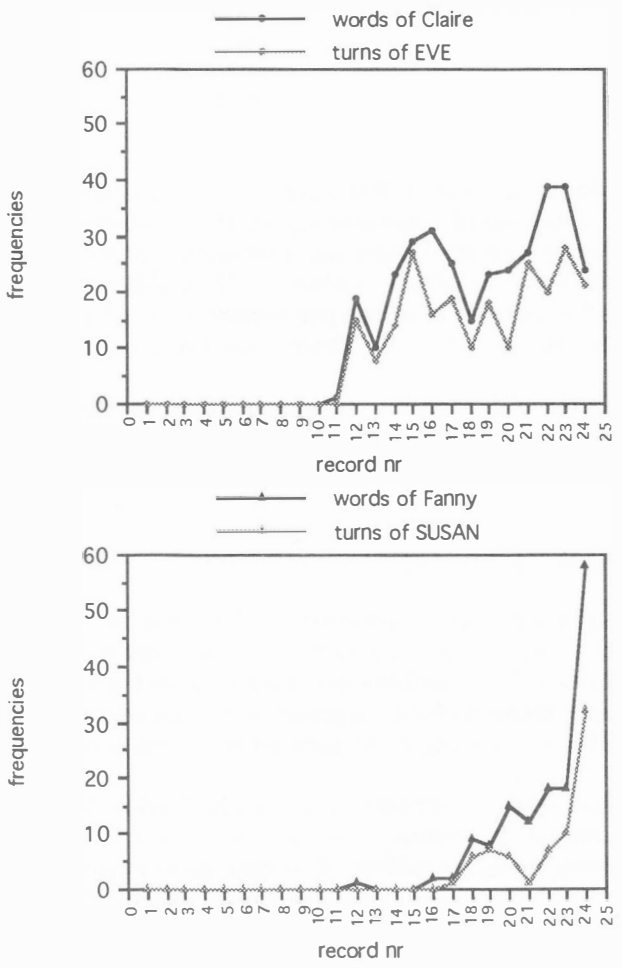


Figure 5.7
Frequency of words produced by the two infants Claire and Fanny (dashed line) and the frequency of words upon which the mothers EVE and SUSAN have taken a turn (continuous line) per recording over the two years.

Table 5.4
Distribution of signs for the percentages of words with turns after the comparison of 24 matched recordings of the pairs Claire and EVE and Fanny and SUSAN. The asterisk indicates the level of significance.

	number of recordings
Total number of recordings	24
Claire + EVE<Fanny + SUSAN (-)	1
	*
Claire + EVE>Fanny + SUSAN (+)	11

* $p < 0.01$

Claire has produced a total of 300 words in the recordings over the two years, of which 231 caused a turntaking by the mother (which is 77 % of the total number of words). Fanny has produced 143 words, and SUSAN has taken a turn upon 70 of them (which is 49 % of the total number). An overview of the frequencies of words per recording, produced by Claire and Fanny, and the turns taken by their respective mothers is given in Appendix VIId.
The two pairs differ with regard to turntaking upon words produced by the infants. In only one recording out of 12, Claire and EVE had a lower percentage of words with turns than Fanny and SUSAN.

5.3.5 Sounds accumulated

In this section the cumulative occurrence of sounds in all four groups is presented for the recordings made over the two years for the two infants, as a kind of overview. The mother's turntaking upon the sounds in the four groups, separately treated above, is presented in a cumulative overview as well (Figures 5.8 a-b, enabling a comparison of the pairs in a glance).

It must be noticed that the vertical axes are identical in the graphs for the sound productions of the infants and for the turns taken by the mother. Because of Fanny's high number of sound productions the graphical resolution might not be optimal for the lower graphs with the turns of the mothers. This compromise between the various possibilities of a set-up of the four graphs shows the discrepancy in turntaking by the two mothers upon the sounds of their infants even better than in graphs with different vertical axes.

The total number of sound productions of the two infants in all recordings over the two years was different (Appendix VII). Claire produced 768 sounds in the four groups and Fanny 1119. The two infants also differed

with regard to the distribution of the frequencies of sounds per recording. Claire's maximum number is found in the second recording (week 8), Fanny's in recording 8 (week 32).
The number of turns taken by the mothers is smaller than the number of infant sound productions, the total number of turns taken being 538 for EVE (which is 70 % of Claire's sounds) and 296 for SUSAN (26.5 % of Fanny's sounds). This difference is partly due to the period between week 28 and 56 when Fanny produces a large number of sounds upon which SUSAN missed a lot of turns.

When a new group of landmark sounds is produced by the infants, I expected the mothers to react to these sounds more specifically. By neglecting more and more the sounds of previous periods (especially when those sounds do not belong to the mother tongue) the mothers can direct the developmental process towards the production of adult speech sounds. As the frequencies of sound productions in a newly occurring group of landmarks were usually very small in that first recording, these incidental data are not checked statistically in a specific way. Only certain tendencies in the increasingly selective turntaking are suggested.

This overview shows also the presence or absence of homogeneities in the recordings with regard to the sound productions of the two children. In certain recordings, sounds from all four groups are produced by the infants (e.g. recordings 15 and 16 for Claire, and recording 19 and 20 for Fanny). When an infant produces in one recording sounds that belong to all four groups, the mother may have problems to take her turns selectively upon the most 'advanced' sound productions.

EVE seemed to do so successfully, with a preference for words, which of course is expected when the development of speech communication proceeds. She reacted upon new sounds of Claire systematically. On the other hand, she did not neglect the 'old' sounds immediately. There was a tendency to pay somewhat more attention to the sounds in the new group (missing relatively few turns in that group on the first occurrences of these sounds, see Appendix VII).
SUSAN, when placed before a choice out of the four groups, did not react immediately upon the sounds in the newest group produced by Fanny (e.g. Appendix VIId, recording 12 and 16, the first words of Fanny). Initially, when only the laryngeals and the simple articulations were present, she largely neglected them. This behaviour changed when Fanny started to produce babbling sounds and words. In the second half of the second year Fanny still produced sounds in all four groups of sounds, and SUSAN reacted upon the different landmark sounds (e.g. recording 18). As SUSAN was not taking her turns very predictably, her reactions on *new* groups of sounds remained unclear as well.

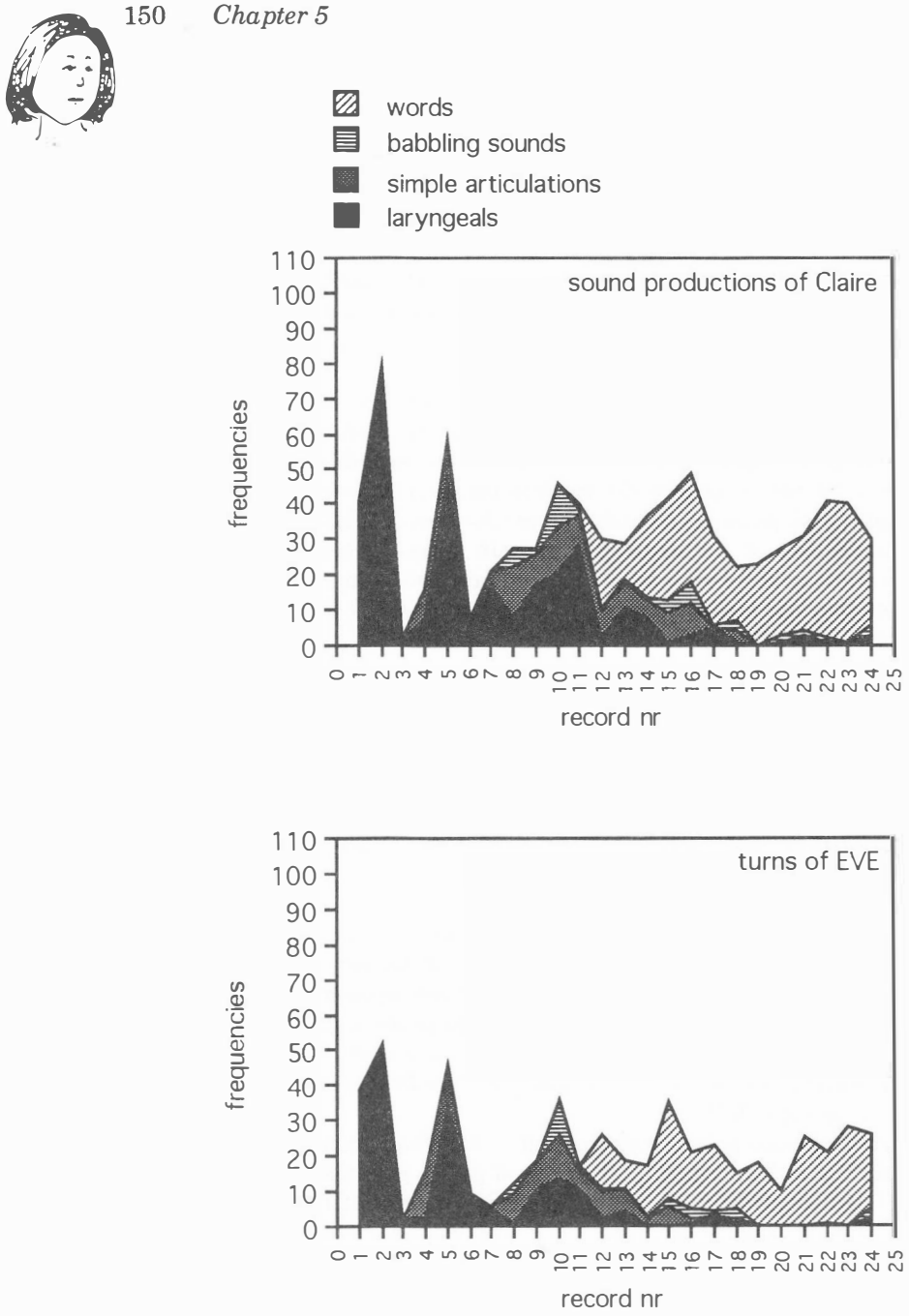


Figure 5.8a
Cumulative number of laryngeals, simple articulations, babbling sounds, and words per recording over the two years of Claire, and the number of turns taken by EVE upon the four groups of landmark sounds of Claire. Any of the individual contributions of the landmarks can be traced in the previous figures.

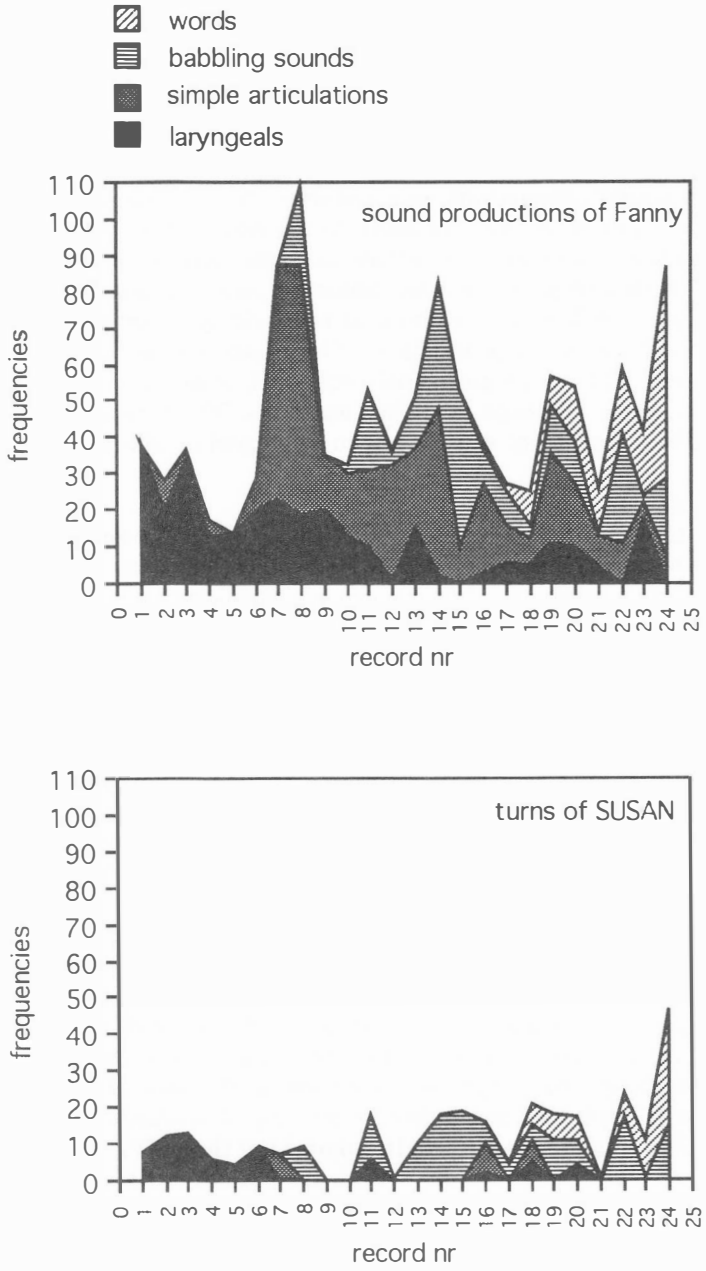


Figure 5.8b
Cumulative number of laryngeals, simple articulations, babbling sounds, and words per recording over the two years of Fanny, and the number of turns taken by SUSAN upon the four groups of landmark sounds of Fanny. Any of the individual contributions of the landmarks can be traced in the previous figures.

5.3.6 Summary on turntaking and landmarks

The infant's sound productions in the four groups represent the ongoing speech motor coordination, with differing onsets during the two years. The quality of the infant's sound production and mother's readiness to react upon sounds is studied with regard to early sounds and, later, words. The number of sound productions, in relation to the numbers of turns taken by the mothers, are considered to indicate the differences between the pairs. The mother's turns must occur within an inter-speaker switch-pause which is chosen in view of previous intersubjective and intentional exchanges.
The two pairs differ with regard to turntaking upon three of the four groups of infant sound productions. Only turntaking by the mothers on babbling sounds is not significantly different, although the frequencies of sounds are quite different over the two years. The turntaking behaviours of the mothers on infant sounds are summarised as follows:

Claire and EVE
Claire produces sounds in all four groups in the recordings over the two years, but relatively few babbling sounds. Laryngeals have their onset in the first recording, simple articulations are present from the second recording onwards, babbling sounds from recording 8 onwards, and words started to occur in recording 11.
EVE is not selective with regard to the sounds produced by Claire, since she takes her turns upon sounds from all four groups from the first recording onwards, and she does so fairly often (70% of the sounds). If sounds from different groups occur in one recording, she does not neglect the 'old' sounds, but pays more attention to the sounds in a new group. From the first recording onwards Claire 'learns' that her mother reacts upon sound productions.

Fanny and SUSAN
Fanny produces sounds in all four groups in the recordings over the two years. The total number of sounds produced by Fanny is high, especially the simple articulations and the babbling sounds: Fanny is a very vocal child. Laryngeals have their onset in the first recording, the simple articulations in the second one, babbling in recording 8, and words from recording 12 onwards.
SUSAN is more selective in turntaking than EVE because she does not take many turns upon the laryngeals and the simple articulations, especially in view of the numbers produced by Fanny. When babbling occurs in week 32 she starts to take her turns only upon those new sounds, still neglecting the large amount of simple articulations in that recording. In the second year turns are taken in some recordings upon sounds from all groups, but SUSAN clearly 'prefers' babbling sounds and words. Fanny has feedback on sound productions more systematically from week 32 onwards, but the overall percentage is low (26.5%).

5.4 Discussion

Turntaking is an important aspect in speech communication, and is based on intersubjective tuning, and the transmitted intentions, inviting to take a turn. The ongoing dialogue usually consists of several turns from both partners, separated by pauses. The structure of conversations varies with length of utterances, timing, turngiving cues (Mayer & Tronick, 1985), and many linguistic aspects.

5.4.1 Our approach

The evaluation of turntaking in mother-infant systems was implemented by analysing the simplest dialogue involving two persons. The crucial role is filled by the mother, who is directing the developmental process towards the mother tongue. Turntaking by the infant upon sounds produced by the mother is not considered in this thesis.

a. *The mother's role*

Turntaking in this chapter is limited to the mother's part in it. This choice is in line with Schaffer et al. (1977) reporting that infants initiate the vocal exchanges with the mother. If the infant produces a sound upon the mother's 'questions' about his well-being, she is likely to take a second turn interpreting the infant's sound, even if it is a 'primitive' one. She thus constructs a pseudo-dialogue by which the infant becomes aware of the alternating sound productions. Thus the mother may take turns upon certain sounds and neglect others, directing the process towards adult behaviour.
Initially, the mother fits in her behaviour into the stream of infant behaviours (Mayer & Tronick, 1985), thus behaving as if the child is transmitting a meaning to her (this chapter). Depending on the kind of cyclic behaviours of the individuals, she must fit in at different moments during the ongoing stream of infant behaviours. Sound production will gradually shift from 'simultaneous' or 'interrupted' to alternating sound production approaching adult speech. The two mothers appeared to differ in their own evaluations of their infant's sound production.
For EVE the mere production of sounds already seems to trigger a vocal turn, and a 'simple articulation sound' like "arreh" can be interpreted by her as "rare" (which is Dutch for 'funny' or 'peculiar'). For SUSAN, the sound should preferably resemble speech (babbling), or 'words', or perhaps it has to be meaningful.
This very different maternal attitude towards the vocalisations of infants has consequences for the procedures (involved in checking infant speech development) used in the Youth Health Care Centres, for example. Questions addressed during those checks at a mother about her infant's production of words tend not to be sufficiently specific and hence the

answers cannot be trusted for certain when evaluating the speech-developmental progress of the infant. Questionnaires to assess infant speech development by means of parental reports (cf. De Ridder-Sluiter, 1990) have to rely on parental observer-qualities and expect that parents can evaluate their own role as well.
While interacting with a baby, it is difficult for the mother to realise at the same time what her own role is. EVE probably was unaware of herself systematically producing two utterances for each sound of Claire.

b. *The infant's notion of turntaking*

Turntaking is described here with the infant's sounds as the first turn in a dialogue of just two turns. It is possible that the infant's turn occurred during a sound production of the mother, which she may then break off immediately, thus giving the stage to the infant. Or the mother may prefer to finish her sentence but is then likely to miss a turn upon that infant sound. In the PROGRAAF search for turntaking behaviours of the mothers -as described in this chapter- it is assumed that the mothers will focus upon the landmark sounds of their infants: mothers are expected to react instantaneously when (a more or less adult) 'speech quality' is present their infant's sound production.

Infants are reported to start turntaking towards the end of the first year only (Mayer & Tronick, 1985), although alternating sound production already becomes prominent after the third month (Ginsburg & Kilbourne, 1988). The definitions of turntaking used by these authors can probably explain this discrepancy in the reported ages. Mothers probably start to alternate their sound production after the third month, and it takes the infant quite some time to *actively alternate* his own sound production with the mother's. When, for example, the infant's turntaking ability upon a mother's sound production is studied (Schaffer et al., 1977), the inter-speaker switch-pauses are usually longer than for the mother. Masataka's (1992) study on the infant's turntaking starts the observations when the children are 8 weeks old. The first inter-speaker switch-pause is chosen to be 3.0 seconds maximally as a time-lapse for the infant to react upon the mother's first 'inviting' utterance which she produced after an initial silence of 5 minutes. A pause of 0.3 seconds demarcates the successive utterances of the mother or the infant. These timing criteria seem fairly arbitrary, and not necessarily related to preferences of the mother-infant system.
In our approach of turntaking by the mothers, an outside criterion for an inter-speaker switch-pause is not taken into consideration: timing criteria were related to the system's vocal behaviour because that was thought to change to an unknown extent over the period studied. We neglected the infant's turntaking upon the mother's sounds because we speculated that the mother would not need these infant reactions for the continuation of her turns upon the infant's sounds.

c. *The inter-speaker switch-pause*

Timing of turns is typical of the flow of a dialogue, and it changes with age and with the quality of the turns. The boundaries of turns are not always clear; e.g. interruptions or 'long pauses' modulate the turntaking flow. If a turn consists of several utterances, the inter-utterance pause can also be into account as another variable.
We assumed that timing of vocal turns in mother-infant interaction changes during the observation period of two years and in relation to the quality of turns as well. The duration of the switch-pause for the mother to take her turn often seems a matter of taste. In their study, Schaffer, Collis & Parsons (1977) have calculated the durations of pauses, and one second was quite acceptable as the switch-pause for the mother's turns. In a previous study (Van der Stelt, 1991), I had chosen a maximum of one second between the intentional turns of mother and child. These fixed time-lapses of one second, however, were an unattractive solution to the switch-pause problem, especially for a prolonged observation period. In this thesis I therefore have experienced with a more flexible time-lapse.
The median duration of the *moments of silence* per recording is an alternative to the median duration of vocalisation in unison which was used in this chapter (see Appendix VI). However, in certain recordings both mother and infant are fairly quiet which would result in a time-lapse of considerable duration. Such a long switch-pause, used throughout the recording to link utterances of mother and infant (or not), then risks to connect two utterances that are no 'real turns'. When an infant is silent for some time, the mother may start her 'invitation to sound production' again. That first turn is then related to the infant's silence, and not to the sound produced, for example, two seconds before.
For sound productions that are interrupted by the partner (the vocalisations in unison) this qualitative relationship is more likely. When the median duration of vocalisations in unison was added *twice* (after the end of an infant sound production) instead of *once*, the frequency of the sounds-with-turns changed with only one or two in some recordings. The inter-speaker switch-pause appeared to remain less than one second in the recordings of the second year (e.g. Appendix VI).

d. *The groups of sounds, turns and numbers*

The four groups of sounds are chosen because they represent speech motor landmarks in the development towards adult speech production. In the group of words *motor* aspects and *meaning* have merged.
Mothers are thought to interpret their infant's sound productions in different ways, i.e. with regard to the mere production of sounds in its motor-act aspect, their 'function' in the actual contexts like asking for attention, and in relation to linguistic characteristics like, for example, the lexicon.

In the course of the development these aspects can appear simultaneously in one recording. If the mother has an unconscious didactic speech program in mind, she may react more often to the sounds which bear similarities to adult speech sounds than to the earlier landmarks, or she may even neglect the previous sounds completely. This picture fits SUSAN who became more 'responsive' when Fanny started to produce babbling sounds and words. Her neglecting of the large amounts of simple articulations is quite remarkable. Initially, SUSAN leaves Fanny to her monologues.
If the mother focuses on different vocal intentions of the infant, she may be less selective in her turntaking pattern, which fits EVE's pattern. EVE's relatively exceptional behaviour in relation to the babbling sounds perhaps finds its reasons in the rare occurrences of sounds in that group, the relative maximum that occurs for the simple articulations in that period (e.g. recording number ten, Appendix VII), and the early occurrence of words for Claire (in that period, recording number 11).

5.4.2 Impact of turntaking for speech communication

The landmark sounds in this study have their onset in the first year of the infants speech motor development. The mothers were followed in their turntaking behaviour throughout the two years and appeared to differ in this respect.
Turntaking is the third fundamental characteristic of communication systems. It can be triggered by the earliest and most primitive sounds of infants, and is based on intersubjective tuning and perceived intentions. From that moment on, the very young infant is regarded as a person who has something to say. The surprising difference as to this aspect between the two pairs does not stand on its own. During the first five to six months the two pairs differed, sometimes more, sometimes less, on all three characteristics discussed in this thesis. Some differences persist over the two years, while others do not.
The most striking difference in turntaking between Claire and EVE on the one hand, and Fanny and SUSAN, on the other, is found in the recordings, made before babbling was present. EVE very frequently takes her turns upon the sounds of Claire, something which SUSAN does not with Fanny. These turntaking patterns upon infant sounds, which seem so closely related to speech development, indicate that feedback *after* the sixth month cannot compensate for earlier negligence of the infant's sound productions. These patterns *were embedded in the other fundamental characteristics*. This finding will be further discussed in the next chapter, together with the finding that the first five months are fundamental to speech communication.

Is the amount of time or the frequency of the mother's utterances sufficient to explain an infant's progress towards the mastering of speech communication? Do we have to suppose that turntaking following upon the

'simple articulations' as early as the first six months instructs infants about the movements of the mother tongue? Is the lack of feedback at that time e.g. related to Fanny's later pronunciation problems? Is a frequent and persistent production of babbling sounds related to later speech-communicative problems?

These questions cannot be answered without further research. And when the questions focus on behaviour of one of the individuals their relevance for the developmental process towards speech communication is limited.

6

GENERAL DISCUSSION

Abstract

In this final chapter the sensori-motor approach of mother-infant systems on their way towards speech communication is discussed.
First of all, the results on the fundamental characteristics of human communication systems (intersubjectivity, intentionality, and turn-taking) are integrated into some conclusions about the development. A discussion is given of the hypothesis that developmental processes towards speech may already be at-risk in the first five months if the distance channels are not used increasingly selectively. After the first five months vision will be used for the orientation upon the environment, and hearing for the transmission of interpersonal sounds.

Three important aspects of my approach are discussed. First, the decision to transcribe mother-infant interaction at a similar sensori-motor level, thus compromising between the sensori-motor abilities of the mother and those of the infant. This compromise disregards certain details in the behaviours of the individuals. The second aspect concerns the transcription model itself, which formulates the constraints for the transmission of movements between the two persons. The third aspect is related to the three fundamental characteristics of communication systems and the way they are formalised.

Further research is suggested, aiming at norms for the fundamental characteristics and guidance programs for mother-infant pairs at-risk.
It is likely that certain speech-communicative problems, which have their origins in the early mother-infant interaction, can be predicted. Possibly, these later problems can even be prevented. A final topic is the outline of an evaluation method that should enable the detection, already during the first five months, of communicative problems in the mother-infant interaction.

6.1 Introduction

" .....to analyze simple phenomena such as the quantity of infant activity can lead to considerable methodological and conceptual problems, if activity is to be measured within interactional situations where contexts constantly vary and provoke varying activity levels."

(Papoušek & Papoušek, 1991, p. 23)

The reason to start this study was our curiosity about the influence of mother-infant interaction upon the outcome of the mother's and infant's developmental process. In the development towards speech communication the necessity of interaction between a baby and an adult is beyond discussion. We think insufficient attention had been paid so far to the *quality* of that interaction. In our approach, the quality is described with regard to only three, yet fundamental, characteristics of speech communication: *intersubjectivity*, *intentionality*, and *turntaking* by the mother following the production of landmark-sounds of the infant.
Two specific test cases were chosen for this approach because their interaction patterns were found to differ and in fact (at the age of two years of the children) the outcome of the developmental processes was different (see section 6.2). The tools used to describe the interactions (the transcription system and the transmission model) are discussed below (6.3), together with the manner to formalise the three fundamental characteristics. The finding that the quality of the interaction between mother and infant *in the first five months*, is indeed related to the quality of speech communication when the child is two years of age, is discussed in section 6.4. Of course, more research is needed for further refining of this approach and for the development of protocols. For pairs at-risk guidance programs are needed (6.5). Such programs must be individually tailored to the mother-infant pair. An outline of a method for an early evaluation of mother-infant interaction is suggested (6.6).

6.2 Speech communication and the mother-infant system

Human infants do not grow up in isolation, and for most developmental processes the presence of an adult is a prerequisite. The development of speech communication is one of the typically human processes that infants only go through in the presence of at least one adult person. The interaction between these two persons becomes a matter of mutual understanding, in the widest sense of the words. In the literature so far, the emphasis has usually been laid upon behaviour of either the mother or the infant. This is understandable since not all factors can be studied at the same time. The results of these studies show us that major, well-known, anomalies in mothers and in infants in interaction have their effect on the outcome of the developmental processes. Lack of human contact

leads to 'wolf-children' (Malson, 1972). Similarly, the death of a chimpanzee mother can 'cause' a deathly depression in her four-year-old chimpanzee son (Goodall, 1971).

What can we conclude about *normal* interactions between adults and their infants? Which aspects in the interaction do we have to describe if we wish to understand the speech-developmental process? In this study we have chosen not to focus on either mother or infant, rather on their interaction by regarding them as a system. Up to a certain detail, all the behaviours were described that occurred in five minutes video recorded interactions, during monthly sessions over the first two years of mother and infant as a pair.
Claire and EVE, and Fanny and SUSAN are two normal mother-infant pairs, like we see around us everyday. In certain ways, both pairs are comparable, in other aspects the differences are more prominent. Infants and adults are able to learn and to develop towards a multitude of well-defined behaviours. The description of these behaviours at different moments in life (age-related) must not be confounded with the developmental process itself (Gottlieb, 1976). It must be very clear by now, that I do not wish to focus on specific behaviours of individuals outside their personal spatio-temporal contexts. What intrigues me in mother-infant interaction is the development of their speech communication, which is a matter of the individuals in one pair. Single-case designs in science, have proved their value, but still have to be defended from time to time (e.g. Denenberg, 1979; Plooij & Van den Dungen, 1985; Van der Stelt, 1985).
Our two pairs have shown that they differ in certain aspects as related to the fundamental characteristics of speech communication systems. We thought that such a complex human behaviour would need its time to deviate from the broad normal path. Thus, we started to study the period of the first two years. Surprisingly, the differences in coping with each other's (speech) communicative behaviour became already clear in the first five recordings which roughly corresponds to the period of the first five months (see Appendix I, and section 6.4).

a. *Results*

With regard to *intersubjective tuning* or mutual orientation Claire and EVE changed their way of tuning around the fifth month, which Fanny and SUSAN did less obviously. Before the fifth month, the co-occurrence in the distance channels of similar behaviours (like looking at the face of the partner and sound production) of mother and infant seems favourable for speech development, but this kind of interaction is expected to decrease in frequency after that period. Mutual visual co-orientation elsewhere, with only incidental face-to-face contacts and not-simultaneous sound production, explains this decrease.

As defined in this study and using quite restrictive criteria, in the *transmission of intentions* (which is an individual's action under a system's condition) during the first five months Claire appeared to be visually more intentional than Fanny. Audibly, Claire was not more intentional than Fanny. In that period, however, no difference in visual intentions was found for the mothers. With regard to the audible intentions, EVE was producing longer (not necessarily more) utterances than SUSAN, throughout the period studied. The visual intentions of the infant during the first five months, and the mother's thereafter together with long utterances seems to favour speech-communicative development. Though expecting to detect a distinction between the two pairs in relation to speech (sound) communication, we found, to our surprise, *audible intentions* to be relatively unimportant in the first months. Only the mothers differed with respect to the percentages of face-to-face time. Since both mothers produce (far) more audible intentions than their infants, the infants are given the opportunity to *see* the mother speak to them. It is possible that the difference in speech communication of the two children is partly related to this quantitative difference (i.e. in duration only) between the mothers.

There are clear indications that the difference between the children, when two years old, is also related to the mother's styles in turntaking following the *early* infant sound productions. During the first five months, the mothers differed extremely with regard to the *turns they take* upon the landmark sounds of their infants, that have their onset in that period. A sharply increasing turntaking by SUSAN, upon babbling sounds of Fanny (which had their onset after the seventh month), cannot compensate for the negligence of earlier landmark sounds. The outcomes of Claire's and Fanny's developmental processes at the age of two years are understandable from the (speech) communicative behaviours that were present in the first five months.

b. *Conclusions*

Mothers and infants must take their time to orient themselves towards each other. In that condition they can show their partner that they move and that they can be moved in many ways. In the development towards speech communication, initially the visual channel is important because in that respect infant and mother behave with a more or less equal quality. With regard to the vocal-aural channel, the mother is handicapped when she is focusing on any adult quality in her infant's sound production (e.g. Greene, 1960). In that case, she will offer not much stimulation to produce sounds, which is triggered in the infant by the mother's own sound production. When an infant produces sounds, the mother must take them 'serious'. Alternating sound production usually occurs only gradually in the first five months, and does not need to be timed perfectly after that period. Alternating sound production implies that the other person is listening to the words of speaker. Certain children in kindergartens suffer from the

'loudest-voice-syndrome'. They always speak louder than the others, they interrupt dialogues and may even end up with voice problems. They feel that nobody listens to them, so they make themselves heard.

6.3 Our approach

In our approach of the development of speech communication in mother and infant (taken as a sensori-motor system), which was presented in this thesis, three important choices have been made. The first one is formalised in the transcription system because I have described the changes in the individuals on the sensori-motor level. Many of the coded movements can occur without the presence of an important other being. Other movements occur only in the presence of another person. The constraints are chosen on the *system* level, by means of the transmission model, which is the second important choice. The transmission model resulted from a particular view on speech communication at a sensori-motor level. The third choice is concerned with the compilation of movements in relation to the three fundamental characteristics of communication systems. The development of speech communication is thus described in an ethological manner.

a. *The sensori-motor level of description*

The transcription system is designed with the idea in mind that all movements in mother-infant interaction can have a meaning for the individuals (see section 2.3.2). We have used eight channels of the 16-channel version, but in principle there is no limit to the nuances one wishes to make in a description of movements. In the codes the researcher can make his choice.

The level of description that we have chosen is a compromise. For phoneticians studying sound production, 'micro-analysis' is much more detailed compared to the micro-analysis used in this study. For cognitive psychologists, this study uses behavioural descriptions that have lost their relation with the conceptual aspect in speech communication. The linguists may ask for the (un-)grammatical structure of utterances, or for an indication of the lexicon.

We have chosen this level to compare the two individuals in the system using more or less similar measures. Initially, the infant does not know the meaning of his mother's behaviour yet and the mother can only guess about the infant's; hence, the system is negotiating the individual movements and their values. Although not used by me in its total extent, the quality of the individual behaviours is still reflected in the codes, and we could count the number of smiles, caresses, and utterances with a simple intonation pattern.

In view of the differences found to be present in the two mother-infant pairs, the chosen level is adequate, at least for the first five months.

b. *The transmission model*

The transmission model was formulated by me in 1985 because we had found in a pilot study, which was part of the *Netherlands Prevention Fund* project, that the mothers see far more movements of their infants than the infants see of their mothers. By means of the model it is possible to distinguish between movements that are transmitted between the two persons and movements that are not. The constraints are defined in relation to the micro-analytic transcription system for movements, and the idea that the partner in the game cannot react upon a move that he has not perceived is fundamental.

We have decided to disregard the *memory* for previous situations, which is a compromise between every-day life and simplicity of the research design. The mother will certainly use her memory when she gazes away from a smiling face and she sees a crying face when looking back. For the young infant, that memory ability may be too complicated. In disregarding memory, one possible explanation for the mother's movements is neglected. On the other hand, the infant is capable to react immediately to changes, in handling for example. Trevarthen (1989) reports that infants freeze or show avoidance reactions when the caretakers movements are abrupt and not geared to the infant's state. Trevarthen's model for 'body language' of early communication (1989, p. 192) is surprisingly comparable to ours, at least with regard to the channels used in this thesis. The difference is that he says that visual and audible communication between mother and infant "couples motivational/emotional states in their brains", and he wonders how this early communication is related to the infant's psychological growth.
This one step to the 'inside' of the individuals involved is not explicitly mentioned by me because I am aware of the difficulties in such research. "It remains a fundamental theoretical challenge to show how emotions, motives and concepts are translated into movement that is communicative, and how communication enhances the development of movement" (Fogel, 1992a, p. 396). Of course I also rely on these internal properties of human beings. In the interaction, the infant contributes properties that are related to (perhaps partly genetically encoded) schemes. The mother contributes her personal history and her socio-cultural knowledge, which can help the infant to find its niche.
In contrast to Fogel (1992a) I think that it is not necessary to account for every detail in the communicative movements. He pleads that every movement must be interpreted, not only in the time- and space-dimensions, but also with regard to social, cognitive, and motivational characteristics. To explain the vast network of components in human behaviour, he uses the scene of a man touching a woman. The timing, speed, and the force of the man's touch have their counterparts in phonetic research. In Fogel's publication I have found the non-linguistic formulation of my scientific problem with the developmental process underlying speech communication. Do I have to measure the infant's fundamental frequency,

or the quality of the vowel sounds, at different ages, in relation to the interactional context, and the mother's voice quality at that time? Scylla and Charybdis are constantly present in research on complex matters (e.g. Wind's scheme, section 1.4.3). Simplicity is attractive, in the exploring stage of research, that to a large extent is based on description of the phenomenon that caused curiosity. To me it seems, that a vast amount of detail will hide more aspects of the developmental process, than it will reveal. Yet, by choosing for the 'simple' approach one knows that important aspects may be disregarded. I have chosen to describe the developmental process by means of the three fundamental characteristics of communication systems. In view of the complexity of human speech communication these characteristics are simple. Thus, the complexity is found in the transcription system and the transmission model because research is never that simple.

c. *The fundamental characteristics of communication systems*

Here I have focused upon the three very important fundamental characteristics of communication systems (intersubjectivity, intentionality, and turntaking), which are closely related to one another. In the developmental phase of such a system, the characteristics are part of one complex of behaviours. In adulthood, we can more easily focus on just one of them. The aspects that I chose to represent the characteristics are quantified only with regard to their *interactional* impacts, avoiding some of the difficulties indicated above (e.g. section 6.1; Papoušek & Papoušek, 1991; and section 6.3: Fogel, 1992a). Of course, there is much more to say about intersubjectivity and intentionality than the aspects that I have actually used in this study, like turntaking in the way it was formalised. But too much detail in the description of individual behaviours overestimates the interactional global function.

The interactional process can be given names like 'co-regulation' or 'co-determination' (Fogel, 1992a), with the main motives of the individuals in the back of our mind (like physical schemes or social motives). In my opinion all such labelling refers to *coping behaviour*. The quality of individual behaviours is not a very important matter since the attuned other person is expected to cope (or not) with the behaviours of the partner. This 'coping' ability is not easily related to characteristics of the individuals; rather it is related to the mother-infant *system*. For instance, the severity of a handicap as such is not predicting the outcome of a developmental process: some seriously handicapped children develop amazingly well, while others with a milder handicap don't (e.g. Koopmans-van Beinum et al., 1990). Partly, this coping behaviour in the development of speech communication is described by the three fundamental characteristics.

On their own, the three characteristics present only limited information about the mother-infant communication system in its development. The three combined, however, touch upon communicative motivation and upon

precursors of social and cognitive behaviour (e.g. Bloom, 1993; Foster, 1990). They represent the conditions for human communication, and not only for speech.

Assuming equality between the two partners, compromises were made in our choice of quantitative measures to evaluate their communicative development, admittedly thereby underestimating the mother and overestimating the infant from certain points of view. In intersubjectivity and intentionality, mother and infant behaviour was evaluated in the same manner. For turntaking, which is already more determined by the socio-cultural schemes for communication, the mother's role is accentuated. Fogel's questions (1992a) about the *schematic* or the *socio-cultural* approaches of mother-infant systems probably can be answered in two ways because both approaches will work, if only the system is studied instead of the individuals. Emotions, motives, and personal characteristics of mother and infant are perhaps more important in the analyses of intersubjectivity and intentionality than in turntaking, while the maternal social schemes should receive more attention when intentionality and turntaking are in focus. In the coping behaviour of the mother-infant system these individual motives should merge.

If it is true that transfer of affection is developing already within the first two months (Trevarthen, 1989), the face-to-face interaction, so prominently present after that period, seems to play a more important role, compared to sound production. Sound production concernes only 'laryngeals' in the infants, and 'nonsense-sentences' of the mothers. These qualitative, more or less phonetic additions are given in quotes, because I think that the mere sound production can be as affective as face-to-face contact. Yet, in research, the two channels are treated quite differently. I feel that (details in) sound analyses are over-accentuated in the communication of human beings. We should certainly bother to evaluate the quality of an infant's smile as much as the quality of its sound production.

In turntaking we have disregarded the visual channel, and thus focused on 'real speech'. Yet, extrapolating from our two pairs, the early landmark sounds have a fair chance to be produced during face-to-face contact. It is very likely that the infant becomes vocal-aurally more responsive and internalises these movements, because of the bi-modal 'mirroring' effect of the mother who is talking back to him during face-to-face contact (e.g. Trevarthen, 1989). The lack of this feedback may have its effect on the *kind* of speech-communicative problems.

In our sensori-motor approach, the sounds produced by the individuals remained fairly unspecified. In the first months, the quality of vocal-aural interaction may prove to be related to the use of the motherese-register, which I did not take into account explicitly. A researcher who is used to study details in behaviours (like the formants of a vowel) may feel at a loss when these aspects are completely neglected in the description of speech communication. I had the feeling that for the quality of the earliest interaction between mother and infant in their development towards speech communication, *sound,* as a general phenomenon, is more important than labels like *vowel* or *consonant.* Of course, these distinctions

are important in the development of speech, but it will not be easy to decide at which moment they start to play a role for the infant and the mother in their communicative development. In my opinion that will not be in the first five months.

6.4 The first five months

The approach in this thesis aimed at the detection of interaction patterns that are favourable for the development of speech communication during the first two years. We have found that the first five months are already determining the outcome of the developmental process towards speech communication. This surprising finding asks for explanations. Some are offered by the biological constraints: after a pregnancy of, say, 14 months the infant's skull would be too large for the infant to be born naturally. This means that a human infant is fairly immature at birth compared to our closely related primates. In relation to the development of speech communication early in life, a psychological point of view also offers an attractive explanation. According to Mahler, Pins, and Bergman (1975), the psychological birth of an infant occurs only around the fifth month. Before that time mother-and-infant are still 'in an eggshell', orienting towards each other only. In that period the basis is laid for the infant in its development as an individual, yet in close relation to the important other person. Miller (1981) points also at the period of the first year in her study on narcism. She wonders if we (adults) will ever understand the emotional loneliness of a child, that was not understood by the proud parents in its unique wish to become a free person. In adulthood, these children may still feel the invasive power of the parental idealistic image, which may result in depressions and megalomania. These psycho-analytic findings further supported my intuition about the importance of the earliest period in development.

The gradual *selective use* of the visual and vocal-aural channels, which takes place in the first five months of a successful developmental process towards speech communication, was an intriguing finding for me. The bi-modal form of tuning is the picture most of us have in mind when studying early mother-infant systems. Visually, mother and infant orient towards each other, transmit intentions and take their turns: sometimes more, sometimes less. They engage in 'vocal play' which combines all three aspects. In a way, I have described the quality of vocal play in relation to speech communication. The bi-modal tuning and the gradual changes in *timing* of movements will perhaps qualitatively contribute to the gradual selection.

It is very likely that the differences between the two pairs during the first five months have their effect upon the interaction thereafter. Perhaps, our measures are becoming too global by then to discover that effect. Incidents of controlled reaching, binocular stereopsis, and looking around in the room or looking at an object in the mother's hands occur around the 12th

week in the infant (e.g. Trevarthen's interaction model, 1989), and these behaviours will have their effect upon the mother's utterances.

An easy critique upon research that points at an early cause or explanation for later developmental delay, is that children may overcome these problems in a next or later stage. However, this type of reasoning relies on global comparisons. A three-year-old non-speaking child has a good chance to speak when he is six years old: why worry? Of course, we don't need to worry, but only when we can formulate why we don't need to worry. Is that six-year-old child capable to talk about similar subjects in a similar way and is his socio-cultural behaviour similar, if we compare him with a child that already talked well at the age of three?

The 'let-time-do-its-work' approach of development must also take the following point seriously. In a way, Fanny has rehearsed articulatory movements over and over again. Turntaking upon the *babbling sounds* of Fanny clearly made a big difference in SUSAN-and-Fanny's interaction after week 32. But the earlier stages were not 'repaired', and a loss of quality in speech communication seems inevitable. The fact that Fanny, at the age of two, scored on the Mental Scales of the Bayley test at the level of a 19 months-old child (see section 2.2.4 b.), may be related to the 'verbal production items'. Understanding verbal instructions, important in e.g. test situations, formed another problem for Fanny. Her 'intelligence' thus cannot be measured by a standard test because her speech-communicative abilities lagged behind those of children of her age. To be sure, most children are not confronted with such formal test situations, but further development of children will be 'easier' if their speech communication is within the norms for their age-group. Parents play *their* role and the pleasure in coping behaviour can be of major importance for child and parent.

I am fairly sure that the pairs will have differed in their interaction with objects, and in the naming of objects which usually starts in the second half of the first year of life. I think that the differences originated in previous stages, which will be interesting to study in our longitudinal observations.

The period of the 'first five months' is a very global indication of a developmental process, sampled with a four-weeks schedule. Looking at the individual, we must look for the progress. It is likely that the interaction patterns during the first five months of mother-infant pairs offer enough information to predict problems in later speech communication, possibly opening advances for prevention. We must find out how the early interactions-at-risk originated and what treatment can be offered then, for example in the form of guidance.

6.5 Further research

In view of our results, the approach of the mother and infant as a sensori-motor system, on its way to speech communication by means of distant intersubjective tuning, transmission of intentions, and turntaking, may

provide suggestions for further research. Direct observations of individual interactions may lead to new theories, although there is always the danger of implicit colourings by the observer (e.g. Plooij & Van den Dungen, 1985) which I attempted to avoid.
The prediction and prevention of speech-communicative problems may be one of the goals of this research area. This kind of research is complicated, time-consuming, and tedious. We aim at studying, first of all, a greater number of normal mother-infant pairs, and secondly, the effects of some guidance offered to pairs at-risk.

a. *More normal mother-infant pairs*

I suggest that an evaluation of early mother-infant interaction on its way to speech communication must include all three characteristics treated in this thesis.

- Moments of *mutual tuning* by means of the distance channels are valuable, as face- and voice-schemes can be constructed.
- The moments of co-orientation must be used for the *transmission of intentions,* in which initially the alternated audible behaviour is not yet important.
- When a young infant produces sounds, the *mother must react* upon the sounds as if she is to fully understand what is 'said'. And soon she will.

In summary, in early mother-infant interactions general structures of communication systems are already present. The ways in which these structures are used in the first five months appear related to the outcome of the developmental process towards speech communication. Answering three main questions can reveal the structures.

1. Are mother and infant paying attention to each other in play-situations?
2. Are these moments used for 'sound-movies'?
3. Are sounds perceived and appreciated as expressions?

Many studies on infant development in the first five months have taken place in *laboratory settings* (e.g. Van Beek, 1993), which may be attractive for the researcher because of technical and time-saving reasons. The (more expensive) free-play situations (in the home-setting), used in my study, may be more difficult to create in a lab-setting. However, it is worthwhile to try this out with children under five months of age and interactions-at-risk.
A closely related question is the *frequency and the duration* of the observations. In the present study, about five minutes of engaged interaction are transcribed and the measures are relative to this duration. Although five minutes of each monthly recording may seem very short, micro-analysing them appears to indicate quite a lot of information, e.g.

variation in behaviour. We have to find out if five minutes suffices for pairs with interaction patterns that are less different.
With regard to the monthly recording, like was done in this study, I now think that another timing of the recordings will give a better picture of the development in a pair: bi-weekly recordings have a better chance to show the pairs in their 'easy' and in the more 'difficult' moments. Four of these 'difficult' periods (with a duration of two to four weeks) are supposed to occur during the first five months (Van de Rijt & Plooij, 1992). In my recordings made during the difficult periods (e.g. recording 3 in week 12), I found that the two infants were more silent and fussed more when not in the mother's arms. Face-to-face contact is likely to be found decreased in those recordings because the mothers must hold their infants. A bi-weekly schedule would show if and how the pairs process these experiences. Once we have some insight in these fluctuations, the observations of mother-infant pairs can be better planned, i.e. at crucial moments in the development.
A first *indication of a 'norm'* must be developed, related to the conceptual age of the infants. The median percentage of face-to-face time and frequency for intersubjective tuning, intentionality, and turntaking upon the first landmark sounds per recording can be used as indications for an interaction 'profile'. These profile-norms then can possibly be used to predict problems in mother-infant pairs at-risk.
For the further development of the theoretical and methodological aspects of the sensori-motor approach, certain findings can perhaps be placed in a mathematical model which formulates relations between behaviours of the individuals. Van Geert (1990) points at gradual, yet irregular increases in the infant's skills in the growth of language and cognition. These skills remain hidden when a theory proposes 'stages' in development and searches for 'stage-specific' behaviours. It is very well possible that coping behaviour in speech development is related to the amount of sound production of the two persons involved, or to the timing of these behaviours. Quantitatively measuring the progress in the mother-infant relations, like was done in this thesis, meets already one of the criteria for the application of the mathematical model that Van Geert (1990) proposes.

It is certain that in such a developmental process, we have to deal with the fluctuations over time of the frequency of specific behaviours. In our Amsterdam Institute of *Phonetic Sciences*, we have built up a valuable body of multi-disciplinary knowledge on this kind of research. This phonetic knowledge is on a microscopic level, compared to developmental processes over two years, yet the problems are similar.
In my early days at the Institute I have measured by hand the first *three* formants in the oscillograms of words and vowels (Van der Stelt, Blom & Van Herpt, 1973) in a longitudinal study on ten persons (the illustration on the cover can thus be seen as a reminder). I have often looked at the fluctuations in mother-infant behaviours, and associated the patterns with the oscillograms of the vowel sounds. It is no wonder that I have described, again, *three* fundamental characteristics in mother-infant interaction.

b. *Pairs at-risk*

Infancy is the most vulnerable period in our life, and in that period the individual develops his abilities and disabilities. Speech communication is, socially, a very important behaviour which can be used and abused. A child that has learned to speak out of an affectionate base can become a person to which others like to listen. All parents should know that early infancy may have far-reaching effects. To be sure, most parents do their 'duty', and when they feel they fail, they know the ways to more information, help, and support. For some parents, however, the responsibility for child raising is too heavy at times. They need further support. Depressed mothers probably interact with their infant differently from normal happy mothers (Messer, personal communication, 1990; Field, 1992). Similarly, unresponsive premature infants will elicit a different interaction pattern (e.g. Van Beek, 1993). It may be difficult for a mother to orient visually towards her infant with a cleft lip and palate in the period that the lip is not yet repaired. Interaction patterns probably can aggravate existing handicaps, and some early guidance may have a preventive effect, also for speech-communicative problems.
Finally, apart from care about the health of our offspring, we should deal with their educational welfare. In the following section a first outline is presented for an evaluation of mother-infant interaction during the first five to six months, as far as it serves the development towards speech communication.

6.6 Outline of an evaluation method

Before discussing this outline of an evaluation method for pairs at-risk it must be said that we provisionally have to disregard the social and economical consequences of this form of guidance. Further theoretical development of the sensori-motor approach is needed before a setting and the funds may be found for this kind of help. From a practical point of view it is clear that such help, e.g. guidance, can only be offered to mother-infant pairs at-risk when their 'case' has been evaluated. A handicap of the infant can be a reason for providing extra guidance during the early period. The request for help may originate from earlier problems, e.g. with other children, maternal depression, or from parental worries that are expressed to a midwife, a social worker, or a physician. An evaluation of mother-infant interaction may be requested by several persons that come into contact with the family. Background information must be gathered on the pair's medical and psycho-social history and the possible origins of the endangered interaction. Parents, asking for support in the education of their infant may need individual help as well in relation to aspects of their personality, and that help should be available in the setting.
This means that infant and mother at-risk may enter the guidance scheme at various ages. In fact, even an unborn child can already be at-risk for communicative problems. Age determines the type of guidance, of course in

relation to other problems of a mother-infant pair: both partners can contribute to the coping problems. Prematurity of the infant, with its effects on the infant's behaviour (e.g. Van Beek, 1993), is but one example. When it is obvious that a mother will have problems in caring for her infant (in the broadest sense of caring: warmth, attention, perhaps ideas about the future), both need immediate support. During the time that the infant cannot yet talk other signals must have our full attention.

For practical and economical reasons the video-recording using two cameras can best be made in a 'laboratory' setting (see section 6.5 a). We should aim at a homely lab-environment with hidden cameras and familiar objects, a free-play situation, and a choice of infant chairs and rugs to sit on. The parents can be suggested to bring the infant's favourite toys. This depends, of course, also on the age of the infant. The video-recording must be sufficiently long, preferably of the face-to-face situations, to include at least five minutes of uninterrupted engaged interaction.
The tape can be analysed more efficiently by means of a computer-assisted method, to help the trained transcribers. The program must have a data-base set-up in which timing is an essential aspect. The analysis is concerned with face-to-face contact (which probably can be scored in one run of the tape), with sound productions of mother and infant (which can be scored automatically from the audio-channels of the tape), and with mimical and head movements of the partners.
The outcome of further research -aiming at theoretical support for this sensori-motor approach- may prove my hypothesis that the quality of infant sound production and mimical and head movements is relatively unimportant for the evaluation of maternal interaction patterns with young infants. As to the investment of time for the analysis of the video-recordings, I am fairly optimistic. A maximum of eight channels must be analysed by hand which costs about four hours for a trained person. The (conditional) merging and combining of files as well as the calculations can be implemented as a standard set of instructions in the program. For the analysis of such complex behaviour this investment seems reasonable, the more so since indications for guidance of the mother-infant system can be deduced directly.
Depending upon 'age, norms, and variation', decisions on the intensity of the guidance program (which always will need support from other disciplines) must be made only following upon a second or third observation. The video-recordings should certainly be used in the guidance program, showing the parents the effective interaction patterns they can further explore with their infant. This is similar to the 'Video Home Training', which is popular in the Netherlands. The additional advantage of our guidance program is that it is based on scientific, i.e. ethological analyses.
I am fully aware that this outline needs further support from research on many points. This does not mean that parents who ask for support cannot yet be helped. In the developmental process sometimes a very 'simple' advice can make a world of difference, especially when it is given at an

early moment. Certain problems arise from the social isolation of mother and infant in our modern society (e.g. Price, 1989; Roscam Abbing, 1992), and the contradictory advises, given to parents for free.

6.7 Epilogue

In this thesis I have tried to focus the reader's attention on the hidden processes that underlie the development of human speech communication. I have sought for a manner to scientifically describe the phenomenon that had attracted my intuitive attention. I found that manner in ethology. Although the mother-infant system was described in a formal way, for me intersubjectivity was constantly related to warmth like a carrier wave between the two partners. Intentionality, in adults often regarded as an individual's goal-directedness, has to do for me with the mutual attention of mother and infant for the meanings transmitted between them. Mother and infant then internalise each other's images, and perhaps, buried in our deepest unconsciousness, we still act because of those impressions. Turntaking is related to the future. We act and react under the condition that there is warmth and understanding. Then, in speech development, simple sounds can become articulated speech.
In the further development of children, these three aspects seem to me of crucial importance. It will be clear that *'Finally a word'* is not my final word.

SUMMARY

In this thesis an approach is presented of mother and infant as a *sensori-motor system* which develops in a speech communication system. In the approach three fundamental characteristics of human communication systems are in focus: *intersubjectivity*, *intentionality*, and *turntaking*. These are present right after birth, although not yet in forms generally known in adult communication systems.
In normal mother-infant interaction both partners adapt their behaviours to create a context of social exchanges. These set the stage for the further development of speech communication. Any abnormalities in this development without obvious physical or mental causes (such as a hearing loss or Down Syndrome) are proposed to originate from early mother-infant interactions.
Two normal mother-infant pairs with different interaction patterns were chosen as test-cases for the approach. The development of these pairs appeared clearly to differ during the research period (from birth to the second birthday of the infants).

In the first chapter the reader is introduced to the human mother-infant interaction in its unique configuration. The fact that mothers and infants are successful in their development towards establishing conversations, that are also understandable for other humans, leads to the idea of *underlying processes,* generally present in mother-infant interaction. Psycholinguistic and psychobiologic literature is presented and related to publications on speech production and language development originating from linguistics, medicine, ethology, and primate evolution. It is concluded that mother and infant form a system that cannot be fully described by characteristics of these two individuals. The two persons mutually regulate each other' s behaviour -to an extent not yet fully understood- which is called *coping*.
In previous research in collaboration with Koopmans-van Beinum (1979, 1986), I have described speech motor landmarks in infant sound production that are basic to adult sound production. In the framework of the Netherlands Prevention Fund project, I have observed mother-infant interactions by focusing on their movements during the first two years. These experiences have led to some working hypotheses on the development of speech in infants and on styles of interaction.
In the present approach, the literature data and the practical experiences have merged. Mother-infant interaction was evaluated as early as possible, in single pairs, and in naturalistic home situations. Only the movements were described because such an approach is independent of language and the interpretation of the observers. The three common characteristics of human communication systems are treated in separate chapters. However, intersubjectivity, intentionality, and turntaking are related: intentionality presupposes an intersubjective orientation towards another person, while turntaking occurs upon transmitted intentions.

The second chapter introduces *two mother-girl pairs,* their medical histories over the two years, psycho-social characteristics (like infant temperament and scores on the Bayley Scales on infant development), and linguistic scores. The differences between the two pairs at the end of the observation period, i.e. when the children are two years old, are supposed to result from the different *interaction* patterns already present soon after birth.

Video-recording procedures, equipment, frequency, and durations are presented. These components originate from a Netherlands Prevention Fund project. Subsequently, the video-recordings of the two pairs as made during the two years have been transcribed in detail by means of a micro-analytic transcription system for movements. All movements of the mother and the infant, which occurred during five minutes per recording, were coded with regard to the body parts moving and the sounds produced. This results in a 16-channel behavioural score, similar to a musical composition for different instruments. This transcription was computer-assisted, and performed by one sole transcriber. Consistency of the transcriber was checked and appeared to be satisfactory (84% as a mean).

Not all movements made by one partner are actually seen by the other. For example, when the infant is looking at the camera, she surely will not see a smile movement on the face of the mother. The procedure to decide upon the classification 'transmitted or not transmitted movements' is described as a sensori-motor transmission model, in which memory for previous movements is neglected.

A computer program FP used for counting was adapted for duration measures. This enabled the calculation of the overall and median durations of specific codes per recording. The micro-analytic data were processed by the program PROGRAAF. This program can select specific channels or codes, indicated for mother or infant from the original transcriptions. In this manner the decomposed movement patterns in the 16 channels can be compiled selectively to obtain more complex behavioural patterns.

Intersubjective tuning is discussed in the third chapter. It is the first characteristic of mother-infant communication systems, and stands for the mutual notion that another human being is present. In the literature on mother-infant interaction it is described in positive terms like togetherness and bonding. In a way, intersubjectivity is already present before the birth, i.e. when the mother is thinking of the baby as a new person.

Our approach employs the transcriptions of movements of mother and infant, and thus intersubjectivity must be translated into movements in which mother and infant mutually orient towards each other.

Three forms of tuning by means of the visual and vocal-aural channels were selected for evaluation. A comparison was made per recording and per pair of the percentage of time and the frequency of the instances of (1) the mother and infant looking at each other's face, (2) their simultaneously producing sounds, and (3) sound production being simultaneous during face-to-face contact.

These three forms of intersubjective tuning appeared to be different for the two pairs in different periods of the development. In one pair (Claire and mother EVE) the presence of face-to-face contact appeared systematically to be less frequent than in the other pair (Fanny and mother SUSAN). Simultaneous sound production was more frequent for Claire and EVE in the first five recordings only. The frequency of vocalisation in unison during face-to-face contact appeared to be higher for Claire and EVE in the first five months, and lower than for Fanny and SUSAN after the first five months.
The impact of these results for the development of speech communication is discussed. After the fifth month Claire and EVE used the two channels more selectively than Fanny and SUSAN who preferred to use the two channels simultaneously. In a book-reading-situation, Claire and EVE no longer looked at each other but visually focused on a picture; this can immediately be given an audible label, which is an efficient way of communication.

In the fourth chapter *transmission of intentions* is discussed. It is related to the frequencies that a person can see, hear, and interpret movements of a partner. In the literature, intentionality of young infants still is a matter of discussion, in which consciousness and goal-directedness play a major role. In mother-infant interaction an inequality seems to be present, but the mutual readiness to interpret and react to the partner's movements functions as if intentions are transmitted.
During face-to-face contact mother and infant can perceive each other's movements. In my approach, *visual intentions* of a person are assumed when mimical and head movements are seen by his partner during face-to-face contact. As *audible intentions* are assumed those sound productions that occur during face-to-face contact, and as *intense intentions* those combined visual and audible intentions.
The two mother-infant pairs were compared with regard to the three kinds of transmitted intentions. Intra-pair comparisons were made because the mother is expected to transmit more audible intentions to the infant than the infant to the mother, probably thereby instructing the infant about the mother tongue. Inter-pair comparisons of the mothers and the infants were also made of the percentage of time and of the frequencies because intersubjective tuning was different. Equally, the infants were compared, to check if they offered comparable amounts of intentions to their mothers' interpretation.
During face-to-face contact the transmission of *visual intentions* appeared not to be different for the mother and the infant of one pair. However, when comparing the children, Claire appeared to transmit more visual intentions to her mother than Fanny did. During face-to-face contact EVE transmitted more visual intentions to Claire than SUSAN to Fanny, but this difference was not yet significant in the first five months.
Mothers transmitted, as expected, significantly more *audible intentions* to their children than vice versa. Already in the first five months this difference was present, although more clearly for Claire and EVE than for

Fanny and SUSAN. The children did not differ, while the mothers differed only with regard to the percentage of time and not for the frequency. This means that EVE's sentences had a longer duration than SUSAN's during face-to-face contact.
The transmission of *intense intentions* was not different for both pairs: the mothers and infants were roughly similar. Within the pairs EVE, however, differed from Claire, because she systematically used the intense intentions during mutual gaze.
The impact of these differences on the development of speech communication is interpreted in the realm of speech instruction, in which the visual information about sound production (the audible intentions) are expected to become redundant.

Turntaking in its simplest form is treated in this thesis in the fifth chapter. It is a well-known aspect in communication systems, and can be regarded as a kind of feedback mechanism. Turntaking implies intentionality and intersubjectivity. In the literature cyclic behaviour is described from an early age onwards, like in gazes at the face of the mother and away from it. After about the fourth month alternated sound production becomes more prominent in mother-infant interaction.
Turntaking by the mother is described upon landmark sound productions (laryngeals, simple articulations, babbling sounds, and words) of the infants. The landmark sounds represent, on the one hand, the ongoing speech motor development of the infants and new sound productions, and, on the other hand, these sounds increasingly resemble adult speech sounds. The mothers are supposed to take audible turns upon these sounds within a certain inter-speaker switch-pause. The mother's turntaking was analysed only with regard to the *onsets* of her utterances because the mothers differed in the amount of sound productions. Per group of landmark sounds the percentages of infant sounds *with* a mother-turn were compared for the two pairs.
Both infants produced sounds in the four groups of sound productions studied. Two of these groups (laryngeals and simple articulations) had their onset in the first two recordings of the infants. EVE took her turns abundantly upon the sounds of Claire. SUSAN took some turns upon Fanny's early landmark sounds, but did so more consistently when the babbling sounds occurred. Fanny was then 32 weeks old. Feedback on sound production started much later for Fanny than for Claire. Fanny produced many more babbling sounds than Claire, possibly because she finally got audible reactions of her mother. One of the conclusions is that *feedback* on later appearing sound productions cannot compensate for the lack of it during the first five months.
The impact for speech development is clear: parents should play the conversational game with their very young infant and should enjoy even the simple sound productions. They will recognise words in the sound stream, and probably sooner than they expected.

The final chapter integrates the previous chapters, and discusses the chosen approach in relation to the results. A surprising result is the crucial impact of interaction patterns, especially during the first five months, upon the outcome of the speech developmental processes at the age of two. The sensori-motor approach has enabled us to formulate suggestions about how the fundamental characteristics of speech communication systems are gradually mastered by the mother and the infant.

Further research is suggested in line with the possibilities of the sensori-motor approach. When speech developmental problems can be predicted already early in mother-infant interaction, such problems can probably be prevented to a large extent as well.

An outline is given for a method to evaluate mother-infant interaction in a laboratory setting. Depending upon the further elaboration of the present ethological approach, and practical and economical consequences, mother and infant pairs that are at-risk for communicative problems, may request for early guidance.

SAMENVATTING

Moeder en kind worden in dit proefschrift opgevat als een senso-motorisch *systeem*, waarin spraakcommunicatie zich kan gaan ontwikkelen. In dat ontwikkelingsproces spelen bewegingen en het waarnemen van die bewegingen door de partner een rol. Menselijke communicatiesystemen hebben drie fundamentele kenmerken: *intersubjectiviteit*, *intentionaliteit* en *beurtnemen*. Deze kenmerken zijn al direct na de geboorte aanwezig, zij het niet in vormen die we van volwassen gesprekspartners kennen.
Moeder en kind passen zich gewoonlijk aan elkaars gedrag aan. Dit psychosociale gedrag vormt de basis voor de spraakontwikkeling van het kind, waarbij de volwassene een essentiële rol speelt. Problemen in de spraakcommunicatie worden wel geweten aan de vroege interactie van moeder en kind wanneer er geen lichamelijke of mentale oorzaken (zoals slechthorendheid, of het Syndroom van Down) voor de problemen aanwezig zijn. Deze interactionele communicatieproblemen worden vaak pas na de tweede verjaardag van het kind gesignaleerd.
Van twee normale moeder-kind paren zijn gedurende de eerste twee jaren interacties op videoband vastgelegd. De kinderen verschilden op tweejarige leeftijd aanzienlijk in hun spraakontwikkeling: het ene kind is een vlotte spreekster geworden, terwijl het andere meisje een achterstand had in de spraakontwikkeling. In dit proefschrift wordt nagegaan of inderdaad verklaringen voor het ontstaan van communicatieproblemen kunnen worden gevonden in de allervroegste moeder-kind interactie.

In het eerste hoofdstuk wordt ingegaan op moeder-kind interactie, die, door de vele verschillen tussen de betrokkenen, *uniek* is voor ieder paar. Toch is het bijna vanzelfsprekend dat moeder-kind paren de moedertaal gaan gebruiken. Vermoedelijk liggen er *gemeenschappelijke processen* ten grondslag aan deze overeenkomstige ontwikkelingen. Psycholinguïstische en psychobiologische literatuur met een sociale, medische, en ethologische invalshoek is bestudeerd in relatie tot publikaties over vroege spraakproduktie van mensenkinderen, alsmede de evolutie van mensapen en hun communicatie. We concluderen, dat in het moeder-kind systeem het *op elkaar inspelen* (coping) van groter belang is dan het afzonderlijke gedrag van de moeder of het kind.
In voorafgaand onderzoek (Koopmans-van Beinum & Van der Stelt, 1979, 1986) zijn *mijlpalen* in de spraakontwikkeling van baby's beschreven, welke op een toenemende coördinatie van ademhaling, stemgeving en articulatiebewegingen zijn gebaseerd. Deze mijlpalen vormen ook de basis van spraak bij volwassenen.
In het kader van een breed opgezet onderzoek naar de spraakontwikkeling en -interactie van kinderen met een lip-, kaak-, en/of gehemeltespleet (schisis), dat van 1984 tot 1990 gefinancierd werd door het Nederlands Praeventiefonds, zijn ook interacties van normale moeder-kind paren bestudeerd. Literatuurgegevens en voorafgaand onderzoek komen in onze benadering van de ontwikkeling van spraakcommunicatie samen. Er zijn

werkhypotheses geformuleerd, welke nader in dit proefschrift worden uitgewerkt.
De interactie is per paar in de thuissituatie bestudeerd. De beschrijving van de interactie heeft zich geheel geconcentreerd op *observeerbare bewegingen* van zowel moeder als kind. Daarmee wordt de benadering onafhankelijk van taalinvloed en van interpretaties van de observator. De drie kenmerken van menselijke communicatiesystemen worden in afzonderlijke hoofdstukken behandeld, hoewel ze duidelijk onderling met elkaar verband houden. Het overbrengen van *intenties* vooronderstelt *intersubjectiviteit*, terwijl *beurtnemen* volgt op intentioneel gedrag van de partner. In het laatste hoofdstuk worden de drie kenmerken dan ook geïntegreerd.

In het tweede hoofdstuk worden de *twee moeder-dochter* paren voorgesteld (moeder EVE met Claire, moeder SUSAN met Fanny) met betrekking tot hun medische voorgeschiedenis, psychosociale kenmerken (zoals het temperament van de kinderen en hun mentale ontwikkelingsscores op de Bayley test), en enkele linguïstische maten. De verschillen tussen de kinderen kunnen teruggevoerd worden tot de verschillende interactiepatronen, die al vanaf de geboorte aanwezig waren.
In het bovengenoemde schisisonderzoek zijn gedurende twee jaar iedere maand *video-opnamen* gemaakt van de twee paren. De daarbij gebruikte apparatuur, de frequentie en de duur van de opnames worden ook in dit hoofdstuk besproken.
De moeder-kind interactie is beschreven met behulp van een micro-analytisch *transcriptiesysteem* met ten minste 200 codes voor bewegingen. Per opname zijn vijf minuten moeder-kind interactie getranscribeerd. Dit resulteert voor de twee personen in een bewegings-'notenbalk' met 16 kanalen. Per kanaal wordt een groep bewegingen weergegeven, zoals die van de handen. Deze tijdrovende transcriptie werd gestuurd en ondersteund door een computerprogramma. De auteur is de enige transcribent van de videobanden geweest. Ter controle is een tweede transcriptie uitgevoerd van steekproefsgewijze gekozen fragmenten. Deze bleek ruim voldoende (gemiddeld 84%) overeen te komen met de eerste transcriptie.
Niet alle bewegingen, die een persoon maakt, worden ook door de partner waargenomen. Als een baby naar de camera kijkt, zal hij zeker niet de glimlach zien op het gezicht van de moeder bij wie hij op schoot zit. De procedure om te beslissen welke bewegingen van de ene persoon overkomen bij de ander, is beschreven in een *senso-motorisch transmissie model* voor moeder-kind interactie.
Een bestaand computerprogramma (FP) is aangepast, zodat daarmee ook tijdsduren van bewegingen kunnen worden berekend. Het programma PROGRAAF maakt het mogelijk de micro-analytische data te bewerken. De verschillende kanalen van moeder en kind, of eventueel specifieke codes in een kanaal, kunnen geselecteerd worden uit de oorspronkelijke transcripties. Deze codes zijn, al of niet met behoud van hun tijdsduur, samen te voegen tot interactieve gedragspatronen, waarvan de complexiteit kan worden gekozen.

In het derde hoofdstuk wordt de *intersubjective afstemming* tussen moeder en kind beschreven. Dit fundamentele kenmerk is voor communicatie van belang: de twee personen moeten zich van elkaars aanwezigheid bewust zijn. In de literatuur over moeders en babies wordt de wederzijdse afstemming veelal beschreven in positieve termen, zoals moederliefde en -binding. De moeder kan echter ten opzichte van de baby, al voor de geboorte, ook negatief getinte gevoelens hebben.
De in dit proefschrift gekozen benadering van communicatie-ontwikkeling speelt zich op het niveau van bewegingen af, en de afstemming tussen moeder en kind moet dan ook als zodanig geformuleerd worden.
Drie vormen van afstemming via de visuele en vocaal-auditieve kanalen zijn gekozen, om na te gaan of de twee paren verschillen. Per opname en per paar zijn percentages van de tijd en frequenties vergeleken voor het (1) elkaar aankijken, (2) gelijktijdig geluiden maken, en (3) gelijktijdig geluiden maken terwijl ze elkaar ook aankijken.
De twee paren blijken te verschillen in hun afstemming via deze kanalen. Dat verschil is er soms al in de eerste vijf maanden, soms pas als de opnames over de twee jaar worden vergeleken. Claire en EVE kijken systematisch minder naar elkaars gezicht dan Fanny en SUSAN. Het gelijktijdig geluid maken komt bij Claire en EVE in de eerste vijf maanden systematisch meer voor dan bij Fanny en SUSAN, maar niet daarna. Het elkaar aankijken en gelijktijdig geluid maken is in die periode ook frequenter bij Claire en EVE dan bij Fanny en SUSAN, terwijl het na de vijfde maand omslaat naar systematisch minder.
Dit verschil in afstemming via de 'afstandskanalen' kan invloed hebben op de ontwikkeling van spraakcommunicatie. Na de vijfde maand worden de afstandskanalen door Claire en EVE selectiever gebruikt dan door Fanny en SUSAN. Als er bijvoorbeeld een plaatjesboek wordt bekeken, *kijken* Claire en EVE naar de plaatjes en *horen* van elkaar welke namen er aan gegeven worden, terwijl Fanny en SUSAN waarschijnlijk naar elkaar kijken *om te zien wat er gezegd wordt.* Dit is een weinig efficiënte manier van communiceren. Door een verandering in blikrichting wordt meestal ook een onderwerpverandering aangegeven, en de partner volgt die blikrichting. Zodra het kind naar de moeder kijkt, wekt het de indruk geen aandacht meer voor het boek te hebben, waardoor de moeder niet zal doorgaan met het benoemen van plaatjes. De betrokkenheid tussen Claire en EVE heeft zich in de eerste vijf maanden zodanig ontwikkeld, dat het niet langer nodig is naar elkaars gezicht te kijken om te zien wat er gezegd wordt.

Het vierde hoofdstuk gaat over *intentionaliteit.* Aan bewegingen van een partner wordt in het algemeen een betekenis toegeschreven. Over intentionaliteit van baby's wordt in de literatuur veel gediscussieerd: bewustzijn en doelgericht gedrag worden met intenties in verband gebracht. Moeder en kind lijken daarin aanvankelijk dan ook te verschillen. Beiden reageren echter op bewegingen van elkaar, en geven er ook betekenis aan. In zoverre is hun gedrag functioneel en worden er, min of meer onbewust, boodschappen overgebracht.

In dit proefschrift worden drie typen intenties onderscheiden. Wanneer moeder en kind elkaar aankijken kunnen ze bepaalde bewegingen van elkaar waarnemen. *Visuele intenties* worden overgestuurd, indien mimiek en hoofdbewegingen van de ene persoon door de andere persoon worden waargenomen. Zo komen *auditieve intenties* voor, wanneer er geluiden gemaakt worden tijdens het elkaar aankijken. Intenties met een overduidelijke boodschap (*intense intenties*) zijn die momenten, waarop visuele en auditieve intenties gelijktijdig voorkomen.
De moeder-kind paren worden vergeleken met betrekking tot deze drie typen intenties. Moeder en kind worden onderling vergeleken, omdat verwacht mag worden dat de moeder meer auditieve intenties verzendt naar het kind dan het kind naar haar. Op die manier instrueert zij het kind over de moedertaal. Van de twee paren worden de moeders en de baby's ook onderling vergeleken met betrekking tot de percentages van de tijd en de aantallen keren dat de verschillende intenties per opname voorkomen.
Moeder en kind van een paar verschillen onderling niet systematisch met betrekking tot de transmissie van visuele intenties. Vergelijken we de kinderen onderling, dan blijkt Claire meer visuele intenties naar EVE te verzenden dan Fanny naar SUSAN. Tijdens het elkaar aankijken verzendt EVE ook meer visuele intenties naar Claire dan SUSAN naar Fanny, maar dit verschil is in de eerste vijf maanden nog niet significant.
Zoals te verwachten was, versturen moeders systematisch meer auditieve intenties naar de kinderen dan omgekeerd. Dit gedragspatroon, bij Claire en EVE duidelijker dan bij Fanny en SUSAN, is al aanwezig in de eerste vijf maanden. De kinderen verschillen onderling niet, terwijl de moeders verschillen met betrekking tot de tijdsduur, maar niet tot het aantal auditieve intenties. Dit betekent dat in situaties waarin moeder en kind elkaar aankijken EVE's uitingen langer zijn dan die van SUSAN.
De transmissie van de intense intenties is niet verschillend voor de paren: de moeders en de kinderen zijn onderling vergelijkbaar. Als moeder en kind van een paar worden vergeleken, blijkt EVE in haar gebruik van intense intenties systematisch van Claire te verschillen, maar SUSAN niet van Fanny.
De verschillen tussen de paren en de invloed van deze verschillen op de spraakontwikkeling worden besproken. Visuele informatie van de mondbewegingen, welke gelijktijdig gegeven wordt met auditieve informatie over de produktie van geluiden, zou in de loop van de spraakontwikkeling overtollig moeten worden.

Het *beurtgedrag* in de meest simpele vorm wordt onderzocht in het vijfde hoofdstuk. Beurten zijn een bekend aspect van communicatiesystemen, en ze kunnen opgevat worden als een terugkoppelingsmechanisme. Beurtwisselingen vooronderstellen intentionaliteit en intersubjectiviteit tussen de twee personen. In de literatuur wordt dergelijk cyclisch gedrag, zoals aan- en wegkijken van moeders' gezicht, al vanaf heel jong bij baby's beschreven. Vanaf ongeveer de vierde maand treedt alternerend geluidgeven meer op de voorgrond in moeder-kind interactie.

In dit hoofdstuk wordt nagegaan of de moeder met een uiting ingaat op geluiden van de baby die een mijlpaal vormen in de vroege spraakontwikkeling (laryngealen, enkelvoudige articulatiebewegingen, brabbelgeluiden, en woorden). Deze mijlpaalgeluiden geven enerzijds de toenemende coördinatie in de spreekmotoriek weer, en anderzijds gaan ze meer en meer op de volwassen spraakgeluiden lijken. Van de moeders verwachten we, dat ze binnen een korte pauze na de uiting van het kind een vocale beurt nemen. Omdat de twee moeders verschillen met betrekking tot het aantal uitingen per opname, hebben we alleen onderzocht of het *begin* van de moederuiting in desbetreffende pauze valt. Per groep mijlpaalgeluiden zijn de percentages geluiden *met een beurt van de moeder* ten opzichte van het totale aantal geluiden in die groepen voor de twee paren vergeleken.
Beide kinderen hebben mijlpaalgeluiden in de vier groepen geproduceerd. Twee van de vier groepen (laryngealen en de enkelvoudige articulaties) komen voor het eerst voor in de eerste twee opnamen. EVE gaat met vocale beurten volop in op de geluiden van Claire. SUSAN gaat wel eens in op de vroege mijlpaalgeluiden van Fanny, maar systematisch doet ze dat pas na de 32e week, als Fanny brabbelgeluiden gaat maken. Fanny heeft dus later dan Claire feedback gekregen op 'geluiden maken'. Vergeleken met Claire heeft Fanny veel meer brabbelgeluiden gemaakt, misschien omdat haar moeder daarop reageerde. Een van de conclusies is, dat het na de vijfde maand ingaan op geluiden van een baby het vroeger nalaten daarvan niet kan herstellen.
Voor de spraakontwikkeling liggen de consequenties eenvoudig: geluid maken, ook met de allervroegste geluiden van een baby, zou een conversatiespel moeten worden. In die stroom van geluiden kunnen dan, waarschijnlijk eerder dan verwacht, door de ouders woorden herkend worden, waarmee 'volwassen' spraakcommunicatie binnen handbereik ligt.

Het laatste hoofdstuk integreert de drie voorafgaande hoofdstukken, en bespreekt de gekozen aanpak in relatie tot de resultaten. Het belang van de eerste vijf maanden voor het niveau van de spraakontwikkeling rond twee jaar is verrassend. De senso-motorische benadering van het moeder-kind systeem maakt duidelijk dat de onzichtbare en toch fundamentele aspecten van communicatiesystemen de basis voor de ontwikkeling vormen. Hoe moeder-kind paren dergelijke aspecten verwerven zal nog veel nader onderzoek vergen. De beperkingen van de benadering en de noodzaak van toekomstig onderzoek in die richting worden aangegeven. Tenslotte wordt een evaluatiemethode en een interventiemogelijkheid geschetst, waarmee in individuele moeder-kind paren met een verhoogd risico communicatieproblemen voorkomen zouden kunnen worden.

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APPENDIX I

Recording dates and age of the infants

The ages are given in weeks+days for the infants Claire and Fanny. Their interactions with their mothers (EVE and SUSAN respectively) were video-recorded every four weeks. Illnesses and holidays, among other factors, interfered with the 4-week schedule.

Ages in months are given with 3-months-intervals: 13 weeks are *3 months*. The + and - signs indicate that the children are either somewhat older or younger than indicated by the month.

rec.	Claire-EVE week.days	months	rec.	Fanny-SUSAN week.days	months
1	4.3		1	4.2	
2	8.3		2	8.2	
3	12.3	-3	3	12.2	-3
4	16.3		4	16.2	
5	18.3		5	20.2	
6	24.3	-6	6	24.3	-6
7	28.4		7	28.2	
8	32.3		8	32.2	
9	37.0		9	36.2	
10	39.0	9	10	39.6	+9
11	42.5		11	43.6	
12	49.0		12	48.2	
13	51.0	-12	13	51.2	-12
14	57.1		14	56.2	
15	61.0		15	60.2	
16	69.0	+15	16	68.2	+15
17	72.4		17	71.2	
18	77.4	-18	18	77.2	-18
19	81.0		19	82.2	
20	84.3		20	85.2	
21	87.0		21	89.2	
22	91.0	21	22	91.6	+21
23	94.0		23	96.2	
24	103.0	-24	24	101.5	-24

APPENDIX II *Transcription system for video-recorded mother-infant interaction*

The system used in this thesis describes micro-analytically the *vocal and non-vocal* movements that occur in naturalistic mother-infant interaction during the first two years of life. Movements are transcribed separately for mother and infant in sixteen simultaneously present channels by means of approximately 200 codes. The codes in the sections I, II, and III do not all occur in one recording. Per channel the codes are mutually exclusive.
The codes are chosen with the developmental processes of the infant *and* the mother in mind. As the development of the mother-infant system proceeds, some codes may disappear while others emerge or return. If the interaction was random, an enormous number of combinations could occur. During the transcription of the tapes, we found that this is clearly not the case. However, a computer assisted transcription has been indispensable.
Below, a brief overview (based on Van der Stelt & Jansonius-Schultheiss, 1990, in Dutch) is given of the codes for *onsets and offsets of movements* in the fourteen non-vocal channels, chosen to describe movements of different body parts (section I).
Sound production is described in two separate channels for mother (section II) and infant (section III).

In the so-called *continuous channels* (gaze direction, mimics, and proximity) a code marks the offset of the previous code as well as the onset of a new situation in the interactional flow. A neutral facial expression may change into a smiling face and back to neutral again. The three situations are separated by three codes.
In *discontinuous channels* (sound production, touch, head-, body-, hand/arm-, and leg-movements) X or XX is the general code for onsets of movements. The offset of a movement is coded exclusively for that specific movement
The codes Q and U are used for 'questionable movements' (rest category) and 'not codable' (not observable) except in the proximity channel with only three codes.
Additional *comments about situational aspects*, or the quality of the movement for example, can be given in a extra text column.
In this description of the transcription system an example of mother-infant interaction is given per channel, as well as the coding for that specific example.

Section I *Non-vocal movements*

Proximity changes (MP), channel 14.

1 = body-body contact between mother and child
2 = child within reach of mother's arms
3 = child outside reach of mother's arms

Example: When reading a book, the child leans backwards against the mothers trunk (1), then the child leans forward to point at a picture (2). Then the child crawls away to a toy (3). This sequence of distance changes is coded as 1-2-3-.

Gaze direction (MV and IV), channels 1 and 2.

F = looking at the face of the partner
B = looking at the body or hand, e.g.
O = looking at an object
A = looking around, not fixing the eyes
P = looking at another person in the room
C = eyes are closed

Example: When playing with objects the gaze direction may shift from one object to another: O is coded, followed by A during the shift, and when fixing the second object another O is coded: O-A-O.

Mimical movements (MM and IM), channels 3 and 4.

S = smile or laughing face
E = eyebrows raised, questioning face
C = crying face, from severe to slightly
F = frowning, between the eyebrows
N = neutral face, mouth opened or closed
M = (exaggerated) mouth and tongue movements

Example: Smiling starts after neutral facial expression, followed by exaggerated mouth movements, then neutral facial expression is present again: N-S-M-N

Head movements (MH and IH), channels 7 and 8.

V = movement in vertical axis, raising or lowering
H = movement in horizontal axis, right or left
R = rotating of head, combining V and H
A = approximation, smaller distance
W = withdrawal, wider distance
K = kissing or hugging
T = movements like tics, undoing of hair
M = mouth or tongue movements, licking lips
S = shaky head movements, lack of control
B = large head movements, lack of control.

Example: When the infant is looking at a book and the mother points at a picture, the infant may look at the hand first (H), and then look up at the face (V) to see what the mother is saying: X-H;X-V is coded. If the infant looks at mother's face right away X-R is coded.

Body movements (MB and IB), channels 11 and 12.

H = hugging, carrying, rocking the partner
F = feeding, offering breast
L = leaning over towards the partner, closing in
A = avoiding contact, withdraw, leaning backwards.
S = slightly swaying body movement, wobbling
P = position change (one's own position, sitting manner)
T = turning the upper part of the body to one side
C = crawling on hands and knees/feet, body moving
W = walking away

Example: In the give-and-take situation the mother may lean over to the child when offering an object (X-L). Once the child is quietly manipulating the object, she may lean backwards (X-A) which may indicate that all goes well: no interference needed.
Coded as X-L;X-A in MB.

Being touched (MT and IT), channels 5 and 6.

H = head or face touched, but not the mouth
M = mouth is touched
B = both mouth and other part of body touched
L = legs/feet or arm/hands are touched
T = only trunk is touched
C = complex combinations of G, L, and R.

Example: Mothers may interfere when the infant puts a hand in his mouth by seizing the hand (L), moving it against the mouth (B), pulling the hand away from the baby's mouth (L), and then letting the hand go; the end of tactile stimulation which is coded as X-L;X-B;X-L.

Leg movements (IL), channel 13.

B = bends the legs, or one leg, e.g. when seated
S = stretches one or two legs
K = kicking leg movements, rhythmically, up/down
C = crawls on hands and knees/feet
L = lifts one and then the other foot, walks away

Example: The mother is sitting on the couch, holding both hands of the child, to give some balance. The child is trying to walk away, by lifting the legs (X-L;X-L;X-L, etc.), but the mother remains seated on the couch.

Hand/arm movements (MA and IA), channels 9 and 10.

G = giving, offering, presenting
A = accepting, taking, grasping, snatching
L = letting go an object, losing it

M = bi-manual manipulation of object, person
H = hammering, and other rhythmic movements
P = play-games including hand movements, rituals
W = waving, even by holding the partner's hand
I = indicating, pointing, reaching for.
D = defending, pushing away, protecting oneself
C = crawling on hands and knees/feet
T = touching, caressing, tickling, laying down one's hand
F = feeding, putting food in mouth
N = nursing, giving care, cleaning the face
S = stirring food or drink, functional movement.
E = self-directed movements, e.g. scratching
K = kind of (semi)circular hand/arm movement
O = object/hand in mouth, e.g. for thumb sucking
R = rubbing hand over own face, eyes, or ears

Example: In the give-and-take situation, the mother may offer the child an object (X-G in the mother's hand/arm channel).
When the child starts to move hand and arm, the onset of a movement is coded (X) in the infant's hand/arm channel.
If the child actually takes the object (the hand no longer moves, A), the mother usually lets the object go (X-L) which may overlap with the child's grasping.
In possession of the object, the child may put it in the other hand as well (X-M) for bi-manual manipulation. This manipulation may end with first one hand letting the object go off (X-L) and then the other hand (X-L).
This is coded for the child as: X-A;X-M;X-L;X-L.
For the mother: X-G;X-L.

Section II *The mother's sound production*

Codes used for *utterances in the mother-speech channel* of a sixteen channel system for microanalytic transcription of mother-infant interaction during the first two years of life.
In this discontinuous speech channel XX is the onset code for each utterance. Non-verbal movements are transcribed for mother and infant in separate channels (See section I).
Groups of codes are given the name of the aspect that mother seems to focus upon.

Infant sounds

01 = comment on loudness, intonation
02 = question focusing on sound aspects
03 = comment on feelings in sounds
04 = question about feelings in sounds
05 = comment on sounds as 'speech'
06 = question as if sound is 'speech'

Imitation of infant sounds is coded by replacing the 0 by another number.

Exact:	voice + articulation:	7
Reduced:	voice only:	5
	articulation:	6
Expanded:	voice only:	8
	articulation:	9

Example: The baby produces a sound like "a\hu//" (fall-rise). Mother responds by "Ohja?"; "Doe je dat." (Oh yes? Do you.). Coded as XX-84;XX-03.
Example: The baby has produced very loud sounds. Mother responds: "Ga je weer eens zo hard gillen?" (Are you going to scream like that again?). Coded as XX-02.

Infant movements
07 = comment on mimics or looking
08 = question about mimics or looking
09 = comment on infant behaviour
10 = question about infant behaviour

Example: The baby is frowning. Mother questions: "Ben je weer boos?" (Are you angry again?). Coded as XX-08.
Example: The baby has pulled herself to a standing position. "Ga je staan." (Are you standing up). Coded as: XX-09.

Mother herself
11 = comment on her own actions
12 = questions on her (future) actions
13 = comment on her own speech
14 = questions about her own speech
15 = comment on her own feelings
16 = questions related to her own feelings

Example: Mother has been imitating infant sounds and comments: "Oh wat praat je moeder weer gek" (Oh, your mother is talking funny again.), the baby 'responds' and mother again: "Moet ik weer zo gek doen?" (Do I have to talk funny again?).
Coded as XX-13;XX-14.

Situations
17 = comment on persons in the room
18 = questions concerning persons in the room
19 = comment on animals, objects or plants
20 = questions about animals, objects, etc.
21 = comment on past, present, future events
22 = questions about the events in code 21.

Example: The baby is playing while looking at the camera. Mother: "Denk je dat Jan dat leuk vindt?" "Heb je ze al verteld dat je by oma was?" "Ga je vanavond weer televisie kijken?"
(Do you think Jan likes that?), (Did you tell them you went to see granny?), (Are you going to watch the television again tonight?). Coded as XX-18;XX-18;XX-22.

Variety of sounds	**23**	= trying to direct infant attention
	24	= games and personal ritual utterances
	25	= laughing sounds, aloud or suppressed
	26	= vegetative and click sounds, left-over sounds
	27	= short, dialogue filling utterances
	28	= order or prohibition intonation
	29	= imitation of mouth movements infant

Example: The baby is sitting in an infant-seat not very happy, eyes closed. Mother touches the cheek, "Claire!" Mother tickles the trunk, "Er komt een muisje aangelopen." (A little mouse is coming), no reaction and mother laughs, then "Tttttt". Coded as XX-23;XX-24;XX-25;XX-26.

Adult's talk	**30**	= talking to adult in the room
	31	= not understandable for transcription

Example: "Er is nog meer koffie hoor." (There is some coffee left if you like).
Coded as XX-30.
Example: The mother is whispering in the infant's ear.
Coded as XX-31.

Explaining the above table.

In this section an overview is given of the *codes used for utterances of the mother* in play interaction with her child, and the successive decisions.
The first decision to be made in the coding is concerned with intonation, followed by a decision about imitative aspects in the utterances, and finally about their interactional function.

a. *Intonation and loudness*

The first selection criterion when coding an utterance is based on the *intonation of the utterance.* Generally spoken we assume that 'comment utterances' have a falling or level intonation, while 'question utterances' have a rising intonation at the end.
Note that not the grammatical construction of the utterance decides about the categories to be selected, since mothers often violate with their intonation the grammatical rules.
An example of a *comment*: "Je bent vrolijk vandaag, zeg!" ("Say, áre you happy today!").
An example of a *question*: "Het lijkt of je moe bent?" ("You seem to be tired?").
An initial loudness accent in a short utterance is coded separately as 'order' or 'prohibition' if the intonation points in that direction too.
An example of a *prohibition*: "NEEhEEh, niet doen!" ("NOOhOOh, don't!").

b. *Imitations*

A second category is formed by utterances of the mother that *imitate* (phonatory and/or articulatory aspects of) sounds of the child. Such imitations belong to the group of utterances that either ask for or comment on (repeated) infant sound productions (codes 01-06). The imitation can thus be 'exact' (starting with 7), 'reduced' (starting with 5 0r 6), or 'expanded' (starting with 8 or 9) with regard to intonation or articulation. (Snow, 1981). Codes for mother's speech are used in the infant speech channel, when the child imitates (parts of) the mother's sound productions
Visual imitations of infant sound production, only mouth movements without phonation by the mother , are coded separately.

c. *Interactional aspects*

Other *interactional aspects* in utterances of the mother are grouped with regard to the *non-vocal behaviours* of the child, the *mother's feelings*, the *context* of their actual interaction, a *rest group* including sounds to direct the infant's attention, and utterances directed towards other persons in the room, for example.
Distorted or very soft sounds are coded separately.
The speech channel codes consist of two numbers, and XX is the general onset-code.

Section III *The infant's sound production*

Codes used for *utterances in the infant-speech channel* of a sixteen channel system for microanalytic transcription of mother-infant interaction during the first two years of life.
In this discontinuous speech channel XX is the general onset code for each utterance. Non-verbal movements are transcribed for mother and infant in separate channels (See section I.).
The groups of codes are based on landmarks in speech motor development. The alphabetic representations are global approximations.

Laryngeals

41 = glottal stop, effort sounds, relatively short
42 = neutral sound, flat, relatively short
43 = series of glottal stops, intonated
44 = aspirated series of syllables, intonated

Articulations

45 = one velar articulatory movement during (interrupted) phonation, simple intonation
46 = one velar articulatory movement during (interrupted) phonation, complex intonation

47 = one frontal articulatory movement during (interrupted) phonation, simple intonation
48 = one frontal articulatory movement during (interrupted) phonation, complex intonation

Prosodic

49 = glissando (rise or fall), loudness variation
50 = roar, (very) loud sound, usually flat
51 = relatively long relaxed phonation, aspiration
62 = intonated 'sentences' (+ articulatory mov.)

Babbling

52 = repetitive frontal articulatory movements during (interrupted) phonation, simple intonation
53 = repetitive frontal articulatory movements during (interrupted) phonation, complex intonation
54 = repetitive backward articulatory movements during (interrupted) phonation, simple intonation
55 = repetitive backward articulatory movements during (interrupted) phonation, complex intonation
56 = combinations of frontal and backward articulatory movements during (interrupted) phonation, simple intonation
57 = combinations of frontal and backward articulatory movements during (interrupted) phonation, complex intonation

Words

58 = one-syllable sound production with a contextual meaning.
59 = two-syllable sound production with a contextual meaning.
60 = three-or-more-syllable sound production with a contextual meaning.

Variety of sounds

61 = laughing, other pleasure sounds, giggling.
63 = cry sound during expiration and inspiration with or without changes in intonation, with or without articulatory movements.
64 = fuss, cry sound interrupted during inspiration, often with glottal stops and changes in loudness.
65 = vegetative sounds, among them respiratory sounds, hiccup, sneezes, swallowing, etc.
66 = mouth movements without sound while looking at the mother, imitating visible speech.
67 = not codable sounds, distorted, not perceivable, no code available.

Explaining the above table.

In this section an overview is given of the *codes used for infant utterances*, that are segmented by means of the respiratory cycles: the duration of a sound is only sometimes taken into account when deciding about a code.
The *phonation aspects and the intonation pattern* are the first criteria, followed by the decision about the *number of articulatory movements*. The place of articulation is globally accounted for as well. The codes used are simplifications of sound description indicated by Van der Stelt & Koopmans-van Beinum (1981).
Speech motor development is roughly indicated by the rising code number from 41 to 60. Groups of codes can be formed based on the milestones in motor coordination. The rest of the codes are a variety of infant sounds.
Whenever the infant *imitates* (only a part of) the mother's utterance, the corresponding code for mother-utterance is used in the infant speech channel. For example, the mother says: "Zeg je nog een keer /mamamama/?" (Say it again /mamamama/?). The baby utters: "/ammamm/". The mother-code XX-02 (question focusing on sound aspects) then is used for the infant sound.

APPENDIX III

Fluctuations in movements per recording

Total *number of movements* (nm, as onsets and offsets) and *number of different codes* (nc) in the sixteen channels per transcription of five minutes mother-infant interaction. The numbers are given for the mother and infant separately.
The age of the child at the time of the recording is given in weeks and days. Indication with ! is a transcription of less than five minutes interaction.

	Claire		EVE			Fanny		SUSAN	
age	nm	nc	nm	nc	age	nm	nc	nm	nc
4.3	184	27	238	46	4.2	348	34	378	42
8.3	242	26	600	50	8.2	384	31	354	42
12.3!	126	17	108	34	12.2!	393	48	305	42
16.3	186	23	344	40	16.2	291	42	405	45
18.3	535	45	461	47	20.2	471	37	339	40
24.3	224	38	249	51	24.3	537	46	353	42
28.4	420	42	370	49	28.2	547	46	276	51
37.0	495	44	525	53	36.2	392	39	220	47
39.0	877	60	884	58	39.6	373	45	268	37
42.5	522	51	408	46	43.6	680	56	407	49
49.0	523	41	548	45	48.2	547	46	427	50
51.0	467	50	508	49	51.2	641	61	484	52
57.1	528	54	508	50	56.2	676	44	508	45
61.0	614	50	753	50	60.2	639	54	441	49
69.0	589	62	482	53	68.2	551	52	440	45
72.4	611	48	512	55	71.2	515	43	339	50
77.4	518	62	437	46	77.2	463	38	387	42
81.0	534	43	571	55	82.2	538	45	443	49
84.3	636	48	578	51	85.2	577	53	395	54
87.0	350	48	455	47	89.2	519	40	326	37
91.0	598	50	464	48	91.6	355	38	383	39
94.0	531	41	365	38	96.2	521	47	402	45
103.0	501	58	424	52	101.5	538	43	309	44
nmtot	11215		11124		nmtot	11776		8811	
nctot		1064		1154	nctot		1073		1089

Claire: 467 nm/rec (44 nc/rec)
EVE: 464 nm/rec (48 nc/rec)
Fanny: 491 nm/rec (45 nc/rec).
SUSAN: 367 nm/rec (45 nc/rec).

APPENDIX IVa

Intersubjective tuning

An overview of the percentages of Claire and EVE (CE) and Fanny and SUSAN (FS) for different aspects of visual intersubjective tuning per (monthly) recording over the two years (rec.).
The percentages are given for *face-to-face contact* (% ftf), the *child looking at the mother's face* (% c laf), the *mother looking at the child's face* (% m laf), and *framing* (% fram) by the mothers in the matched recordings.
Framing is calculated by subtracting the second column from the third column for the respective pairs.

	CE	FS	CE	FS	CE	FS	CE	FS
rec.	% ftf		% c laf		% m laf		% fram	
1	34.2	65.6	36.0	74.0	91.7	89.4	55.7	15.4
2	52.5	45.0	65.1	47.3	75.9	94.5	10.8	47.2
3	5.2	17.6	10.4	21.5	80.2	85.4	69.8	63.9
4	85.3	13.7	86.3	22.1	94.0	70.4	7.7	48.3
5	6.7	3.1	7.0	3.1	86.7	54.5	79.7	51.4
6	10.8	30.7	10.8	32.2	89.2	91.4	78.4	59.2
7	5.6	19.1	7.3	22.2	52.2	85.8	44.9	63.6
8	7.4	11.5	8.1	12.5	43.3	90.1	35.2	77.6
9	0.3	41.0	0.3	43.7	37.3	90.2	37.0	46.5
10	1.0	2.0	1.0	2.3	17.5	54.0	16.5	51.7
11	1.6	15.8	2.6	16.8	24.8	83.6	22.2	66.8
12	3.3	0.3	5.3	0.3	28.1	24.6	22.8	24.3
13	2.3	2.6	2.3	2.9	16.5	30.4	14.2	27.5
14	3.0	0.3	3.6	0.7	26.2	37.0	22.6	36.3
15	2.0	8.2	3.9	10.5	16.1	45.6	12.2	35.1
16	1.8	4.4	2.4	5.4	35.5	40.4	33.1	35.0
17	1.3	6.0	2.0	7.9	23.9	26.2	21.9	18.3
18	6.2	9.1	6.9	15.0	22.0	53.4	15.1	38.4
19	4.3	13.4	8.3	17.7	17.5	43.0	9.2	25.3
20	12.3	12.9	16.9	17.5	37.1	31.1	20.2	13.6
21	4.0	4.6	7.6	6.9	16.8	17.2	9.2	10.3
22	3.9	0.3	7.4	1.3	9.7	27.3	2.3	26.0
23	2.3	1.0	6.5	2.9	22.8	5.5	16.3	2.6
24	0.0	15.0	0.3	16.6	5.6	43.6	5.3	27.0
Mean	10.7	14.3	12.8	16.8	40.4	54.8	27.6	38.0

APPENDIX IVb

Intersubjective tuning

An overview of the frequencies of Claire and EVE (CE) and Fanny and SUSAN (FS) for different aspects of visual intersubjective tuning per (monthly) recording over the two years (rec.).
The frequencies are given of *face-to-face contacts* (n ftf), the *child looking at the mother's face* (n c laf), and the *mother looking at the child's face* (n m laf) for the matched recordings.

	CE	FS	CE	FS	CE	FS
rec.	n ftf		n c laf		n m laf	
1	10	25	5	10	18	25
2	43	17	15	9	58	19
3	4	23	6	21	4	33
4	14	32	18	30	6	77
5	16	9	17	9	30	31
6	13	45	13	44	18	23
7	17	20	19	20	39	43
8	12	21	12	21	65	23
9	1	28	1	21	50	27
10	2	6	3	6	15	29
11	4	31	5	32	25	52
12	11	1	14	2	50	53
13	5	9	5	9	22	47
14	9	3	12	3	60	86
15	9	18	10	12	51	60
16	3	13	5	12	44	61
17	5	17	5	20	28	39
18	16	20	16	20	29	42
19	16	29	27	29	48	62
20	29	30	39	32	53	40
21	7	12	5	12	14	35
22	8	2	14	3	21	82
23	9	8	19	10	33	24
24	0	26	2	28	15	41
Total	272	471	308	453	811	1095
Mean	11	19	12	17	33	44

APPENDIX IVc

Intersubjective tuning

An overview of the percentages of Claire and EVE (CE) and Fanny and SUSAN (FS) for different aspects of vocal-aural intersubjective tuning per (monthly) recording over the two years (rec.).
The actual percentages are given for vocalisation in unison (% viu), the *child's sound production* (% c sp), and the *mother's sound production* (% m sp) for the matched recordings.

	CE	FS	CE	FS	CE	FS
rec.	% viu		% c sp		% m sp	
1	23.7	1.6	48.2	13.2	51.4	12.9
2	20.0	3.9	58.3	13.2	69.2	32.2
3	22.9	8.3	33.3	39.0	63.5	26.3
4	5.7	2.2	14.0	8.8	58.5	20.8
5	18.3	2.2	32.7	12.8	55.3	15.0
6	9.1	2.9	54.0	20.4	55.1	21.2
7	2.0	8.9	10.0	44.9	25.6	17.8
8	2.7	6.2	21.1	55.3	25.8	14.5
9	3.0	2.1	13.7	28.1	31.0	8.6
10	5.6	0.3	17.2	10.6	39.7	7.0
11	2.0	4.6	12.7	26.3	27.1	23.4
12	1.7	1.7	9.9	10.0	30.4	20.6
13	2.9	3.9	15.2	21.9	28.5	27.5
14	2.6	3.0	13.2	21.8	26.5	16.8
15	6.2	4.9	14.5	46.6	57.9	17.0
16	3.9	0.9	31.0	11.7	22.9	18.3
17	3.6	1.0	10.8	7.6	40.8	18.2
18	1.6	1.3	11.8	7.2	35.7	21.2
19	2.0	4.6	10.9	20.7	37.9	31.5
20	1.3	5.5	10.3	21.7	32.1	23.6
21	2.0	0.7	14.2	7.9	45.2	8.9
22	2.6	3.3	17.8	26.0	35.0	19.7
23	1.3	2.0	17.9	16.6	36.2	21.2
24	2.5	3.6	15.1	28.0	41.4	25.7
Mean	6.2	3.3	21.2	21.7	40.5	19.6

APPENDIX IVd

Intersubjective tuning

An overview of the frequencies for Claire and EVE (CE) and Fanny and SUSAN (FS) for different aspects of vocal-aural intersubjective tuning per (monthly) recording over the two years (rec.).
The frequencies are given for *vocalisations in unison* (n viu), the *child's sound productions* (n c sp), and the *mother's sound productions* (n m sp) for the matched recordings.

	CE	FS	CE	FS	CE	FS
rec.	n viu		n c sp		n m sp	
1	67	13	65	60	104	43
2	59	20	95	49	157	103
3	21	26	18	66	47	57
4	17	4	21	19	130	47
5	64	7	98	32	130	54
6	26	14	30	56	75	81
7	12	20	43	102	62	31
8	12	25	37	137	60	50
9	12	10	34	65	70	32
10	32	1	54	35	106	28
11	11	33	48	76	71	85
12	12	13	37	47	85	79
13	20	22	57	73	87	99
14	20	31	51	84	78	59
15	40	34	54	137	134	55
16	24	12	73	46	74	68
17	23	5	41	29	105	59
18	17	11	36	27	90	79
19	13	37	31	63	98	103
20	10	30	37	67	104	71
21	17	6	47	32	108	30
22	20	24	53	68	95	62
23	15	15	47	65	94	72
24	16	38	46	96	100	85
Total	596	489	1199	1627	2364	1617
Mean	24	19	48	64	94	64

APPENDIX IVe

Intersubjective tuning

An overview of the percentages and frequencies for Claire and EVE (CE) and Fanny and SUSAN (FS) for simultaneous visual and vocal-aural intersubjective tuning per (monthly) recording over the two years (rec.). The actual percentages and frequencies are given for *vocalisation in unison during face-to-face contact* (% viu/ftf, and n viu/ftf) for the matched recordings.

rec.	CE	FS	CE	FS
	% viu/ftf		n viu/ftf	
1	5.4	1.0	14	7
2	10.5	2.9	41	15
3	2.1	1.5	3	7
4	5.0	0.0	15	15
5	1.0	0.6	8	3
6	1.0	0.9	5	7
7	0.7	4.9	3	12
8	0.3	1.3	1	7
9	0.0	1.2	1	6
10	0.3	0.0	1	1
11	0.0	1.6	0	14
12	0.0	0.0	0	0
13	0.0	0.0	0	0
14	0.0	0.0	0	0
15	0.0	0.3	0	3
16	0.3	0.3	1	3
17	0.0	0.7	0	3
18	0.0	0.0	0	1
19	0.3	0.7	2	6
20	0.0	1.0	0	8
21	0.0	0.3	0	1
22	0.3	0.0	2	1
23	0.0	0.0	1	1
24	0.0	0.7	0	15
Total			99	162
Mean	1.1	0.8	4	6

APPENDIX Va

Transmission of intentions

An overview of the percentages of face-to-face time and the frequencies of *visual intentions* of Claire and EVE and Fanny and SUSAN per (monthly) recording over the two years (rec.).
The *percentages* are given (% vi), and the *frequencies* (n vi) per person and per recording.

	Claire		EVE		Fanny		SUSAN	
rec.	% vi	n vi	% vi	n vi	% vi	n vi	% vi	n vi
1	47.2	9	78.0	12	6.4	15	4.4	12
2	12.3	13	34.1	55	8.2	11	14.8	29
3	36.1	2	0.0	0	16.7	8	9.8	6
4	6.4	21	46.3	78	0.3	1	6.7	3
5	11.4	5	42.2	11	0.0	0	3.7	1
6	5.7	4	13.8	4	6.8	23	11.4	15
7	2.6	3	30.4	9	12.2	11	6.9	6
8	1.4	1	41.1	7	16.4	11	14.2	9
9	99.8	1	35.3	2	43	12	10.0	16
10	14.0	1	1.0	1	0.0	0	17.5	2
11	54.6	4	26.6	1	12.2	15	12.2	7
12	7.2	4	9.4	3	91.1	1	55.2	1
13	0.0	0	14.3	2	1.5	1	2.8	2
14	9.0	4	0.0	0	0.0	0	0.0	0
15	0.0	0	54.0	6	8.1	4	13.2	6
16	11.3	3	7.1	1	13.7	5	7.1	5
17	32.3	3	13.0	1	0.0	0	4.4	2
18	14.2	7	9.9	4	0.0	0	1.1	1
19	3.3	1	12.4	5	11.5	16	7.2	5
20	19.1	20	20.9	15	6.4	11	14.2	13
21	0.0	0	8.4	2	3.2	1	3.2	1
22	22.3	6	25.4	5	0.0	0	0.0	0
23	37.3	7	0.0	0	0.0	0	13.3	1
24	0.0	1	0.0	0	2.3	5	1.3	1
Total		128		229		157		146
Mean	18.7	5	22.9	10	9.2	6	9.8	6

APPENDIX Vb

Transmission of intentions

An overview of the percentages of face-to-face time and the frequencies of *audible intentions* of Claire and EVE and Fanny and SUSAN per (monthly) recording over the two years (rec.).
The *percentages* are given (% ai), and the *frequencies* (n ai) per person and per recording.

	Claire		EVE		Fanny		SUSAN	
rec.	% ai	n ai	% ai	n ai	% ai	n ai	% ai	n ai
1	22.1	13	51.1	39	9.4	24	9.4	26
2	25.3	39	68.5	70	16.2	18	37.5	54
3	32.6	2	62.3	5	42.5	16	25.5	17
4	13.4	12	61.7	67	3.7	2	17.4	12
5	35.6	12	55.6	14	28.2	4	53.3	7
6	15.7	6	46.3	14	13.4	19	23.7	28
7	16.1	5	53.2	13	34.5	16	43.1	16
8	16.3	2	50.5	11	55.1	21	17.6	9
9	23.2	2	82.5	1	30.3	23	13.4	23
10	16.5	1	44.8	3	7.2	1	32.9	3
11	0.0	0	27.1	2	40.5	26	40.5	27
12	2.2	1	28.4	7	0.0	0	100.0	1
13	0.0	0	41.3	3	63.7	7	7.5	2
14	15.4	4	16.2	3	0.0	0	0.0	0
15	13.3	2	44.3	5	38.6	11	29.2	8
16	43.7	2	42.1	4	7.2	3	46.8	9
17	0.0	0	21.4	3	34.8	10	31.9	9
18	0.0	1	60.7	13	10.1	5	36.3	16
19	32.1	7	54.2	9	21.1	13	51.2	26
20	7.3	7	38.9	22	23.3	12	37.3	19
21	10.0	3	51.4	8	3.1	3	37.1	5
22	12.2	4	49.5	6	39.7	1	77.8	2
23	23.7	4	54.1	4	10.2	2	18.5	2
24	0.0	0	0.0	0	35.6	34	43.1	26
Total		129		330		311		373
Mean	15.7	5	46.1	14	23.7	11	34.6	14

APPENDIX Vc

Transmission of intentions

An overview of the percentages of face-to-face time and the frequencies of *intense intentions* of Claire and EVE and Fanny and SUSAN per (monthly) recording over the two years (rec.).
The *percentages* are given (% ii), and the *frequencies* (n ii) per person and per recording.

	Claire		EVE		Fanny		SUSAN	
rec.	% ii	n ii	% ii	n ii	% ii	n ii	% ii	n ii
1	6.5	11	15.2	34	1.3	8	1.7	6
2	3.3	10	13.0	53	1.9	7	5.0	28
3	1.1	2	0.0	0	2.4	7	1.0	3
4	0.7	3	30.5	75	0.0	1	0.0	1
5	0.3	4	1.7	9	0.0	0	0.0	1
6	0.0	0	0.7	4	0.6	8	2.8	14
7	0.0	2	1.3	8	0.9	7	0.9	5
8	0.0	0	2.3	8	0.9	6	0.9	5
9	0.0	2	0.0	2	0.6	6	0.9	8
10	0.0	0	0.0	0	0.0	0	0.2	2
11	0.0	0	0.0	0	0.6	7	1.3	6
12	0.0	1	0.0	2	0.0	0	0.0	1
13	0.0	0	0.3	1	0.0	1	0.0	1
14	0.0	1	0.0	0	0.0	0	0.0	0
15	0.0	0	1.0	5	0.6	4	0.3	3
16	0.0	1	0.0	1	0.0	1	0.3	3
17	0.0	0	0.0	0	0.0	0	0.0	2
18	0.0	0	0.3	4	0.0	0	0.0	0
19	0.0	0	0.3	2	0.6	6	0.9	5
20	0.3	3	1.0	7	0.0	2	1.2	8
21	0.0	0	0.0	2	0.0	0	0.0	0
22	0.0	1	0.6	4	0.0	0	0.0	0
23	0.3	2	0.0	0	0.0	0	0.0	0
24	0.0	0	0 0	0	0.3	3	0.0	0
Total		47		221		77		117
Mean	0.5	2	2.8	9	0.4	3	0.7	4

APPENDIX VI

Inter-speaker switch-pause

The median duration in seconds and the frequencies of vocalisations in unison (viu) per recording over the two years for the two pairs.

rec.	Claire-EVE median viu	nviu	rec.	Fanny-SUSAN median viu	nviu
1	0.45	67	1	0.32	13
2	0.55	59	2	0.47	20
3	0.75	21	3	0.42	26
4	0.80	17	4	1.15	4
5	0.63	64	5	0.56	7
6	0.83	26	6	0.57	14
7	0.35	12	7	0.72	20
8	0.36	12	8	0.54	25
9	0.60	12	9	0.58	10
10	0.53	32	10	0.54	1
11	0.50	11	11	0.32	33
12	0.44	12	12	0.40	13
13	0.39	20	13	0.47	22
14	0.29	20	14	0.26	31
15	0.41	40	15	0.28	34
16	0.41	24	16	0.08	12
17	0.36	23	17	0.36	5
18	0.16	17	18	0.48	11
19	0.32	13	19	0.28	37
20	0.29	10	20	0.30	30
21	0.36	17	21	0.29	6
22	0.35	20	22	0.31	24
23	0.22	15	23	0.36	15
24	0.47	16	24	0.19	38
Total		622			451
Mean	0.43	240		0.42	19

APPENDIX VIIa

Turntaking

An overview of the *frequencies of laryngeals*, produced by Claire and Fanny, the *turns taken* by the mothers EVE and SUSAN, and the *percentages of turns* per total number of laryngeals in the recordings (rec.) over the two years for both pairs.
Claire and EVE are indicated as CE, and Fanny and SUSAN as FS.

rec.	CE n laryngeals	FS n laryngeals	CE n laryngeals with turns	FS n laryngeals with turns	CE % of turns upon laryngeals	FS % of turns upon laryngeals
1	41	38	39	8	95.1	21.1
2	77	20	51	12	66.2	60.0
3	2	34	2	13	100.0	38.2
4	7	13	3	5	42.9	38.5
5	47	14	34	4	72.3	28.6
6	7	20	8	9	100.0	45.0
7	17	23	5	0	29.4	0.0
8	8	19	1	0	12.5	0.0
9	17	20	11	0	64.7	0.0
10	21	13	14	0	66.7	0.0
11	28	10	11	6	39.3	60.0
12	2	1	2	0	100.0	0.0
13	11	15	4	0	36.4	0.0
14	8	2	0	0	0.0	0.0
15	1	0	0	0	0.0	0.0
16	3	3	1	2	33.3	66.7
17	5	6	3	0	60.0	0.0
18	1	5	1	5	100.0	100.0
19	0	11	0	0	0.0	0.0
20	0	10	0	4	0.0	40.0
21	3	4	0	0	0.0	0.0
22	1	0	0	0	0.0	0.0
23	0	18	0	0	0.0	0.0
24	2	0	1	0	50.0	0.0
Total	309	299	191	68		
Mean	13	12	8	3		

Overall percentage of turns upon laryngeals: Claire and EVE: 61.8 %
Fanny and SUSAN: 22.7 %

APPENDIX VIIb

Turntaking

An overview of the *frequencies of simple articulation* sounds produced by Claire and Fanny, the *turns taken* by the mothers EVE and SUSAN, and the *percentages of turns* per total number of simple articulations in the recordings (rec.) over the two years for both pairs.
Claire and EVE are indicated as CE, and Fanny and SUSAN as FS.

rec.	CE n simple articulations	FS n simple articulations	CE n articulations with turns	FS n articulations with turns	CE % of turns upon articulations	FS % of turns upon articulations
1	0	0	0	0	0.0	0.0
2	2	8	1	0	50.0	0.0
3	0	3	0	0	0.0	0.0
4	9	4	13	1	100.0	25.0
5	11	0	12	0	100.0	0.0
6	1	9	1	0	100.0	0.0
7	4	64	1	7	25.0	10.9
8	14	68	8	0	57.1	0.0
9	9	15	8	0	88.9	0.0
10	13	17	12	0	92.3	0.0
11	9	21	5	0	55.6	0.0
12	8	31	8	0	100.0	0.0
13	7	22	7	0	100.0	0.0
14	5	46	2	0	40.0	0.0
15	8	10	6	0	75.0	0.0
16	9	24	1	8	11.1	33.3
17	0	10	0	0	0.0	0.0
18	3	7	1	6	33.3	85.7
19	0	25	0	0	0.0	0.0
20	1	17	0	0	0.0	0.0
21	0	9	0	0	0.0	0.0
22	0	11	0	0	0.0	0.0
23	1	4	0	0	0.0	0.0
24	1	7	1	0	100.0	0.0
Total	115	432	87	24		
Mean	5	18	4	1		

Overall percentage of turns upon articulations: Claire and EVE: 75.7 %
Fanny and SUSAN: 5.6 %

APPENDIX VIIc

Turntaking

An overview of the *frequencies of babbling sounds* produced by Claire and Fanny, the *turns taken* by the mothers EVE and SUSAN, and the *percentages of turns* per total number of babbling sounds in the recordings over the two years for both pairs.
Claire and EVE are indicated as CE, and Fanny and SUSAN as FS.

rec.	CE n babbling sounds	FS n babbling sounds	CE n babbling sounds+turns	FS n babbling sounds+turns	CE % of turns upon babbling sounds	FS % of turns upon babbling sounds
1	0	0	0	0	0.0	0.0
2	0	0	0	0	0.0	0.0
3	0	0	0	0	0.0	0.0
4	0	0	0	0	0.0	25.0
5	0	0	0	0	0.0	0.0
6	0	0	0	0	0.0	0.0
7	0	0	0	7	0.0	10.9
8	5	22	3	9	60.0	40.9
9	1	0	0	0	0.0	0.0
10	12	2	10	0	83.3	0.0
11	2	22	1	12	50.0	54.5
12	1	4	1	1	100.0	25.0
13	1	14	0	10	0.0	71.4
14	1	35	1	18	100.0	51.4
15	4	43	2	19	50.0	44.2
16	6	10	3	6	50.0	60.0
17	1	9	1	4	100.0	44.4
18	3	4	3	4	100.0	100.0
19	0	13	0	11	0.0	84.6
20	2	12	0	7	0.0	58.3
21	1	1	0	0	0.0	0.0
22	1	30	1	17	100.0	56.7
23	0	2	0	1	0.0	50.0
24	3	22	3	15	100.0	68.2
Total	44	245	29	134		
Mean	2	10	1	6		

Overall percentage of turns upon babbling sounds: Claire and EVE: 65.9 %
Fanny and SUSAN: 54.7 %

APPENDIX VIId

Turntaking

An overview of the frequencies of words produced by Claire and Fanny, the *turns taken* by the mothers EVE and SUSAN, and the *percentages of turns* per total number of words in the recordings over the two years for both pairs.
Claire and EVE are indicated as CE, and Fanny and SUSAN as FS.

rec.	CE n words	FS n words	CE n words with turns	FS n words with turns	CE % of turns upon words	FS % of turns upon words
1	0	0	0	0	0.0	0.0
2	0	0	0	0	0.0	0.0
3	0	0	0	0	0.0	0.0
4	0	0	0	0	0.0	0.0
5	0	0	0	0	0.0	0.0
6	0	0	0	0	0.0	0.0
7	0	0	0	0	0.0	0.0
8	0	0	0	0	0.0	0.0
9	0	0	0	0	0.0	0.0
10	0	0	0	0	0.0	0.0
11	1	0	0	0	0.0	0.0
12	19	1	15	0	78.9	0.0
13	10	0	8	0	80.0	0.0
14	23	0	14	0	60.9	0.0
15	29	0	27	0	93.1	0.0
16	31	2	16	0	51.6	0.0
17	25	2	19	1	76.0	50.0
18	15	9	10	6	66.7	66.7
19	23	8	18	7	78.3	87.5
20	24	15	10	6	41.7	40.0
21	27	12	25	1	92.6	8.3
22	39	18	20	7	51.3	38.9
23	39	18	28	10	71.8	55.6
24	24	58	21	32	87.5	55.2
Total	300	143	231	70		
Mean	13	6	10	3		

Overall percentage of turns upon words: Claire and EVE: 77.0 %
Fanny and SUSAN: 49.0 %

STELLINGEN
behorend bij het proefschrift

FINALLY A WORD:
A sensori-motor approach of the mother-infant system
in its development towards speech.

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. P.W.M. de Meijer,
in het openbaar te verdedigen
in de Aula der Universiteit
(Oude Lutherse Kerk, Singel 411, hoek Spui),
op
dinsdag 14 september 1993 te 13.30 uur

door

Jeannette Mathilde van der Stelt

geboren te Zwolle

1.
Het is zeer verhelderend wanneer moeder-baby interactie in sensomotorische termen wordt beschreven. De onderzoeker wordt daarmee gedwongen afstand te nemen van adultomorfe interpretaties van het gedrag.
Dit proefschrift.

2.
Een linguïstische beschrijvingsmethode doet onvoldoende recht aan het proces dat ten grondslag ligt aan beginnende spraakcommunicatie.
Hoofdstuk 2 van dit proefschrift.

3.
De eerste vijf maanden na de geboorte van een baby zijn voor de ontwikkeling van spraakcommunicatie van groot belang. Het kind ervaart in die periode met oog en oor, welke bewegingen van de moeder in het communicatiesysteem een rol (gaan) spelen.
Hoofdstuk 3 en 4 van dit proefschrift.

4.
Het ene, halve, woord haalt alleen dan het andere woord uit, wanneer intersubjectiviteit en intentionaliteit tussen de betrokken personen geen punt van discussie meer is.
Hoofdstuk 5 van dit proefschrift.

5.
Preventie van ontwikkelingsstoornissen is alleen dan goed mogelijk wanneer de essentie van het ontwikkelingsproces bekend is. Het zoeken naar normen kan dan beperkt worden tot die gedragingen die ook werkelijk van invloed zijn op het ontwikkelingsproces.

6.
Het gemak waarmee in het dagelijkse sociale verkeer betekenis wordt toegekend aan bewegingen van een individu, staat niet in verhouding tot de inspanningen die een onderzoeker moet opbrengen om tot een evaluatie te komen van de bewegingen in het zich ontwikkelende moeder-kind communicatiesysteem.

7.
Hulpverleners die de ontwikkeling van een kind beoordelen op basis van (leeftijds)specifiek gedrag en daarbij geen oog hebben voor de kwaliteit de *intersubjectieve* relatie van de verzorgers en het kind, gaan volledig voorbij aan het belang van het kind.

8.
Brabbelen, timmeren, tikken en kauwen hebben gemeenschappelijke senso-motorische kenmerken. Het verschijnen van slechts één van deze gedragingen is mogelijk al voldoende om voortgang in het ontwikkelingsproces van een kind vast te stellen.

9.
Onderzoek naar de diadochokinese in spreekbewegingen van doofgeboren kinderen en van kinderen die in de loop van de eerste twee levensjaren doof zijn geworden, wijst op een vroege ontwikkeling van een geheugen voor ritmiek in het spreken.
(Van der Stelt, 1976)

10.
Volwassenen zijn onvoldoende bekend met de systematiek in de ontwikkeling van de geluidsproducties van baby's. Daarmee dreigt de communicatieve waarde van de allervroegste niet-huilgeluiden van de kinderen onderschat te worden.

11.
> *"Thus, the triad of impairments in autism - in communication, imagination and socialization - is explained by the failure of a single cognitive mechanism."*
> (Frith, *Scientific American*, juni 1993, p. 83)

De veronderstelling, dat een "innate component" (p. 83) ten grondslag ligt aan de problemen bij autisme, gaat voorbij aan de mogelijke invloed van de allervroegste moeder-kind interactie op de sociale ontwikkeling van baby's.

12.
Sara bevalt.

Jeannette M. van der Stelt

FINALLY A WORD

Jeannette M. van der Stelt (1943) was trained as a speech therapist. In 1977 she graduated in Special Education at the University of Amsterdam. As a staff member of the Institute of Phonetic Sciences of that university she has published on early speech development and mother-infant interaction since 1979. The database used in this thesis was collected during a project which was financed by the Netherlands Prevention Fund until 1990.

Speech-communicative problems in young children are often thought to originate from early mother-infant interaction, especially in the absence of physical or mental causes for such problems. In this thesis, an approach of early speech communication is elaborated in which the mother and the infant are considered as a sensori-motor system in development. Three fundamental characteristics of human communication are studied: *intersubjective tuning, transmission of intentions, and turntaking.*
Two mother-infant pairs were chosen as test cases for the approach. The interaction patterns of the two pairs appeared to be clearly different during the first two years of the infants' lives. When the children were two years of age a difference in their level of speech communication was found. Already in the first five months interaction patterns of mother and infant appeared to be related to the level of the speech developmental process at the end of the first two years.

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