Infant and Child Development
Inf. Child Dev. **12**: 1–26 (2003)
Published online in Wiley InterScience (www.interscience.wiley.com)
DOI: 10.1002/icd.333

A Longitudinal Examination of the Transition to Symbolic Communication in the Second Year of Life

Luigia Camaioni[a,*], Tiziana Aureli[b], Francesca Bellagamba[a] and Alan Fogel[c]
[a] *University of Rome ''La Sapienza'', Italy*
[b] *University of Palermo, Italy*
[c] *University of Utah, USA*

Between 10 and 24 months of age, children progress from communicating through conventional signals to communicating through symbols in a variety of situations. The present study investigates this transition analysing mother–child communication frames and the child's communicative acts, and tracing the developmental changes in both frames and communicative acts. Four children (2 girls, 2 boys) and their mothers were observed longitudinally and extensively, from 10 to 24 months of age, using a multiple case-study method. Through the detailed investigation of these single cases, clear developmental trajectories were found, showing that conventional frames and representational gestures 'bridge' the transition from attentional to symbolic communication. There were significant differences between dyads and children in the developmental trajectories for several frames and communicative acts. The results not only confirm previous findings on the development of verbal and gestural communication, but provide new insights into the transition to symbolic communication in the second year of life, first because of the use of frame analysis and second because of a focus on individual trajectories in development.

Key words: communication; symbols; mother–child frames; developmental transition; multiple case study; longitudinal

Between 10 and 24 months of age, children typically progress from communicating through conventional signals (vocal and gestural) to communicating through symbols (words and representational gestures) in a variety of situations.

*Correspondence to: Luigia Camaioni, Department of Developmental and Social Psychology, University of Rome ''La Sapienza'', Via dei Marsi 78–00185 Roma, Italy. Email: luigia.camaioni@uniroma1.it

The emergence of symbolic communication, as well as the development of communication prior to language, has received a great deal of attention in the infancy literature over the past 30 years. A comprehensive review of the now huge literature on communication and language development during the first 2 years of life is beyond the scope of this paper. Instead, we will focus on two major lines of research that have provided a valuable developmental description of presymbolic communication, on the one hand, and of symbolic communication and the emergence of language, on the other hand. Both these research lines have underscored the functional continuity between prelinguistic and linguistic communication, showing how young children's early communicative intentions are expressed gesturally and vocally before they can be encoded in verbal symbols.

First, research has indicated that, between 9 and 12 months of age, the onset of intentional communication is marked by the emergence of so-called *deictic* gestures as well as by the use of word-like sounds for communicative purposes (e.g. Bates *et al*., 1979, 1975; Bruner, 1975; Masur 1983). Deictic gestures such as pointing, showing, offering/giving and ritualized requesting (extending the arm with hand open, palm-up), may be used alone or accompanied by word-like sounds (e.g. the baby points and vocalizes 'da' to direct her mother's attention to an interesting toy), and subsequently by words. According to Masur (1983) and Lock (1980), gestures and verbalizations rapidly become productively combined, generating a variety of meaningful gestural-verbal expressions.

A second line of research has shown that soon after the use of deictic gestures—between 12 and 15 months of age—typically developing children start using a new type of gesture, called *representational* or symbolic (e.g. Acredolo and Goodwyn, 1988, 1990; Iverson *et al*., 1994). Different from deictic gestures, whose referent can only be interpreted by looking at the context, these new gestures represent a specific referent and thus their meaning does not change with context (e.g. the child raises the palms meaning 'allgone' when she finishes her milk or juice, or the child waves her hand meaning 'bye-bye'). Approximately at the same age range, children produce their first words to label objects (e.g. *shoes*, *bottle*, *car*; see Nelson, 1974) or to regulate social interaction (e.g. *hello*, *bye-bye*, *no*; see Bloom, 1973). Some studies have reported striking similarities between production in the gestural and the vocal modalities during the first months of symbol use, showing how the two modalities start developing in parallel and undergo a similar process of gradual decontextualization (e.g. Bates *et al*., 1979; Iverson *et al*., 1994). Later on, however, gestures tend to decline in use whereas words increase sharply, as types as well as tokens. Looking at the interaction between gestural and verbal communication at 16 and 20 months of age, Iverson and her colleagues (1994) found a decline in the production of representational gestures relative to words at 20 months, suggesting the idea that these gestures fail to develop into a fully fledged linguistic system as words do.

Taken together, all these findings highlight how some research has focused on the acquisition of gestural and vocal signals (9–12 months), while other research has examined the acquisition of first words as symbols and their association with representational gestures (12–20 months). Furthermore, previous studies of presymbolic and symbolic communication have been either cross-sectional or longitudinal in design, concentrating mostly on a brief age span (e.g. Bates *et al*., 1979; Iverson *et al*., 1994). A few diary studies in which the author is the child's parent (see Dromi, 1987; Halliday, 1975) have examined the same child along the entire age period over which language is being acquired. A wide-ranging and detailed longitudinal investigation that spans the entire second year of life is still warranted.

In the present study, we observed four children and their mothers as dyads bi-weekly, from 10 to 24 months of age, using a multiple case-study method (Fogel, 1990). This resembles diary-based methods but with more subjects. In addition, we used a semi-naturalistic laboratory-based observational procedure with standardized play materials, thus equating the observational setting within and across dyads. The multiple case-study approach allows one to examine the developmental trajectories of each dyad and child on several indices of social and communicative development. Developmental trajectories are best revealed when observations are made within cases at intervals that are considerably more frequent than the typical time course of developmental change. Since the change process we observed occurs over a 14 month period, making observations every 2 weeks was deemed sufficient to capture the shape of the developmental trajectory.

The key developmental transition we examine in the present study is the emergence of symbolic communication in the second year of life and the child's acquisition of first words used for communicative purposes. By conducting intensive observations before, during and after this developmental transition on a small number of individuals, we expect to describe the dynamics of change at two levels: (a) the dynamics of individual development within the child (b) the dynamics of communication within the mother–child dyad. So far most studies have looked either at the child's communicative acts—gestures and words—or at the mother–infant communication, described as play 'formats' (Bruner, 1983), 'coordinated joint engagement' (Bakeman and Adamson, 1984), and 'frames' (Fogel, 1990). Few studies have considered both the individual child and the mother–child dyad longitudinally using frequent observations over a lenghty period of time (e.g. Adamson and Bakeman, 1984; Camaioni and Laicardi, 1985; Ratner and Bruner, 1978). In the study presented here we will examine both the developmental trajectories of child communicative acts and the developmental trajectories of mother–child communication frames over the second year of life. Given the small number of cases observed, we will not try to link the two levels of analysis—the individual and the dyadic—with each other in any systematic way. However, some interesting insights derive from comparing the developmental trajectories obtained at each level of analysis.

Following Fogel (1990, 1993), communication frames were defined as regularly occurring patterns that regulate the communication and sharing between the participants, such as co-action episodes, social games, pretending, telling stories together and talking about past experiences. In this study, we considered communication frames with respect to the level of sharing. When mother and child jointly participate in an activity, they can do so at different levels. The mother can act upon an object in a symbolic manner, whereas the child is only attending to it; or, conversely, the child can act conventionally while the mother is just looking at him/her. Therefore, to detect what is the shared level in mother–infant joint activity, we have to consider what the two participants have in common, that is what aspects of the activity are taken into account by both of them. To continue our earlier examples, what in both cases is common between mother and infant is the same object as a focus of attention.

Four levels of sharing were coded: (1) *attentional*, when mother and child share a common focus of attention; (2) *conventional*, when they share the conventional meaning of actions or signals; (3) *symbolic*, when they share arbitrary meaning-referent relationships; and (4) *non-shared*, where no common focus occurs (see the Coding procedure and Table 1 for details). In addition to frames, we categorized the child's communicative acts into five categories (see the Coding procedure and

Table 1. Mother-child communication frames

Coding procedure
• Frames involve four components: (a) location, (b) postural co-orientation, (c) topic, (d) level or focus. In this study the location is the table condition and the co-orientation is sitting side by side at the table. Frames are coded if they last at least 3 s. • Topics include the various toy sets: telephones, doll set, food set, puzzle, etc. For each instance of a frame, both the topic and the level are coded. Also the onset and offset time (minutes and seconds) of the frames is coded. • In each frame, we code the level the participants have in common. In a case where the mother pretends to call on the telephone (conventional or symbolic level) and the child is acting literally by tapping on the toy telephone (attentional level), we code this as *shared attentional* focus. If the child is dialing numbers and bringing the receiver to his/her ear, we code this as *shared conventional* focus. If the child is also pretending to talk on the phone, we code this as *shared symbolic* focus. • The level of *shared symbolic* focus may include aspects of the level of *shared conventional* focus and of *shared attentional* focus. The level of *shared conventional* focus may include aspects of the level of *shared attentional* focus.

Category	Operational definition
Shared attentional	Mother and child are looking at and/or acting together on the same focus. Actions are literal and functionally related to the topic. Dyads share an attentional focus if one person is acting and the other only looking. E.g. tapping; shaking; combining objects.
Shared conventional	Mother and child are referring to a common focus through conventional means. Conventions are culturally defined non-literal actions (idiosyncratically shared among members of the dyad or shared among members of a culture). E.g. giving and taking games; peekaboo; brushing the doll's hair or feeding the doll.
Shared symbolic	Mother and child are sharing arbitrary meaning-referent relationships as when they talk together on a common topic. E.g. pointing and naming games; alphabet and number games; talking about experiences; telling stories; singing together; pretending.
Non-shared	Mother and child are looking, acting, and/or talking about different foci.

Table 2 for details). There were two gestural categories (deictic and representational gestures), and three vocal/verbal categories (systematic vocalizations, protowords, and words).

AIMS OF THE PRESENT STUDY

Our aim is to trace the developmental changes in the duration of communication frames and the frequency of communicative acts by constructing developmental trajectories through a multiple case-study design. Developmental transitions in frame duration can be observed as systematic changes in the slope of the developmental trajectory, modelled as a polynomial function of age.

According to research on developmental change based on a dynamic systems perspective (Fogel and Lyra, 1997; Thelen and Smith, 1994) transitional forms of action often appear between two stable developmental stages. These transitional forms have characteristics that combine the earlier with the later stage. Crawling,

Table 2. Child's communicative acts

Coding procedure
• A gestural or verbal communicative act is coded whenever it occurs, inside and outside frames. Only one gesture or one verbal act is coded on the same line of the transcription. • A gesture has a communicative intent when accompanied by other's directed gaze or by systematic vocalization and coherent facial expression. However, a deictic or representational gesture produced as an answer to a maternal request or comment, has a communicative function eventhough it is not accompanied by other's directed gaze. • A vocal/verbal act may be intentionally communicative even if not accompanied by other's directed gaze.

Category	Operational definition
Deictic gesture	Expresses the child's communicative intent and its meaning can only be determined through reference to the context. E.g. the child offers to the mother the phone receiver while they are playing with the phone.
Representational gesture	Represents a specific referent and its meaning does not change with context. E.g. while putting the doll to bed, the child brings her index finger to own's lips meaning 'silence' and smiles at the mother.
Systematic vocalization	A vocalic or syllabic sound which occurs in a stable context (at least three times in the same action, attention or play context), and is regularly associated to a specific act (e.g. pretending to phone, constructing a tower). E.g. the child points and vocalizes 'da' to direct her mother's attention to an interesting toy;
Proto-word	An onomatopoeic or an idiosyncratic sound who has a specific meaning for a mother–child dyad, and is associated to a specific referent through an iconic relationship. E.g. 'Bow-wow' (dog), 'meeow' (cat), 'brum-brum' (car), 'gi-gi' (horse); 'baba' used as an idiosyncratic word to refer to the puzzle.
Word	A sound associated to a specific referent through an arbitrary relationship. Single words, combinations of two or more words, combinations of gesture and word are included in this category.

for example, is a transitional form of locomotion that combines elements of the pre-locomotor period (cyclic movements of arms and legs) with elements of upright walking (self-initiated movement from one place to another). Prior research (e.g. Fogel 1993; Fogel and Lyra, 1997) suggests that developmental transition in frames is likely to occur in a three phase process: (1) an initial phase in which there is one predominant historically existing frame; (2) a final phase in which a new frame emerges and becomes predominant; and (3) a middle phase in which a frame that shares the features of the historically existing frame and the newly emerging frame becomes predominant and serves as a developmental bridge. Based on previous literature, we expect to find the following developmental patterns:

A. There will be a developmental sequence in the predominant frames shared by the dyad. Shared attentional frames will predominate during early sessions and then decrease in duration. Shared conventional frames will increase in duration during the middle of the age period considered and

decrease toward the end of the second year. This trend is expected since conventional frames have features of both attentional and symbolic frames. In fact, they involve actions associated with a specific object (e.g. telephone receiver, spoon, bowl), but culturally derived and agreed-upon within a dyad (e.g. bringing the telephone receiver to the ear, stirring in a bowl with a spoon). Therefore, we expect conventional frames to be predominant in the middle phase of this developmental period. Finally, shared symbolic frames will be the last to emerge, increasing in duration some time during the second year. Shared symbolic frames are expected to predominate over the other frames by the end of the second year. We expect between dyad differences but we do not have hypotheses about the specific form of the differences.

B. There will be a developmental sequence for the child's communicative acts, with deictic gestures predominating earlier than representational gestures and with representational gestures predominating at later ages. We also expect that both protowords and words will increase in frequency across the second year whereas systematic vocalizations will remain stable during this period. These predictions are well established in the literature, at least on the basis of cross-sectional studies or short-term longitudinal studies (for a review see Adamson, 1996; Bates *et al*., 1987; Camaioni, 2001). Ours will be the first to verify the predictions within multiple individual subjects observed frequently over the entire developmental period. In addition, we will examine between child differences.

METHOD

Subjects

Four children, two boys (subjects 1 and 2) and two girls (subjects 3 and 4), were videotaped bi-weekly in two different conditions interacting with their mothers and a set of age-appropriate toys in a laboratory playroom. Each condition lasted 10 min. The observations started when the infants were 10 months and continued until they were 24 months. All the infants were later-born, between August 1986 and August 1987, and the families were middle class, non-separated, two-parent homes from the United States. The language of the families was American English. The infants were full term at birth. One mother and infant were African–American and the others were Caucasian–American.

Observational Sessions

Infants were videotaped in a 12.5 ft $\times$ 12.5 ft laboratory playroom equipped with three pan-tilt-zoom video cameras mounted on the walls. Each camera was remotely controlled from an observation room located behind a one-way mirror. Camera 1 was focused on the mother's face and the side of the infant. Cameras 2 and 3 were both focused on the infant's face and body. The outputs from the three cameras passed through a special effects generator. Camera 1 and either Cameras 2 or 3 (depending on which had the better view of the infant) were mixed into a composite video image onto which a digital timer (accurate to $\frac{1}{30}$ s) was superimposed. An omnidirectional microphone was hung from the centre of the ceiling and passed through an amplifier and then to the audio track of the videotape.

Mothers were asked to bring their infants to the laboratory every 2 weeks. Attrition and missed visits were kept to a minimum by regular telephone contacts with the staff, bi-monthly newsletters for the parents, and subject payments of $150 made at the end of every 6-month period. One dyad completed all 30 possible sessions. The others completed 26, 28 and 29 sessions, respectively. In this study, we examine data only from the first condition in which infants and their mothers were sitting together at a child-sized table. Age appropriate toys that allowed for both functional and symbolic play were available in a toy box beside the table. The mother and infant were free to choose any toy but the mother was asked to take out only one at a time. These toys included a pair of toy telephones, a cooking and eating set, a baby doll with cradle, bottle, and brush, and a wooden puzzle.

Coding procedure

The child's vocal/verbal productions were transcribed by native English speakers. Using both the videotapes and the transcriptions, each session was then coded for each mother–infant dyad. Two different coding schemes were constructed in order to answer the research questions. One scheme was used to code mother–child communication frames (see Table 1 for operational definitions and examples) and the second to code child's communicative acts (see Table 2 for operational definitions and examples).

Four types of mother–child communication frames were coded that capture shared focus on different levels of activity: attentional, conventional, symbolic and non-shared. For a specific activity, such as playing with the toy telephone, the following narrative illustrates how a mother–girl dyad gets from attentional (paragraph A) to conventional (paragraph B) to symbolic shared focus (paragraph C), centred on the same object, the phone:

A. Betsy looks at the telephone and manipulates it. The mother looks at her, saying: 'Will we call daddy'? The girl looks at the mother, holding the telephone in their hands. The mother puts the receiver to the ear and says: 'Daddy, where are you? Betsy is here! Betsy, do you want to greet daddy'? The girl puts the telephone upside down, hits the receiver on the table, pulls the telephone wire, occasionally looking at her mother. (Age: 11;2)
B. In a subsequent session, the mother puts the receiver to her ear, while saying: 'Hi dad? How are you'? Betsy is looking at the mother, lifts up the receiver to her shoulder, and then places it on the table. The mother continues to pretend, saying: 'Daddy? Where are you?' and invites the girl, who is attending to her mother, to call too: 'Betsy, daddy is on the telephone! Do you want to talk with him'? The girl lifts up the receiver again, this time putting it near to her ear and waiting for a moment. Then she places the receiver on the telephone in the right way. (Age: 14;10).
C. Two weeks later, Betsy enriches her way of using the telephone by adding some pieces of formulaic language. She says 'Hi' when putting the receiver to her ear and 'bye' when placing it down, still not evoking any pretend partner to talk with. (Age: 14;24). In a later session, is the girl who initiates a pretend call. As soon as she sees the telephone on the table, Betsy puts the receiver to her ear calling 'Daddy'?, smiling and looking at the mother. The mother replies: 'Dad? Where are you? When are you coming home?' The girl continues the conversation saying 'Daddy?....home?....bye' and then hangs up the receiver (Age: 21;13).

Communicative acts were distinguished in gestural acts (deictic and representational gestures) and verbal acts (systematic vocalizations, protowords and words). The following are some examples of how children used deictic gestures (1, 2), representational gestures (3, 4, 5), proto-words (6, 7), words (8, 9, 10) and combinations of words (11, 12, 13) when interacting with their mothers at different ages. It is worth noting that some examples contain more than a single communicative act on the part of the child. Specifically, in example 5 the child produces not only a representational gesture (drinking from an empty glass) but also a word (milk); in example 7 the child uses not only a proto-word (oh-oh) but also a two-word combination.

(1) The child is rolling an apple. The mother asks 'Can mommy have it?' The child *offers* the apple to the mother (Child 1, Age:10;22).
(2) The mother asks 'Were is the baby's nose?' while the child is holding a doll. Child *points* to the doll's nose (Child 2, Age: 13;14).
(3) The mother asks 'Do you want to play with the puzzle?' The girl *shakes her head* to say 'no' (Child 3, Age: 12;26).
(4) The mother is singing a song and making the doll dance. When she stops the boy *claps his hands* while smiling at her (Child 2, Age:14;13).
(5) The girl *drinks from an empty glass* while looking and smiling at the mother. Mother asks 'What are you drinking?' Child replies '*milk*' (Child 4, Age: 21;11).
(6) The mother asks 'Can you smell the baby's piggie?'. The boy pretends to smell the doll's feet and says '*bleah*!' while wrinkling the nose for 'stinks' (Child 1, Age: 14;20).
(7) The mother asks the child to put the spoon in the pot. The girl drops the spoon, turns to mom and says '*oh-oh*'. She then gets off the chair, picks up the spoon from the floor and states '*got it*' (Child 3, Age: 18;4).
(8) The child offers an apple to the mother. The mother replies 'Can I have a bite? Ham!' She pretends to take a bite. Child answers '*appe*' (apple) (Child 1, Age: 12;29).
(9) The mother asks 'What did we do yesterday? What did you see at the zoo?' Child replies '*Gi-affe*' (giraffe) (Child 4, Age: 18;9).
(10) The girl brushes the doll's hair. After that she says '*nice*' and smiles at the mother (Child 3, Age: 22;18).
(11) The mother offers the phone receiver to the child while asking 'Can you talk to daddy on the phone?' The boy takes the phone receiver and brings it to his ear, he smiles at the mother and says '*hi dad*' (Child 1, Age: 14;20).
(12) The boy hears the sound of an airplane and says '*Purplane*.' Mother says 'Yes, that was an airplane!'. The boy says '*gone, all gone*' (Child 2, Age: 22;27).
(13) The girl is rocking the doll in the bed. She says '*Rock baby*'. Mother asks 'The child is taking a nap?' The girl says '*no*'. She takes the doll out of the bed and pretends to feed the doll with the bottle (Child 4, Age: 23;4)

Coding was done independently by two different coders, one for each coding scheme. In the case of child's communicative acts, coding was checked against a written transcription of the child's vocal/verbal production. The onset and offset times of each communication act and frame were recorded.

Reliability

Reliability was assessed separately for frames and communicative acts. In each case, two second coders, the primary researcher and a graduate student, coded

10% of the entire set of videotapes, corresponding to 12 sessions. To specify, for each mother–child dyad, one session was randomly sampled from each of the following three age periods: from 44 to 64 weeks, from 65 to 84 weeks and from 85 to 104 weeks.

For frames, since duration was used as the dependent variable, *kappa* assessments were based on whether the coders agreed with the frame category coded for each second. Across all four categories, the average *kappa* was 0.72 for the first period, 0.65 for the second period and 0.75 for the third period. For communicative acts, *kappa* coefficients were computed for the vocal/verbal categories. Since frequencies were used as dependent variables, *kappa* assessments were based on whether the coders agreed with the category coded for each occurrence. Across all three categories, average *kappa* was 0.70 for the first period, 0.79 for the second period and 0.89 for the third period. For the two gestural categories, agreement percentage was computed. We analysed each category separately, by considering the gestures claimed by both observers and the ones noted only by one observer. For both categories, the percentage agreement score was above 90% in each of the three periods.

From the coding records, both frequencies and durations were derived by computer and used as dependent variables. The independent variable used in the analyses was age in weeks. Observation sessions were meant to last 10 min but may have ended slightly sooner or later. All variables were therefore proportionalized according to the duration of the session.

RESULTS

Statistical Analyses

Hypotheses A and B were tested using hierarchical linear modelling (HLM), specifically with MLn software (Woodhouse, 1996). This method is suitable to test models of developmental trends, the shape of the developmental trajectory, for data such as ours in which subjects are observed frequently and over a long period of time (cf. Fogel *et al*., 1999). The main advantage of HLM over ordinary regression approaches is that models for both group and individual trajectories can be tested. As a first step, regression parameters are estimated for the group of subjects as a whole. Then, regression parameters for each subject are computed in terms of the between-subject variance from the group parameters.

To test hypothesis A, the durations of each of the four categories of frame—derived as proportions of the total duration of each observation session—were used as dependent (response) variables to be predicted by a polynomial model based on the independent (explanatory) variable of the infant's age in weeks. To test hypothesis B, the frequencies of each of the four categories of communicative acts, derived as frequencies per minute of each observation session were used as dependent (response) variables.

Inclusion of an intercept term and a first-order age parameter indicates that development is best described by a linear trend. Inclusion of higher-order age parameters (such as Age^2 and Age^3) indicates a curvilinear developmental trend. Parameters are added to the model when they exceed twice their standard error ($p < 0.05$). This process is repeated until no more significant higher-order age parameters can be added to the model. Significant individual variation from the group model is tested with a *chi-square* statistic.

Developmental Transitions in Communication Frames

We will begin by presenting and describing the raw data trajectories for communication frames in each dyad separately (see Figures 1 and 2).

Examination of trajectories for attentional frames shows that, in all dyads, they were quite high in proportional duration during the first sessions, and sharply decreased between 74 and 81 weeks for three dyads (1, 3, 4), and at 88 weeks for dyad 2. Conventional frames occurred for the first time approximately at 48 weeks of age and peaked around 80 weeks for dyads 1, 2, 3. In these dyads, conventional frames overlapped both with attentional frames before 80 weeks and with symbolic frames after 80 weeks. For one mother–child dyad (4), on the other hand, conventional frames occurred since the first session, when this girl was 44-weeks old, and they peaked around 70 weeks, overlapping only with attentional frames in the period in which these were predominant. In all dyads, symbolic frames appeared between 56 and 63 weeks and began to predominate over all other frames after about 88 weeks. Dyads differed with respect to their rate of increase and the age at which symbolic frames began to predominate. In three dyads (1, 2, 3) they began their increase between 74 and 86 weeks, while in one dyad (4) the increase began earlier, at 72 weeks.

This picture suggests that in all dyads there were three distinct developmental periods in frame duration, somewhat different in each dyad with respect to the age range (in weeks). During the first period the duration of attentional frames was predominant, while in the second period attentional frames decreased, symbolic frames increased, and conventional frames were at their peak. Finally, during the third period, symbolic frames were predominant. Therefore, we examined mean proportional durations of each of the four frames in each period. Because we are using a case-study design, we assigned the age range to the dyads by preserving the developmental profile that was unique to each dyad rather than imposing an arbitrary or average age criterion that may not fit any of the dyads.

Figures 3 and 4 show mean proportional durations for attentional, conventional, symbolic and non-shared frames for each dyad and for the group in each of the three periods. These figures confirm the three period pattern for each of the dyads. Non-shared frames showed low mean duration, especially in the third period. It is worth noting that they accounted for less than 10% of the total duration of the sessions.

Turning now to hypothesis A, we expected that there would be a developmental sequence in the predominant frames shared by the dyad. Attentional frames will predominate during early sessions and then decrease in duration. Conventional frames will increase during the middle and decrease toward the end of the second year. Finally, symbolic frames will be the last to emerge, increasing some time during the second year, and are expected to predominate over the other frames by the end of the year. We further expected between dyad differences. This hypothesis was tested using hierarchical linear modelling.

For the proportional duration of shared attentional frames, we found a curvilinear decrease with age (see Figure 5 and Table 3). Attentional frames predominated over all other types of frame and then began to decrease sometime around the middle of the second year. There was also significant between dyad variation. Dyads differed with respect to the rate of decrease and the age at which attentional frames no longer predominated.

For the proportional duration of shared conventional frames, we found an inverted U-shape curvilinear trajectory, peaking in the middle of the second year

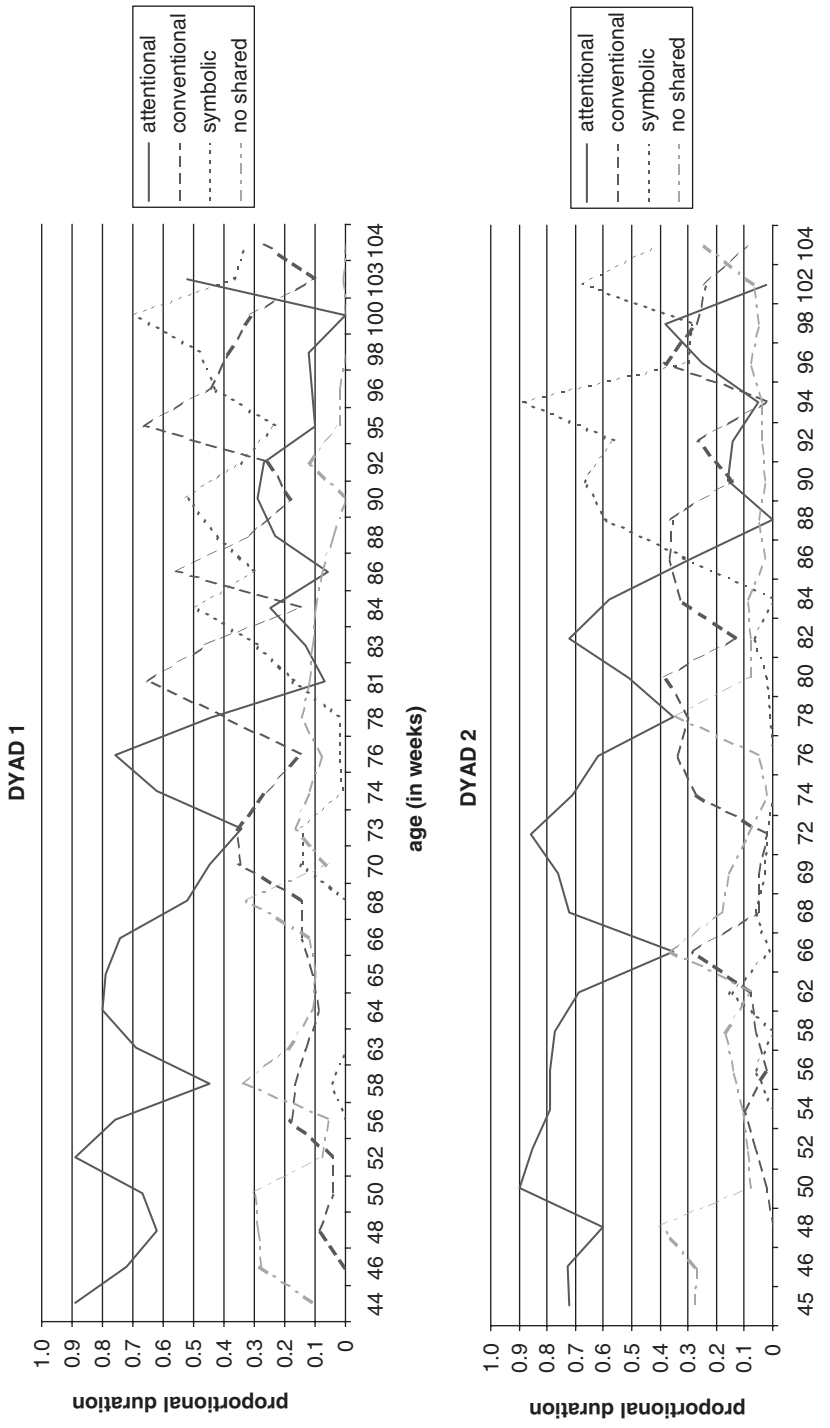

Figure 1. Developmental trajectories of the propotional durations of communication frames for mother-child dyads 1 and 2.

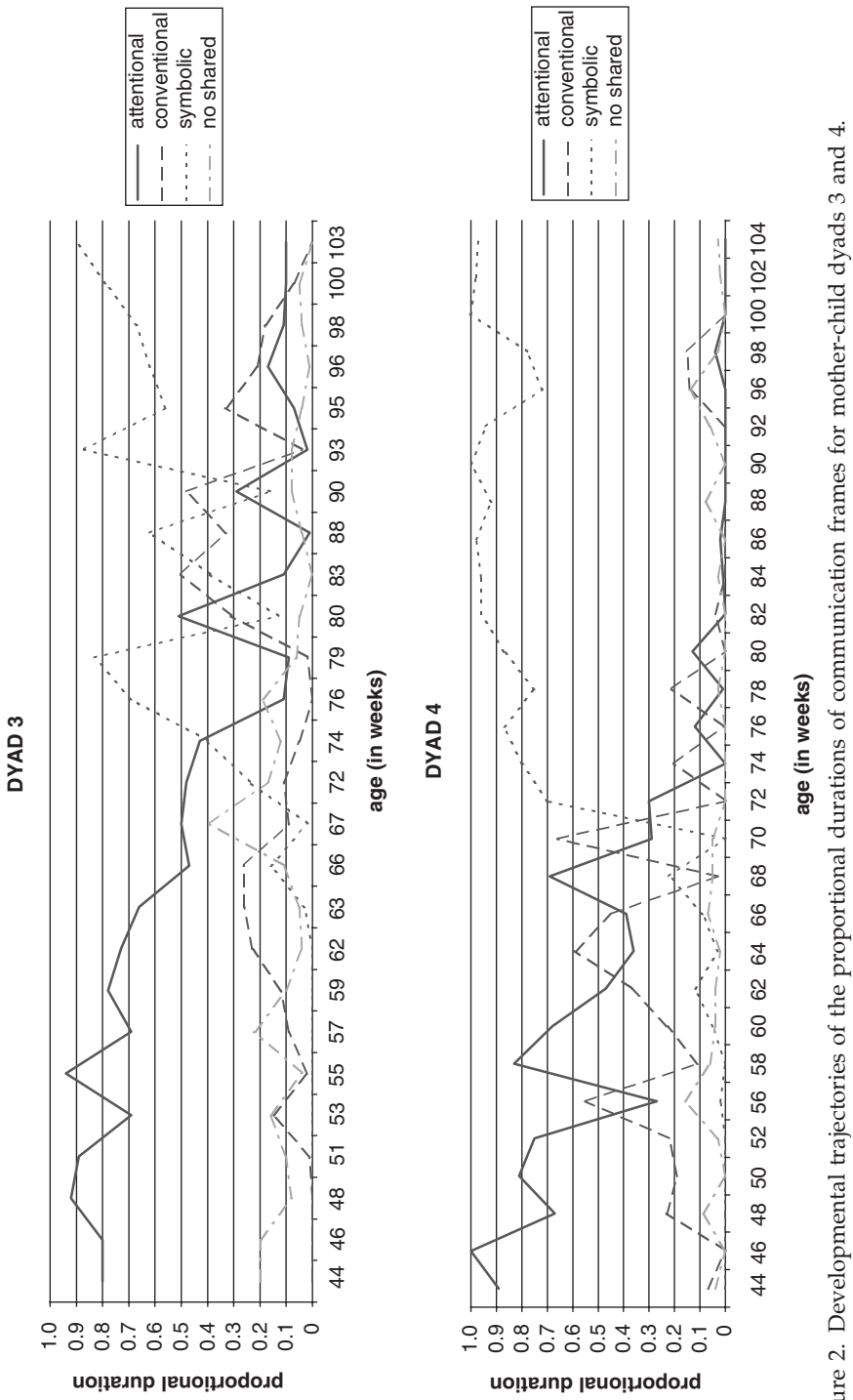

Figure 2. Developmental trajectories of the proportional durations of communication frames for mother-child dyads 3 and 4.

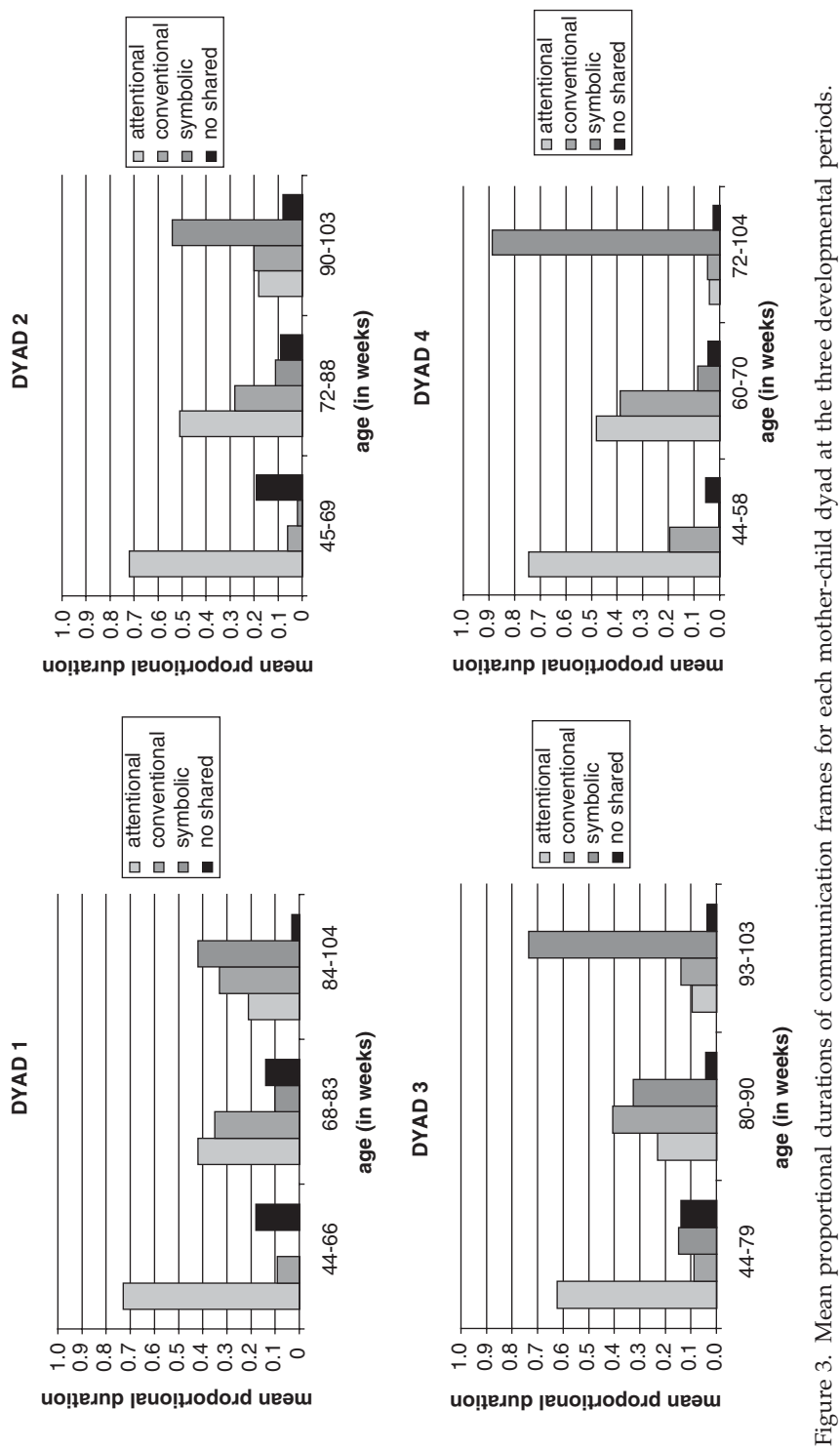

Figure 3. Mean proportional durations of communication frames for each mother-child dyad at the three developmental periods.

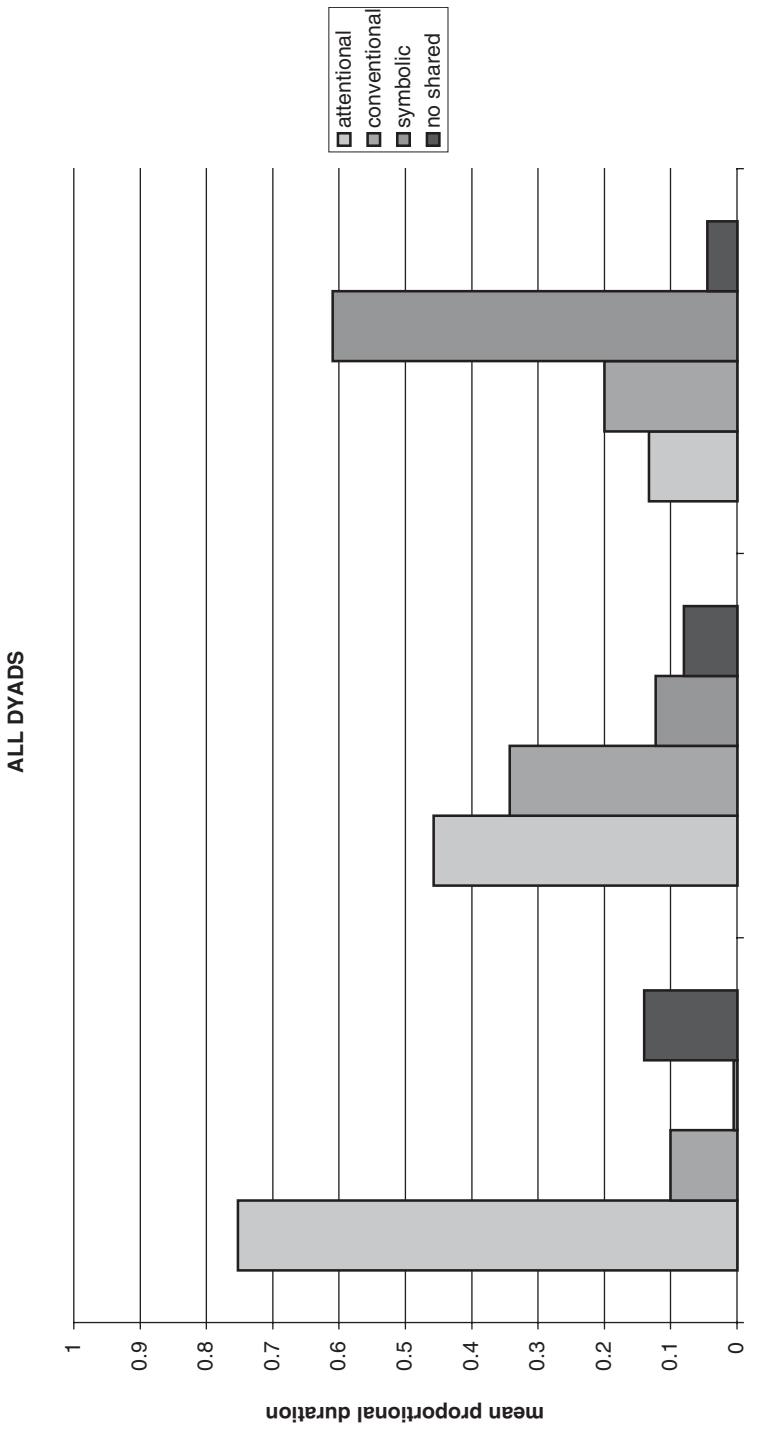

Figure 4. Mean proportional durations of communication frames for all mother-child dyads as a group at the three developmental periods.

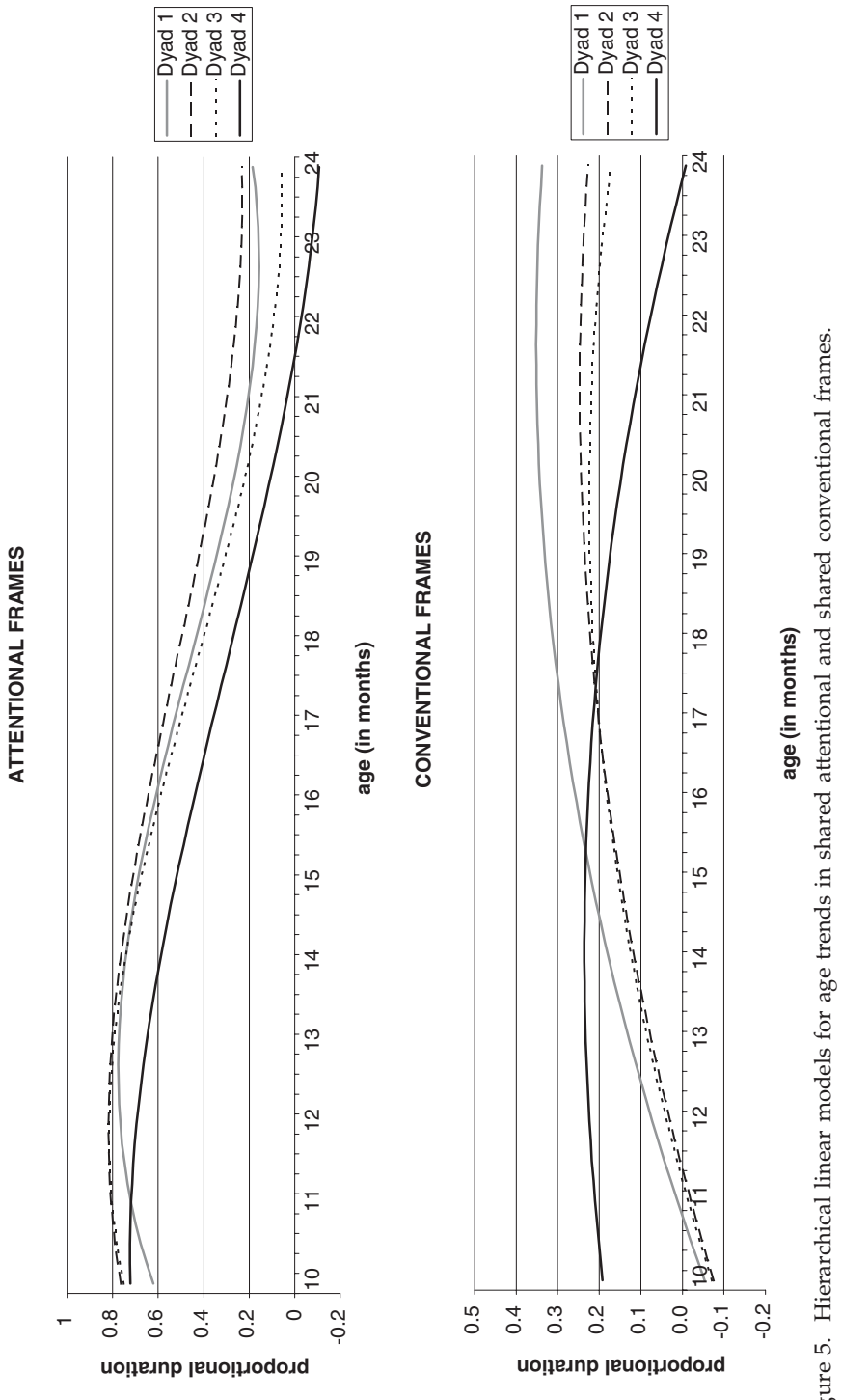

Figure 5. Hierarchical linear models for age trends in shared attentional and shared conventional frames.

Table 3. Standardized parameter estimates from hierarchical linear models for age trends in communication frames

Response variable	Intercept	Age	Age^2	Age^3
Shared Attentional	0.43	−0.02	ns	0.000013
Shared Conventional	0.23	0.002	−0.0002	ns
Shared Symbolic	0.29	0.02	ns	−0.000013
Non-shared	0.09	−0.002	ns	ns

Note: The dependent variable is the total duration of each frame expressed as a proportion of the duration of a session. Only significant values are shown.
Parameter estimates are significant when they exceed twice their standard error ($p < 0.05$). The intercept parameter estimate gives the predicted proportional duration of each frame at 10 months, when observations began on these dyads. The parameter estimates for the age terms give the rate of change of the predicted trajectories.

(see Figure 5 and Table 3). Significant individual differences showed a wide variation between dyads. For the proportional duration of shared symbolic frames, we found a curvilinear increase with age as well as significant inter-dyad differences (see Figure 6 and Table 3). Finally, for the proportional duration of non-shared frames, they decreased over time in a linear way (see Figure 6 and Table 3).

Looking at the modelled trajectories together, there is a clear confirmation of our hypothesis as attentional frames, which predominate early, are gradually replaced by symbolic frames (see Figure 7). In addition, conventional frames tend to occur during the middle of this developmental period, overlapping in part with both the other frames. This suggests that conventional frames may play a bridging role in the developmental transition from attentional to symbolic communication.

Being culturally defined non-literal actions, conventions convey a meaning, not because they are 'naturally' linked to the referent, but because they are recognized and shared by a community of at least two individuals (the child and her mother). Since conventions are mid-way between actions and symbols, this explains why sharing a communication focus through conventional means may serve as a bridge between sharing attention on a common focus and sharing symbols, i.e. arbitrary meaning-referent relationships.

Developmental Profiles in Child's Communicative Acts

Examination of the raw data trajectories (see Figures 8 and 9) shows that deictic gestures were produced since the first session and continued to increase over the second year in all children. Children differed, however, in how frequently they used these communicative acts. Representational gestures increased, peaked between 74 and 88 weeks, and then decreased in three children. In one girl (child 4), a clear peak was not readily discernible. This child produced almost as many representational gestures—about 1 per minute—during the first half of her second year as during the remaining weeks. Comparing the trajectories of deictic and representational gestures, deictic gestures predominated over representational gestures across all observations for three of the four children in the sample (1, 2, 4).

Considering the children's production of vocal/verbal communicative acts, the distribution of frequencies for each act by child and age revealed that the frequency

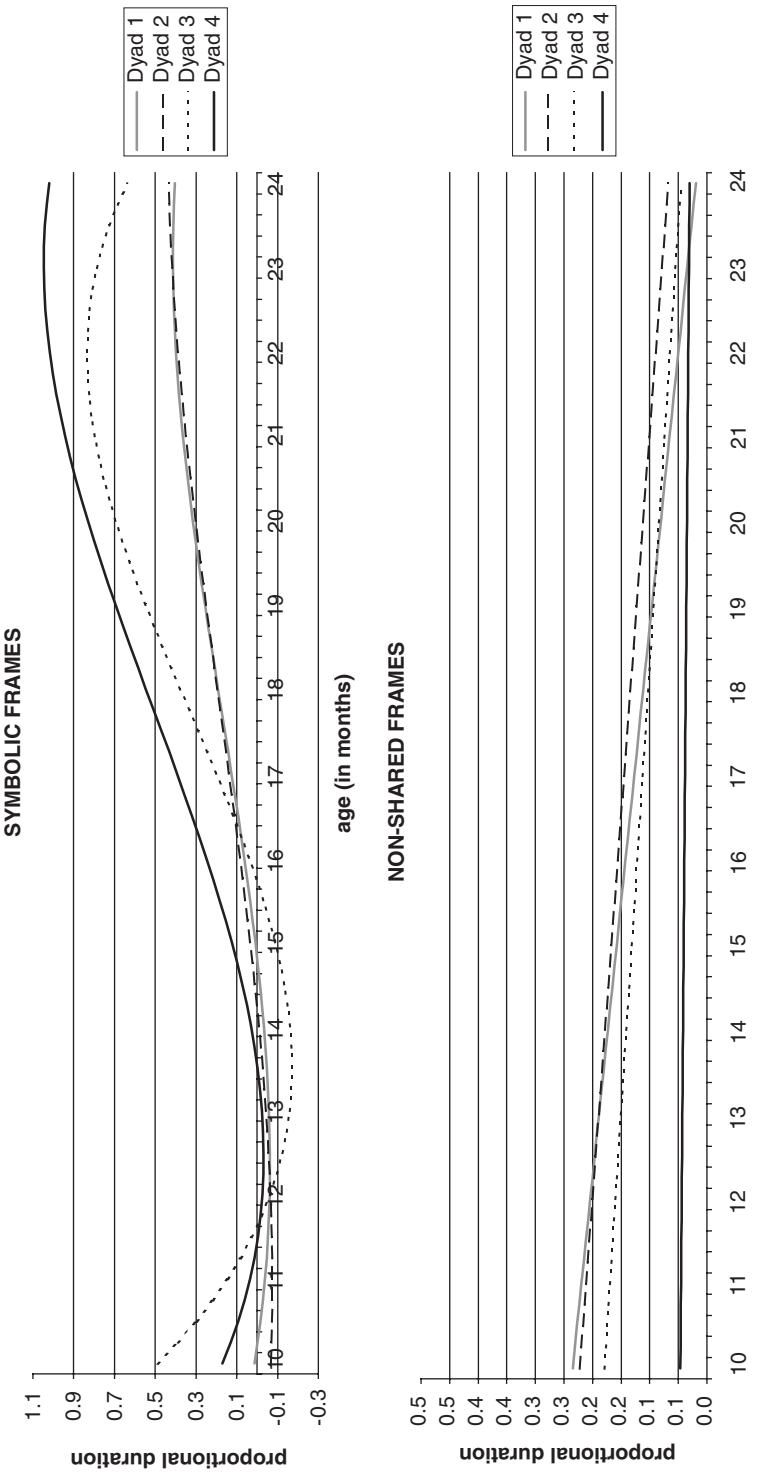

Figure 6. Hierachical linear models for age trends in shared symbolic and non-shared frames.

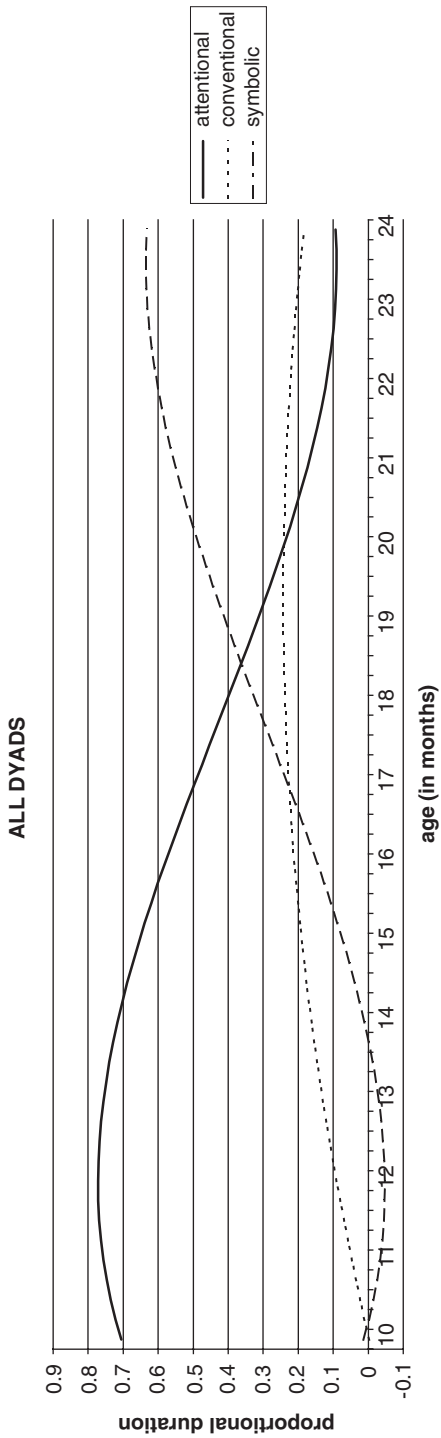

Figure 7. Hierarchical linear models for age trends in shared attentional, shared conventional and shared symbolic frames.

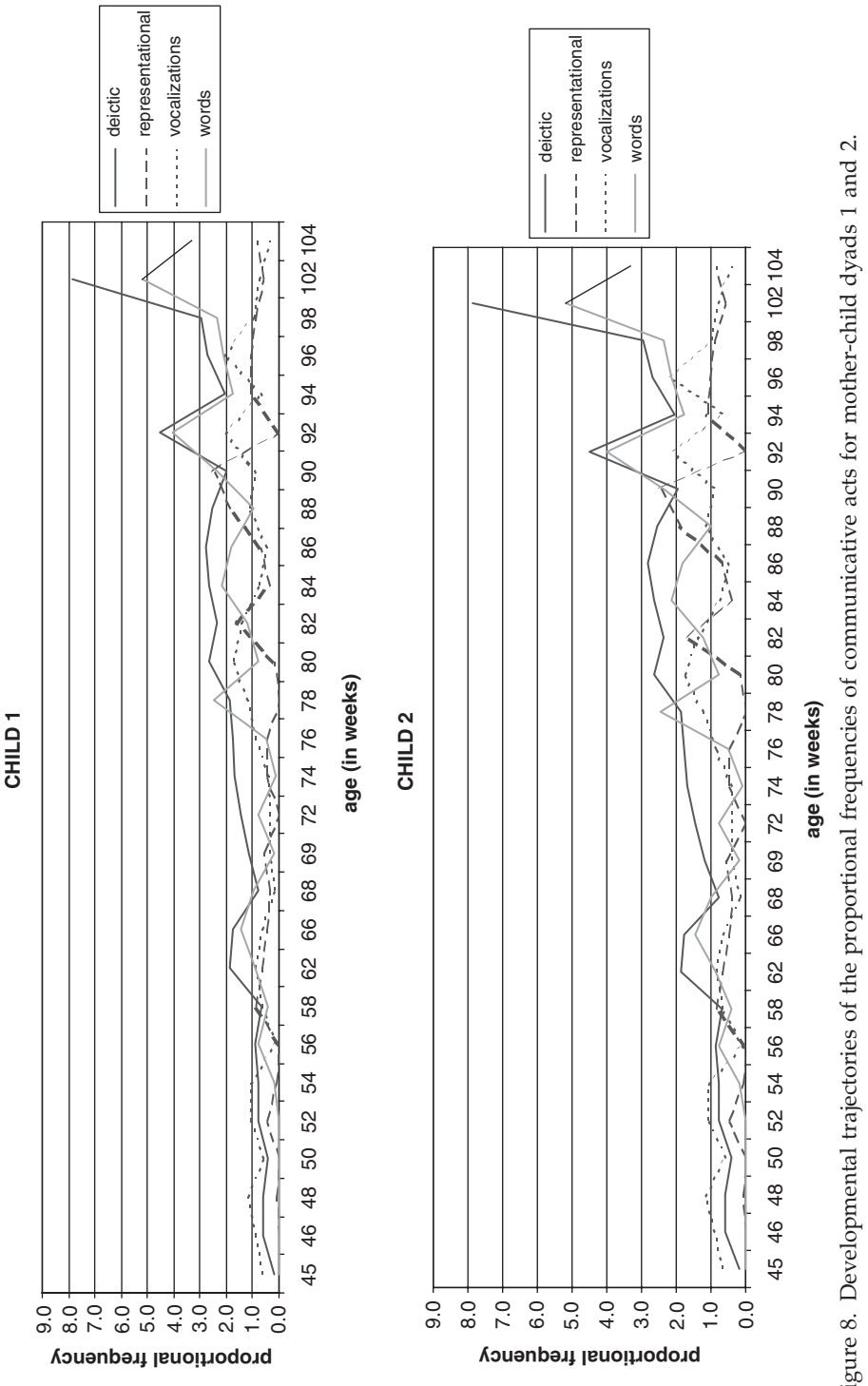

Figure 8. Developmental trajectories of the proportional frequencies of communicative acts for mother-child dyads 1 and 2.

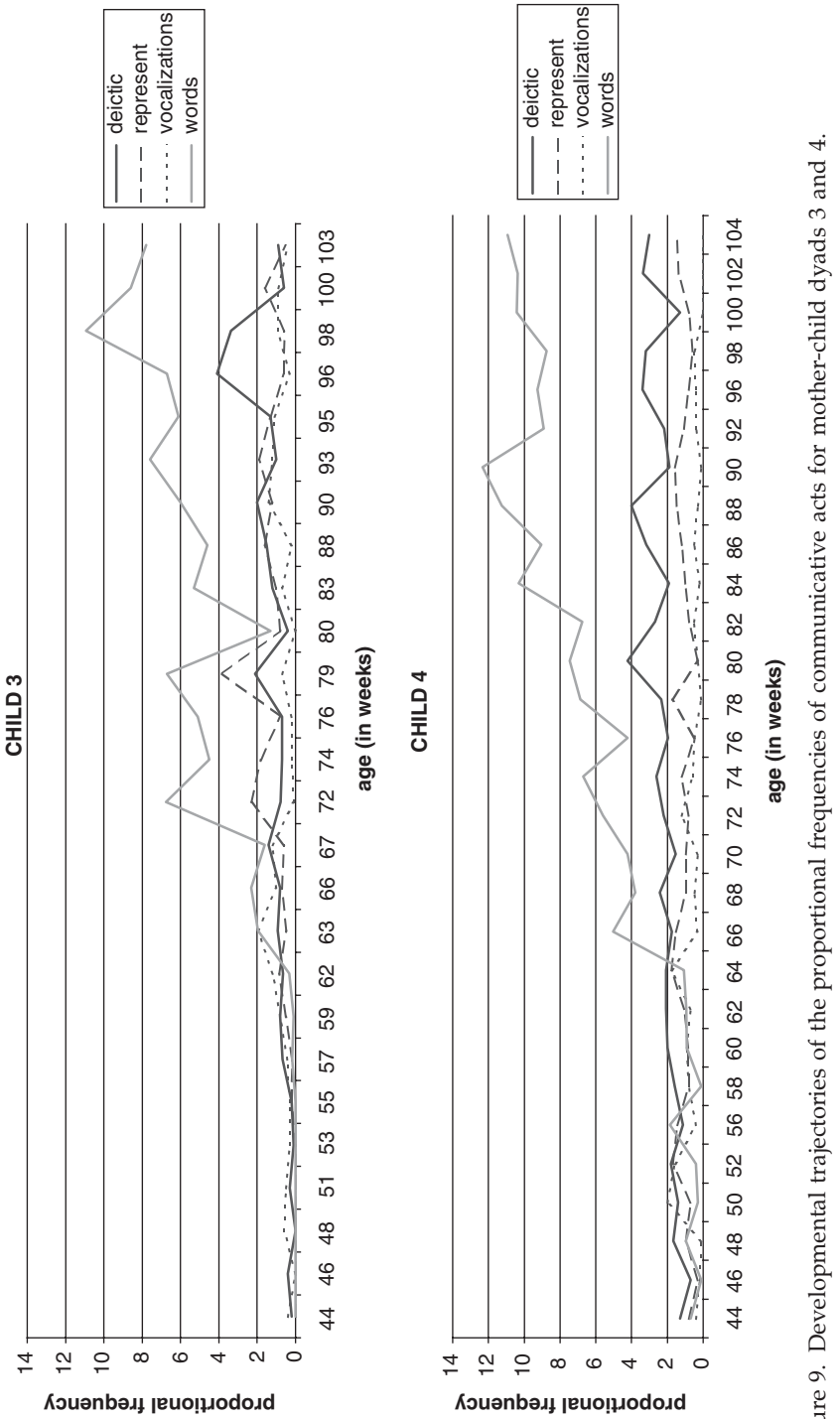

Figure 9. Developmental trajectories of the proportional frequencies of communicative acts for mother-child dyads 3 and 4.

Table 4. Standardized parameter estimates from hierarchical linear models for age trends in communicative acts

Response variable	Intercept	Age	Age^2
Deictic gesture	1.79	0.04	ns
Representational gesture	0.99	0.02	−0.0005
Systematic Vocalization	ns	ns	ns
Word	3.03	0.12	ns

Note: The dependent variable is the total frequency of each communicative act expressed as a proportion of the duration of a session. Only significant values are shown.

of protowords was relatively low compared to the frequency of other verbal acts. We therefore combined protowords and words into a single category, words.

We found that systematic vocalizations were stable in frequency. Words, on the other hand, increased with age. There were individual differences in the trajectories of word production. One girl (child 4) had an earlier onset of words, at 44 weeks, and her vocabulary increased at a more rapid rate compared to the other three children. These three children produced their first words at 50, 54 and 57 weeks, respectively.

In hypothesis B, we expected a developmental sequence for the child's communicative acts, with deictic gestures predominating earlier than representational gestures and with representational gestures predominating at later ages. We also expected that words would increase in frequency in the second year whereas systematic vocalizations would remain stable in frequency over the second year. This hypothesis was tested using hierarchical linear modelling.

For the development of gestures, the proportional frequency of deictic gestures showed a linear increase with age as well as individual differences (see Table 4 and Figure 10). The proportional frequency of representational gestures, on the other hand, showed an inverted U-shape trajectory with age, increasing, then peaking and decreasing (see Table 4 and Figure 10). Three children had a relatively narrow U-shape function, exhibiting a peak in the communicative use of these gestures. One girl (child 4), however, had a much wider U shape.

It is interesting to note that the developmental trajectory of representational gestures is similar to the trajectory for conventional frames: both show an inverted U-shape function suggesting that representational gestures may serve developmentally a bridging role as conventional frames do. We will return to this finding in the discussion.

As far as children's production of vocal/verbal communicative acts, we found as predicted that systematic vocalizations do not change significantly with age. On the other hand, words increased significantly with age, as expected. The proportional frequency of words was best modeled by a linear trajectory (see Table 4 and Figure 11). There were significant individual differences in the trajectories.

These findings confirm our hypothesis. Systematic vocalizations are stable sounds produced in the same context. It appears that they do not increase in frequency so that verbal development is accounted for primarily by the increase in frequency of words. Words increase in frequency rapidly towards the end of the second year, showing a profile similar to the increase in symbolic frames. In addition, this rapid increase may be interpreted as indicating the emergence of a 'vocabulary spurt' at the end of the second year (see Goldfield and Reznick, 1990). According to some authors, there is a moment, at around 18–20 months,

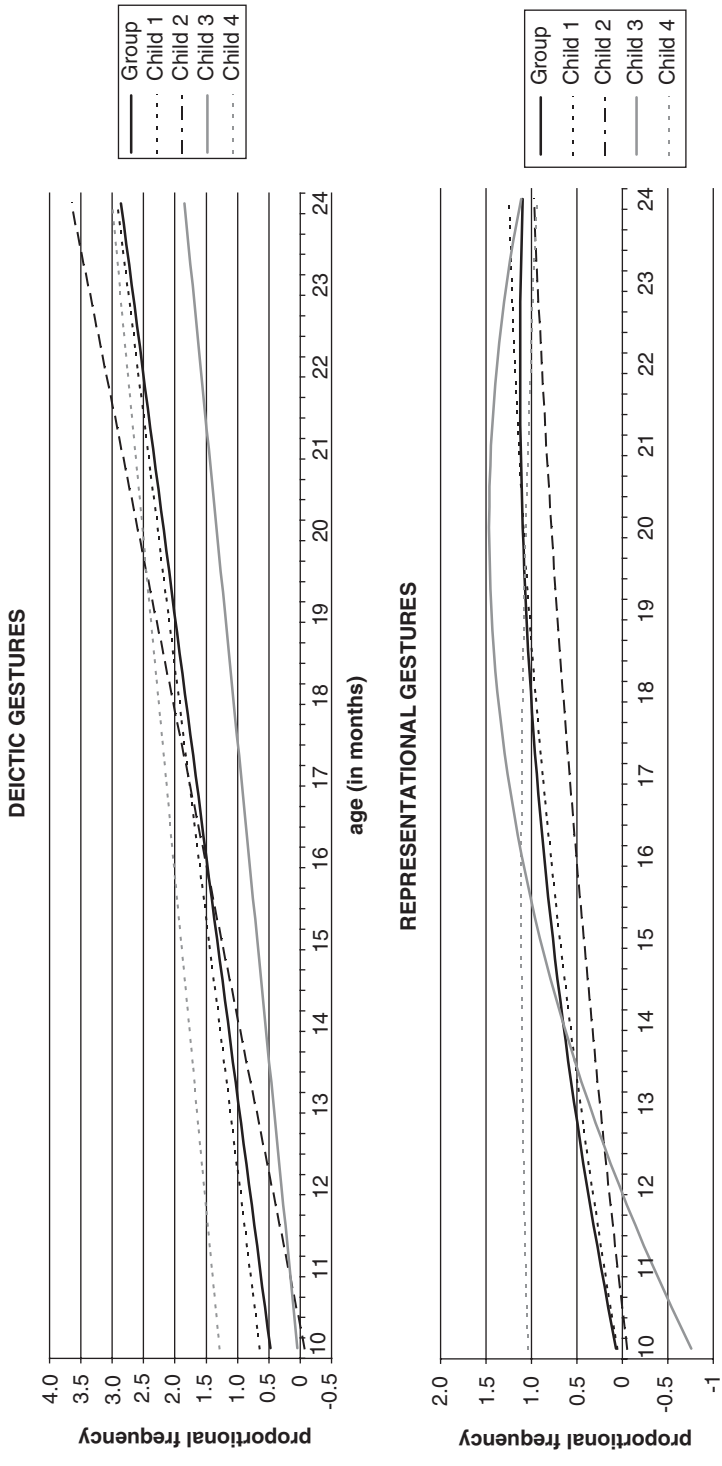

Figure 10. Hierarchical linear models for age trends in deictic and representational gestures.

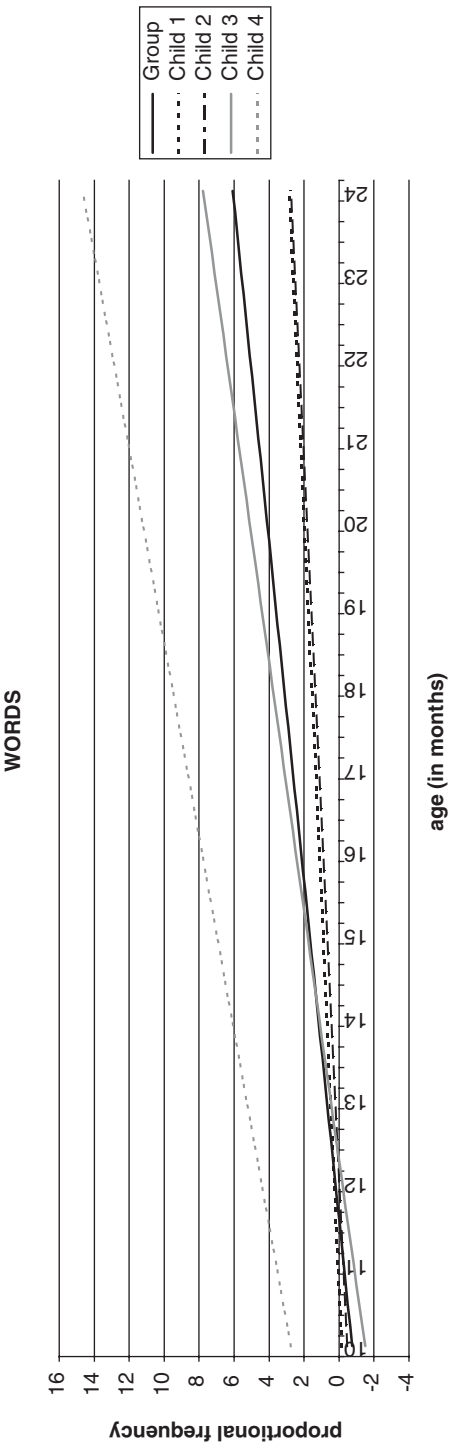

Figure 11. Hierarchical linear models for age trends in words.

when children seem to discover that things have names and that there is an arbitrary relationship between names and their referents. Soon thereafter, children rapidly acquire a large number of new words.

DISCUSSION

Our main aim in this study was to trace the developmental transitions in shared communication frames and communicative acts during the second year, using a multiple case longitudinal design and applying hierarchical linear modelling in order to analyse the developmental trajectories of frames and acts. The results not only confirm previous findings on the development of verbal and gestural communication but provide new insights into the transition to symbolic communication in the second year of life, first because of the use of frame analysis and second because of a focus on individual trajectories in development.

The use of frame analysis allowed us to specify periods in which there was a shared intersubjective experience between mother and child regarding attentional, conventional and symbolic themes. With respect to trajectories, we confirmed our hypothesis regarding developmental sequence since attentional frames, which predominate early, are gradually replaced by symbolic frames. The fact that conventional frames become predominant during the middle of this developmental period for every dyad and then decrease, led us to propose that conventional frames 'bridge' the developmental transition between attentional and symbolic communication. This finding, which can only be revealed through this methodology, confirms the significance of detailed analysis of single cases, observed intensively over the second year, in order to study the process of developmental change. It also confirms the validity of the three phase model of change in frame development, proposed by Fogel and colleagues and briefly reported before (see the section on 'Aims of the present study' and also Fogel and Lyra, 1997).

Our approach focusing specifically on shared dyadic frames, therefore, has highlighted a novel way to study the development of communication and the acquisition of language. When analysis focuses on the relationship, rather than on the contributions of each individual, a new level of developmental change is revealed. The systematic developmental patterns found at the level of frames suggest that individual actions must always be understood with reference to the developing relationship in which they are a part. Our analyses of the dynamics of the child's communicative development further emphasizes the point that these 'individual' acts, although emitted by the child and attributed to the child, are developing in concordance with the development of frames.

When we examined the child's communicative acts by themselves, as if they occurred outside the context of the mother–infant relationship, we found a significant change with age for all types of communicative acts, with the exception of systematic vocalizations. In the case of representational gestures, this change had an inverted U-shape profile suggesting again that representational gestures may 'bridge' the developmental transition between pre-symbolic and symbolic modes for expressing meaning. At the pre-symbolic level, the deictic gesture allows the child to refer to an object or event in the environment ostensively; at the symbolic level the object is referred to through an arbitrary form-meaning relationship. In between, the representational gesture serves to refer to something mimicking either its form or its function, i.e. iconically.

We had predicted that deictic gestures would predominate in frequency over representational gestures at earlier ages. Comparing the trajectories of deictic and representational gestures, this occurred not only in the earlier sessions but across all the observations for the four children in the sample. In addition, we found a linear increase in deictic gestures over the second year. Since there have not been systematic studies of the developmental course of deictic gestures over all the second year, this was not predicted. Consistent with our results, however, Iverson *et al*. (1994) found a significant increase in the production of deictic gestures between 16 and 20 months of age, whereas the use of representational gestures decreased in the same children between the two ages. In general, the linear increase in deictic gestures suggests that they continue to be useful means for communicating until the end of the second year. For example, children sometimes use a combination of a deicitic gesture and a word to express a more complete meaning or to clarify/reinforce the meaning they wish to communicate (point toward an object labelling it at the same time, or say 'thanks' accompanied by a hand open palm-up gesture to request a toy; see Bates *et al*., 1975; Iverson *et al*., 1994; Lock, 1997).

We would have liked to systematically explore the link between the child's communicative acts and frames in real time and in developmental time. Given the small sample size, only the addition of more cases to our study would allow us to further clarify these links. For example, it is reasonable to expect that deictic gestures are associated with shared attentional frames, whereas words would co-occur mainly with shared symbolic frames. More dyads would also allow us to further explore the formation of individual differences. It is clear from these four cases, however, that dyads and children differed significantly in the developmental trajectories for several frames and communicative acts.

The separate analysis of frames and communicative acts, however, strongly suggests that they are closely linked, that the child's acts are in fact part of an unfolding communicative relationship out of which language may develop. Note the obvious similarities in the developmental trajectories of frames and communicative acts. The main finding of the present study is that conventional frames and representational gestures play a crucial role in the developmental transition that leads to the emergence of symbols. Having identified these two phenomena as a 'bridge' between attentional and symbolic communication suggests that the emergence of new forms—symbols—is a result of the continuous and historically grounded re-organization of the dynamic communication system. Symbols do not emerge only from a cognitive re-organization in the child's own mind. Instead, child and adult co-create a bridging form of communication—conventional frames and acts—that are mid-way between attention getting devices and arbitrary meaning-referent relationships. We use the 'bridge' metaphor to characterize transitional forms in the developmental process leading to symbolic communication. Accordingly, we argue that 'true' symbolic communication and language do not arise as a sudden burst of words and sentences (something like a 'language organ'), but rather are grounded on social conventions constructed within communicative frames.

ACKNOWLEDGEMENTS

This work was supported by a grant to Luigia Camaioni from the University of Rome 'La Sapienza' (Ateneo 1998, 051501273) and by grants to Alan Fogel from the United States National Institute of Mental Health (MH48680 and MH 57669).

REFERENCES

Acredolo L. Goodwyn S. 1988. Symbolic gesturing in normal infants. *Child Development* **59**: 450–466.

Acredolo L, Goodwyn S. 1990. Sign language in babies: the significance of symbolic gesturing for understanding language development. In *Annals of Child Development*, Vasta R (ed.). Jessica Kingsley: London; 1–42.

Adamson LB. 1996. *Communication Development During Infancy*. Westview: Boulder.

Adamson LB, Bakeman R. 1984. Mothers' communicative acts: changes during infancy. *Infant Behavior and Development* **7**: 467-478.

Bakeman R. Adamson, LB. 1984. Coordinating attention to people and objects in mother–infant and peer–infant interaction. *Child Development* **55**: 1278–1289.

Bates E, Camaioni L, Volterra V. 1975. The acquisition of performatives prior to speech. *Merrill Palmer Quarterly* **21**: 205–226.

Bates E, Benigni L, Bretherton I, Camaioni L, Volterra V. 1979. *The Emergence of Symbols: Cognition and Communication in Infancy*. Academic Press: New York.

Bates E, O'Connell B, Shore C. 1987. Language and communication in infancy. In *Handbook of Infant Development*, (2nd edn), Osofsky J (ed.). Wiley: New York.

Bloom L. 1973. *One Word at a Time*. The Haugue: Mouton.

Bruner J. 1975. The ontogenesis of speech acts. *Journal of Child Language* **2**: 1–19.

Bruner J. 1977. Early social interaction and language acquisition. In *Studies in Mother–Infant Interaction*, Schaffer HR (ed.), Academic Press: New York.

Bruner J. 1983. *Child's Talk: Learning to use Language*. Norton: New York.

Camaioni L. 2001. Early Language. In *Handbook of Infant Development*. Bremner G, Fogel A (eds). Blackwell: Oxford; 404–426.

Camaioni L, Laicardi C. 1985. Early social games and the acquisition of language. *British Journal of Developmental Psychology* **3**: 31–9.

Dromi E. 1987. *Early Lexical Development*. Cambridge University Press: Cambridge.

Fogel A. 1990. The process of developmental change in infant communicative action: using dynamic systems theory to study individual ontogenies. In *Individual Differences in Infancy: Reliability, Stability, and Prediction*. Colombo J, Fagen JW (eds). Erlbaum: Hillsdale, NJ; 341–358.

Fogel A. 1993. *Developing Through Relationships*. University of Chicago Press: Chicago.

Fogel A, Lyra M. 1997. Dynamics of development in relationships. In *The Psychological Meaning of Chaos: Self-organization in Human Development and Psychotherapy*, Masterpasqua F, Perna PA (eds). American Psychological Association: Washington, DC; 75–94.

Fogel A, Messinger DS, Dickson KL, Hsu H. 1999. Posture and gaze in early mother-infant communication: synchronization of developmental trajectories. *Developmental Science* **2**: 325–332.

Goldfield BA, Reznick JS. 1990. Early lexical acquisition: rate, content, and the vocabulary spurt. *Journal of Child Language* **17**: 171–83.

Iverson J, Capirci O, Caselli MC. 1994. From communication to language in two modalities. *Cognitive Development* **1**: 23–43.

Halliday MAK. 1975. *Learning How to Mean: Exploration in the Development of Language*. Edward Arnolds: London.

Lock A. 1980. *The Guided Reinvention of Language*. Academic Press: London.

Lock A. 1997. The role of gesture in the establishment of symbolic abilities: continuities and discontinuities in early language development. *Evolution of Communication*, **1**(2): 159–192.

Masur EF. 1983. Gestural development, dual-directional signaling, and the transition to words. *Journal of Psycholinguistic Research* **12(**2): 93–109.

Nelson KE. 1974. Concept, word, and sentence: interrelations in acquisition and development. *Psychological Review* **81**: 267–285.

Ratner N, Bruner J. 1978. Games, social exchange and the acquisition of language. *Journal of Child Language* **5**: 391-402.

Thelen E, Smith LB. 1994. *A Dynamic Systems Approach to the Development of Cognition and Action*. Mit Press: Cambridge, MA.

Woodhouse G. 1996. *Multilevel Modelling Applications: A Guide for Users of MLn*. Institute of Education, University of London.

