Change Processes in Relationships

A Relational-Historical Research Approach

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We dedicate this work to Alexandra Lynn Marie Stroming and to Delno C. West

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Overview of the research problem and summary of findings

The real is fragile and inconstant:
its law is restless change:
the wheel of appearances turns and turns
over its fixed axis of time.
[Es frágile lo real y es inconstante;
también, su ley el cambio, infatigable:
gira la rueda de las aparencias
sobre el eje del tiempo, su fijeza.]

Octavio Paz, *A tree within (Arbol adentro)*, pp. 14–15.

. . . change is conceived partly as the continuous transformation of the one force into the other and partly as a cycle of complexes of phenomena, in themselves connected, such as day and night, summer and winter. Change is not meaningless – if it were, there could be no knowledge of it – but subject to the universal law, tao.

Richard Wilhelm, Introduction, *The I Ching or Book of Changes*, p. *lvi*.

The scientific study of change is an oxymoron. Science attempts to observe and classify, to demarcate and delimit, to specify and contain. Change resists classification, limitation, and containment. Things change and nothing remains the same. If observed a sufficiently long period of time and with sufficient patience, everything in the entire universe changes. Change must be a fundamental property of all things – just as the concrete features that appear to us at any moment can be called properties of things. The universe unfolds from the big bang. An embryo becomes an adult. Mountains are pushed through the earth's crust and then erode.

The quoted excerpts on the opening pages suggest that change may obey universal laws. The idea of a law of change also appears to be an oxymoron. There is at least one way that change can be lawful. This can occur if the pattern of change repeats itself. The simplest example is the repeating pattern of the seasons of the year. Depending upon your global latitude, the "same" pattern of seasons repeats every year, albeit with

variations from one year to the next. This type of change is cyclical. There is clearly something lawful about seasonal cyclic change: a set sequence of seasons related to the inclination of the earth's axis with respect to the sun.

Historical change, on the other hand, does not at first appear to be lawful. It is a continuously unfolding process from one generation or event to the next. While the atmospheric climate is cyclical, the earth registers the cycles historically with wind and water erosion. Global warming and ice ages are probably examples of atmospheric changes that are historical, built over time by an accumulation of past events. Geologists and climatologists, however, seek laws of historical change in these domains by searching for hidden repeating cycles with the "continuous transformation of one force into the other" (see opening quote from the *I Ching*).

In this book, we set out to ask whether the historical changes manifested in the development of interpersonal relationships contain hidden cycles, patterns, or laws. All humans go through the life cycle, moving in a known sequence from one developmental stage to the next. Even though we are studying change across a well-known developmental succession in early infancy, the occurrence of particular developmental stages in a particular sequence is not the type of law that we seek to uncover. Rather, we are searching for laws of change that could be applied to the developmental transitions between any two stages of the life cycle, or between any two stages of relationship growth (stages like acquaintance, friendship, and intimacy or dating, engagement, and marriage).

Research on the problem of change processes in development has been facilitated by recent advances in dynamic systems theory within developmental psychology and historically grounded qualitative methods in life history research. Based on these advances, we present a method called **relational-historical research** on developmental change processes in interpersonal relationships. Relational-historical research rests on three premises: that the developing relationship (not the individual) is the unit of analysis, that change emerges from but is not entirely constrained by the patterns of the past, and that developmental process is best revealed by making frequent observations within a particular case before, during, and after a key developmental transition.

In this work, we studied developmental change process in interpersonal relationships using mother-infant dyads. In particular, we studied the developmental transition, around four months of age, from primarily face-to-face communication to communication about and with toy objects. In this transition, mother-infant dyads use face-to-face play as

the historical background from which to launch a triadic relationship: infants' exploration of the object world in the company of their mothers.

We make the working assumption that his developmental transition may serve as a model for many other relationship changes in which exclusive focus on the dyad is replaced by an addition beyond the dyad: the birth of a child for a married couple or the addition of a new member into an existing group. This work may also be a model for the introduction of a new or "foreign" topic into an existing relationship. This may be, for example, an interpretation in psychotherapy or a suggestion for an innovative way of relating in a romantic couple.

The relational-historical research used here focuses on the description of change in dyadic communication from the perspective of the history of that communication within the dyad. We used a multiple case-study design of thirteen infant-mother dyads, when the infants were between the ages of two and seven months. Each dyad was videotaped for ten minutes weekly while interacting spontaneously with a set of age-appropriate toys. Relational-historical research combines quantitative analyses of developmental trajectories and behavior sequences with qualitative descriptions of the historical emergence of change and stability within dyads.

In this study, we focus on observable patterns of communicative behavior rather than on each participant's subjective experience. Interpersonal relationships have regularly recurring patterns of communication called **frames** (See Chapter 3). Frames are segments of co-action that have a coherent theme, that take place within a particular location (in space or in time), and that involve particular forms of mutual co-orientation between participants. The coherent themes involve shared meanings or goals, implicit or explicit, about the nature and course of the communication. Examples of frames are recurring topics in conversation and interaction rituals such as bedtime stories. Frames recur repeatedly over weeks and months and are reconstituted dynamically and dyadically each time they reappear.

The communication between these mothers and infants was coded into four frames that form the basis for the data analysis in this study. The **social frame** was coded when the topic of communication was face-to-face play without objects. The **guided object frame** was coded when mother took an active role in demonstrating and scaffolding the infant's use of objects. The **non-guided object frame** was coded when the infant played with objects without the mother's direct assistance but with her ongoing attention and verbal commentary. The **social/object mixed frame** was coded when elements of both face-to-face play and guided object play appeared at the same time, as when a mother used a

toy to touch the infant's face or body while vocalizing in an expressive manner typical of the social frame. These frames are illustrated in Figure 0.1.

By way of preview of our main results, we found that there was a three-part historical sequence of the change process: historical frames, developmental bridging frames, and the emergence of new frames. Depending upon the dyad, the historical frames were either the social or the guided object frames. The bridging frames were either the social/object mixed frame or the guided object frame, and the emerging frame was the not-guided object frame for all the dyads. This is represented as the following sequence:

$$(P_1) \quad (\text{Historical} \leftarrow \text{Bridging}) \Rightarrow (\text{Bridging} \leftarrow \text{Emerging})$$

Figure 0.1. (a) Social frame (mother and infant engaged in face-to-face play without objects), (b) guided object frame (mother demonstrates objects while infant observes), (c) social/object mixed frame (mother uses object socially, as in tickling the baby with the toy), (d) not-guided object frame (the infant explores the object while mother observes).

In this sequence, the inner bi-directional arrowheads represent realtime transitions between frames, such as when a guided object frame is immediately followed by an instance of the social frame. The bold unidirectional arrowhead represents the developmental time sequence. Thus, before the bold arrow, the dyad spends most of their time in historical and bridging frames and makes regular realtime transitions between them. After the bold arrow, the dyad spends most of their time in emerging and bridging frames and makes regular transitions primarily between these two frames. We considered a particular target frame to serve the function of **bridging** if it met four criteria:

- If realtime transitions between frames in any observation session were more likely between the target frame and the historical frame, or between the emerging and the target frame, as compared to the likelihood of realtime transitions directly between historical and emerging frames.
- If the target frame became predominant in duration in the weeks in between when the historical frame was predominant and later when the emerging frame becomes predominant (A bridging frame, therefore, "touches" and mediates between historical and emerging frames both in realtime and in developmental time).
- If the target frame contained some elements of the emerging frame of mother-infant-object communication, yet it occurred developmentally before the emerging frame becomes the predominant pattern.
- If the target frame contained elements of the historical frame, yet it occurred developmentally after the historical frame became the predominant pattern.

Bridging frames arose spontaneously in all of the dyads and bridging appears to be a process that serves several developmental functions. First, bridging frames point toward the future since they always contained some elements of the emerging frame of mother-infant-object communication. Second, bridging frames also contained elements of the historical frame, thereby carrying the relational history within them. In most cases, the social/object mixed frame served as the bridging frame. During this frame, the dyad uses objects as if they were part of social play – such as mother tickling the baby with the object – and not as objects for exploration. Bridging frames, therefore, seem to buffer the developmental transition from the old to the new by creating an intermediate frame having elements of past and future. We argue that bridging frames provide communicative stability that allows the dyad to try out the future actions without having to suddenly let go of the historical stable patterns to which they have become accustomed.

The accompanying series of photos (Figure 0.2) illustrates a realtime transition, in a single observation session for one dyad, between the guided object frame (the historical frame), the social/object mixed frame (the bridging frame), and the not-guided object frame (the emerging frame). Note that the bridging frame of "kissing" the baby's face with the object serves as a transition between the mother's demonstration of the object and the infant's taking hold of the object.

Some models of change derived from dynamic systems theory suggest that developmental change occurs in sudden jumps called phase

Figure 0.2. A realtime transition from the guided-object (historical) frame, to the social/object mixed (bridging) frame, to the not-guided object (emerging) frame. The bridging frame, in which the mother uses the toy to "kiss" the infant's face, mediates the realtime transition between the historical frame in which mother is demonstrating the toy while the infant observes and the emerging frame in which the infant is holding the toy while the mother observes.

shifts or catastrophes, and that during this period of change the system experiences a relatively chaotic form of variability. In our data, although the developmental trajectories of some individual frames indeed had rather abrupt increases or decreases, our results on bridging frames suggest that for the developing relationship as a whole – the multiple frames taken as a complex communication system – developmental transitions need not be precipitous or chaotic. The fact that every dyad in our sample showed some form of bridging suggests that social systems capitalize on their complexity to create relatively smooth developmental transitions: literally to make bridges between the old and the new.

Our concept of bridging may apply more generally to many different types of relationship change. Consider romantic relationships, for example. The general model could be applied in the following ways:

(Historical ← Bridging) → (Bridging ↔ Emerging)
(Courtship ↔ Betrothal) → (Betrothal → Marriage)
(Marriage ← Pregnancy) → (Pregnancy ← Parenting)

Most societies have some finite period of betrothal, such as an engagement period marked by rituals such as engagement rings, wedding planning, and parties, prior to marriage. Perhaps society has simply discovered the importance of bridging courtship and marriage and thus developed a culturally standardized bridging period. In the model above, we refer to conversational frames about courtship, betrothal, and marriage as well as to the ongoing formal state of being betrothed or married. In the case of pregnancy, bridging occurs by the fact of biology but it still serves the same function: a window of time in which couples can make the developmental transition to include a new family member. In addition, in the historically prior period, conversational frames about pregnancy are more likely to occur and make realtime transitions with conversations about the everyday occurrences of married life, than are conversations about parenting.

In therapeutic and educational relationships there is likely to be a bridge between the known and the new. Psychotherapy clients are unlikely to accept the intensity of their own feelings of loss, separation, or trauma unless they can first feel as if there is emotional safety in the relationship. Therapists can create a bridging frame around acceptance and empathy that bridges the emerging reconstructive work that creates new patterns of thinking and feeling for the client. Teachers must package new knowledge in ways that students can see its relationship to what they already know. They must create a set of supports and encouragements that keep a student working hard toward an emerging understanding that they do not yet possess.

Coming back to our results, we further found that there are different types or levels of change in relational-historical systems. First there are realtime transitions between frames, that is, when the dyad shifts from one to another frame. These were brief but recognizable periods in which actions from the prior frame were either deleted, included, or overlapped with the next frame during the transition. We also found transitions between different actions within the frame, actions that could be considered variations on the theme of the frame. These changes between the actions that constitute this variability, however, do not change the frame but rather serve to constitute the realtime dynamics of what is usually done during a particular frame. We call this type of change ordinary variability or **level 1 change**. Level 1 change in both frames and transitions are forms of stable change, change that maintains the frame or transition in realtime. Level 1 change shows how even regularly recurring patterns in communication are always dynamically changing even as they remain "the same."

To illustrate level 1 change, imagine a pair of friends that share a frame for meeting regularly for lunch. They show level 1 change because they do not always eat in the same restaurant, nor do they always meet on the same day of the week. These things change while the frame remains the same. For them, the variability in time and location is ordinary, an accepted part of the frame.

Figure 0.3 illustrates level 1 change for one of our mother-infant dyads. The mother holds and demonstrates to the infant a series of different toy objects. The toys change and the actions with the toys vary to some extent, but the guided object frame – in which mother holds the toy and the infant watches – remains unchanged.

Level 2 change is defined as an innovation within the ordinary variability of the frame dynamics. An innovation is a novel action appearing for the first time over the history of observations of a particular

Figure 0.3. Level 1 change, or ordinary variability, during the guided object frame. The mother demonstrates different toys while the infant observes.

type of frame. We discovered that at its first appearance, the innovation has the effect of maintaining the ordinary, level 1 variability even as it introduces a new element into the frame. At this level, an innovation does not significantly alter the ordinary variability within the frame when it first occurs.

For the pair of friends with a regular lunch frame, level 2 change is a change that is more out of the ordinary for the couple. This could occur in many different ways. They may decide, one time, to go to a really expensive restaurant that was not part of their ordinary pattern. Or, they may decide to meet for dinner, or to go for a walk after lunch. So long as the participants perceive the change as substantially different from what they shared before, it can be called level 2 change. When it first occurs, level 2 change typically does not alter the general pattern of the frame: the act of meeting together regularly and talking to each other.

Figure 0.4 illustrates level 2 change during the guided object frame in one of our mother-infant dyads. In the previous set of photos from the guided object frame, the mother demonstrated a series of toys while the infant watched. In these examples the mother attempts briefly to place a toy into the infant's hand. The infant, however, did not hold the toy for long and the mother quickly resumed the ordinary variability (level 1 change) of the guided object frame. These level 2 innovations, therefore, did not change the basic pattern of the guided object frame in the session when they first appeared.

We found, however, that some innovations appear to become "amplified" in subsequent sessions, developing into a new predominant pattern of ordinary variability within the frame and replacing the prior regime of ordinary variability. When this occurs, a "significant change" in the system arises. These "significant changes" constitute **level 3 change** or developmental change. This finding also shows that in all cases that we observed, the origin or source of significant changes in frame dynamics is the appearance of innovations in earlier sessions. We write this developmental process as follows

$$P_2 \quad \text{level } 1 \rightarrow \text{level } 2 \rightarrow \text{level } 3$$

Our analysis of levels of change leads us to suggest that innovations are a way in which the relationship tries out novel actions but without a serious alteration of the current pattern of ordinary variability. If these novel actions are accepted or ratified by the members of the dyad upon subsequent occasions, they become amplified in importance to the dyad gradually replacing the old pattern. Innovations are seeds that may change the ordinary variability within frames and that have the potential

to alter the dynamics of the other frames in the entire relationship system.

When developmental change is observed, as indicated by a significant increase or decrease in the duration of frames in the system, it is typically accompanied by a permeability of the frames: frames incorporate innovations from other frames and, as a result, new frames form while historical frames dissolve. This is part of the dynamics that occur during the bridging period. For the friends who shared lunch and perhaps went out to dinner together, this dinner might have been a one-time event and their relationship may have continued in the same lunch-time pattern without a significant developmental change. On the other hand, the

Figure 0.4. Level 2 change, or innovations, during the guided object frame. Mother attempts to put a toy into the infant's hand and the infant reaches. On another occasion, mother offers toy and infant takes it. Each of these instances was a divergence from the ordinary variability of the guided object frame. In each case, the frame dynamics quickly return to the ordinary variability of demonstrating objects while infant observes.

dinner may precipitate more intimacy in the couple, which may lead to sharing more dinners and evenings together. A level 3 change may occur in which a friendship relationship develops into a romantic relationship. According to our findings from the mother-infant dyads, we would hypothesize that this kind of developmental change could not have occurred without the ratification of some prior innovation that moved the couple to greater levels of intimacy.

Where do innovations come from? Which of the participants introduces them? What determines whether they are ratified or discarded by the participants? How do they lead to developmental change? These are all questions that will be addressed in our research. The answers have implications for many different types of relationship change.

In our lunch date couple, perhaps the innovation arose spontaneously as part of a playful "what if?" dialogue that developed during one lunchtime meeting. Perhaps one participant spent months getting up the courage to take the risk toward more intimacy. Perhaps the other one was nonverbally communicating the desire for this to happen. Everything then depends upon how the dinner is experienced. A host of verbal and nonverbal communicative exchanges, emotions, and the creation of a shared goal to move to a new level of intimacy may be part of a process of amplification of the innovation that may carry the relationship forward.

In psychotherapy, some of the most successful innovations arise in a co-discovery process between client and therapist. When the therapist allows the client to discover their own understanding, and is present and supportive of the client's discoveries, a shared "dyadic state of consciousness" can emerge during a highly emotional "now moment" (Stern, 1998; Tronick, 1998). There is something about the shared moments of discovery – their emotional resonance perhaps – that play a role amplifying the innovation into real developmental change.

Microsoft CEO Bill Gates was quoted widely in newspapers on July 30, 2004 saying, "One thing about innovation is we've got to make sure it maps to what the consumer sees as value." Gates suggests that for a technological innovation to lead to a successful new product or service (a level 3 change), it must be first ratified by a substantial number of consumers. Not only that, the manufacturer must be in touch with the consumers in the process of creating the innovation, to make sure that they are making an investment in the product's development that is likely to pay off. With the most successful business innovations, there is a constant dialogue between maker and consumer and a strong intention to maximize the chances for ratification. This ratification sets off a process by which the original innovation, a small seed, can become

amplified into a widely used and distributed product, a product that may significantly alter the consumer's relationship with the world.

Finally, our case history approach also revealed that each dyad develops their own style of communication reflecting different ways in which their history was retained or discarded as they changed. Dyads developed unique communicative routines within frames and individual infant's styles of relating to objects and to mother appeared to form out of the initial conditions of the communication system during the earliest observations. We conclude that the historical dynamics of relationship change must be part of a complete understanding of individual development.

Our findings suggest a new way of looking at all forms of interpersonal relationships – including friendships, romantic partnerships, therapeutic alliances, employer-employee relationships, and even larger groups, organizations, and society as a whole. If the laws of change we found in our sample generalize in some form to other relationships, we may be able to understand how change for the better may be facilitated and change for the worse may be avoided. In the Epilogue, we shall speculate on the implications of our work for all forms of human change in relationships. Parenting, training, education, and clinical applications can all benefit by a clearer understanding of when and how to create innovations that most effectively lead to desired developmental change. In situations in which people's development has been restricted or compromised in relationships – as in abusive and coercive relationships, or in insecure attachments – our model may suggest ways of introducing innovations and creating bridges across emotionally threatening territory in therapeutic relationships. The goal is to understand processes that may lead to a reconstruction of more developmentally healthy ways of relating.

Outline of this book

In Chapter 1, we introduce our relational perspective and review theoretical perspectives on early development that have inspired our work. These theoretical perspectives all focus on the person-in-relation. They include Piaget's theory, Vygotskian sociocultural theory, Gibsonian ecological theory, and dynamic systems theory. Chapter 2 is a review of the literature on the developmental transition, around the age of four months, of infants' relationship to objects, both alone and in the social context. Chapter 3 presents a relational-historical theoretical perspective that integrates these other theoretical influences and applies them to the study of relationship change. Chapter 4 presents an outline of a relational-historical research methodology: frame analysis, quantitative and

qualitative analysis, and the case study method. Chapter 5 gives the research propositions that guide the methods and analysis. In Chapter 6 we cover methodological details of the present study, such as the subjects, procedures, coding, and data analysis. Chapters 7 – 11 present the results, and Chapter 12 provides a summary and interpretation of findings. The Epilogue brings us back to taking a broader perspective on the process of change in relationships, where we explore applications to other forms of relationship change in clinical, educational, and cultural processes.

1 Relationships as developing systems: theoretical foundations

In this introductory chapter, we begin with an overview of our basic theoretical orientation toward relationships. Relationships are not simply a thing to be studied and understood. Rather, we view all of nature as a system of interconnected relationships. In that sense, everything is part of a nexus of relationships: there are no "individuals" but only persons-in-relation. Second, we review a group of developmental theories that have their foundation in this relational world-view.

Overview of the theoretical orientation

A relational perspective on development

The foundational principle of this book is that people develop in relation to others and to their environments. A full grasp of a relational perspective must involve each person in their local relationships (family, work, school) and in relation to the sociocultural system. Here, however, we take a relatively simple relationship system – mother and child – and use it as a model system for revealing some of the details of how all relationships change over time. In the Epilogue, we shall elaborate ways in which our findings can be generalized to other relationships but the reader is encouraged to explore their own implications throughout the book.

People are not "themselves" in isolation but become fully realized as whole human beings in relation to others (Beebe & Lachman, 2002; Collins, 1999; Fogel, 1993; Hinde & Stevenson-Hinde, 1987; Lyra & Winegar, 1997; Overton, 2002; Sander, 1977; Stern, 1985; Tronick, 1998). The categories that people use to describe and to operate on the objective environment have developed from a shared understanding, derived from live interpersonal communication, of the world (Beebe & Lachman, 2002; Lyra, 1998; Rommetveit, 1990; Trevarthen & Aitken, 2001; Tronick, 1998; Vygotsky, 1978).

Like individuals, relationships develop over time as observed by changes in patterns of communication, emotional closeness, feelings of mutual intimacy, and attachment (Bahktin, 1988; Baxter, 1994; Bowlby, 1969; Duck, 1991; Fogel, 1993; Gottman, Murray, Swanson, Tyson, & Swanson, 2002; Lyra & Winegar, 1997; Markova, 1990; Rawlins, 1983; Werner, Altman, Brown, & Ginat, 1993). In this work, we study developmental change and stability in thirteen mother-infant dyads videotaped weekly during free play between two and seven months of age. We document the changes in the regularly recurring patterns of communication between weeks for each dyad.

Regularly recurring patterns in a communication system are called **consensual frames** (see Chapter 3). Consensual frames (or simply, frames) are recurring segments of socially shared co-action that have a coherent theme, that take place in a specific location (in space or time) and that involve particular forms of mutual co-orientation between participants (Bateson, 1955; Fogel, 1993; Goffman, 1974; Kendon, 1985). The coherent themes involve shared meanings or goals, implicit or explicit, about the nature and course of the communication. Examples of frames are greetings, topics of conversation, conflicts, or in the case of this study, different forms of mother-infant social play. The period between two and seven months was chosen because mother-infant relationships undergo a well known developmental transition from frames for face-to-face social play without objects to frames for object-directed social play.

The choice of frames as the unit of analysis in this study is guided by theory and research from a dynamic systems perspective. In this view, complex systems, such as the mother-infant dyad, develop regular and repeating patterns of co-action called **attractors** that are qualitatively different from each other (Kelso, 2000; Thelen & Smith, 1994). Human locomotion, for example, has a number of attractors such as crawling, walking, and running. In communication research, frames provide an essential macroscopic level of analysis in which patterns of change with development can become as apparent to observers and participants alike. This macroscopic level differs from the microscopic level of specific actions such as smiling, reaching, or demonstrating a toy.

In this study, we show how the four frames we have identified for this communication system have systematic developmental trajectories in their durations and systematic changes in their qualitative meaning for the participants. Frames allow developmental change to become visible and understandable in a way that a sole focus on microscopic changes in realtime behavior cannot provide. Although microscopic changes may be difficult to observe or their significance may

be easily ignored, through the use of frames, we are able demonstrate how less observable microscopic changes may lead to major qualitative developmental changes in the relationship.

An historical approach to relationship development

Our research is focused on the process of change, and specifically on how the relationship changes from earlier to later frames. An historical approach to development suggests that change grows systematically out of earlier periods. How does the history of the system affect its future? This can only be answered by observing the same relationship at relatively frequent intervals over a period of time in which that relationship is likely to change developmentally.

According to a dynamic systems perspective, change in the macroscopic regularities, the attractors of the system, is most likely to occur when the ordinary variability within the attractor exceeds the ability of that attractor to maintain its dynamic stability. When ice is heated, molecules move faster and eventually break the bonds of the ice crystals, which eventually shift the system into a different attractor: water. In this kind of physical system, change is related to the increase of a simple physical parameter of temperature. It is possible to capture the history of the system by its prior temperature.

Communication, on the other hand, is an informational system. Communication is not bound solely by the physical laws of motion but rather by relationships in which actions may signify a complex set of meanings and/or other actions (Fogel, 1993; Pattee, 1997). In other words, communicative actions change peoples' behavior not by a physical force but because those actions have a certain "meaning" that is shared by the participants. The sequence of bases in the DNA molecule works in the same manner: each type of sequence communicates to the cell to manufacture a different type of protein. The genetic code is therefore informational.

Communication systems cannot ever be reduced entirely to quantitative variables and the methods for studying communication as a dynamic system will necessarily diverge from those used for the study of primarily physical systems. The history of a communication system is captured by the frames for shared meanings of the co-participants. Change in the system must be understood in terms of informational differences: that which, from the perspective of the participants, appears novel in comparison to prior shared meanings.

An historically grounded developmental psychology focused on change processes in social or cognitive meaning systems was the hallmark

of the work of Piaget, Vygotsky, and other mid-century developmentalists. The historical approach has been applied more recently using microgenetic research designs (Bruner, 1983; Fogel, 1990; Granott & Parziale, 2002; Lavelli, Pantoja, Hsu, Messinger, & Fogel, 2005; Overton, 2002; Siegler & Crowley, 1991) such as narratives of life histories (cf. Rosenwald & Ochberg, 1992) and frequent observations of within-case developmental change from a dynamic systems perspective (Fogel, 1993; Thelen & Smith, 1993; van Geert, 1998). Infant-mother dyads are excellent subjects for microgenetic life history research because they undergo major developmental changes in a relatively short period of time: over months instead of years.

Although Piaget, Vygotsky, and others set a research agenda for the study of historical change processes, only a small number of developmentalists have followed in their footsteps (Lerner, Dowling, & Chaudhuri, 2005; Overton, 2002; Siegler & Crowley, 1991). Historical research is difficult to do, requires detailed observations on individuals, in-depth qualitative analysis to understand changes in meaning and a relatively small number of individuals (as exemplified by Piaget's case studies on his own three children). Developmental psychologists have tended to focus on normative and experimental research because it is believed to be more generalizable to the population, more understandable to funding agencies and journal reviewers, and because the readily available research toolkit is the most complete for these research designs.

Recent advances, however, have given developmental scientists new tools for the study of change processes. This study relies on an eclectic combination of some of these new tools. There now exist a new class of statistical models (called hierarchical linear models or multilevel models; cf., Prosser, Rasbash, & Goldstein, 1991) that allow researchers to examine developmental trajectories, made by tracking a key measure over frequent observations, for the group as a whole and for each individual. There have also been recent improvements in qualitative research methods, giving new credibility and rigor to the use of narrative descriptions of observed behavior and life history narratives (Denzin & Lincoln, 2000; Polkinghorne, 1995). Finally, there have been theoretical advances that provide new models for the study of change process, most notably, the dynamic systems perspective. According to that perspective, when the unit of analysis is the within-case developing system, the process of developmental change is best revealed when research is focused on key developmental transition periods (Chen & Siegler, 2000; Fogel, 1990; Thelen & Ulrich, 1991). By conducting intensive observations before, during, and after a key developmental transition, we can observe the dynamics of change. These new quantitative and qualitative

methods fit perfectly with the focus of dynamic systems on change over time in the qualitative macroscopic attractors.

Transitions in relationship development

From a dynamic systems perspective, development is conceptualized as the re-organization of prior attractors and the emergence of new ones as the system moves through a developmental transition (Fogel & Thelen, 1987; Thelen & Smith, 1994). Our study is focused on the developmental transition around the fourth month of the infant's life, as the mother-infant relationship shifts from stable face-to-face play frames to stable object-directed play frames.

From the perspective of individual (rather than relational) development, the existence of a developmental shift around the age of four months is well documented (see Chapter 2 for a review of the literature). Piaget's (1952; 1954) detailed case studies of the process of sensorimotor development in his own three infants are the most detailed descriptions of developmental process during this period. Piaget, however, focused on infants in relation to objects but did not explicitly include the role of the adult. We will follow Piaget's example in the use of detailed case study methods, but our cases will be mother-infant dyads with and without objects. We present data from thirteen mother-infant dyads observed for twelve consecutive weeks during this particular developmental transition. We also complement our quantitative descriptions of frequencies and durations of frames and other behavior patterns using multilevel models with narrative descriptions. These data are intended to document that each of the frames makes systematic changes in quantity and quality across the four-month developmental transition.

Since we have weekly videorecordings of each dyad beginning at one month of age, we took the onset of visually guided reaching as a marker for the developmental transition. The emergence of reaching changes the character of the mother-infant relationship. It shifts the focus from the mother's demonstration of visual and auditory properties of objects to the infant's tactile exploration of objects with the mother's assistance. We focused our coding and analysis on the six weeks before and six weeks after the acquisition of visually guided reaching. In this way, we were able to focus on the same developmental transition in our subjects, independent of age. In our study, we track the historical changes in infant's and mother's actions in parallel with changes in the relational frames. Also following Piaget's example, we write narrative descriptions of communicative actions using a qualitative analysis on four of the

thirteen dyads, and we examine these in conjunction with the detailed coding and quantitative sequential analysis of the data from the whole sample. In Chapters 4 and 6, we discuss further our methods of analysis.

Summary

This study is based on a **relational-historical** perspective of development. The unit of analysis for the relationship is the communication frame. We use a case study method in which we can understand the details of the history of each developing relationship. We describe changes in relationship frames as each dyad passes through the developmental transition from face-to-face to mother-infant-object communication.

Theoretical foundations

The relational-historical research that guides our work has been influenced by a number of related theoretical perspectives. We review theories that focus on one or both of the following criteria: (a) a relational mutuality between individual and environment, and (b) a focus on historical change within the developing system. Specifically, we review the theory of Piaget, sociocultural theory inspired by Vygotsky, the ecological psychology of J. J. and E. Gibson, and dynamic systems theory as applied to developmental psychology. It is not our intention to explain these theories in depth. For more details, the reader can consult a number of very thorough reviews (Bruner, 1982; Fogel, 1993; Kaye, 1982; Melkman, 1988; Michaels & Carello, 1981; Rogoff, 1990; Thelen & Smith, 1994; Wertsch, 1991; Wood, 1980).

Piaget's theory

Schemes and development. For Piaget (1952; 1954), schemes are conceptualized as patterns of action or thought that emerge out of the relationship between person and environment. As patterns of action vis-à-vis the environment, schemes are relational procedures. They are the way in which the person engages with and comes to "know" the environment. Mere associations between stimulus and response cannot explain the relational aspect of schemes because there is no motive for changing the schemes and thus developing. Piaget's motive for change was disequilibration. The individual perceives that something is missing or incomplete in the relationship. The person orients his or her activity toward that facet of the relationship that is more likely to realize their

intention. In many cases, people actually discover new intentions through the dynamics of exploring their relationship with the environment. Piaget describes examples such as when a baby who is kicking the side of her crib notices that the kicks make the mobile move, and then she continues to kick with the newly found intention of moving the mobile.

Schemes develop by a process of assimilation and accommodation. In the process of adapting to disequilibrating perturbations from the environment, people assimilate novelty into historical schemes and accommodate those schemes to aspects of the environment that are themselves perceived as meaningful to the individual because of some prior historical relationship. As schemes become more articulated and differentiated in relation to the environment, they become at the same time more linked to other schemes – both new and historical schemes – through integration of schemes within the individual. In addition, the person becomes more completely linked with the environment through the increasingly complex set of relational schemes. Thus, changes in any single scheme alter the systemic organization of schemes in the whole system. New sub-stages of development – new ways of relating to the environment – arise through system-wide re-organization processes (Piaget, 1954).

Implications. Unlike the other theorists reviewed here, Piaget sought to explain the developmental transition that occurs around four months. According to Piaget's model, during the first two sub-stages of the sensorimotor period (reflexes and primary circular reactions) infants are focused primarily on constructing knowledge about their own bodies. The onset of the third sub-stage (secondary circular reactions and coordination between schemes) occurs around four months. In this sub-stage, infants show the first signs of deliberately affecting objects in the environment. This transition involves the integration of schemes for acting on the self with schemes for acting on the environment.

The first actions in relation to any particular object, according to Piaget, are discovered by chance, that is, they are accidentally assimilated to an available scheme. By repeating "interesting" discoveries (a discovery that is only partially assimilated), the infant adapts action to the characteristics of the object by accommodation of the scheme in order to better assimilate the discovery. Although Piaget conceptualized schemes as relational-historical structures, he only reported on the infant's relationships with objects, failing to consider the role of social partners. Piaget did not explicitly recognize that the guidance of the caregiver created opportunities for the infant to make "chance" discoveries. Although the writing of his case examples makes clear that the

parents played an important role in the infant's development, Piaget did not integrate any of this data into his constructivist theory.

Nevertheless, Piaget's theory has important implications for our study because it suggests that the acquisition of new schemes is best understood as a relational-historical process. There is also an analogy between schemes and frames. Piaget frequently pointed out that schemes were dynamic and open to change. This is similar to our view of frames as stable attractors in a dynamic relationship system. In this study we will use Piaget's case study approach, his focus on historical analysis, and we will analyze functional actions on objects and people indicative of developing sensorimotor schemes. This will be done before and after the developmental transition to the third sensorimotor substage. We also borrow Piaget's use of qualitative research methods, relying in part on detailed narrative descriptions of patterns of mother-infant communication in order to capture the sequential complexity of these processes. Finally, Piaget's observation that developmental change often involves the re-organization in the relationship between all the schemes in the system will inform our observations of developmental changes in frames.

Sociocultural theory

The social relational-historical aspects of development have been elaborated in more detail in sociocultural theory. Although research based on sociocultural theory has focused primarily on children after they acquire language, its principles can be extended to the problems addressed in this study.

Microgenesis and culture. The sociocultural perspective recognizes mutuality in the individual-environment relationship, and it is explicit in including the social environment as part of the relational system in which the child develops. In this perspective, development arises in the process of co-construction that occurs through social transactions (Bruner, 1983; Dewey & Bentley, 1949; Fogel, 1993; Kaye, 1982; Mead, 1934; Rogoff, 1990; Valsiner, 1987; Vygotsky, 1978).

According to Vygotsky, development of the individual takes place within a microgenetic context of moment-to-moment transactions with people and cultural objects. Development is a "complex dialectical process, characterized by periodicity, unevenness in the development of different functions, metamorphosis or qualitative transformation of one form to another, intertwining internal and external factors, and adaptive processes" (Vygotsky, 1978, p. 21). These microgenetic developments are set within the context of sociocultural history. In other

words, the specific microgenesis depends upon how and when the individual enters into the stream of cultural history that includes tools and technologies, values and practices (Cole, 1985; Rogoff, 1990; Vygotsky, 1987; Wertsch, 1985).

Although cultural factors in development are thought to emerge primarily once language is acquired (Vygotsky, 1978), there are many features of the sociocultural process that structure the microgenesis of human infancy. The immaturity of human infants requires not just an adult caregiver but a cultural system of infant care practices. Patterns of behavior, beliefs, and infant care tools make up this cultural system. Infants partake in this cultural system, not through the mediation of symbols and language, but through dynamic features of perception and action such as gazing, co-acting, imitating, and nonverbal dialogues (Bril, 1986; Fogel, 1993; Kaye, 1982; Reed, 1991; Schaffer, 1984; Tomasello, Kruger, & Ratner, 1993; Trevarthen, 1978; Zukow-Goldring, 1997).

The sociocultural perspective shows how children actively organize their own development with the guidance and support of skilled partners and in the context of the cultural technologies and practices available to them. In the "zone of proximal development" (ZPD), where children are just beginning to develop skilled action, they can perform activities in the company of an adult that could not be accomplished alone (Valsiner, 1997; Vygotsky, 1978). Children can be viewed as apprentices because they develop through shared problem solving with the skilled partner, participation in everyday activities, supportive structuring, and later transfer of responsibility (Kaye, 1982; Lave, 1988; Rogoff, 1990; Schaffer, 1984). Other models of guidance based on Vygotsky's concept of the zone of proximal development include Bruner's (1983) notion of scaffolding and the one-step-ahead model articulated by Heckhausen (1987).

Sociocultural theory suggests that developmental change processes involve the "transformation of participation" (Rogoff, 1997). The ZPD includes the idea that children can move from old ways of acting into new ways of acting via the guidance from social partners. Rogoff (1990) describes this as building bridges from the known to the new, in which the caregiver links new knowledge to what the child already knows (1990). One of the functions of the ZPD, then, is the "construction of novel forms in anticipation of *possible future conditions* of organism-environment interchanges" (Valsiner, 1997, p. 29). This requires some idea, often on the part of the more mature guide, of the possible future and the ways in which bridges to that future may be co-constructed. This process of linking past to future within changing patterns of activity

is called **bridging** (Camaioni, Aureli, Bellagamba, & Fogel, 2003; Granott, Fischer, & Parziale, 2002).

Sociocultural approaches thus emphasize that adult-infant interaction is a jointly constructed process, even after the child gains mastery over a domain. This view is clearly articulated in Rogoff's (1990) notion of appropriation. As contrasted with internalization of skilled action derived from earlier social experiences (Vygotsky, 1978), the child appropriates forms of participation in larger spheres of sociocultural activity. Action becomes skilled not so much in the sense of being internal or independent but in the sense of increasing the range of participation as an equal partner in social systems. Appropriation, therefore, places the developing individual within the sociocultural process of communication at all times and preserves the mutuality between individual and sociocultural environment.

Tools. The sociocultural perspective, in addition to highlighting the role of adults in children's development, focuses on the structuring features of tools and technologies. According to the Vygotskian view, tools are considered to be cultural devices that facilitate, mediate, and amplify the individual's transactions with the social and physical environment. Tools and technologies extend the body into the environment in order to use or discover something about the environment (Dewey, 1896; Heft, 1989; Ihde, 1979; Smitsman, 1997; Vygotsky, 1978). A tool such as the writing system facilitates the continuing acquisition of higher order cognitive skills such as classification (Goody, 1989; Scribner & Cole, 1981). Thus, it is impossible to disentangle the forms of action and thought observed to occur in humans from the sociocultural systems in which the individual is embedded: both are part of a single system.

Cultural tools can also become objects of acting and knowing. If tools are simply facilitators, mediators, and amplifiers, they should be theoretically "transparent" to the user. This, however, is not always the case (Ihde, 1979). A metal rod that is too heavy, for example, will still allow one to poke at a fire, but the weight of the rod imposes itself on the tactile experience. In such a case, the tool becomes a meaningful part of the experience of its use. When focusing on the cultural tool as an object of exploration, people (acting alone or jointly) can discover structure within the cultural system and use these discoveries to generate creative uses of the cultural system (Lock, 1980; Locke, 1993).

Infant toys are cultural rather than natural objects (Fogel, 1993; 1996). In cultures in which infants are exposed to objects in the social context before and during the acquisition of reaching and object manipulation skills – and this includes the majority of cultures (Bakeman, Adamson, Konner, & Barr, 1990; Sorenson, 1979) – those objects are

designed to afford actions the infant is capable of performing or learning to perform in the company of an adult. A rattle, for example, is readily graspable once an adult transports it to the infant's hand and has easily perceived consequences of action (the sound it makes). Toys (indeed all cultural objects) have remained in the culture over time because their uses can be readily perceived (Fogel, 1993). Archeological and historical evidence suggests that rattles, balls, and other squeezable, shakable, and manipulable toy objects – such as the objects used in the study presented here – have been part of the culture of childrearing at least since the earliest agricultural settlements over 10,000 years ago (Greenleaf, 1978).

Implications. We follow the basic assumption of sociocultural theory that individual development occurs entirely within communicative and cultural contexts and that "individual" action is inherently sociocultural in its origins. In the case of the pre-reaching infant's relationship to objects there is a ZPD in which adults structure object related activity. Before the acquisition of visually guided reaching, infants in most cultures are exposed to objects (toys, maternal jewelry, body parts, clothing, or hair, etc.) that are brought within reach and sight by adults. After the acquisition of reaching and/or grasping, the infant has more opportunity to further explore objects with parental assistance. According to Vygotsky (1978, p. 30), "the path from object to child and from child to object passes through another person. This complex human structure is the product of a developmental process deeply rooted in the links between individual and social history."

Sociocultural theory also directs our attention to the dual level analysis of microgenesis and macrogenesis. We assume that macrodevelopmental change (over months and years) is explainable as arising from the process of microdevelopmental (realtime) interactions. We study the role of culture in the early mother-infant relationship as we examine the structuring activity of the parent and the structuring effects of infant toys in the communication system. In other words, we supplied infants and mothers with commercially available (and therefore culturally standardized) toy objects and we observed their effects on both infant and mother joint action. In the next section we describe the implications of Gibsonian ecological theory as an additional approach to understanding how objects structure the perception and action of the users.

Ecological theory

Affordances. In the perspective of James and Eleanor Gibson, knowledge about objects is directly available through systems of perception

and action that have evolved phylogenetically to allow mutuality between individual and environment (E. Gibson, 1988; J. Gibson, 1966, 1979). Ecological psychology, based on J. J. and E. Gibson's thinking, suggests that individual and environment are "mutually constraining components of a single system" (Kugler, Kelso, & Turvey, 1982, p. 46). One cannot describe the individual without reference to the environment and one cannot describe the environment without reference to the individual. A central concept that reflects the idea of mutuality is affordance. **Affordances** are functional relationships between the individual and the environment, what the environment "offers the animal" (J. Gibson, 1979, p. 127), and are directly perceived through action.

Starting from the Gibsonian ecological perspective, some have proposed that developmental change is the result of the "education of attention" leading to the perception of more differentiated affordances. Through individual exploratory activity, one can educate their own attention to perceive dynamically stable modes of action with respect to the environment (Kugler et al., 1982; Newell & McDonald, 1993; Thelen, 1989). The education of attention can also be social, as in directing a child's attention to an affordance or creating joint affordances. Adults typically structure the physical environment in such a way as to highlight affordances in relation to the infant's level of ability and motivation (Lockman, 2003; Lockman & McHale, 1989; Michaels & Carello, 1981; Reed, 1982; Ruff, 1984; Smitsman, 1997; Zukow-Goldring, 1997).

Whether attention is educated via the infant's own exploratory activity or guided by others, there is an important distinction between Gibson and Piaget. At no time, from the Gibsonian point of view, is the infant left to chance discovery: the infant's actions are always taken in relation to the perceived affordances of the environment even if such affordances are rudimentary. Exploration, however, leads to an increasingly sophisticated knowledge of the world as perception and action serve to regulate and guide each other (E. Gibson & Spelke, 1983; Kugler, Kelso, & Turvey, 1982).

Thus, although both Piaget and the Gibsons are relational thinkers, the form of the relationship is somewhat different. Piaget's constructivism suggests that children can make the environment conform to their own activity, as in fantasy play in which the object's properties are only loosely coupled with the child's construal and activity. The Gibsonian perspective adopts a "natural realism" in which the existing affordances of the world "out there" can be known through active engagement, exploration, and guidance (Fogel, 1997). The two views are compatible,

however, with respect to the role of the active child who engages in a dynamically changing relationship with the world.

Research on sensorimotor development from a Gibsonian perspective has shown, for example, that different objects afford different kinds of action. Affordances become more differentiated with age. Not only do actions become more coordinated through experience with objects but there is an increasing intersensory integration (e.g., vision with touch) with respect to objects (Bushnell & Boudreau, 1991; Butterworth, 1981; Fogel, 1993; 1997; E. Gibson, 1988; Hofsten & Ronnqvist, 1988; Lockman & McHale, 1989; Reed, 1982; Rochat, 1989; Ruff, 1984; Smitsman, 1997; Zukow-Goldring, 1997). Some of these studies are reviewed in Chapter 2.

Implications. The Gibsonian perspective is applied to our work in conceptualizing and coding of infant's and mother's actions on objects. Our categories for infant and maternal action are defined by the affordances given by the toy objects that we used in the study. Thus, our categories of both infant and maternal actions on objects include reach, grasp, manipulate, shake, and squeeze. We also chose toy objects that provided variability in their affordances and in the perceptual modality needed to generate that affordance. Objects used vary in shape, texture, graspability, softness, and whether or not they make a sound. We also coded gaze toward objects and various forms of tactile modalities (manual and oral) in order to examine intersensory integration.

The social education of attention is a concept that overlaps with sociocultural theory. From both theories we can expect to see mothers guiding infants toward object-specific affordances. In addition, however, the affordances of the cultural object may constrain action for both members of the dyad. Thus, what appears to be a tutorial by the parent may be the emergent result of mutually creative co-action between partners of different skill levels, facilitated by a cultural tool that motivates and constrains the social co-activity (Fogel, 1993; 1997). It is likely that both infant and parent action are guided by the cultural ecology, the tools and practices of which create opportunities for communication and relationship development.

Dynamic systems perspective

Self-organization. The dynamic systems perspective is another approach to conceptualizing the mutuality of individual and environment. A key concept is that organized patterns of behavior – such as schemes or frames – emerge from the mutual relationship between constituents coming from the individual and the environment and are not the result

of a prior (maturational) or a teleological (end-state) program or plan within the individual. The dynamic systems perspective does not make a distinction between constituents from the individual and from the environment. Both sets of constituents are part of the same system and enter into the formation of attractor patterns (Fogel & Thelen, 1987; Thelen & Fogel, 1989; Thelen, Kelso, & Fogel, 1987; Thelen & Smith, 1994).

Self-organization occurs as constituents act together to constrain the multiple possible actions of other constituents so that the complex system coheres into stable relational patterns called **attractors** (Kugler, Kelso, & Turvey, 1982; Prigogine & Stengers, 1984). Action schemes, emotions, cognitions of the individual, and frames of the social system can be conceptualized as attractors (Fogel, 1993; Lewis, 1995; Thelen, Kelso, & Fogel, 1987). Some attractors that emerge through self-organization are **dynamically** stable. This means that although they are dynamically changing processes that occur in time, they preserve their integrity across a wide variety of conditions. The concept of dynamic stability replaces the concept of structure, habit, and association in traditional theories of psychology (Capra, 1996; Fogel, 1993; Thelen & Smith, 1994).

The concept of attractors reveals that dynamic systems models focus on the behavior of the collective, the system as a whole, in relation to the individual components of that system. In the collective organization, attractors are qualitatively different modes of system organization (Kelso, 2000). This means that there is no simple numerical index that would distinguish one attractor from another. Take the example of the states of H_2O (ice, water, and steam). Although these states change with temperature, which can be expressed as a number, the collective behavior of the states differs in qualities. Ice has crystals and water does not. Water and steam have dynamic flow patterns and stable ice does not. Thus, the differences between the states of water can most fully be expressed as qualitative differences.

In dynamic systems approaches based on quantifying the physical parameters of systems, attractors are expressed mathematically as a well in a field of potential energy, i.e., once in the well, it takes energy for the system to leave the attractor. A stable attractor is represented as a relatively deep well of potential energy. Other attractors are less stable (less deep) and the system will spend relatively less time in them (Thelen & Smith, 1994).

These quantitative models fit the behavior of most dynamic systems. Once in a potential energy well, the collective is likely to stay there for some period of time, giving the appearance that the collective attractors

are stable. A system near the top of a well is relatively unstable and quickly returns to the same or another well. As temperature is increased from −100° C to 0° C, for example, H_2O remains solid. Between 0° C and 100° C, it remains liquid, and above 100° C it becomes a gas. Within only a few degrees around 0° C and 100° C we can observe H_2O in a transitional state, as it makes a shift from one stable attractor to another. So, for most temperatures, H_2O is in one or another qualitatively different stable attractor.

When a dynamic system is in a stable attractor, it is functioning in an energetically conservative mode where it maintains its equilibrium. In order to change from one attractor to another, for the system to reorganize, energy is required to move the system far from its equilibrium state. As water is heated, for example, there is an increasing disorganization of the water's movements, a relatively chaotic state. At some point, however, boiling water begins to form rolling patterns that more efficiently move the heat energy from the bottom of the vessel to the surface of the water where it can convert to steam. The water "finds" a new pattern of self-organization that most effectively "dissipates" the heat energy. In this kind of "dissipative" system, new patterns of order – attractors – emerge as systems seek to conserve energy in far-from equilibrium states (Capra, 1996).

The inter-individual relationships that account for the collective behavior in dynamic systems, however, cannot always be modeled quantitatively in terms of physical parameters. In some cases, individual components communicate via **information** rather than by physical forces. An alternative perspective on dynamic systems theory focuses on information rather than the physical features of the system (Pattee, 1987). Information, not amount, distinguishes interpersonal communication systems from physical systems. Facial expressions, for example, alter the behavior of social partners and change the organization of action in a communication frame. A tiny facial movement requiring little energy can induce large expenditures of movement energy in the social partner, as when a smile elicits a partner's heart rate changes and movements of approach. Intracellular communication via the different sequences of bases in DNA, and neural communication via different neurotransmitters are other examples of informational dynamic systems (Oyama, 1985; Pattee, 1987).

This information approach has an emphasis on the mutuality between constituents which change as they enter into relational processes, altering their identities in order to establish the ground for a relationship. In digital and electronic systems, information is usually thought of as discrete bits having a concrete value (either "on" or "off" in a binary

system typical of most computers). A dynamic system, however, requires a completely different conceptualization of information that is not fixed in advance and not "transmitted." Rather, information created in the process of communication is always dynamically related to the current state of the entire developing system (Oyama, 1985).

In a social system, for example, long-term social partners develop unique patterns of speech and expression that are informative to each other but not shared outside the relationship. The terms of endearment for a romantic couple (sweetie, lover, honey, etc.) along with non-verbal gestures, to take a more concrete example, have evolved historically from the couples' affectionate encounters. These words and gestures signify or "mean" that entire history of affection. They are informative in the sense that they often re-create particular feelings and may engender further states of intimacy. They are also dynamically alive each time they are used. "Honey" can be spoken with love, anger, or impatience and those affective tonalities arise spontaneously (are created dynamically) in the act of communicating. "Honey," in other words, does not always mean the same thing.

Because constituents change **in relation to** each other, each constituent reflects in some way the collective attractors of the system; each constituent implies all the others. This property of dynamics systems has been called **implicate order** (Bohm, 1980). Constituents of an attractor share an implicate relationship. All the attractors in the same system also imply each other, giving the system as a whole a coherent identity.

The type of actions observed in a greeting frame (whether people bow, shake hands, hug, or kiss, and the relative warmth of those patterns), for example, is related to the intimacy of the dyad during conversational and other types of frames. Although each of the frames retains its own coherence and identity, in some way, they are related to each other and share in a meta-collective identity as different aspects of the same relationship. The dynamic system of the human body is similar. Skills manifested in the skeletomotor system are reflected in the neurological system and vice-versa. The histories of the neural and motor systems imply each other as well. The effects of traumas as well as training are distributed across all the systems of the body, each of which implies the other. Traumas at the periphery affect the brain, circulation, the immune system and these effects can be both short-term and long-term (Schore, 2003).

Transitions in realtime. One unique feature of the dynamic systems perspective is its focus on transitions, the way in which the system changes over time. How do systems move from one attractor to another

in realtime? In the case of interpersonal relationships, how does the system move from one frame to another, such as between a face-to-face play frame and a social-object play frame? In some dynamic systems accounts (Kugler, Kelso, & Turvey, 1982; Thelen, Kelso, & Fogel, 1987), transitions from one to another attractor occur because random variability creates a few highly energetic occasions during which the system can jump out of the equilibrium of its attractor well and move quickly into a nearby well.

Stabilization and transitional processes have been conceptualized in terms of feedback between constituents. **Negative feedback**, or regulation, works to maintain changes of constituents within the boundaries of the attractor. It fosters a stable coupling of constituents (Edelman, 1987; Lewis, 1995; Prigogine & Stengers, 1984; Thelen & Smith, 1994). Transitions, on the other hand, have been conceptualized as **positive feedback** which occurs when a change in constituents is amplified in a way that takes the system beyond the boundaries of the attractor and far from equilibrium (Lewis, 1995; Prigogine & Stengers, 1984).

In the re-organization of the cell from DNA, to take an example of an information system, the activation of particular combinations of amino acids in the environment of the cell can cause the cell to make a transition from one type to another type, as when normal skin cells develop wound tissue due to an injury (Pattee, 1987). This example of skin cells reveals that in complex informational systems, not all of the constituents are active at all times. There is always some addition and deletion of constituents that occurs within the same attractor configuration depending upon local conditions.

This is also true during the early stages of prenatal development. Very early in development, all the cells are similar and all contain the same set of genes. Ultimately, however, these cells will form into different organs and structures of the organism. This is in part due to the location of the cell. Different physical and chemical environments will activate a different set of genes which in turn will activate different proteins to be manufactured. During face-to-face play, for example, mothers and infants shift gaze toward and away from the partner, they alternate between smiling and non-smiling, they may or may not vocalize, and yet the face-to-face attractor can remain stable across these variations. A face-to-face frame can occur when participants mutually gaze, or mutually smile, or mutually vocalize, or by many different combinations of these behaviors depending upon the history of communication between participants.

Under certain conditions, however, some additions and deletions will evoke a transition to another attractor. If the behavior of a system

within an attractor is dynamically changing in realtime, then a realtime transition between attractors can be thought of as a change in the pattern of change. In informational terms, systems make transitions when the change in the pattern of change is noticeable to the constituents. Information is generated, then, when a system notices a difference, what has been described as "a difference that makes a difference" (Bateson, 1979; Oyama, 1985). A change can only make a difference from the perspective of the participants' history of communication within the system, otherwise, how would the system notice the difference?

> Developmental information . . . has a developmental history . . . Information is a difference that makes a difference, and what it 'does' or what it means is thus dependent on what is already in place and what alternatives are being distinguished (Oyama, 1985, p. 3).

Thus, when the infant ceases to smile (a change in one constituent of face-to-face play) but continues to gaze at the mother, the mother may not interpret the change in infant smiling as a difference that makes a difference, that is, as a difference that would precipitate a realtime transition to another frame. She may continue her efforts to repeat the infant's smile in order to maintain the frame. Now assume that the infant stops smiling, and instead of continuing to look at the mother, the infant also turns away to look at a toy. This combination of actions that have been added to the system may or may not be perceived as a meaningful difference by the participants. If it is a difference that makes a difference, the mother can follow the infant's gaze to an object, retrieve the object, and the system will transition into a social object play frame. In either case, the grounds for a transition are based on what the participants notice in relation to their history of communication.

Developmental change. Given the inherent stability of attractors, how does the system change from one attractor to another? In realtime, some informational difference that makes a difference pushes the system out of one attractor and into another. In development, however, the entire system of attractors (schemes, frames) – the collective behavior of the system – changes. It is not necessarily a matter of changing from one to another available attractor but it is the creation of new attractor patterns and the loss of others, and in addition, the emergence of a new implicate order. Development is the destabilization, re-organization, and re-stabilization of the collective system of historical attractors (Fogel, 1993; Lewis, 1995; Thelen & Smith, 1994).

Because dynamic systems are historical, however, available attractors serve as resources for the system to create opportunities for change. The same idea is contained in Piaget's thinking: that some chance discovery

may eventually change the system of schemes via assimilation and accommodation. It is also likely that historical transitional processes in realtime are implicated in the process of change. The system must be able to make transitions in realtime from historically stable attractors into newly forming attractors whose stability is not fully established (Fogel et al., 1992; Fogel & Lyra, 1997; Pantoja, 1996).

The problem of the emergence of new forms is at the very core of developmental inquiry. How does something new emerge from something that has been there in relatively stable form? Dynamic systems theory recognizes the emergence of novelty as a fundamental feature of organized systems. Non-biological systems, such as chemical reactions and the physical universe, develop over time because novel variability provokes the system into new stable attractors that are neither planned nor pre-programmed (Prigogine & Stengers, 1984; Weimer, 1987). A growing number of thinkers have embraced the idea that spontaneous emergence is at the heart of behavioral and psychological change. This concept has also been called discovery, creativity, construction of novelty, and transformation (Carvalho & Pedrosa, 1998; Eckerman, 1993; Fogel, 1993; Gottlieb, 1992; Lewis, 1995; Lock, 1980, 2000; Lyra, 1998; Mohoney & Moes, 1997; Nelson, 1997; Overton, 2002; Schore, 2003; Stern, 1998; Thelen & Smith, 1994; Tronick, 1998; Valsiner, 1997; 2001).

The idea of emergence rejects the notion that all development is planned or programmed and embraces the idea that chance and indeterminism are fundamental to all dynamic systems. It is because of these chance events that systems produce novelty. Novelty, generated *sui generis* within the system is thought to be the seed of developmental change. This concept alone distinguishes dynamic systems perspectives from other theories of developmental change. The indeterminacy in dynamic systems can produce historically unique trajectories that partly account for the formation of individual differences (Fogel, 1990; Fogel & Branco, 1997; Fogel, Lyra, & Valsiner, 1997; van Geert, 1997; Kellert, 1993; Thelen, 1990; Valsiner, 1997). Informational approaches to dynamic systems perspectives can help us understand why historical changes (in people, groups, or societies) can never exactly repeat, why every social system is unique, and why these differences are contingent on the dynamics of the communication process and not always amenable to prediction (Fogel, Lyra, & Valsiner, 1997; Gould, 1977).

If we take a historical perspective on change so that we can observe particular systems at frequent intervals before, during, and after key developmental transitions, we are more likely to find and describe the emergent processes that bring about developmental change (Fogel,

1990; Kugler, Kelso, & Turvey, 1982; Lewis, 1995; Prigogine & Stengers, 1984; Thelen & Smith, 1994). This is because the often fortuitous contingent series of events that give developmental change its unique character are most likely to be observed during transitional periods (Fogel, 1993) and we are more likely to observe such events with frequent observations on the same individuals.

Implications. With respect to early infant development, the dynamic systems approach has been applied to motor development (Beek, Hopkins, & Molenaar, 1993; Savelsbergh & Kamp, 1993; Thelen & Ulrich, 1991), to cognitive development (van Geert, 1994; Thelen & Smith, 1994; Valsiner, 1997; 2001), to communicative and emotional development (Camras, 1991; Carvalho & Pedrosa, 1998; Eckerman, 1993; Fogel, 1992; Fogel, 1993; Fogel & Thelen, 1987; Fogel et al., 1992; Lewis, 1997; Lyra, 1998), and to relationship development (Fogel, 1993; Gottman et al., 2002). With regard to the application of dynamic systems theory to the study of change in communication systems, physical-quantitative models have had limited success in capturing the element of information inherent in interpersonal communication. This is because dynamic information cannot be quantified: it is based on the perception of differences at a particular point in time in the context of the entire system. In this work, we use qualitative-information models alongside quantitative models.

For the study presented here, we conceptualize the system as the mother-infant relationship in the context of toy objects. We make the assumption that communication frames are attractors in a relational landscape. We describe the co-occurring processes within frames and in realtime transitions between frames.

In dynamic systems theory, the unit of analysis is the particular system observed repeatedly over time. In our case, each dyadic relationship becomes the focus of a case study and we present both narrative description on four dyads and statistical analyses of the developmental trajectories of the durations of each of the frames on all thirteen dyads. Within-dyad trajectories of frames across twelve weekly observations are also compared with trajectories of specific infant and maternal action schemes. The focus of the quantitative analysis, therefore, is not differences between frames at a single point in time but the shape of the developmental trajectory – flow of the system through time – of the set of frames vis-à-vis the developmental trajectories of "individual" actions on objects (Fogel, 1990; Thelen, 1990).

According to a dynamic systems perspective, the process of system change is best revealed through the study of transitions. Here we examine transitions between frames in both realtime and developmental time.

For the latter, we explore the changes in the mother-infant relationship in six weekly observations of mother-infant-object play before, and six weekly observations after, the acquisition of visually guided reaching. During periods of developmental transition, particular events may make more of a difference in the shaping of the future of the system than if the same events occurred during stable (non-transitional) periods.

Summary

Piaget's theory focuses on the historically grounded emergence of schemes within the individual infant. Sociocultural theory specifies some of the means by which social processes are coordinated with the development of individual action. Sociocultural theory sets development within the broader context of the cultural system. Gibsonian ecological psychology focuses on the functional affordances of actions on objects and the social and individual education of attention related to those affordances. The dynamic systems perspective is a general model of change and stability in complex systems. Combined with insights from the other theories, a dynamic systems perspective offers a model to study change over time in the organization of the system. Following a review of the literature in the next chapter on the developmental transition that occurs around four months, we combine these ideas with respect to the articulation of relational-historical research on developmental change in Chapters 3 and 4.

2 Mother-infant relationship development in the first six months: from face-to-face play to object play

In this study, we apply a relational-historical perspective to the study of the developmental transition from face-to-face to mother-infant-object play in early infancy. In this chapter, we review the literature on that transition. In the first part of this chapter we review the literature on infant's early relationships to objects. We focus on the changes in infant object manipulation skills before, during, and after the acquisition of visually directed reaching: the "individual" hallmark of this developmental transition. In the second part of this chapter, we review research on the development of social play with and without objects during this developmental period. In the final part of this chapter, we review evidence related to the development of individual differences in object-directed skills that emerge following this developmental transition.

The individual perspective

A great deal of research has been done using normative and experimental approaches and focusing on infants' acquisition of perception and action with objects. This section is a brief review of the findings from this perspective – on perception of objects, reaching, manual and oral exploration – especially as they regard changes during the period between two and seven months.

Perception of objects

A developmental transition occurs between three and four months, when infants begin to perceive moving objects as whole units (Baillargeon, 1987; Kellman & Spelke, 1983; von Hofsten & Spelke, 1985). If part of an object is blocked from the infants' view, for example, they recognize it when it is no longer obscured. Around the same age, infants acquire sophisticated visual expectancies for object shape and for events in a

visual series, such as by scanning dashed-line patterns as if they were solid lines (Bornstein, Krinsky, & Berasich, 1986; Burnham, 1987; Caron, Caron, & Carlson, 1979; Fagan, 1979; Gibson, Owsley, Walker, & Megaw-Nyce, 1979; Haith, Hazan, & Goodman, 1988; Kellman, 1984; McKenzie, Tootell, & Day, 1980; VanGiffen & Haith, 1984). By six months, and perhaps a few months earlier, infants can recognize objects by touch as well as vision (Bushnell & Boudreau, 1991; Lockman & McHale, 1989; Palmer, 1989; Ruff, 1984; Steele & Pederson, 1977; Steri & Pecheux, 1986). Cross-modal transfer between touch by hand and vision begins between four and six months of age (Gottfried, Rose, & Bridger, 1977; Harris, 1972; Rose & Ruff, 1987; Ruff, 1984; Ruff & Kohler, 1978; Streri & Pecheux, 1986; Streri & Spelke, 1989). By the age of four months, therefore, infants can detect objects as whole entities in both visual and tactile modalities. Beginning at four months and increasing thereafter infants have the ability to coordinate visual and tactile sensations for the purposes of object exploration.

Reaching

Visually directed reaching is a smooth approach to a nearby seen object with the fingers either opening or closing prior to contact with the object. Other terms used for this skilled action are goal directed reaching, visually guided reaching, and prehension. In this report, we will simply use the term reaching to refer to the developmentally more mature form of action.

Reaching emerges between three and five months (Piaget, 1952; Bushnell, 1985; von Hofsten, 1984; White, Castle, & Held, 1964). Once a mature reach develops, infants no longer need to focus all their attention on the object and can coordinate their reaching with other motor and perceptual actions such as looking at mother or other objects (Bushnell, 1982; Butterworth, 1981; Field, 1976; Mathew & Cook, 1990; Thelen & Smith, 1994; von Hofsten, 1984).

Manual exploration

Generally, looking at objects appears to be a mode of exploration at all ages. Under two months, infants explore objects using palmer grasping with one hand, and rotating. Once grasped, objects are either brought to the mouth, brought to midline, or dropped (Karniol, 1989; Piaget, 1952; Piaget, 1954; Rochat, Blass, & Hoffmeyer, 1988; White et al., 1964). By the third month, infants begin to use finger movements to explore their own hands and clothing. Between two and four months, infants translate

Table 2.1. *Developmental sequence of object manipulative actions in the first half year*

Age (Months)	Action
0 – 2	Mouth, grasp, rotate
2 – 4	Translate, shake, squeeze, two-hand grasp
4 – 7	Hand-to-hand transfer, two-hand coordination, hand-mouth coordination

objects (move them from one place to another), shake or vibrate them, and hold objects with two hands, often for the purpose of bringing them to the mouth, and more often for holding larger compared to smaller objects (Karniol, 1989; Piaget, 1954; Rochat, 1989).

At four months we see the beginning of coordinated activity between the hands, and between hand and mouth. Infants transfer objects between hands, they coordinate both hands by holding the object with one hand and manipulating it with the other, and they alternate between manual and oral exploration (Bushnell, 1985; Hatwell, 1987; Karniol, 1989; Piaget, 1954; Rochat, 1989; White et al., 1964). Also, after five months, infants develop rhythmical actions applied to objects, including rotating, squeezing, and shaking (Thelen, 1981). These findings are summarized in Table 2.1.

These actions of manual exploration are sometimes, but not always, accompanied by looking in a pattern called examining behavior (Belksy, Goode, & Most, 1980; Fenson, Kagan, Kearsley, & Zelazo, 1976; Ruff, 1986). Examining behavior, the coordination between vision and manipulation, has been shown to occur when six-month-old infants are introduced to novel objects that differ from previously habituated objects in either shape or texture, but not in color (Steele & Pederson, 1977). When object manipulative actions are used, they appear to be adapted to the affordances of objects. Grasping, fingering, and rhythmical movements are believed to be particularly useful for perceiving texture, shape, hardness, and temperature before the age of six months (Bushnell & Boudreau, 1991).

Oral exploration

Object exploration with the mouth is present from the newborn period. Infants can systematically detect shape differences using the mouth only and in some cases can transfer that knowledge of shape to other modalities (Butterworth, 1986; Rochat, 1989). Between three and five months, infant reaching appears to be partially regulated by the motivation to

make oral contact. If infants' hands are held down at their sides, they will lean toward an object and attempt to make oral contact (Rochat & Bullinger, 1994). At six months, mouthing continues to be used systematically in object manipulation. Infants tend to mouth objects that are smooth rather than fuzzy (Fenson et al., 1976; Palmer, 1989; Ruff, 1984).

Summary

In summary, around the age of four months, infants are becoming skilled in reaching, grasping, and manipulation both by manual and oral exploration of objects. According to our review of the literature in both perception and exploration of objects, it seems clear that there is a developmental transition around four months in which the infant's relationship with objects makes a relatively rapid change. What accounts for this developmental transition? Investigators using an individual perspective have assumed that it is spurred by a neurological shift that occurs as infants gain experience with perception and action on objects. This must certainly be the case but it may not be the whole story. As we discussed earlier, objects are typically presented to infants by adults. Based on sociocultural theory, one might suspect that object-directed skills are formed in the relational ecology of adult-infant communication.

The relational perspective

Before infants can successfully reach for objects on their own, objects are brought to them by their parents and/or other adults and they play a role in presenting objects in ways that make it easy for infants to reach for them and to appreciate their affordances. When presenting a rattle to a pre-reaching infant, for example, a mother may hold it by the handle and shake it to highlight the noise. She may also place the handle in the infant's hand and shake the infant's hand to make the rattle sound.

In the real world, infants rarely encounter objects alone. Objects are always embedded into a sociocultural system. Before infants can acquire objects by reaching, objects are either encountered accidentally or when adults bring objects to infants. Accidental encounters in the first few months are almost always because adults place objects in the vicinity of infants. During this period, infants have limited locomotor ability (see Table 2.2) For most infants, reaching is acquired before independent sitting and around the time when infants' only locomotor and postural achievement is rolling over.

For human infants early in the first year, therefore, the primary means to acquire experience with objects is with the assistance of another

Table 2.2. *Motor chronology during the first eight months of life from Denver Developmental Screening Test (DDST) (Frankenburg, Dodd, Fandal, Kuzuk, & Cohrs, 1975), and the Bayley Infant Development Test (BIDT) (Bayley, 1969)*

Action	DDST Median quartile range	BIDT Median quartile range
Rolls over	2.8 (2.3–3.8)	2.5 (2.0–7.0)
Grasps rattle/cube	3.3 (2.5–3.9)	3.7 (2.0–7.0)
Reach, one hand	3.6 (2.9–.5)	5.5 (4.0–8.0)
Sits w/out support	5.5 (4.8–6.5)	5.2 (4.0–8.0)
Pulls self to sit	6.1 (7.6–9.3)	8.2 (6.0–11.0)
Finger–thumb grasp	7.1 (8.3–9.1)	7.0 (5.0–9.0)

person. After the acquisition of reaching, infants can act more independently upon objects. The achievement, however, does not necessarily make object skill less social as it is acquired through social exchanges with another person (often times the primary caregiver) and carries its social history within it (Silva, 1998).

The research literature suggests that there is a developmental transition in the mother-infant relationship around four months that corresponds with the developmental transition in perception and action, reviewed above. Object-directed social play develops from a historically prior period of face-to-face social play that begins in the early months of life and involves mutual facial and gaze orientation, smiling, and positive vocalizations. Between the ages of three and six months, object-directed social play takes up an increasing share of the dyad's free play time, eventually supplanting but not totally eliminating face-to-face play (Cohn & Tronick, 1987; Kaye & Fogel, 1980; Keller & Gauda, 1987; Lyra & Rossetti-Ferreira, 1994; Super & Harkness, 1982). In this report, we explore the developmental process by which the mother-infant relationship changes from a predominant focus on face-to-face play into a predominant focus on object-directed social play. At the same time, we track the infant's relationship with objects in the context of mother-infant social play.

This developmental transition involves a change from a primarily dyadic form of communication to a triadic form. We know that infants under six months are capable of sustaining triadic communication. Research on mother-father-infant triadic communication shows that young infants are remarkably sensitive to patterns of communication between mother and father, and to whether or not they are included in that communication (Fivaz-Depeursinge & Corboz-Warnery, 1999). By

comparison, mother-infant-object communication can be expected to be within the cognitive abilities of the young infant.

In the remainder of this chapter, we shall review literature suggesting that from the early months of life, the development of perception and action is part of a sociocultural process. We suggest that infant developmental change and individual differences are best understood from a relational-historical perspective. Objects are not things in themselves for infants in the first half year. Objects are enlivened by their embeddedness in social activities and become part of the infant's world through their incorporation into the historical process of the development of the parent-infant relationship.

A sociocultural perspective on infant object-directed skill development

A number of investigators have interpreted the infant's growing skills with objects in a way that is consistent with sociocultural theory. In this view, infant developmental transitions arise as a joint enterprise of mutual regulation within the infant-caregiver relationship. Adamson (1995), Fogel (1993), Kaye (1982), Mahler (Mahler, Pine, & Bergman, 1975), Lyra & Rossetti-Ferreira (1994), Sander (1962), Schaffer (1984), Stern (1985), and Trevarthen (1978) have observed changes in the mother-infant dyad across the developmental transition in which the infant's attention shifts from a focus on affective exchanges with the mother to an inclusion of the object into the direct social play with the mother.

For Sander (1962), for example, the dyad begins with a period of "initial regulation" and around four months moves to a period of "reciprocal exchange," in which new coordinations with objects emerge in caretaking and in play. The first four months for Mahler (Mahler et al., 1975) are "symbiotic," where, by virtue of shared rhythms and emotional sharing, the infant does not distinguish self from mother. This is followed by a period of "differentiation" in which the baby begins to look away from the mother, engages in relatively independent activities with objects while checking back visually to ensure or enlist the mother's support.

Trevarthen describes the period between two and three months as primary intersubjectivity. During this period, mother and infant create highly coordinated dialogues in which "it is difficult to perceive any content in the communication except the exchange itself" (Trevarthen, 1977, p. 241). During this period, infants have their first experience of sharing emotions and intentions with another person. Beginning in the

fourth month, Trevarthen noted the shift of the relationship as "infants making persistent refusals of their mothers' approaches by withdrawing gaze from them and looking pointedly elsewhere" (p. 254). This change marks the onset of the period of that Trevarthen called the "epoch of games," in which the infant's achievements in the area of object perception and manipulation are integrated with the mother-infant communication.

A similar view is advanced by Schaffer (1984) as the change from face-to-face interactions in which "the topic arises from the dyad itself" (p. 79), to topic sharing interactions in which mother and infant must learn to coordinate their action with respect to topics outside the dyad. This change begins around four months with the onset of infant object manipulation skills. Infants and mothers learn to coordinate their gazing to an external object and infants begin to follow the movements of the mother's hands and her gaze direction. This is similar to Kaye (1982), who describes this change as a shift from "shared rhythms" (mutual cycling of attention and expression) to "shared intentions" (the mother serves as supporter of the infant's actions and provides guidance when needed).

Both Schaffer and Trevarthen view this developmental transition as the beginnings of a phase of development that will culminate, at the end of the first year, with the onset of infant referential pointing and linguistic naming. The period from four until seven months, when objects are first brought into the mother-infant relationship, is thought to be the origin of these later developments in social coordination and mutual understanding.

Research on infant-object interaction in the social context

Object play in both human and non-human infants is typically embedded in a social ecology. Object play in kittens, for example, is more likely to occur in the presence of other kittens. If one kitten has an object, this inhibits the play of other kittens. While this seems to be non-social, the bystander kitten will watch until the kitten possessing the object leaves it, after which the bystander will approach the object. Objects, therefore, are mediators of social regulation. A similar pattern occurs when kittens possess prey or watch their mothers hunt. The style of mother's hunting appears to influence the kitten's willingness to approach prey. It seems as if "cats like to be watched playing" and also "like to be seen with prey" (Egan, 1976, p. 164).

In Japanese Macaques, infants and juveniles in a free ranging group account for about 95 percent of object contacts even though they make

up only 30 percent of the population of the group. Everyday handling of objects consists of brief grasping and mouthing. When another monkey is present, the object becomes a focus for chasing and wrestling. Typically, only one animal has the object at a time (Menzel, 1976). Similar patterns have been observed in chimpanzees (Goodall, 1971; Menzel, Davenport, & Rogers, 1976; de Waal, 1989). As in kittens, objects offer opportunities for unique forms of social relationship.

!Kung (African hunter-gatherer society) infants observed in natural situations begin independent play with objects at the same time as infants elsewhere, between three and four months. Unlike adults in industrial societies, !Kung parents do not engage in object play with their infants until they are eight months old, and then only for offering and receiving objects from infants. When a four-month-old infant picks up an object, adults typically cease their social play with infants. This inhibitory effect need not be considered non-social. Since the infant's play is always in close proximity to adults, adults often watch the infant playing with the objects and will return smiles and vocalizations the infant makes during object play (Bakeman et al., 1990).

The importance of the social context for object skill has been well-documented in Western samples for infants older than six months. In a longitudinal study of social play in the United States, monthly videotapes were made of mother-infant-object interactions between eight and sixteen months. Results show that objects are frequently introduced within social games, and that during games infants show a higher level of play than when tested alone with the objects (Hodapp, Goldfield, & Boyatzis, 1984). Zukow-Goldring (1997) finds that mothers of six-month-olds highlight object affordances for infants by moving objects in ways that amplify the child's perception of those affordances. Lockman and McHale (1989) examined the social context of object play in six-, eight-, and ten-month-old infants. They found that both infants' and mothers' activity was adjusted to the affordances of objects and that mothers often demonstrated object affordances before the infant acquired them. A study of six infant-mother dyads at seven, ten and thirteen months found that the uses of objects develop systematically within frames for sociocultural communication (Moro, 1999). The amount of maternal scaffolding of object play at nine months predicted Bayley MDI and vocabulary at fifteen months in a sample of thirty infant-mother dyads (Stevens, Blake, Vitale, & MacDonald, 1998). In general, for infants older than six months, exploring objects with an adult guide enhances infant attention and manipulation of objects (Lockman, 2003).

There are only a small number of studies of objects in the social context for infants under six months. Research on a sample of thirty

dyads observed at five and eight months (Danis & Saules, 1994; Findji, Pecheux, & Ruel, 1993; Pecheux, Findji, & Ruel, 1992; Ruel, 2000) shows that mother and infant actions on objects depend upon the relational context in which the action takes place. There are different patterns of co-action that correspond to what we have called frames. In a one-hour laboratory observation, four frames were discovered in this sample: infant care, a social frame, an object play frame, and infant alone. By five months, the object play frame takes up about one-third of the time while the social play frame takes only half of that percentage. Focused attention on objects is considerably higher when the infants and mothers are engaged in joint object play than when the infants are alone or in social play. There are large individual differences in the duration of each frame and in the quality of attention within the frames. Finally, mothers are more successful at achieving joint attention using familiar, compared to unfamiliar objects. These results support the idea that frames reveal relational-historical processes that regulate joint transactions with familiar objects. Different patterns of joint attention to objects at five months have been found for play compared to teaching frames (McCollum & Stayton, 1988).

In an experimental study, pre-reaching infants were given a series of play sessions at home wearing "sticky mittens" that allowed toys to be picked up even though the infants were not yet able to reach and grasp. Compared to a group of infants who did not receive this enrichment program, laboratory tests revealed that the enriched infants showed more object engagement and more sophisticated object exploration strategies (Needham, Barrett, & Peterman, 2002). This study reveals that a specific form of sociocultural mediation, providing pre-reaching infants with a tool for grasping objects, enhanced their skills with objects. Although our study uses naturalistic observations, individual differences in object skill may be related to inter-dyad differences in the scaffolding provided in the context of the social communication about objects.

Trevarthen (1978) found that objects were incorporated into mother-infant games as early as four months. The single dyad that Trevarthen studied had differentiated frames of purely social face-to-face play and of socially-mediated object play as well as smooth transitions between them. Lyra and Rossetti-Ferreira (1994) found that during the third month of life, objects are introduced into an already available frame of mother-infant face-to-face play. During infant and mother mutual gaze and sharing of positive expressions, mothers attempt a frame transition by introducing objects according to the infant's level of interest in the objects. The objects, when first introduced, are highlighted as "figures" against the relational "background" of the face-to-face play frame. It is

on the basis of this shared history of face-to-face play that the object becomes incorporated into the expanding spiral of the relationship dialogue. The "shared nature of the dyadic exchanges, which exhibit a degree of mutual knowledge which mediates each partner's actions, can be understood as an historical process of transformation-construction" (Lyra & Rossetti-Ferreira, 1994, p. *xx*).

In this perspective, realtime transitions to object play frames can only be introduced to the extent that they are meaningful with respect to historical frames. Mothers do this by following the infant's gaze as it shifts from her face to objects, by introducing objects to the infant in the space between mother and infant, and by "highlighting" objects for the infant through movement and sound. Once object play becomes the main focus of the mother-infant interaction, beginning around the age of four months, the face-to-face frame does not disappear but rather becomes "abbreviated." While playing with objects, for example, the infant may pause briefly to look at mother and smile, as if to include her in the play by referring to an abbreviated form of the earlier face-to-face frame (Lyra & Rossetti-Ferreira, 1994; Lyra & Winegar, 1997). These findings make it clear that the developmental emergence of social object play is part of a complex relational-historical process.

These findings also suggest that individual differences in the infant's perception and action on objects are related to interdyad differences in the process of communication about objects. The historically established communication frames at any point in time exert a powerful influence on the subsequent developmental transformations within the dyadic relationship system (Fogel, 1993; Hsu & Fogel, 2003). Through a historical transformation process, each dyad develops a different set of frames in which objects are explored (Fogel & Lyra, 1997). Thus, we can expect to find individual differences in the amount of time spent in different types of frames, in the types of activity within each frame, in the patterning of transitions between frames, and in the developmental trajectories of the frames over weeks. According to Gray, "the action of the mother and action of the child, vis-a-vis each other and an object of reference, change, and change in relationship to each other as the child develops" (Gray, 1978, p. 163).

Summary

Research suggests that early exposure to objects occurs in the context of the early adult-infant relationship. Research in this area, however, is relatively less detailed than research on infants observed with objects without the company of the adult, especially in the first year of life.

Another way to examine the role of the social context for the development of infant object-directed skills is to study how variability in the social and non-social context contributes to individual differences in object-directed skills. In the next section, we review work on individual differences in object-directed perception and action.

The relational perspective on interdyad differences

Relatively little is known about individual differences in object exploration before six months. Moderate stability has been found for individual differences in sustained attention to objects during the first year (Kagan et al., 1971; Ruff & Lawson, 1990; Ruff, Lawson, Parrinello, & Weissberg, 1990). In addition, measures of sustained attention to objects during exploratory play in the first year are reasonable predictors of preschool-age problem solving, language comprehension, level of pretend play, Bayley MDI, and Stanford-Binet IQ scores. This is the case even after variables such as maternal encouragement, SES, education, and infant medical risk are partialled out (Colombo & Mitchell, 1990; Kopp & Vaughn, 1982; Rose, Feldman, Wallace, & McCarton, 1989; Ruff, 1990; Tamis-LeMonda & Bornstein, 1989).

On the other hand, more is known about the relationship of styles of parent-infant communication and the development of individual differences in infant exploration of objects. Caregiver styles of interaction with infants under six months of age, particularly with respect to strategies of directing infant attention and action toward objects, have been shown to predict individual differences in sustained attention to objects.

For infants with high durations of sustained attention, caregiver actions are related to the objects to which the infant is currently attending or to which the infant has most recently attended. Caregivers of these infants are more likely to have structured strategies for guiding the infant's object exploration such as pointing, demonstrating, instructing, and highlighting specific features of objects. For infants with low durations of sustained attention, caregivers more often interrupt the infant's object engagement by presenting a different object, performing an unrelated action, inserting bids for face-to-face play into periods of infant object-focused activity, or they are less likely to provide structured experiences of guidance for the infant's play with the objects. By the end of the first year and into the second year, low sustained attenders have mothers who are more socially active during object play (Belsky, Goode, & Most, 1980; Brighi, 1997; Gray, 1978; Landry & Chapieski, 1989; Landry, Chapieski, & Schmidt, 1986; Landry, Garner, Swank, & Baldwin, 1996; Lawson, Parinello, & Ruff, 1992; Parinello & Ruff,

1988; Pecheux, Findji, & Ruel, 1992; Rolfe-Zikman, 1987; Schaffer & Crook, 1980; Sigman & Beckwith, 1980; Tamis-LeMonda & Bornstein, 1989).

These results suggest that there are at least two groups of infants and mothers. In one group the focus is on sustained attention to objects and on maternal support of object exploration. In the other group, the focus is on social play and infants show relatively less attention to objects with relatively less systematic exploration of objects.

Some of the studies that focus on the infant alone suggest that the differences in attention to objects are due to early endogenous attentional patterns of the infants. This dispositional explanation is based on the assumption that the individual infant is relatively stable over time and the mother fits into the pattern by providing stimulation that is either object or social focused. The alternative explanation is that the effect is due to the mother. In this view, maternal encouragement of attention to objects and her scaffolding of infant attention and exploration, lead to more "positive" outcomes such as sustained attention, object focus, and advanced language development. Some studies find statistical interactions between maternal and infant measures but do not offer evidence for how such interactions may contribute to developmental change. These individualistic views favor one or the other member of the dyad, or the simple interaction between them, as being the cause of the later outcome.

We were only able to locate one study in the literature in which there was an attempt to understand the emergence of individual differences in object attention from what we have called a relational-historical perspective. In this perspective, individual differences are seen as arising out of the negotiations between mother and infant, a result of the historical process of change in the relationship and not a unidirectional or bi-directional linear product of one partner or the other. In a study of spontaneous mother-infant-object interactions from three to five months of age, Gray (1978) used a qualitative approach to describe the relational features of early object play in two mother-infant dyads. The following is a description of infants Kathryn and Ruth and their mothers at three months.

> Kathryn's mother first played socially with the baby, tickling her, talking to her, responding to her vocalizations and changes of facial expression, until the baby had reached a state of vigorous motor activity, happy smiling to the mother and long intonated vocalizations . . . *At this point the mother introduced the rattle, markedly reducing her own vocalizations, including her responses to the baby's own behavior.* Such responses as did occur were always short, excited, whispered

comments on the baby's activity in respect of the rattle, rather than longer, fully intonated utterances she used earlier (p. 167, emphasis added).

[Ruth's] mother moved the rattle almost constantly around the baby's visual field, continually shaking it. Ruth . . . made swiping movements at the rattle. . . *the mother responded to these movements by briefly moving the rattle nearer to the swiping hand, but the task of reaching for the rattle was not otherwise scaffolded for the baby*. . . Consequently, unlike Kathryn, Ruth's visual fixation frequently shifted away from the rattle to the mother. Indeed, this mother actively attempted to gain the baby's attention away from the rattle to herself (p. 169, emphasis added).

Kathryn progressed over the next few months to a high level of sustained attention to objects and Ruth became more socially oriented. What is clear from both of these examples is that the object is embedded into the ongoing relationship system and is not something that is isolated as the focus of activity independent of that system. Also, individual differences in object play are linked to the relational history of object-related exchanges.

We have highlighted in italics (not in the original) the actions relevant to transitions between face-to-face and social object play. Kathryn's mother was able to make smooth transitions between social and object play by co-regulating her activity with respect to changes in the infant's gaze and movements. Each play frame was equally developed and equally important in the flow of the relationship. Ruth and her mother showed a preference for social play, and this became the dominant focus of their relationship. Transitions to object play frames were not well developed, tending to return the dyad to social play.

Summary

The studies reviewed in this chapter suggest that the development of perception and action in the first half year of life may occur as a sociocultural and relational process. A number of studies converge on the finding that individual differences in attention and object-related skills are related to patterns of mother-infant communication. On the other hand, the evidence for this link is based on group correlation coefficients that explain only a limited portion of the variance. With the exception of the study by Gray, there are no relational-historical studies. In the work presented here, we attempt to document the process of developmental change across this developmental transition by making weekly observations of mother-infant play within dyads. We examine the developmental coordination between changes in the dyad's communication and changes in the infant's actions on objects.

3 Relational-historical research on developmental change

In this chapter we intend to show how interpersonal relationships can be conceptualized as dynamically developing systems. We first define relationships as systems of organized and patterned flows of communicative co-activity called frames. Next, we describe relational-historical research on developmental change, hypothesizing three main processes by which frames re-organize to make way for the emergence of new frames. Finally, we discuss implications of this approach for understanding the developmental transition in the mother-infant relationship from face-to-face to mother-infant-object play.

Relationship frames and transitions

A **relationship** is a developing communication system encompassing action, physiological processes, and the psychological meaning of those processes to each individual. When we use the word relationship, therefore, we are talking about a living, developing system. Relationships have been observed to move through various phases of development including initial attraction, familiarization, intimacy, commitment, distancing, rejuvenation, and dissolution (Altman & Taylor, 1973; Bowlby, 1969; Gottman et al., 2002; Knapp, 1984; VanLear & Trujillo, 1986). Part of the developmental process is the emergence of new dynamically stable attractors (see Chapter 2) of patterned communicative action called frames.

The ability to identify frames seems to be part of the basic social perceptual abilities with which humans, and most social animals, are endowed. Research on social perception suggests that observers are better at detecting the global aspects of communication than at identifying the precise beginnings and endings of discrete action units (Ginsburg, 1985; Newtson, 1993). Ethological research also shows that socially living animals have evolved highly sensitive social perceptual skills that allow them to detect and respond to global features of social action. Thus, most social animals can recognize and react appropriately in

particular kinds of communication frames such as greeting and leave taking, threat and defense, attachment behavior, dominance, and cooperation (Ekman, 1984; Frijda, 1986; Tomkins, 1962; de Waal, 1989). Neuroscientific research suggests that the brain has evolved to develop and identify categories that have adaptive significance for the individual (Edelman, 1987; Thelen & Smith, 1994).

The concept of frame as applied to communication systems was used first by Bateson (1955), to describe the ways in which individuals enter into mutual agreement regarding the meaning of a pattern of action. In research on rough-and-tumble play in juvenile animals and humans, Bateson described the formation of a mutual agreement that "this is play," rather than a fight. This agreement ensures the mutual consent to engage in a highly arousing communication that otherwise might be taken to have aggressive connotations. According to Goffman (1974), frames are context-specifying patterns within social systems.

In our definition, based on that of Kendon (1985), frames are segments of co-action that have a coherent theme, that take place within a particular location (in space or in time), and that involve particular forms of mutual co-orientation between participants. The coherent themes involve shared meanings or goals, implicit or explicit, about the nature and course of the communication. Although frames are recognizable and observers can agree when asked to code frames in a communication system (see next chapter), frames are not readily defined. The problem is that there is a good deal of variability within the global features of the pattern. Attachment frames, for example, differ according to the age of the child and the development of the relationship. Young infants cry to express the need for parental proximity, year-old infants approach the parent, and older children can express attachment needs by asking for attention or talking about feelings (Sroufe, 1977). Most observers, nevertheless, can recognize all these as instances of attachment.

There seems to be no consistent rule by which participants recognize a set of actions as constituting one or another frame, nor is there a specific quantity of action that distinguishes one frame from another. Lacking a consistent objective criterion for a frame, one must conclude that an unobservable process of information creation intervenes (Bateson, 1955; Fogel, 1993). A particular set of actions, perceptions, and physiological processes, occurring in a particular context must be interpreted by the participants as being informative to distinguish this or that frame. In other words, following Bateson's contribution to information theory, some differences make a difference and others don't. All we can do at this point is to focus our effort on recognizing patterns of co-activity in

which "differences that make a difference" are documented in detailed ways by observers.

Because frames are informational, they "exist" in the relationship between the observer and the data of social action; they are not concrete in the same way that a specific behavior is concrete. The more the observer is familiar with the data, in our case the more the observer repeatedly views the videotapes, the more likely it is that a distinction between different frames will become clear. We make the assumption that there is likely to be a convergence between our familiarity with the data over time and the research participants' familiarity with their own partaking in their relationship. Although we may only be able to completely answer this question by sitting down with the mothers and asking them to identify frames we have previously identified, we document their behavior in detail and invite the reader to agree or disagree with this assumption.

Nevertheless, communication researchers have noted that differences between frames can be conceptualized with respect to a small number of features. These features reflect the relational dynamics of the communication system, dynamics that transcend particular behavioral manifestations. Four features have consistently emerged in communication research (Fogel, 1993; Fogel & Branco, 1997; Kendon, 1985).

1. Frames reflect participant's **attention to particular aspects of action and context**. While many different aspects of action could be informative for participants (such as clothing, respiration, intestinal noises, odors, and gestures), a frame isolates only some of those aspects as potentially meaningful for a possible joint focus of attention. In addition to action, frames may direct attention to thoughts, feelings, and symbolic referents. Attention may be **shared** (partners look at the same object) or **non-shared** (partners look at different objects) (Camaioni, Aureli, Bellagamba, & Fogel, 2003).
2. Frames are composed of **situated** forms of communication, which includes spatial location as well as genre of communication. The spatial location (inside or outside, a particular room), the distance between partners, and the presence of others, all may contribute to which events in a frame are perceived as informative. Frames may be located within a particular cultural-historical discourse or genre of communication. Examples of this include baby talk, romantic relationship talk, professional talk, or particular styles of written communications. Finally, frames may have a location in the time sequence of everyday activities, such as frames for bedtime stories or prayers before meals.

3. Frames have particular **co-orientations** between participants. These include postural co-orientations, such as sitting, standing, lying down, and mutual body orientation. These co-orientations may take place in different locations, as specified in the previous point. Co-orientations may be defined by the media of communication, as when people interact live, via telephone, or in writing such as letters or email. Co-orientation may also involve informative communicative stances such as formality or informality, aggressiveness or playfulness, emotional openness or closeness.
4. Frames have a coherent shared **topic** or **theme**. This theme can be thought of as what the communication is about for the participants, their particular intentions for relating in this particular manner. Participants may communicate about objects and events in the world, about issues in their own relationship, or about psychological experiences.
5. Finally, frames have a particular configuration of actions (attention, location, co-orientation, and theme) that are assembled into **dynamically stable** and recurring patterns of communication.

These features have emerged through empirical investigation as reasonably general constituents of frames and other features may be found in future research. These features are useful to list here, however, because they help observers to distinguish one frame from another.

Returning to the attachment frame example, participant's **attention is directed** to behavior that leads to the maintenance of proximity and orientation toward a particular other person. By definition (Bowlby, 1969), attachment results in a **co-orientation** of mutual approach and physical proximity. Different types of attachment involve different forms of co-orientation such as mutual approach in secure attachment and withdrawal in avoidant attachment. Attachment frames may occur in particular relational **locations** such as in a bedroom, using genres of intimacy in talk and/or action. Finally, attachment has the **theme** of expressing and acting upon the need to be in the company of the other person. We recognize the alternative manifestations of attachment because they all share these particular four aspects. A frame, therefore, is distinguished by its meaning to the participants and by a configuration of meaningfully connected and dynamically stable actions.

This example illustrates that the four features are not necessarily independent from each other. Communication systems are highly redundant in the sense that similar information (in this case, maintaining proximity) can be detected and created through different means (Smith, 1977). When we focus our theory and research on systems in which parts are

organically connected to the whole, we cannot expect to separate the whole into independent or orthogonal segments. This is the idea of implicate order (Bohm, 1980, see Chapter 2).

If attachment is one communication frame in a relationship, other frames can also be present in the same relationship. In principle, according to a dynamic systems perspective, there are not an infinite number of frames in a relationship. Rather, relationships are characterized by a relatively small number of frames, those attractors which prove to be stable under the dynamics of self-organization. At any given point in time, mother-infant relationships have frames for attachment, feeding, comfort, greeting, leave taking, and various kinds of play frames. Adult romantic relationships have similar frames and perhaps in addition frames for childrearing, family finances, vacation trips, and so on.

Each time a frame is reconstituted in a relationship, small variations in attention, location, co-orientation, and topic create a sense of ongoing novelty within sameness (Fogel, 1993; Stern, 1985). The variability of action within the same frame on repeated occasions suggests that frames have dynamic stability. This variability is potentially problematic from the perspective of trying to specify the exact definition of a frame and establishing reliability between observers. Variability within stability, however, is the hallmark of dynamic systems, indeed of all living systems (Capra, 1996; Darwin, 1859; Thelen & Smith, 1994). Without systematic variability there could be no development. Development at all levels of biological systems, from species evolution to ontogeny, relies on variability that is intrinsic to the system as the source of system change.

One advantage of dynamic systems theory is the idea that systems change because of this intrinsic variability and this variability cannot be ignored or subsumed into an "error" term. The study of development from a dynamic systems perspective, therefore, requires the researcher to accept and measure both the variability and the stability. The goal of a systems analysis is to balance observations of microscopic variability alongside observations of macroscopic stability and change. In the case of frames in a relationship, therefore, the coding of frames is only one step in the process of understanding how microscopic variability gets transformed into macroscopic stability at certain times and into macroscopic change (development) at other times.

We know that frames within relationships undergo developmental changes such as formation, transformation, and dissolution. New frames form as partners expand their relationship into new areas. With continued communication, these newly formed frames become more detailed and encompass a wider range of actions and meanings for the participants. Finally, frames may eventually disappear from the relationship

system in the sense that they may no longer be observed in their complete original form. In our research, we consider the transition from face-to-face to object-directed social play as a problem in the analysis of developmental change in a relationship from a primary focus on one type of frame to a primary focus on another type of frame.

The gradual decline of one frame and the emergence of another is a common phenomenon in relationship systems. Styles of dress or food preferences in a culture change over time after some period of common use and acceptance. Standards that regulate interpersonal behavior in the work-place have changed to include increasing tolerance for diversity, equal rights, and a decline of language and manners that can be perceived as hostile or discriminatory. States of war continually cycle with periods of peace.

Information and frame dynamics

As discussed elsewhere by the first author (Fogel, 1993), traditional models of communication are non-developmental and non-dynamic. They rely on a concept of predefined information that is transmitted between senders and receivers. In this **discrete state** model of communication, information is a state of knowledge, emotion, or intention "contained in" the senders and receivers. Information is assumed to be transmitted faithfully from the sender and failures to communicate are ascribed to noise in transmission (Shannon, 1963; Smith, 1977; von Neumann, 1958). In this view, the total information in the system is fixed at the outset by the intentions of the participants. In the process of communicating, information is gradually lost due to noise. We could describe the mother-infant smile sequence in discrete state terms by suggesting that the mother attempts to communicate some of her own emotional information (affection for the infant, or wanting to get the baby to smile), and the infant responds with his "own" experience of joy at seeing the mother smile. If the infant does not smile in return, it means – from the perspective of the discrete state model – that the infant did not get the mother's message due to noise in the system. Noise is a form of variability that is considered a source of error in the discrete state model. The mother would then attempt a different way to get the baby to smile until the baby "got it." Participants in this view are continually working to get their message across to the other person.

An alternative to the discrete state model is a **continuous process** model of communication (Fogel, 1993). In this view, *communication produces a net gain of information* in the system. Research on animal and human communication shows that some information is **emergent**, that

is, created as part of the communication process. Hinde's (1985) analysis of animal conflict, for example, suggests that the initial postures and threat displays of rival animals do not exactly specify their internal states. The animals may not be entirely certain of their intentions at the time of the displays.

> Such signals are thus to be seen as involving negotiation with the rival as well as an expression of internal state. The term negotiation does not necessarily imply manipulation but emphasizes the continuous interaction between the two individuals involved (Hinde, 1985, p. 111).

This observation suggests that under some conditions, information – in the form of each individual's experience of the partner – is the *result*, and not the cause, of communication. One may have a "possible intention" or a "tentative feeling" that can only be realized or transformed in the act of communication. A casual glance between two strangers may create an indeterminate heightening of mutual interest. If that glance is repeated, and coupled with head and body co-orientation, a more defined sense of "interest" may emerge as informative about the possible future of the encounter. Further approach and eventual proximity continue to help define the emerging information for the participants in this potentially romantic encounter. The communication process, therefore, is a dynamic system in which the whole is more than the sum of its parts, in which order emerges as constituents self-organize, and in which information is created in the process (Fogel, 1997).

In the mother-infant smile example, research shows that maternal smiles are most likely to be returned by the infant when the infant is already gazing at the mother and when they are engaged in a face-to-face play frame including joint attention, mutual postural orientation, physical contact, and en-face positioning (Fogel, Nelson-Goens, Hsu, & Shapiro, 2000; Kaye & Fogel, 1980; Messinger, Fogel, & Dickson, 2001). The information for the infant of the mother's smile, therefore, cannot be divorced from the historical context of the relationship frame in which smiling occurs (Oyama, 1985). What is meaningful for the dyad in any particular moment, in other words, depends upon earlier consensual co-activities. The infant smile means not just a received transmission of the mother's prior act of smiling, but the intersubjective experience of co-participation in a historically established frame for positive emotional communication (Trevarthen & Aitken, 2001; Tronick, 2001). The historical frame is not transmitted nor is it bound by rigid sequencing rules. Each new instance of mutual smiling occurs in a slightly different pattern than previous instances. This variability *creates information* – feelings of enjoyment, recognition, trust, and the

motivation to continue communicating – amplifying the flow of positive emotion in the system.

A continuous process model follows a dynamic systems perspective. Dynamic systems theorists prefer not to rely on storage and representation metaphors to explain history because they imply a static, discrete state view of how the past affects the present state of the system (Fogel, 1993; Thelen & Smith, 1994). Attractors, stabilized by historical precedent, preserve the fluid and dynamic aspects of individual and communicative action. Social play, by virtue of its spontaneity and creativity, seems to be an excellent example of self-organizing historical communication.

> Anticipation based on prior expectations is certainly part of the enjoyment and engagement. The existence of such cognitions, though a component of the play, does not mean that those cognitions are constitutive of the game, any more that a coach's game plan and score card and each player's knowledge of the 'rules' regulates the specifics of the encounter between two opposing teams.
>
> (Fogel, Nwokah, & Karns, 1993, p.54)

When information is historically emergent, the communication process is symmetrically **co-regulated** (Fogel, 1993). Symmetrical co-regulated communication occurs when co-action is coordinated (both sequential and co-occurring), when partners are open to mutual influence, and when the resulting process creates new information, information that was not entirely available to the participants prior to this instance of their joint engagement. Co-regulated communication fits the definition of self-organization (see Chapter 1) in which elements of a system mutually and continuously modify each other in such a way that new forms of organization and new information emerge from the transaction.

Markova (1987), for example, envisions a three step dialogical process in which novelty is created. A acts and B responds. But as B is composing the response, A is already changing and perhaps the observed changes in A alter the response of B as it is unfolding in time. Participants cannot count on communication being totally predictable because the "signal" is changing continuously before the "response" is completed, and vice-versa. Because of this continuous co-regulation, the passage of time in a dialogue creates the conditions that lead to the emergence of innovative information and action (Ayres, 1983; Bahktin, 1981; Baxter, 1994; Baxter & Bullis, 1986; Canary & Stafford, 1993; Cissna, Cox, & Bochner, 1990; Dindia, 1994; Fogel, 1993; Fogel & Lyra, 1997; Lyra & Winegar, 1997; Newman, 1982; Surra & Huston, 1987; Werner, Altman, Brown, & Ginat, 1993; Wilmot, 1994).

Frames are maintained through these informational dynamics, as both familiar and novel information brings partners together. There are a set of dedicated neurophysiological processes that orient people to each other and that create familiar and expectable neurological, hormonal, and behavioral patterns that orient each partner to the other for the purposes of co-regulation (Schore, 2003). These neurophysiological aspects of frame maintenance are "experience dependent," that is, the neural connects are formed by repeated similar experiences and lead to the development of preferred pathways of sensation, emotion, and orientation to others.

Such frames may create both positive and negative, shared and non-shared forms of information. Insecure attachment, for example, is a frame for mutual proximity but with feelings of threat or avoidance coupled with approach for the insecure partner but not necessarily for the other partner. Mutual aggression, in families or between nations, can be thought of as a frame in which information is created about vigilance and readiness to attack. The "attack-defend" pattern serves to maintain the frame. Each party to the conflict is likely to have different and in fact conflicting intentions and reasons for fighting. Shared feelings or intentions, therefore, are not required for the maintenance of a frame nor for changes in the relationship (Fogel, 1993).

Transitions between frames

In general, dyads engage in one frame at a time (either face-to-face play or social-object play) but eventually one frame ends and another begins. Frames are connected to each other primarily by realtime sequential **transitional processes**. Transitional processes are moments when the dyad makes a realtime change from communication in one frame to communication in another frame. As in film or theater, the transitional moments are links between changes from one scene to the next.

From a dynamic systems perspective, the study of transitional processes is as important as the study of within-frame dynamics. It is important to know, for example, why and how a particular couple makes transitions into a frame for an argument and has difficulty making transitions out of that frame and into a frame for reconciliation. One way to think about ending mutual aggression is to conceptualize it as one frame in a dynamic system in which other frames may possibly exist and to which transitions may be possible to foster. In the case of the study presented in this report, transitions in realtime represent the propensity of mother-infant dyads to enter and leave frames for social play or for social-object play.

Interdyad differences may be explained as much by the differences in the duration of frames and the actions within frames, as by differences in transitional processes. We might expect that a more socially oriented dyad may differ from a more object oriented dyad not only in their different durations of frames for social and object play but in the richness of their transitional processes for moving to and from social and object frames. In the study presented here, we examine both frames and transitions between frames in order to illuminate the developmental change process in relationship, a topic to which we now turn.

Relationship development

When communication is co-regulated there is a gradual emergence of information within the system over time, both for within frame processes and for transitional processes. Thus, even when participants are engaged in the "same" frame, the system generates novelty and that novelty is informative with respect to the specific sequences of communicative processes that led up to it (Fogel, 1993). We propose that this emergent novelty is the source for developmental change in the relationship. Given this general idea of frame change as emerging from informative innovations, in this chapter we suggest three related processes by which relationships change. These will be explained in detail in the following sections. Further elaboration of these processes can be found in Chapter 5 (Research propositions) and in the results chapters (7–11).

Change process I: historical, bridging, and emerging frames

According to some dynamic systems models, developmental change is believed to occur rather abruptly. These abrupt changes have been called phase shifts, catastrophes, or non-linear change (Kelso, 2000; Thelen & Smith, 1994). This is because systems are thought to spend most of their time in one or another qualitatively different attractor, leaving no middle ground in which the system may spend time easing into a new attractor pattern. Also, re-organization of the constituents, as in the shift from the solid to liquid states of matter, is often observed to occur suddenly. Slush may be an intermediate state between ice and water but the molecular system does not "need" to spend time in slush before making a transition between ice and water or vice-versa. Some motor systems, such as gait changes from walking to running also appear to follow similarly abrupt change processes (Kugler, Kelso, & Turvey, 1982; Thelen & Smith, 1994).

Findings about change processes in physical systems, however, may not apply to cognitive and social-relational informational systems. Piaget's descriptions of scheme development, for example, suggest that there is a gradual evolution with many intermediate schemes which gradually differentiate or integrate with each other. Changes between sensorimotor sub-stages are hard to detect because, at any given time, there are temporal overlaps with "prior" and "emerging" stages. Schemes for each stage co-exist with schemes for the prior and subsequent stages, and there are intermediate schemes that combine features of both.

Vygotsky's notion of the ZPD emphasizes the way in which interpersonal relationships "smooth" the change process. The ZPD is a type of frame in which the past (what the child knows how to do) and the future (what may be possible for the child) are blended together to help the child appreciate the links between prior and emerging actions (Valsiner, 1997, 2001). Rogoff (1990) makes a case for parental guidance as a form for building bridges between past and future. The ZPD actually creates a place for the possibility of change, for introducing potential future actions without disrupting familiar ones.

Bruner (1983) described play "formats" (equivalent to frames) in which mothers first create a sequence of dialogical activity with their infants in which they play two parts. In a telephone game, for example, the mother may ask a pretend question to the pretend person on the phone, and then answer it herself. The mother creates a bridge in which the child eventually comes to pick up one of those parts, filling in the blank spaces of the dialogue that the mother leaves open.

> Formats 'grow' and can become as varied and complex as necessary. Their growth is effected in several ways. They may in time incorporate new meanings or strategies for the attainment of goals, including symbolic or linguistic ones. They may move toward coordination of the goals of the two partners not only in the sense of 'agreement,' but also with respect to a division of labor and a division of initiative (Bruner, 1983, pp. 132–133).

Informational systems that regulate human conduct, therefore, spontaneously generate multiple frames. In addition to frames for particular activities, cognitive and communicative systems create frames – like the ZPD – whose sole purpose is to foster and support developmental change. Work by Granott and colleagues (Granott et al., 2002) has described a process of **bridging** in cognitive development.

> Bridging is a process of leaping into the unknown by inserting marker shells that indicate targets for future development and learning . . . A shell is like a formula in mathematics in which the variables represent unknown values that can be later defined. Bridging operates like an attractor in dynamic systems and pulls

development toward more advanced, relatively stable levels . . . A bridging shell serves as a dynamic attractor after its initial emergence in realtime activities within context (p. 131).

Once it is created, a bridging shell achieves the level of a stable attractor in the cognitive system, an attractor that has the function of a transitional frame between lower and higher levels of activity.

According to the "overlapping waves theory" of cognitive development (Siegler, 1996), children tend to have different ways of thinking about a problem, some of which are more and others less advanced. Over developmental time, more advanced ways of thinking come to predominate. But at any given time, a child may approach the same problem using older, intermediate, and newly emerging thinking strategies. Children use the older and intermediate strategies as a way of linking what they know to what they do not yet know. The point here is that there are always multiple co-existing strategies in a cognitive system just as there are always multiple co-existing frames in a relationship system. This is not mere complexity for its own sake, but a way in which systems dynamically self-organize in order to remain open to the possibility for change.

Granott's notion of bridging is similar to Piaget's idea of a balance between assimilation (to available schemes) and accommodation (toward changing the scheme), and to Bruner's notion of the social format as a place holder that provides familiar locations in which a child can insert novel behavior. An example of this is when mothers take both roles in peekaboo (Where's Mommy?. . .Here I am!), after which the child begins to play one or the other part (Bruner, 1983; Holt, Fogel, & Wood, 1998). Observations of infant cognitive and emotional development suggest that the infant's growing consciousness of links between past experience and potential future actions are maintained in a dynamic balance as a result of learning during intersubjective communication between parent and infant. This is because the neurological and behavioral abilities of the infant and young child require companionship and coupling with adult bodies and brains in order to develop the skills to bridge past and future (Trevarthen & Aitken, 2001; Schore, 2003).

Theories of psychotherapy also include concepts similar to bridging, generally focused on intrapersonal processes. Winnicott (1971) talks about how a person's inner needs and experiences come to be coordinated with "reality," meaning the limitations of the real world to satisfy all those needs. Humans create an "intermediate area of experience" in which a person can play with the possibilities of the real world and at the same time not be challenged about the form of play. Winnicott's

example is what he called " transitional objects," soft toys that include dolls, teddy bears, and blankets. These transitional objects can be played with and relied upon even if the real parent cannot be so available.

> This intermediate area of experience, unchallenged in respect of its belonging to inner or external (shared) reality, constitutes the greater part of the infant's experience, and throughout life is retained in the intense experiencing that belongs to the arts and to religion and to imaginative living, and to creative scientific work (p. 14).

Family systems models of marriage and family therapy rely on the concept of "re-framing," originally formulated in a book titled simply, *Change* (Watzlawick, Weakland, & Fisch, 1974). When families develop frames of disagreement of conflict, the creation of an alternative frame that allows them to bridge the past situation with an "everyone wins" alternative, has proved therapeutically valuable.

> To reframe means to change the conceptual and/or emotional setting or viewpoint in relation to which a situation is experienced and to place it in another frame which fits the 'facts' of the same concrete situation equally well or even better, and thereby changes its meaning (p. 95).

The key to re-framing is not to change the "facts" of the situation but to alter the meaning of those facts for the participants. In other words, a different attractor is created that bridges the anger and resentment about the historical pattern into a no-fault alternative.

Our own prior research (Camaioni et al., 2003; Fogel, 1993; Fogel & Lyra, 1997) suggests that change in relationships is likely to occur gradually in a three-part historical sequence of the change process: (1) an initial phase in which there is one predominant historical frame; (2) a second phase in which a different frame becomes predominant and serves as a developmental bridge; and (3) a final phase in which a new frame emerges as predominant. Assuming repeated observations at frequent intervals of the same relationship across some developmental transition, there should be a frame that is predominant in the early sessions before the developmental transition and then declines (the historical frame), another frame that is predominant in the middle sessions during the developmental transition (the bridging frame), and another frame that becomes predominant during the final sessions after the developmental transition (the emerging frame). There is likely to be a higher frequency of realtime transitions between historical and bridging frames and between bridging frames and emerging frames. This suggests the following model of relational-historical development, as expressed in developmental sequence (P_1):

$$(P_1) \quad (\text{Historical} \leftrightarrow \text{Bridging}) \Rightarrow (\text{Bridging} \leftrightarrow \text{Emerging})$$

In this sequence, the inner bi-directional arrowheads represent realtime transitions while the bold arrowhead represents the developmental time sequence. Frames are bridging in realtime because they mediate realtime transitions between historical and emerging frames. Frames are bridging in developmental time because they become predominant in the period in between the predominance of historical frames and the predominance of emerging frames. Frames are bridging also because they may incorporate components of previously established frames at a time that these frames are dissipating, thereby creating a developmentally intermediate area of shared experience for the dyad.

According to these examples, bridging is sometimes observed as a *process*, as in the idea of re-framing which takes place in the moment and may shift the system from one frame to another. When bridging is a process, we conceptualize it as a realtime transition between frames that work to bridge, in a brief period of time, one frame to another. Most of our examples, however, suggest a sense in which bridging can become a "structure," that is a dynamically stable attractor in its own right. The blanket as transitional object is a physically concrete example of such a structure. Our notion of a bridging frame, then, is a dynamically stable "structure" or attractor in the relationship which mediates a developmental transition between historical and emerging frames, analogous to the way in which a realtime transition mediates the shift from one to another frame in realtime.

As an example of this developmental sequence, we present observations on one infant, Hannah, and her mother, who were observed once a week in the period from nine to twelve months playing with a pair of toy telephones (the example is adapted from the observations of Reinecke & Fogel, 1994). The historical frame involved playing with the phones as physical objects, the newly emerging frame involved pretend play with the phones, and the bridging frame combined elements of both physical and pretend play.

Historical frame. Beginning at nine months, Hannah and her mother played for extended periods with a pair of toy telephones, treating them as physical objects. The focus of play was on banging the phones against the table, making noises by pushing the buttons on the keypad, or giving and taking. This interaction can be classified as the historical frame in which there is shared attention to the toy phones as physical objects.

Bridging frame. After a few sessions, this dyad developed a bridging frame that combined the mother's attempts at convincing Hannah to

join her in pretend play with Hannah's physical play. This was a different frame because Hannah's actions were not the same as in the historical physical play frame. Specifically, she began to imitate some of the physical actions that constituted the pretend sequence, such as placing the receiver of the toy phone near her ear without saying "Hello!" while looking at her mother. The dyad also played the physical game of give-and-take with the receiver while the mother verbalized the elements of the pretend game. The mother would make the phone ring, for example, and then say, "Hannah, it's for you," while handing the receiver to Hannah. This is reminiscent of Bruner's idea of the dyad creating formats in which the child can begin to play a different role. Hannah frequently initiated transitions back to the historical frame by turning away from the mother and engaging in physical play with the phones, throwing or banging the receiver. These differences between the bridging frame and the historical frames are differences that make a difference in the quality of the play, at least from the perspective of the observer of the videotapes.

Emergence of new frames. The growth of the bridging frame set the stage for the establishment of a new frame for pretend play. In the emergent frame, Hannah put the phone to her own ear spontaneously, said "Ha–o," and handed the phone back to mother while looking and smiling at mother. In this frame, the offering of the phone was different in meaning compared to the offering during the bridging frame. The pretend offering no longer signified a simple give-and-take of a physical object. The newly emergent meaning of the phone exchange – the information that was created within the frame over developmental time – was to pretend to have a telephone conversation.

Change process II: innovations as seeds for change

How does the developmental sequence from historical through bridging to emerging frames occur? From a dynamic systems perspective, we presume that there is variability inherent in the system that creates the conditions for new frames to emerge spontaneously. Dynamic systems researchers have been describing variability as a fundamental part of the understanding of behavior and development (van Geert, 1997; Grannott, 2002; Thelen & Smith, 1994). Rather than treating variability as error or noise in the system, these and other researchers have been attempting to understand the developmental significance of variability.

From the perspective of an informational dynamic system, variability is not simply physical change but rather the detection by participants of a difference that makes a difference to them. What are the informationally

significant forms of variability in a changing sociocultural system? We propose that there are three types or levels of variability.

One level of variability is the change of actions within a frame, the ebb and flow of dialogue that gives the frame its dynamic yet stable character. These changes, however, do not change the frame in realtime. *Level 1 change is ordinary variability within frame or between-frame transition dynamics, variability that allows the frame or transition to persist in realtime even though there are continual changes in action.* In a greeting frame, romantic partners may sometimes kiss, sometimes embrace, or sometimes use endearing words. Over a long period of time, these forms of variability become part of the frame. The frame is still recognizable as a greeting between romantic partners, which probably does not include hand shakes, bows, or formal verbal styles as part of its ordinary variability (at least not in Western cultures).

There is also level 1 change in the variability within the realtime transition between frames. Realtime transitions from the bridging to the historical frame in the telephone game occurred when Hannah stopped imitating the pretend actions and looked away from the mother. Across repeated instances of a transition between any two particular frames, dynamic variability occurs. Sometimes Hannah may look away, and at other times turn her body away. She may even continue to look at her mother while stopping the imitative actions. These are all examples of level 1 change within the realtime transitions between frames because they allow the transitional dynamics to persist in realtime.

Physical dynamic systems models assume that ordinary variability is sufficient to produce a change in attractors that may lead to a developmental transition. Developmental change in informational systems, however, cannot arise from level 1 variability. By definition, level 1 variability is perceived by participants as ordinary variations on a theme, variations that are not perceived as having the possibility of changing the system. From the perspective of information, level 1 variability is that which is perceived to constitute the current ongoing dynamics of the communication system.

For developmental change to become possible, something that is perceived as genuinely new must be identified in the system, something that transcends the ordinary. *Level 2 variability is an innovation, a novel action appearing for the first time within the frame or transition dynamics.* An innovation is a difference that makes a difference. It is noticed by participants as being a discovery, being novel, being a change from the ordinary types of change.

What is the source of innovations? The answer to this question is fundamental to our understanding of the process of developmental

change. One does not, however, have to look very far for the answer because communicative informational systems are *inherently innovative.* Let us return to the concept of the ZPD. Where do the future possibilities come from, the possibilities that are innovations from the perspective of the child?

According to Valsiner (2001), communicative signs by their very nature implicate past, present, and future. To say that, "This child is blind," according to Valsiner, suggests that the child was blind, currently is blind, and will continue to be blind in the future. Participants have the opportunity to choose one or more of these possibilities. Lock (1980) makes a similar point.

> . . . through interaction with his mother, the child is engaged in a process of developing communicative behaviours, which contain by their very nature such implicit emergent phenomena. By establishing meaningful communication between them, the mother and child open up a 'whole new universe of possibilities and potentialities' some of which comprise the 'problems' the child has to surmount in progressing toward a fully fledged language (p. 36).

Lock goes on to say that codified forms of communication, such as language or the number system, are sufficiently complex and enriched that people can discover their properties on their own, a process he calls "re-invention." Thus, communication systems are constructed in such a way that they invite innovative uses. If a child discovers that he can ask for milk, why not ask for lots of other things too? Innovations are inherent in every single sentence uttered and in every complex nonverbal frame.

> . . . the structure of relations between people and the properties of discourses and practices they engage in constitute the conditions that enable their discovery of the unintended properties (implications) of the systems of symbols, social relations, and discourse practices their modes of life constitute. These 'discoveries' then constitute the phenomena that have been subsumed under the term the 'evolution' of human abilities (Lock, 2000, p. 116).

Hannah's spontaneous incorporation of new elements into the telephone game during the bridging process is an example of how the existing frame creates opportunities for innovation. These opportunities are implicit in the structure provided by the mother, waiting to be discovered, or re-invented, by the child. From the point of view of the larger cultural system in which many children play telephone and most of them discover means for pretending, Hannah's discovery is a re-invention. From Hannah's point of view, however, it is clearly an innovation, a difference that to her makes a very big difference in her engagement in the game (as indexed by her smiling, see below).

The final form of change to be considered here is developmental change, or level 3 change. As we stated earlier, *development change, or level 3 change, is the destabilization, re-organization, and re-stabilization of the collective system of historical attractors or frames.* In the context of this discussion, we expect to see the re-organization of the frames in the system following upon level 1 and level 2 changes.

Our prior work (Fogel & Lyra, 1997) using microgenetic designs suggests that an innovation alters frame and transition dynamics in subsequent sessions and does not significantly change the frame and transition dynamics in the session in which it first appears. We write this developmental sequence (P_2) as follows:

$$(P_2) \quad \text{level 1} \rightarrow \text{level 2} \rightarrow \text{level 3}$$

In the example of Hannah and her mother, the change process from historical to bridging frames began at level 2, as a novel innovation was established during the historical frame. Hannah's mother tried to introduce pretend actions as innovations into the historical physical play frame. These innovations, when first introduced, did not significantly alter the frame because Hannah showed relatively little interest in them. In other words, although the level 2 change does not produce a developmental change when it first appears, it occurs in realtime along with the level 1 ordinary variability. As Hannah began watching her mother's pretend actions and imitating them, this constituted a level 3, developmental change. The developmental change did not occur when the innovation was first introduced but only later during the bridging frame.

The newly emergent frame for pretend play was made possible by the earlier innovations that created the bridging frame. The first appearance of the new pretend frame was observed in our videotapes at forty-four weeks:

> Hannah picks up the phone and looks at it, then at her mother. She offers the phone to her mother in the same manner that she had done in previous weeks **[Bridging frame]**. *Mother takes the phone, puts it to her ear as in previous instances and says, 'Hi, grandma!' At that point, Hannah looks and smiles at mother and reaches out to request the phone* **[Realtime transition]**. Her mother offers the phone to Hannah, who puts it to her ear and says, 'Ha–o'. Hannah again looks at mother then offers the phone to mother **[Pretend frame]**.
>
> (Reinecke & Fogel, 1994, p. 184, annotations and italics not in the original).

The bridging frame and the transition in this example had been present in the dyad for several weeks, organized around innovations introduced into the bridging frame. In prior instances of this frame and transition, Hannah either ignored the mother's attempts to make a

transition to pretend play, or she just grabbed the phone back from her mother, thereby returning the dyad to the bridging or physical object frame.

In the developmental process of integrating the innovation into the historical frame and the emergence of a new frame, we frequently observe the dyad returning to previous forms of co-activity. Hannah's resistance to pretending and the return of physical play is an example of what we call recapitulation. **Recapitulation** is a recurrence of historical frames, or parts of historical frames, for brief periods during the system-wide re-organization that constitutes level 3 developmental change (Pantoja, 2000). It appears that relationships require a return to the past in order to stabilize the system during developmental transitions. Like a bridging frame, recapitulations buffer the system against sudden developmental change and may be a mechanism to regulate the potentially chaotic effects of re-organization.

A similar process has been noticed in cognitive developmental change, called " backward transitions" (Granott, 2002).

> When people at all ages encounter a new, somewhat unfamiliar task, they often cannot immediately start processing the task at their highest developmental levels. . . If the task is not immediately understood, lower levels have to be reconstructed within the context of the task before people can construct higher levels within that context. Therefore, they first have to regress to adapt their knowledge structures to the task's attributes and process the task through lower levels . . . The backward transition is apparent before major progress: it precedes and prepares for change and predicts a spurt of growth (p. 217).

According to Granott, backward transitions have to do with the subjective experience of the task, whether or not it is perceived as easy or too difficult. This emphasizes the importance of perceived information in understanding the change processes in dynamic systems.

It is also clear from the above quote that backward transitions are observed primarily once a developmental change process is underway, when the participants perceive that systemic change is occurring. Innovations at level 2 do not necessarily provoke recapitulation because they already occur within the context of a known and comfortable frame. Recapitulations, then, are one of the signs that participants perceive themselves to be in the midst of a more sweeping type of change, one that has the potential to destabilize the current system and make way for a new one. Regressions in child behavior are commonly observed around major developmental transitions. At the birth of a new sibling or upon the first entrance to preschool or day care, children are observed to regress to more infantile patterns of behavior

such as increased neediness, loss of bowel and bladder control, externalizing, and the like.

In our example, following the transition, Hannah recapitulated the same set of actions she had used before during the bridging frame in the form of imitation of the mother's actions: vocalizing, putting the receiver to her ear, and offering the phone to her mother. In this case, however, the entire pattern of these imitative actions was re-organized giving the observer and the mother alike the clear impression that Hannah was, for the first time, pretending to talk on the phone. In addition, the other attractors in this system changed. The physical play frame shifted to other objects that had clear physical play properties, like balls and slides. The bridging frame disappeared altogether. Pretending extended to other kinds of frames (with dolls and other toys), permeating the entire communication system.

This first instance of a pretend frame was a difference that makes a difference. On the other hand, it was a qualitatively different kind of difference than those observed at level 2. Innovations are typically single actions that make a difference in prospective terms but not so much of a difference that they change the frame at the time they first appear. In this case of developmental change to pretending, we witnessed a change in the pattern of organization of multiple actions of both infant and mother (level 3 change) that constituted a new frame. So, there is a difference that makes a difference in realtime in the sense of being noted as different from the ordinary (level 2 change) and there is a difference that makes a difference in developmental time in the sense of re-arranging the configuration of the system (level 3 change).

On the one hand, this model suggests that developmental changes arise historically within the relationship because earlier innovations are predicted to become the seeds for developmental change in frames and transitions. Developmental change, in other words, can be directly observed as part of the change dynamics of the relational-historical system. On the other hand, developmental change does not arise directly from frame and transition dynamics (level 1 changes). Instead, developmental change is predicted to appear first as an innovation of a few actions within level 1 frame and transition dynamics and then later as a re-organization of those dynamics partly as a result of the innovation.

Describing change using developmental sequence (P_2) yields some advantages over other models of change. First of all, sequence (P_2) integrates change at all levels into a single consistent model. Frames are not seen as structures in the same manner as Piaget conceptualized schemes. Frames are conceptualized with regard to level 1 changes that have a particular pattern and a particular variability around that pattern.

Second, sequence (P_2) provides a clear link between the system's observed behavior and the concept of information. Levels 2 and 3 changes refer to differences that make a difference. Level 2, however, is a difference that makes a difference with respect to level 1, while level 3 is a difference that makes a difference with respect to level 2. They also integrate two important time scales in developmental analysis.

We intend to demonstrate in this study that these levels of change can be observed reliably and consistently if one pays close attention to communication process and if one observes the same dyads communicating frequently across a developmental transition. As mentioned earlier in this chapter, it is impossible to fully define frames and their dynamics in words. On the other hand, it is relatively easy as a full-time participant in an interpersonal relationship, or as an involved observer, to recognize differences that make a difference because sensitivity to information seems to be a fundamental part of living systems (Bateson, 1979; Oyama, 1985). We return to the issue of what constitutes an involved observer in the next chapter.

Summary

From a relational-historical perspective, the task of studying developmental change in the communication system is to examine changes in frames and realtime transitions between frames across a key developmental change. Frames are regular dynamic patterns that involve particular forms of the participants' attention, specific locations, particular forms of co-orientation, and a particular theme.

We conceptualized three levels of change. Level 1 is ordinary variability within frames and transitions between frames. Level 2 is innovations within level 1 dynamics. Level 3 is developmental change, a re-organization of the frame dynamics. Developmental change occurs via three related processes. First, change occurs in phases beginning from a historical frame, changing to a developmental bridging frame, and ending with the emergence of new frames. Second, developmental change (level 3) is likely to be preceded in developmental time by level 2 changes, innovations. In other words, first innovations appear that do not change the frame and later those innovations become the seeds for frame changes. Third, developmental change is likely to be accompanied by recapitulations. Finally, we suggested that individual change is developmentally parallel to relational-historical change. In the next chapter, we discuss a relational-historical research methodology, including the specific types of frames observed in our data and the issues related to coding and analyzing frames and transitions between frames.

4 Relational-historical research: the multiple case study approach, frame analysis, qualitative and quantitative analysis

In this chapter we suggest how the relational-historical perspective, outlined in Chapter 3, can be translated into a research program on developmental change processes. Relational-historical research is the study of how relationships change with respect to their own history. The purpose of this method is to describe not only the quantitative changes in the relationship, but also the historical changes in the meaning of the actions for the participants. The detection of differences that make a difference can only be done with respect to the bases for intersubjectivity that have been established in the past within the relationship.

Relational-historical research is an adaptation of a research approach that has come to be called microgenetic. The **microgenetic research design** has three features. First, observations begin before the onset of a change, continue through the change process, and conclude once a new pattern has clearly emerged. Second, observations are made frequently across this period of time in order to observe the system while it is changing. Finally, analyses focus on the study of processes that contribute to an understanding of how change occurs (Fogel, 1990; Granott & Parziale, 2002; Lavelli, Pantoja, Hsu, Messinger, & Fogel, 2005; Overton, 2002; Siegler & Crowley, 1991). This is illustrated in Figure 4.1, in which the time between observations (t) is considerably less than the time taken for the developmental transition (T).

Microgenetic designs are typically carried out with large numbers of observations on a relatively small number of cases. Although this leaves microgenetic studies vulnerable to the critique of not being generalizable to the population, microgenetic research has significant advantages that make it a valuable complement to traditional population studies. One major advantage is to enhance our understanding of how individuals and relationships change over time. Most microgenetic studies allow for both a quantitative and qualitative assessment of change. Because there are relatively few cases, observers can make room for

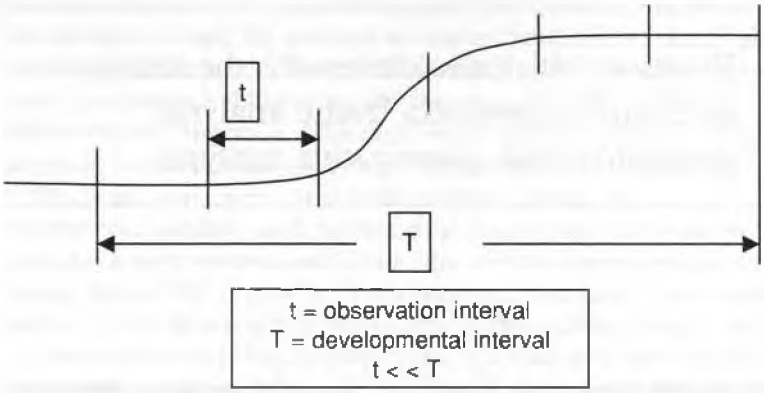


Figure 4.1. Observational strategy for microgenetic research in which observation intervals are considerably shorter than the time interval for developmental change.

discovery of how each case constructs their own change and navigates from the old to the new. Another advantage is that observers can examine individual differences in change processes. When and how are people most likely to pick up on innovations and move towards developmental re-organization? Does recapitulation always occur when a system is moving toward change? Or under certain conditions, does recapitulation hold the system back in the past?

Relational-historical research applies the microgenetic method specifically to the study of historical change in the communicative information within interpersonal relationships. Relational-historical research can apply to many different types of relationship systems such as mother-child, teacher-student, therapist-client, and employer-employee as well as to peer, romantic, and group relationships in which participants share roles of equal status. Relational-historical research can also be used to study changes in larger social systems such as organizations, institutions, and societies. Our method is divided into three parts: the multiple case study method, frame analysis, qualitative and quantitative analysis. In this chapter, we describe how each of these aspects of the method applies to the study of relationship change.

The multiple case study approach to developmental change

The case as a unit of analysis is central to relational-historical research. Case studies are often used as a means for emphasizing individuals in

their real life contexts. In sociology, anthropology, women's studies, education, and law, case studies are used frequently and follow a standardized set of methods (McCall & Wittner, 1990; Robson, 1993; Stake, 1994). Case studies have also been used in psychology in the clinical literature, in Piaget's studies of the development of his own infants, in single-case behavioral analysis research, and studies of child language development (Thorngate, 1987; Wallace, Franklin, & Keegan, 1994). Case studies have most recently been used in dynamic systems approaches to behavior and development (for example, Fogel, 1990; Fogel & Lyra, 1997; Thelen, 1989; Thelen & Smith, 1994) and in microgenetic designs (Granott & Parziale, 2002; Siegler & Crowley, 1991).

There is a good deal of discussion and debate about the scientific merit of case study research within developmental psychology. On the one hand, there has long been a clear recognition that the unit of developmental analysis is the individual (or dyad, or group) and that casewise longitudinal studies are the method of choice (Wohlwill, 1973). On the other hand, most scholars avoid such work – not because its value is in doubt – but because it is costly, time consuming, and does not easily fit into the standards and practices of professional development within the field of developmental psychology. These standards and practices include the need to publish widely, the ready availability of population statistics, and the ideal of a value-free approach to science (White, 1994). In what follows, we list some of the advantages of a case study approach for the research questions we investigate in this study.

Case study methods focus on the process of development

Because the case study researcher invests time in multiple intensive observations of a small number of cases there is more of an opportunity to observe how people change. When one's time and resources are divided across many cases, it is inevitable that fewer observations can be made on a single case. Thus, potentially more about the dynamics of change, and the actual moments or periods of important developmental transitions, can be directly observed in a case study (Fogel, 1990; Thelen, 1990; Wallace et al., 1994). Case studies are ideal for taking a developmental process approach, one that should

> show us about the timing of events, the susceptibility of processes to various kinds of perturbation and the manner in which the regulation is achieved, if it is achieved . . . what is needed to enable a particular developmental sequence to proceed, what will induce, facilitate or maintain such a sequence, how does sensitivity to these factors change with developmental state, what degree of

specificity is evident in these interactions, what is the relationship among events at various levels of analysis? (Oyama, 1985, pp. 160–161).

Research from a relational-historical perspective requires the use of a longitudinal case study approach. This approach is essential to understanding the whole relational system (all the relevant frames, within-frame processes and between-frames processes) at any one point in time, as well as how the organization of the system (frames, within-frame processes and between-frames processes) changes over time within any particular relationship. Showing that mother-infant relationships change, in general, from face-to-face play to object play is not a purpose of this study. Indeed, this general transition during the first six months is well documented from larger samples as reported in Chapter 2. The purpose of this study is to show how dyads navigate across this well-documented developmental transition.

Case study methods focus on developmental transitions

One advantage of a case study approach is that one can isolate a particularly interesting developmental transition in order to study how individuals, dyads, or groups navigate across it.

A case study usually deals with a relatively short, self-contained episode or segment of a person's life. The episode is usually important in that it is formative, critical, or culminant – the sort of episode one would regard as a life event worth mentioning in a life history (Bromley, 1986, p. 1).

Our research design is based upon the known existence of a well-documented change in infant action and the corresponding changes in the mother-infant relationship: the transition to visually directed reaching and the shift from face-to-face frames to mother-infant-object frames. Given this known developmental transition, the study design was invented to examine changes in the mother-infant relationship process before, during and after the change in visually directed reaching.

Case study methods focus on developmental trajectories

Dynamic systems theory suggests that the case is the unit of analysis for the examination of general laws of development (Capra, 1996; Fogel, 1990; van Geert, 1994; Lewis, 1995; Thelen, 1990).

When considerable individual differences are expected in the outcome, it is even more crucial to use *individual developmental trajectories* as the primary data source. Once individual developmental paths are identified, it may then be possible to cluster subjects, not on the basis of outcome, but on the basis of

route. This means that detailed longitudinal studies are necessary to capture the times of stability and change. (Thelen, 1990, p. 39)

Given repeated observations on the same subjects, and contextually appropriate measures, analytic approaches can be applied that preserve the integrity of the individual's life history in order to construct generalities of developmental change. It is only when a sufficiently large sample of individual case histories are collected that longitudinal process research can be generalized to the population. (Fogel, 1990, p. 344)

The study presented here is designed to make inferences about convergent and divergent patterns of developmental change across the thirteen cases of dyadic relationship under study here. Many of our research questions, and the statistical approaches we have chosen, are meant to preserve interdyad differences in developmental trajectories.

Case study methods focus on the context of development

In our study, for example, we not only focus on measures presumed to be related directly to object play, but on the relationship of object play frames to other frames that form the relational context of object play. One could choose larger relational contexts such as the whole family and their play with the infant, or the broader contexts of caregiving in the mother-infant relationship. In order to limit the scope of the investigation, we focus on a few relational processes, looking at actions within-frames and between-frames in which object play is most likely to occur.

Case study methods focus on the coherence of development

Because we are open to the complexity of the mother-infant system, we are more likely to detect higher-order patterns and processes that may not be apparent if one focused on a small number of measures. Case studies

have been empirical activities designed to help investigators in the search for patterns and orderliness of phenomena, not activities designed to prove to others that those patterns exist. Unfortunately, the organization of psychology's highly regulated normal science has led toward over-emphasis of the contrasting context of justification, and away from recognition of and respect for the fundamental scientific work that must take place in the context of discovery. (White, 1994, p. 38)

For this study, we have made detailed observations not only of frames but of the multiple types of action that comprise within frame and between frame transition processes.

Case study methods move from the particular to the general

How do we arrive at nomothetic principles? General or nomothetic principles about developmental change processes cannot be solely derived from group statistics, although it is often thought that group averages are equated with nomothetic laws. Research that attempts to construct general principles building upon the study of individual cases has been called *holistic interactionism* (Bergman, 2000; Magnusson, 2000).

> Many researchers within developmental psychology . . . regard single case studies as non- or pre-scientific approaches, suitable to provide an impressionistic glance at development, but unsuitable to test nomothetic relationships.
> (Deutsch, 1994, p. 34)

> It is tempting to equate the nomothetic approach with the analysis of averages. To do so is to equate statistical models of experiments with models of people . . . To find out what people do in general, we must first discover what each person does in particular, then determine what, if anything, these particulars have in common. This implies that we pay more attention to case histories, find or develop models sufficient to account for each, then examine the models for common themes or elements. (Thorngate, 1987, p. 75)

The early baby biographers believed that only by collecting a substantial number of detailed case histories of infants by persons who knew them well, could general developmental laws be constructed (Wallace et al., 1994). Case study research focuses on what has been called "clinical significance" rather than statistical significance. Clinical significance refers to the verification of interpretations made about a particular case, based either on confirmatory evidence or on the predicted outcome of a clinical or educational intervention for that particular case (Robson, 1993).

In this report, we will not attempt to generalize the results to the larger population but we will make claims about regularities that we can observe across all of the cases in our sample. We will suggest that these claims can serve as hypotheses that can be tested on larger samples, assuming one has sufficient data on developmental trajectories.

The case study method is empirical and systematic

Case studies, like population studies, are guided by a theory of the phenomenon. In our study, we use the relational-historical perspective and we have argued that the case study method is best suited for investigation using this theoretical perspective. Without a theory, the

investigator would be lost in a sea of potentially interesting data. In our view, the use of theory to guide research is no different, in principle, in case studies and population studies.

Case study researchers form lasting relationships with the research participants

From a relational-historical perspective, the quality of our data depends on our relationship to the research participants. In this study, mothers brought their infants to our laboratory weekly for the entire first year of the infants' life and we continued to collect data until the end of the third year of life. During that period, our research staff formed close ties with each of the dyads. We became part of their weekly agenda. The staff often had regular telephone contacts with mothers outside the laboratory and we became involved in helping them arrange their activities to find the most convenient time to come each week. This was especially true during family crises, work pressures, and holidays.

These participants became active collaborators in the work. We shared with them the reasons for intensive longitudinal observation and they took their role in the research seriously and responsibly. As collaborators, therefore, we have a similar responsibility to take their lives seriously and to avoid making judgements about their activities taken out of the context of the whole relationship process. As people share even a small portion of their personal lives with us, it is inevitable that we will see both good days and bad, cooperation and conflict, happiness and anger.

We suggest that the scientific warrant to interpret human life histories for case study work is based upon several conditions.

1. The investigators are well trained observers and abide by the ethical standards of their profession for the collection and dissemination of scientific results.
2. The investigators interpret each case in a fair and complete manner, in the context of their collaborative relationship with the participants and with respect for their courage in sharing a part of their lives with us.
3. The investigators present a sufficient amount of data to allow the readers to construct alternative interpretations.

These guidelines can be summed up with the principle that researchers should invest whatever time it takes to "get to know" each of the dyads in the sample. There are several different senses of the verb, to know, in English. We refer here to the kind of open-ended, experiential,

emotional way of knowing that usually occurs in close interpersonal relationships, in contrast to the more abstract form of knowledge as generalization. Some languages make explicit the semantic differences between these different "ways of knowing" (Belenky, Clinchy, Goldberger, & Tartule, 1986). The more interpersonal way of knowing is **conocer** (Spanish), **conòscere** (Italian), **connaître** (French), and **conhecer** (Portuguese). The corresponding words for abstract knowing in these four languages are **saber, sapere**, **savoir**, and **saber**. This distinction is not directly available in English.

The more interpersonal way of knowing is central to the scientific warrant for case study and qualitative investigators. Three of the authors of this study (A. F., H. H., & D. W.) were part of the team that collected the data in 1986 and 1987 and who knew each of the dyads personally. A more important criterion, however, is the extent to which the investigator "knows" the collected archival data, in our case, the videotapes that served to record the mother-infant relationship over time. All four of the authors have spent at least six years, and in some cases almost twelve years, with repeated, systematic examination, and re-examination of these data. All of the authors have worked with infants and are experts in the literature on infant development. The interpretations we publish here have gone through much iteration and changes as we as a team moved – over a period of ten years – from observation to discussion to writing and back again.

Frame analysis

The second major feature of our relational-historical research method is **frame analysis**. Frame analysis is the identification of the most frequently occurring frames in the data, the coding of realtime onsets and offsets of frames from the videotaped records, and the coding and analysis of realtime sequences of action within frames and transitional actions between frames. We divide the discussion of frame analysis in the following sections. First we discuss different approaches for identifying and coding frames in communication systems. Then we discuss the analysis of within frame dynamics and the analysis of the dynamics of transitions between frames.

Frame identification

In practice, there are potential difficulties that face the observer of communication when asked to identify a set of frames. One problem is that frames are hierarchically embedded (Fogel, 1993). We could, for

example, lump face-to-face play and social object play together as a single play frame in the mother-infant relationship, as contrasted with a frame for caregiving, for example. Within the play frame or the caregiving frame, however, there are easily distinguishable types of play (face-to-face, mother-object-infant) or forms of caregiving (bathing, feeding, calming). Because of this embedding, it is necessary for the observers to set the level of analysis for the particular study.

In our case, we chose to limit the scope of our observations to the globally defined play frame, and then to study sub-frames – types of mother-infant play – within the play frame. This means the frames we study here were chosen to have a sequential rather than a hierarchical relationship: they are mutually exclusive and cannot overlap in time. Other forms of frame analysis not studied here have examined frames across multiple hierarchical levels using co-occurrence analysis rather than sequential analysis (Fogel, 1977).

Once a decision is made about hierarchical level, then observers must demarcate segments of communication that meet the definition of a frame given in Chapter 3:

1. Frames direct participant's **joint attention** to particular features of action and context.
2. Frames specify particular **locations** for communication.
3. Frames specify particular **co-orientations**, such as sitting, standing, lying down, and mutual body orientation.
4. Frames specify the **topic** or theme of the joint activity.

Frame definitions, therefore, should be tailored to the specific communicative situation. The definitions for the frames that we identified in our data are shown in Table 4.1. In addition to the two frames that mark the traditional conceptualization of this developmental transition in the mother-infant relationship – face-to-face play (here called the social frame) and mother-object-infant play (here called the guided object frame) – we found two additional frames in our middle class North American sample, both of which involved object play. In other cultures, different frames may have been observed.

The **social frame** is coded when the topic of communication is the participants themselves with no intervening objects. This is primarily face-to-face play and it also may include physical-motor play. The **guided object frame** is coded when mother takes an active role in demonstrating and scaffolding the infant's use of objects. The **not-guided object frame** is coded when the infant plays with objects without mother's direct assistance but with her ongoing attention and verbal commentary. The **social/object mixed frame** is coded when

Table 4.1. *Definitions of the four frames used in this research*

Frame	Description
Social	Mutual social play not mediated by objects. Includes primarily face-to-face play and physical-motor play.
Guided object	Mother's actions are directed toward demonstration of an object's properties or supporting an object. Mother or infant may be holding an object.
Not-guided object	Mother's visual attention is on the infant and the object and she may talk to the infant about the object or provide postural support, but she does not touch the object or act on it in any direct manner. The infant is holding an object.
Social/object mixed	Mutual social play, in this case mediated by objects. Occurs, for example, when mother touches the infant's body with an object as part of physical play or when the infant holds or mouths an object, but the actions and co-orientations are characteristic of the social frame. Mother or infant may have an object.

elements both of face-to-face play and guided object play appear at the same time, as when a mother uses a toy to touch the infant's face or body while vocalizing in an expressive manner typical of the social frame. This frame has not been described in prior research and its role in the development of the mother-infant relationship will be explored here for the first time.

These four frames do not constitute all of the recognizably different play frames we found in the data. We observed other frames but their frequency and duration of occurrence was not sufficient to justify keeping them as separate categories. The social play frame, for example, was originally broken down into purely face-to-face play, motor play (in which mother moved the infant's arms or legs in a cycling manner), and tactile play (involving touching and tickling of the infant's body). Because of relatively low frequency of motor and tactile play, and also because of wide variability in their occurrence across dyads, we chose to combine all forms of play in which the focus or topic is entirely on the participants, with no intervening objects. This decision is theoretically consistent with earlier descriptions of primary intersubjectivity (see Chapter 2 and Trevarthen, 1977).

In summary, frame identification involves decisions about the application of the theoretical model, about the level of analysis, about the overall organization of behavior, and about collapsing categories based on observed low frequencies of occurrences. This, in principle, is no different from decisions required of any observational sequential analysis (Bakeman & Gottman, 1986). The major difference is that the frame

Table 4.2. *Computer criteria for the selection of frames from the microanalytic codes*

Frame	Action	Object
Social	Mutual social play	Neither partner has an object
Guided object	Mother shows objects or mother supports infant's actions on objects	Mother or infant may have an object
Not-guided object	Mother comments while infant plays with an object	Infant has an object, the mother does not
Social/object	Social play, or mother touches infant	Mother or infant has an object

is a unit of analysis that is more encompassing than specific actions: it is more than a reach, smile, or other microanalytic unit of informative communication. Also, the frame is not defined on the basis of a single person's actions. Frames are composed of sequences of communicative co-action, defined and analyzed as a dynamically stable relational pattern.

Frame coding

Frame analysis was not the original approach we used for these data. The videotapes were recorded originally in 1986 and 1987 and the first attempt to analyze them, before we began to conceptualize the relationship in terms of frames, consisted in a detailed microanalytic set of discrete categories that specified mother and infant communicative actions, coded as a function of elapsed time in the session and recorded in a computer data file (See Chapter 6, for a listing of some of these categories). When we shifted our conceptual orientation toward frame analysis, we used this earlier coding to guide us in searching for the onsets and offsets of frames.

We generated computer transcripts of these microanalytic codes in realtime, and we reviewed the videotapes as we looked at the transcripts. As a result of these observations and the resulting discussions among the co-authors, we defined the four frames listed in Table 4.1. These frame definitions were translated into a set of criteria for the computer, which produced a new transcript showing the original actions as well as the onsets and offsets of the frames. As a confirmation, we used a subsample of four dyads to check whether the computer's definition of frames corresponded with the judgement of an independent observer. The observer's task was to find the boundaries of frames based only on the definitions given in Table 4.1, and not based on the microanalytic

decisions used by the computer. As a result of this approach, adjustments were made to the computer criteria to better fit the computer's definition to the observer's interpretation. The final set of computer criteria are shown in Table 4.2. These criteria produce onsets and offsets of frames that correspond to the definitions given in Table 4.1.

A more straightforward approach would have been to code frames directly from the videotapes before coding of the microanalytic actions within frames. Following that, more detailed microanalytic coding could have been done selectively, for only those actions within frames or transition processes most relevant to the research questions. As it happened in the historical development of this work, we had already done the opposite and decided to use the power of the computer to recode and collapse across the earlier coding categories. We have described both methods here: the use of the computer to find frames and the use of direct coding of frames. This may make the approach more useful to other investigators, depending on where they are in their own data analysis projects.

If one starts out coding frames directly, coders should check their reliability at the level of frames. In our case, since the computer identification of frames was based on a set of discrete state codes that had already been tested for their interrater reliability (Chapter 6), we thought it unnecessary to mount additional reliability checks. Instead, with our four subject sub-samples we confirmed the computer recodings against the direct observation of the videotapes. In the case of the frames under study here, their appearance and reappearance in the literature on development in the first six months of life leads us to believe that we have chosen frames that are common to all dyads, easy to recognize, and occur sufficiently frequently to support quantitative and qualitative analyses.

Frame dynamics

The identification and coding of frames are the first steps in frame analysis. Once a transcript of onsets and offsets of frames is obtained, the next phase of frame analysis is the observation of changes of action within and between frames, or frame dynamics. This includes the three levels of change discussed in Chapter 3. The study of frame dynamics based on the microanalytic coding is straightforward. One can use standard sequential analysis methods to examine the sequences and co-occurrences of actions within frames, and the types of actions that form the transitions between frames. These methods will be discussed in detail in Chapter 6. The informational approach, understanding which

differences make a difference over time, requires a qualitative research method, discussed later in this chapter.

From a relational-historical perspective, transitional actions are especially important features of frame dynamics. To study transitional actions, observers watch the videotapes at the boundaries between frames. Transitions have no clear beginning and ending. It is a matter of distinguishing the difference that makes a difference between changes that maintain the frame in realtime and changes that change the frame in realtime. According to dynamic systems theory, the duration of transitions between attractors is relatively brief compared to the duration of attractors. In our data, transitions lasted only a few seconds, on average.

Quantitative analysis

Once frames, actions within frames, and transitions have been coded, they are amenable to quantitative analysis. In this study, we use several recently developed techniques that apply to complex sequential processes in both realtime and developmental time. These include the study of developmental trajectories for the realtime durations of frames and actions within frames using multilevel modeling (Mln) or hierarchical linear modeling (HLM). These methods will be discussed in more detail in Chapter 7.

When we study communication quantitatively, part of the methodology requires that we break down events into discrete sequences of codes for "individual" action. When one codes more microanalytically, however, participant actions may seem less relational and may be interpreted as "belonging" to an individual, such as the code "infant reaches for an object." In the context of the frame, however, microanalytic codes should be interpreted with respect to their relational role in the communication process. Infant reaching for objects, for example, is only meaningful in relation to the sequence of dyadic co-activity, the frame, which makes reaching possible at that particular moment. Codes such as infant mouthing an object or looking at mother establish the infant's relationship to the object or to the mother at that moment and should not be interpreted as what the infant does or can do independent of the frame in which the action is coded.

This microanalytic coding of "individual" behavior needs to be regarded not as theory but as technique. We do not believe that our subjects analyze their relationship into these codes or into the frequencies, durations, and probabilities that we construct as part of the quantitative analysis. These techniques are merely one window into the study of a complex human relational process. Since we define our codes

initially as relational actions, and since our analysis of sequences and co-occurrences arises from a principled theoretical recognition of action as relational-historical, the burden is on us as investigators to guide the reader from the details of technique back to a relational-historical interpretation. One way to accomplish this is to combine quantitative approaches with qualitative analysis, discussed below.

Qualitative analysis

In this section, we give an overview of the role of qualitative analysis in relational-historical research. In Chapter 6, we outline the specific qualitative methods used in this report. In the quantitative sequential analysis, discussed above, the frequencies and durations obtained from the data are not summed over an entire observation session, but rather summed within particular types of frame. In addition, we also use a qualitative analytic approach in which the goal is to focus on information and to study the frames as globally stable dynamic patterns, that is, from a macroanalytic perspective. As explained in the next chapter, we chose a sub-sample of four mother-infant dyads as the focus of a qualitative investigation.

In the traditional quantitative research paradigm, one constructs hypotheses at the beginning of the study, carries out the planned observational or experimental procedure (coding from pre-established categories, for example), analyzes the data in a manner directly driven by the hypotheses, and makes an interpretation. If one's interpretation is that the original hypothesis needs to be altered, the researcher must go back to the population to select another sample to test with a slight variant of the procedure, or to re-code the data based on a different set of observational categories.

One of the central principles of qualitative research is an iterative, cyclical approach to interpretation during rather than after the process of observation (Bromley, 1986; Robson, 1993). Thus, hypotheses, methods and interpretations regularly cycle back on each other, creating an inductive spiral known as the hermeneutic circle. The observer is no longer naive to the data but becomes an informed and involved scientist. Hermeneutic approaches have been used in case study, ethnographic, rhetorical, phenomenological, feminist, and symbolic interactional methods in the humanities and behavioral sciences (Bernstein, 1983; Eckartsberg, 1986; Erickson, 1992; Gaskins, 1994; Lather, 1991; McCall & Wittner, 1990; Rogoff, Mistry, Goncu, & Mosier, 1993; Schwandt, 1994). Based on this method, our observers write narratives that describe the frames and transitions.

In place of the traditional approach to reliability, we use a peer research team and the constant comparative method (Strauss & Corbin, 1990) which requires an iterative process of interpretation and revision until the observers feel confident that the narratives are consistent throughout and new interpretations do not emerge during the process of reading and re-reading the narratives (Patton, 1990). A related approach to reliability in qualitative research is the use of agreement between observers who have shared perspectives on the process under investigation and who have similar training. "Objectivity is no more than shared subjectivity" (Rogoff et al., 1993, p. 31), and this can be achieved via conventional reliability estimates or via ongoing discussions between observers. Traditional sequential analysis is more amenable to conventional measures of reliability, but by decontextualizing the behavior into discrete packages, the meaning of the behavior for the participants is often lost (Bruner, 1983; Cicourel, 1974; Rogoff et al., 1993). In our work, we use ongoing discussions between members of a peer research team.

Another advantage of qualitative analysis is its focus on the significance of actions (their information, the differences that make a difference) and not just their description. As one observes, one is focused on the presumed meaning of the actions for the participants. In our case, we observe a whole frame, one frame at a time, and try to write a narrative description of that frame at a level that seems meaningful or informative for the participants. Rather than saying, "the infant extends an arm," we would say "the infant reaches for an object," or "the infant touches the mother." Meanings of events that constitute frames must be examined and re-examined cyclically in order to achieve a coherent view of the frame being studied and its changes over time.

> The inquirer constructs a reading of the meaning-making process of the people he or she studies . . . The activity of understanding unfolds as one looks over one's respondents' shoulders at what they are doing. (Schwandt, 1994, p. 123)

> . . . participants in social interaction usually provide explicit evidence to each other regarding the meaning of their actions . . . This evidence is essential to the achievement of understanding between participants, and it also provides researchers with evidence regarding the meaning of actions. (Rogoff et al., 1993, p. 31)

In this work, we equate the concept of meaning making with the concept of information creation. To "make meaning" refers to the detection of a difference that makes a difference. The basis for validity in interpretation of subjects' meanings is the subject of considerable debate

between multiple schools of thought, a debate that takes us beyond the scope of this book. At issue is the extent to which the **warrant** for interpretation of participants' meaning is based on:

1. the investigator's subjective identification with the participants using empathy,
2. the investigator's construction of the participant's meaning system within their own sociocultural context, or
3. the investigator's linking of the interpretation of this case with the history of interpretations of other such cases within the literary genre that defines the investigator's field of inquiry (Bradley, 1994; Jansen & Peshkin, 1992; Keegan & Gruber, 1994; Schwandt, 1994).

In practice, qualitative research involves all three of these warranting procedures. Empathy is used, but it has a limit as a scientific tool since our participants are not the same as ourselves. Observers "can only approximate other's experiences and so gain only limited access to their knowledge" (Belenky et al., 1986, p. 113). This sense of incompleteness, the inability to fully define and categorize another person, "marks the tragic, perpetually inadequate aspect of social research" (Reinharz, 1984, p. 365). This is perhaps especially the case when we study nonverbal infants or people from very different cultures. Similarly, investigators can rely on the literature in their field only so far because much of the work is done from a normative and "objective" point of view. Finally, we can compare evidence from different cases, but the detail with which we gather case study data (see next section) limits the inquiry to a small number of dyads. We argued in the last chapter, however, that people seem predisposed to detect differences that make a difference, especially to the extent that the observers are very familiar with the culture of the research participants.

Credibility is a criterion used in qualitative research methods to evaluate whether the investigation captures the meaning for the participants. Credibility can be viewed as parallel to the notion of internal validity in quantitative methods. Credibility is assessed through different standards such as the prolonged engagement of the researcher with the researched, the persistent observation of the phenomenon under investigation, and the use of a peer research team (Denzin & Lincoln, 1994; Savage-Rumbaugh & Fields, 2000). Another approach to credibility is for the investigators to share excerpts of the original transcriptions to allow the readers to make their own interpretations of the material (Rogoff et al., 1993). More details on the credibility of this investigation will be presented in Chapter 6.

Summary

Relational-historical research on developmental change is supported by three types of methods: frame analysis, qualitative and quantitative analysis, and the case study approach. These methods allow investigators to examine individual development in the context of a developing relational system. The methods take the case as the unit of developmental change and allow for the conceptualization of change in historical systems of communication. Frame analysis is the identification and coding of dynamically stable frames in the communication system. Qualitative research uses narrative descriptions and hermeneutic procedures to interpret the communication patterns at the level most likely to be informative for the participants. Quantitative analysis focuses on developmental trajectories and sequential patterning of actions in real-time. Case study designs allow for the historical interpretation of longitudinal data, in this study, the history of dyadic relationships across a known developmental shift. In the next chapter, we describe our research questions based on these methods.

5 Research propositions about relationship change processes

In this study, our goal is to provide a detailed description of the relational-historical process of development within the thirteen mother-infant dyads who participated in our multiple case study design. This is documentary science, similar to descriptive embryology, genome mapping, or astronomy.

This chapter is a transition, from the abstract to the concrete. This is especially daunting because the topics of research – frames and their changes – cannot be measured easily. How can change be captured? Its nature is to escape into another form, to be different on each reviewing of the data. As qualitative researchers who have spent a great deal of time with our data, we are convinced that patterns – perhaps even laws – can be perceived in frames and their change even though they cannot be defined precisely. In the remainder of this work, our task is to convey in words and pictures the patterns we have detected in our data. As scientists an additional task is to provide sufficient detail so that others with similar training and experience could attempt to replicate these observations, but let's be clear: the patterns implicate us as well as the videotapes, in our conspiracy of long-term involvement with them.

What follows is a report on the history of our relationship with a unique set of documentary videorecordings and the people in them. They show a tiny segment – a few short months – in the life history of a small group of babies playing with their mothers. The videorecordings were a collaborative project of the research team and these families whose dedication to the study is reflected in their regular attendance and cooperative spirit. Although the mothers were not aware of the specific goals of the research study, they knew that they were part of a research project on the development of parent-infant communication.

In this chapter, we describe our research propositions and preview the methods of analysis on which each question will rely. We choose the word "proposition" to reflect that our research questions are based on prior theory and research in this area. We do not use the word "hypothesis" because it implies the use of inferential statistics. Our research

propositions, however, are stated in ways that can be falsified with respect to the data: the proposition either fits the existing data or it does not. The statistical approaches we use are descriptive of trends in the data for this sample of subjects and are not intended to generalize to the population. Instead, our goal is to create a faithful and accurate account of each of the dyads in our sample using both quantitative and qualitative analysis. Even though we do not make inferences to the larger population, our study suggests hypotheses about developmental and relational processes in early development that can be tested using inferential population approaches. In Chapter 6, we provide more detail on specific methods of observation and analysis.

Propositions about frames and transitions

Proposition 1: There will be a three-part historical sequence of the change process: historical frames, developmental bridging frames, and the emergence of new frames.

This proposition is the research statement related to change process I, from Chapter 3.

Proposition 1 makes the prediction that relational-historical change will occur in three phases: (1) an initial phase in which there is one predominant historical frame; (2) a second phase in which a different frame becomes predominant and serves as a developmental bridge; and (3) a final phase in which a new frame emerges as predominant. We wrote this as the developmental sequence for Proposition 1, or (P_1), where the inner bi-directional arrowheads represent realtime transitions and the bold arrowhead represents the developmental time sequence.

(P_1) (Historical $\leftrightarrow$ Bridging) $=\blacktriangleright$ (Bridging $\leftrightarrow$ Emerging)

In this sequence, frames are considered to be bridging in developmental time because they become predominant in duration in the period in between the predominance of historical frames and the predominance of emerging frames. Frames are considered to be bridging in realtime because they mediate transitions between historical and emerging frames.

This proposition is tested quantitatively in two ways. First, we examine the durations of each of the four frames (social, guided object, not-guided object, and social/object mixed) as a function of the infant's age in weeks. When these durations are plotted across the twelve weekly observations on each of the thirteen dyads in the sample, we refer to them as the **developmental trajectories** of each frame. We do not know at the outset which of

the four frames will play the role of historical, bridging, or emerging, nor do we know if any of the frames will fit sequence (P_1). In order to fit sequence (P_1), there should be one or more frames whose developmental trajectory peaks in the early sessions and then declines (the historical frame), another frame(s) whose trajectory has an inverted U-shape peaking in the middle sessions (the bridging frame), and another frame(s) whose trajectory gradually increases and peaks in the final sessions (the emerging frame). We employ multilevel analysis to model the shape of the developmental trajectories of duration as a function of age and to examine interdyad differences in these trajectories.

The other quantitative approach to this model is to examine the frequency of transitions between frames in realtime. We predict that bridging frames should mediate transitions between other frames during the period when the bridging frames are relatively high in duration. Transitions between the historical frame and the newly emerging frame, for example, would first occur via the bridging frame rather than directly between the historical and emerging frames. For four frames, there are twelve possible types of between frame transitions: for example, when the dyad changes from the social frame to the guided object frame or from the guided object frame to the social frame. This analysis identifies the most frequently occurring transitions and how they change with age. We tabulate the frequencies of each of the twelve possible transitions for each observation session. There should be a higher frequency of transitions between historical and bridging frames and between bridging frames and emerging frames. Conversely, there should be a relatively low frequency of transitions between historical and emerging frames.

Since we have chosen a well established developmental transition, we know that all the dyads will change from a predominant historical frame for social play to the predominance of some type of newly emerging frame for social object play. The model in developmental sequence (P_1) will be disconfirmed if there is no evidence for a bridging frame, as shown in sequence (P_1').

$$(P_1') \quad \text{Historical} \quad =\blacktriangleright \quad \text{Emerging}$$

In this case, we would not expect to find any frame that serves an intermediary bridging role. This could occur if there are no frames with an inverted U-shaped trajectory and/or there are no frames that bridge the realtime transitions between historical and emerging frames.

In addition, qualitative analysis will be used to examine the details of the actions within frames and interdyad differences. Our theoretical

model of bridging frames suggests that they should contain actions that are common both to the historical frames and to the emerging frames. In the example of the telephone game used in Chapter 3, for instance, the bridging frame had actions that combined some of the characteristics of physical play with the phones and some of the characteristics of pretend play with the phones. Hannah imitated the physical movements of the mother's pretend actions but without understanding the pretend nature of those actions. We expect that realtime transitions between frames with actions in common (i.e., between historical and bridging or between bridging and emerging) would be relatively easier for a dyad than realtime transitions between frames that were relatively more different from each other (historical and emerging). The qualitative descriptions of each of the frames will provide evidence for this proposition.

Another contribution of the qualitative analysis will be to examine the historical process by which each dyad negotiates the developmental sequence (P_1) or (P_1'). We expect that each dyad will develop their own style of communication reflecting a different sequence of historical, bridging, and emerging frames. Some dyads may develop toward an examination of objects as the focus of their communication with few social frames and relatively few social-object mixed frames. Others may develop patterns in which social and social-object mixed frames predominate. In these dyads, objects are transformed into social purposes, such as using a toy to tickle the infant, rather than being the focus of attention as things in themselves. The qualitative analysis should help to reveal how the general developmental sequence (P_1) unfolds within each case.

For the purposes of the qualitative analysis, we chose four representative dyads from the sample of thirteen. This is necessary due to the time consuming nature of qualitative analysis. Quantitative results are presented in Chapter 7. The qualitative results are presented in Chapters 8–11, one chapter for each of the four representative dyads. We also used these four dyads to examine the frequencies of transitions between frames, one of the quantitative analyses.

Proposition 2: We expect that innovative actions during frames and transitions are historical preludes to later developmental re-organizations in the frames and transitions.

This proposition is related to change process II, Chapter 3. Proposition 2 distinguishes between actions that recur each time the same frame or transition is repeated and actions that are innovations. This proposition can not be tested using quantitative analysis because the judgment of whether an action is innovative (whether it is a difference that makes a difference) can only be done qualitatively, that is, in relation to

the dyad's history. The actions of the dyads in each repeating instance of the frames and realtime transitions must be described in detail and examined for their similarities and differences with respect to prior occurrences of those frames and realtime transitions.

Sessions for the four representative dyads are observed in their original developmental sequence, beginning from the first session. The patterns of actions in the first instance of each frame and each realtime transition in that first session are taken as the baseline actions. A sequence narrative is written to describe the pattern of actions in that first instance. The second instance of a particular frame or transition is then observed and another sequence narrative is written. In that process, the second instance is compared with the first to determine if the pattern of actions is similar or different. The observer may return to the first instance in order to check their judgement of similarities and differences, to help in the writing of the sequence narrative for the second instance and perhaps to modify the sequence narrative for the first instance according to the constant comparative method (Chapter 6). The process continues until all instances of all frames and realtime transitions are described for all twelve sessions. Observers have the opportunity to replay any prior instances or any sequence of prior instances in order to decide whether the current instance is sufficiently different from a prior instance to count as an innovation. Innovations are then noted in the sequence narrative of the instance in which they first appeared on our video records.

The testing of proposition 2, then, is based on a study of these sequence narratives. Proposition 2 predicts that innovations will become the seeds for developmental changes in frames and realtime transitions. Proposition 2 is based on the idea that there are multiple levels of change in relational-historical systems (see Chapter 3). These are ordinary variability in frame and transition dynamics (level 1), innovations within frame and transition dynamics (level 2), and developmental change or re-organization of the frames in the system (level 3).

Proposition 2 is a prediction about the effects of innovations (level 2 changes) in the sessions in which they first appear and in subsequent sessions. Proposition 2 predicts that an innovation developmentally alters frame and transition dynamics in the subsequent sessions and does not significantly change the frame and transition dynamics in the session in which it first appears. Proposition 2, in other words, suggests that the origin or source of developmental changes in frame and transition dynamics is the appearance of innovations in earlier sessions.

On the one hand, proposition 2 makes the assertion that developmental changes arise historically within the relationship because earlier

innovations are predicted to become the seeds for developmental change in frames and transitions. Developmental change, in other words, should be directly observed as part of the change dynamics of the relational-historical system. On the other hand, proposition 2 suggests that developmental change does not arise directly from frame and transition dynamics (level 1 changes). Instead, developmental change is predicted to appear first as an innovation and second as a re-organization of the frame and transition dynamics.

Proposition 2 would be confirmed if the qualitative analysis showed these three different levels of change, with innovations arising from frame and transition dynamics, and developmental changes arising from innovations. We write this developmental sequence (P_2) as follows:

$$(P_2) \quad \text{level } 1 \Rightarrow \text{level } 2 \Rightarrow \text{level } 3$$

Proposition 2 would be less likely to be supported if we found the appearance of level 3 changes without the observation of prior changes at level 2. We would then need to consider a model of development by which developmental re-organizations within frames or transitions occur spontaneously, as illustrated in sequence (P_2') below.

$$(P_2') \quad \text{level } 1 \Rightarrow \text{level } 3$$

How can level 3 changes be recognized empirically? Consider the following example. During the guided object frame for a pre-reaching infant, maternal frame dynamic actions (level 1) might consist of demonstrating the objects to the infant by moving them in the visual field but out of the infant's reach. The infant's corresponding frame dynamic actions (level 1) might be simply gazing at the object, actively moving the body, and vocalizing. At the same time, realtime transition dynamics might be a change in the infant's gaze direction away from the object which leads mother to follow up by placing the object in the infant's hand leading to a not-guided object frame.

The innovation may come during the guided object frame in the form of the infant attempting, for the first time, to reach out for the object held by the mother. The novelty of this action may precipitate a frame transition: as the infant reaches out, the mother places the object in the infant's hand leading to the not-guided object frame. For the next session or two in this example, the infant's reach attempts would continue to precipitate a transition from the guided to the not-guided object frame while both of these frames and the transition between them would continue to display similar level 1 and level 2 dynamics.

Ultimately, however, the use of reaching in the transition dynamics may facilitate the growth of the relationship between the infant's reaching skill and the mother's actions in relation to it. Instead of simply putting the object in the infant's hand when a reach attempt is made, thereby creating a realtime transition, the mother may alternatively hold the object within the infant's reach space as a way of allowing the infant to become more active in moving from reach initiation to reach completion. Generally, it takes several weeks for infants to move from the intention to reach to the consolidation of the control required to execute a reach and grasp. Via the co-regulation between the mother and infant, then, the infant can be scaffolded in developing the reaching skill.

From the relational-historical perspective, on the other hand, the infant's reaching intention, which first appeared as an innovation during the transition dynamics (level 2) may begin to alter the dynamics of the guided object frame. Instead of making a transition out of the guided object frame each time the infant intends to reach, the mother can change her actions within the guided object frame to accommodate a new kind of relationship process vis-a-vis reaching. The guided object frame might then re-organize its frame dynamics from its earlier focus on maternal demonstration and infant gazing at objects to maternal scaffolding and infant reaching. We would consider the whole process from innovation (level 2 change) to the emergence of the new frame dynamics as an example of developmental dynamics (level 3 change).

Note that the model as specified in sequence (P_2), above, can lead to many different possible pathways of developmental change within and between dyads. Innovations could occur in any of the four different types of frames or in any of the twelve different types of transitions between frames. Also, innovations could arise during frames or transitions.

Proposition 3: The developmental trajectories of particular actions toward objects (the durations of gazing, touching, and/or mouthing) will relate to the developmental trajectories for the durations of the frames.

For proposition 3, quantitative analyses using multilevel modeling seek to find the contribution of infant's attention and actions on objects to the developmental trajectories of frames. Although the links are correlational, their confirmation suggests at a minimum that individual change occurs in tandem with relational change. Based on the relational-historical perspective, we expected that the development of infant attention to and action upon objects is embedded within changes in

the mother-infant communication system. The developmental trajectories of infant's attention to objects and object-related actions are entered into a multilevel model as predictors (independent variables) while the developmental trajectories of the proportional durations of frames are entered as response (dependent) variables. We know from the literature review (Chapter 2) that some infants are more attentive to objects than others. We also know that all infants increase in their attention to objects with age. We do not know the details of the developmental path but research reviewed in Chapter 2 predicts that for some infants the developmental trajectory of certain frames (for example, non-guided object frames) will accelerate more rapidly than for others.

We also expect that some infants may develop preferences for looking, others for touching, others for mouthing, and still others for the cross-modal matching of these modalities. Research reviewed in Chapter 2 also suggests that modality preferences may become part of the relational-historical process by which infants communicate about objects with their mothers. Using quantitative analysis, infant preferences for forms of action will be judged by the time spent touching or mouthing objects with or without gazing. Mouthing, for example, could be exploratory mouthing that is systematically combined with looking at the object or it could be mouthing that is not coupled with apparent exploratory activity. For instance, while exploratory mouthing is more likely to be an integral part of a social-object mixed frame, simple mouthing is more likely to be embedded in a social frame.

Proposition 4: The infant's acquisition of skilled actions with objects will emerge in a developmental sequence.

For proposition 4, we used categorical data analysis to study the developmental sequence of emergence of infant's actions on objects in the context of mother-infant communication about objects. The literature on developmental sequences in the emergence of infant action is based primarily on observations of infants in non-social laboratory conditions. The known developmental sequence for manual action is shown in Table 2.1. Relatively little is known about the actual sequence of acquisition within subjects, nor about the sequence of skill acquisition in the natural ecology of the mother-infant relationship. To answer this question, we noted the age (in weeks) at which infants in our sample were first observed to use a particular action. We compare our findings with those in Table 2.1. Another reason for this proposition is that these skilled actions with objects have the potential to constitute level 2 changes (innovations) in frames or frame transitions.

Summary

The research propositions outlined in this chapter focus on the process of developmental change within and between dyads. The goal is to discover the process of development of frames, transitions between frames, and actions within frames as well as how these change processes are dynamically integrated to constitute a system-wide change (level 3 change). Both quantitative and qualitative analysis will be used. We also examine individual actions with respect to changes in the dyadic relationship.

6 Research methods for the current investigation: subjects, procedures, and data analysis

Subjects

Thirteen mother-infant pairs volunteered to participate in a longitudinal investigation on the development of infant communication. They were contacted by letter from birth announcements in the local newspaper. All had full-term births with no complications and all passed a six-month hearing test. Only middle-income mothers older than 21 years were included in the sample. Seven infants were male and six were female. Twelve of the dyads were Caucasian and one was African-American.

Procedure

Infants and mothers were videotaped weekly from age 4 to 52 weeks and then bi-weekly from 53 to 104 weeks. Here we report the findings from twelve observation sessions on each infant, six sessions prior to and six sessions following the acquisition of visually guided reaching (see below for definition and coding) for a total of 156 observation sessions. By design, the observed first instance of successful visually guided reach was designated as observation session number seven, and coding was done for six sessions prior and six following and including the session containing the first observed reach. The age range for the first observation session was 5–16 weeks, for the last session the range was 18–30 weeks. The age range for the onset of the first observed instance of successful reaching was 12–22 weeks (Mean = 16.3 weeks). [This mean age of onset of 4 months was earlier than the Bayley norm for reaching onset of 4.8 months, which we attribute to the facilitative effect of the social context].

On average, there were four missed weeks per subject over the approximately 3.5 month period of observation reported here. Visits were missed due to scheduling problems, vacations, and sickness. Table 6.1 shows the ages of observation for each of the subjects in the sample.

Each observation session took place in a $12.5' \times 12.5'$ carpeted laboratory playroom. Infants and mothers were videotaped during free play

Table 6.1. *Infant ages (in weeks) at each observation session prior to and following the acquisition of visually guided reaching. Mean age for onset of reaching = 16.3 weeks*

	Pre-reaching sessions							Post-reaching sessions				
Dyad	1	2	3	4	5	6	7	8	9	10	11	12
1	7	8	9	10	12	13	14	15	16	17	18	19
2	5	6	8	9	10	11	12	14	15	16	17	18
3	16	17	18	19	20	21	22	23	24	25	26	28
4	6	8	9	10	11	12	14	15	16	17	19	20
5	8	9	10	11	12	13	17	19	22	23	24	25
6	6	8	9	10	11	12	14	15	16	17	18	19
7	9	10	11	14	15	17	20	21	23	25	27	28
8	9	10	11	12	15	16	17	18	19	20	21	22
9	10	11	12	13	14	16	18	19	21	22	23	25
10	6	7	8	11	12	13	14	16	17	18	20	21
11	7	8	9	10	11	14	15	17	18	19	20	21
12	9	11	12	13	14	18	19	21	22	23	28	30
13	9	10	11	14	15	17	20	21	23	25	27	28

while the infant was initially put in a supine position on a blanket. Sessions lasted between five and ten minutes in each condition, depending upon the age and state of the infant, therefore, measures were adjusted as a proportion of the session duration. There was a set of ten age appropriate toys, although only seven of those toys were used sufficiently frequently for analysis (see Table 6.2).

The instructions to the mothers were to "play and talk with your infant as you might normally do at home." These instructions were given to mothers on their first visit to the lab when the infant was one month old. Thereafter, mothers and infants were left to develop their own styles of play within the standardized setting of the laboratory playroom. The mother had access to all the toys and was free to choose as many as she wished to play with the infant or no toys at all. Infants were typically in a supine position on a blanket on the floor. It is important to keep in mind that after several weeks, this setting became very familiar and comfortable. Mothers enjoyed the opportunity for uninterrupted play with their babies.

Outputs from three pan-tilt-zoom color video cameras were passed through a special effects generator to produce a split screen image. Each camera was remotely controlled from an observation booth located behind a one-way mirror. Camera 1 was focused on the mother's face

Table 6.2. *Toys most frequently used by mothers and infants in this study*

Toy	Description
Tube rattle	Clear plastic tube with colored beads inside, two red solid balls at the ends; a red wooden ring and a smaller yellow ring surround the tube (15cm long)
Porcupine	Red rubber ball with red spikes which makes a noise when squeezed (8cm in diameter)
Caterpillar	Yellow rubber tube with textured surface which makes a noise when squeezed (20cm long, 8cm wide)
Sun rattle	Two yellow suns with interlocking rays that when rotated against each other make a rattle sound (15cm long, 8cm wide)
Ball rattle	Clear plastic ball with colored beads and clown inside, makes noise when turned (14cm in diameter)
Mirror	Circular shape plastic white backing with teddy bear picture, mirror on other side (16cm in diameter)
Lock rattle	Yellow plastic lock with face and movable eyes, red key that makes eyes turn, makes a rattle sound when shaken (11cm wide and 13cm long)

and the side of the infant. Cameras 2 and 3 were both focused on the infant's face and upper body and the observer selected the better of these two outputs to combine with that of camera 1. An electronic digital timer accurate to .01 secs was superimposed on the screen. The quality of the tapes is excellent and all relevant codes were visible to coders at all times.

Coding

Action coding was done by a graduate student observer (D. W.) and reliability was scored by a trained undergraduate coder who was naive to the hypotheses of the study and to the work of the graduate student coder. Infant actions toward objects (grasp with one hand, grasp with two hands, shake, squeeze, manipulate [active touch with the fingers], mouthing, reach), mother actions toward objects and the infant (demonstrate affordances, show, scaffold, shake, squeeze, touch infant, observe infant's action, and social play), and infant gaze (at objects, at mother, away) were coded on three independent passes through the videotape. On each pass, the coder stopped the tape each time a defined action category occurred and recorded both the event and the time from the digital timer on the screen. The categories for each pass were mutually exclusive and exhaustive, allowing for a continuous transcription of the events. Codes lasting less than 1.5 sec proved to be unreliable and thus were not recorded. During the coding of the infant and mother

actions, the coder noted the name of the toy being used. A computer program merged all the separately coded streams of events into their original time order, and derived all of the frequency, duration, and co-occurrence measures for the data analysis.

Categories' definitions were derived from the literature as follows. Visually guided (or goal directed) reach is defined as a smooth approach to a nearby, seen object with the fingers either opening or closing prior to contact with the object (Bushnell, 1985; von Hofsten, 1979; 1983; White, Castle, & Held, 1964). Visually guided reach has been first observed to occur in normal infants between the third and fourth month of life.

Infant object grasp with one or both hands, shake, squeeze, finger, and mouthing have all been observed and defined in previous research, reviewed in Chapter 2, on the development of object-appropriate exploratory play. Similarly, most of the coded maternal actions have been observed, although the list of codes for both mother and infant were empirically derived from the data presented here as the most frequently occurring categories. The category of "maternal observe" has not been defined in previous research. It refers to those periods of time in which the mother is not active with objects, but allows the infant the opportunity to explore objects independently, often with maternal verbal encouragement or commentary (the not guided object frame). Maternal social play refers to periods in which mother attempts to engage the infant in face-to-face play or motor play without objects (the social frame).

Note that the maternal actions were used here only to determine the onsets and offsets of the frames, as described in Table 4.2. Infant actions and infant gaze were also used in the analysis of the relationships with the developmental trajectories of frames. There is, however, no confounding of these measures of frame and infant action because the specific infant actions and gaze directions are not used in defining the frames (Table 4.2). The frame definitions only rely on whether the infant does or does not have an object and not on what the infant does with the object.

For reliability, 10 percent of the sessions were coded independently by the second trained coder who was naive to the hypotheses of the study. Reliability sessions were randomly selected to include equal numbers of sessions from the beginning (sessions 1–4), middle (sessions 5–8) and end (sessions 9–12) of the observation period. Average Cohen's kappa was .84 for mother actions, .85 for infant actions and .80 for infant gaze. In addition, proportion of agreements was calculated for each category separately. An agreement was scored if coders recorded the onset of a category within two seconds of the other (although the average time lag between coders for agreements

was 0.5 sec). The proportion of agreements was a minimum of 80 percent for all categories.

We created qualitative data by narrative descriptions of the actions within frames and of transitional processes between frames. We followed the procedures outlined in Chapter 4. Portions of these narratives appear in the text. Qualitative analysis is done on a sub-sample of four dyads. Two of these dyads developed a relatively higher duration of not guided object frames in the post-reach period, and two developed relatively higher proportions of the mixed social/object frame. In addition, two were male and two were female infants.

Quantitative data analysis

Our quantitative data analysis is developmental-longitudinal and is based on multi-level hierarchical regression analysis for the study of age trends (see Chapter 7). The proportional duration of each frame was computed separately for each dyad and for each week. Using this approach, between-dyad variability in the developmental trajectories of the proportional duration of frames and infant actions within frames is analyzed in some detail to look at the origins of individual differences. Furthermore, sequential ordering of the occurrence of infant actions and frames was preserved in a data file, permitting the cross tabulation of the frequency of transition between frames separately for each dyad and by each week. The proportional duration is the total number of seconds in which a frame or an infant action was coded to have occurred during a session divided by the total number of seconds in the session. The proportional durations for all of the frames combined sum to 1.00.

Qualitative data analysis

We qualitatively examined developmental changes in the frames and in the transitions between the frames of the mother-infant communication system using twelve weekly observations on four dyads of the larger sample of thirteen. Our goal was to describe in detailed narratives the changing conditions under which the frames developed during the developmental transition resulting in the emergence of mother-infant-object play.

Narrative analysis. The method of narrative analysis (Polkinghorne, 1995) was used to investigate the developmental changes in the frames and in the transitions between the frames. The first step was to compose a **sequence narrative** (Pantoja & Nelson-Goens, 2000;

Pantoja, 2001) consisting of sequences of actions within a frame or sequences of actions in the transitions between frames for four of the mother-infant dyads. Here, the observers wrote a description of an occurrence of a frame or a transition between frames at a level that seemed meaningful or functional for the participants. This was done for all four frames in the data set, that is, the social frame, the guided object frame, the not-guided object frame, and the social/object mixed frame. The onset and offset times of the frames were provided by the computer. Guided by the computer transcripts of realtime changes, the sequence narratives of both frames and transitions between frames were produced. The sequence narrative was written by two independent graduate student observers – one whose focus was on the frames and the other whose focus was on the transitions between frames. Two examples of a sequence narrative follow:

Example 1
Lewis and his mother
Age: 7 weeks
The guided object frame

Using a cheery high pitched voice, the mother shakes the ball and highlights the sound it makes saying, "nice noise . . . watch . . . see." Then, she manipulates the ball in a new way, rolling it on her hand. Baby watches the object, with little arm or leg movements and quietly vocalizes (coos). Mother makes a few sounds "wooh, wooh," as the ball moves on her hand.

Example 2
Richard and his mother
Age: 16 weeks
Transition from the not-guided object frame to the social/object mixed frame

The infant holds a toy while looking at mother as the mother talks to the infant about the toy (the not-guided object frame). The mother starts leaning towards the infant while she keeps talking to the infant about the toy and starts touching the infant's stomach with her right hand (the social/object mixed frame). [In this example, the transition from the not-guided object frame to the social/object mixed frame was primarily made through the addition of the mother's actions of leaning towards the infant and touching the infant's stomach].

Next, the observers read the sequence narratives for each dyad separately to search for consistencies and differences across instances of the same frames or transitions at different ages for that dyad using the constant comparative method (Glaser & Strauss, 1967; Strauss & Corbin, 1990). Next, based on the sequence narratives, observers wrote a description of the highlights of each weekly observation session, summarizing the main features of frames, realtime transitions, and infant and mother actions. These documents are called summary narratives. The iterative process of interpretation and revision continued until the observers felt confident that the summary narratives were consistent throughout. At this point, redundancy was reached since new interpretations did not emerge during the process of reading and re-reading the sequence narratives (Patton, 1990).

The next step was the writing of a **historical narrative** (Pantoja & Nelson-Goens, 2000; Pantoja, 2001). Similar to the sequence narrative, the historical narrative was written by the same two independent graduate student observers. This historical narrative described the developmental changes in frames and in the transitions between frames, based on the observers' interpretations of change in the sequence narratives as they read them chronologically by week. The goal here was to synthesize the developmental **history** of the frames and of the transitions between frames for each dyad. Three or four distinctly different developmental periods, as perceived by the observers, emerged for each of the four dyads as the historical narratives were written. The historical narratives of the four dyads are presented in Chapters 8–11.

Credibility of the historical narratives

Credibility is a criterion used in qualitative research methods to evaluate the rigor of the qualitative investigation, a type of validity (Denzin & Lincoln, 1994). Credibility is assessed by the prolonged engagement of the researcher with the researched (in this case, the mother-infant dyads), the persistent observation of the phenomenon under investigation, and the use of a peer research team.

Regarding prolonged engagement and persistent observation, one of the graduate student observers was part of the team that collected the data in 1986 and 1987 and who knew each of the dyads personally. A more important criterion, however, is the extent to which the investigator systematically examined and re-examined these data (that is, persistent observation), simultaneously establishing a prolonged engagement with the data. The two graduate student observers who did the narrative analysis of the frames and of the transitions between

frames had spent at least six years with repeated, systematic examination and re-examination of these data. This prolonged engagement and persistent observation of the data allowed the observers to develop a unique sensitivity to the idiosyncrasies and commonalities among the four dyads which is reflected in the level of concordance between the historical narratives written by the two independent observers.

It is also worth highlighting how the peer research team was used as a way of increasing the credibility of the historical narratives presented here. As mentioned earlier, the historical narratives of the frames were written **independently** of the historical narratives of the transitions (co-author D. W. wrote the frame narratives and co-author A. G. wrote the transition narratives). In the narrative analysis of the frames, the observer identified developmental periods for each dyad based on systematic processes across all four frames. The number of sessions of each developmental period and its characteristics varied for each dyad. These developmental periods coincided with the ones described in the historical narratives for the transitions between frames, although these narratives were written independently. Despite slight discordance in the two narratives, such as the different emphasis on certain dyadic actions, a concordance between these two independent historical narratives was still observed, such as perceived predominance of certain frames or how the twelve sessions were divided into developmental periods. We suggest that this level of concordance between the two observers is a strong indication of the credibility of the historical narratives presented in this report.

7 Results of the current investigation: quantitative analysis of developmental changes in relationship frames and in infant actions

In this chapter, we present quantitative analyses of the development of frames and transitions related to propositions 1, 3 and 4. Please refer to Chapter 5 for a review of the specific research propositions. Proposition 1 is a prediction about developmental sequence related to historical, bridging, and emerging frames. We present the analysis of the developmental trajectories of the proportional duration of each of the four frames for each of the thirteen mother-infant dyads in the sample and compare them to the model predicted for proposition 1 (sequence (P_1): see Chapter 5 and below). Proposition 3 is a prediction regarding the contribution of infant actions on objects to frame development while proposition 4 is about the developmental sequence of infant innovative actions on objects during frames and transitions. In Chapters 8–11, we present qualitative and further quantitative analysis of these three propositions and of proposition 2, on four representative dyads.

Proposition 1: developmental trajectories of frames

According to proposition 1, there will be three phases of the change process as shown in sequence (P_1).

(P_1) (Historical $\leftrightarrow$ Bridging) $\Rightarrow$ (Bridging $\leftrightarrow$ Emerging)

In this section, for all thirteen dyads, we examine models for the developmental trajectories of the proportional durations of each of the four frames (social, guided object, not-guided object, and social/object mixed) as a function of the infant's age in weeks. The proportional duration is the total number of seconds in which a frame occurred during a session divided by the total number of seconds in the session. The proportional durations for all of the frames combined sum to 1.00.

In order to fit sequence (P_1), there should be one frame whose developmental trajectory peaks in the early sessions and then declines

(the historical frame), another frame trajectory with an inverted U-shape peaking in the middle sessions (the bridging frame), and another frame trajectory that gradually increases and peaks in the final sessions (the emerging frame). We employ multilevel analysis to model the shape of the developmental trajectories of duration as a function of age and to examine interdyad differences in these trajectories.

This analysis can give us a general picture of the shape of developmental trajectories, but a more stringent test of sequence (P_1) requires that we look at all four developmental trajectories within each dyad. For this purpose, we examine the raw data trajectories of each frame for four representative dyads and the frequency of transitions between frames in realtime. These analyses will be presented in Chapters 8–11, accompanying the qualitative analysis of each of these four representative dyads. In addition, in this chapter we present a multiple correlation and graphical analysis of frames within dyads.

For the analysis presented in this section, a multilevel modeling statistical technique was applied (ML3 software, Prosser, Rasbash, & Goldstein, 1991). Specifically, repeated measures multilevel models were used to analyze the proportional duration (the proportion of the session) of the four frames as a function of the infant's age, in weeks. In repeated-measures models, data are structured as a two-level hierarchy. Level 1 units are repeated observational measures (in our case, weekly observations), which are nested within level 2 units – dyads. Multilevel models are extremely robust in extrapolating missing data, an advantage since dyads missed an average of four weekly visits on their way to completing the twelve observations sessions that were included in these analyses (see Table 6.1).

In these models, statistics are estimated at two different levels: group and dyad. The average growth curve of all dyads as a group is modeled by an *n*th degree polynomial function of infant age. These age parameters determining the shape of the average growth curve estimated from the data are termed fixed parameters. Fixed parameters are comparable to the regression coefficients in a regression model. Inclusion of an intercept and a first-order age parameter indicates that development is best described by a linear trend. Inclusion of higher order age parameters (i.e., Age^2 and Age^3) indicates a curvilinear developmental trend. The order of the polynomial is based on the significance of the highest order parameter.

The individual developmental curves are expressed as deviations from the average developmental curve. Since the dyads in the current study are a random sample from a large population, a level 2 variation (or individual differences among dyads) is referred to as a *random* variation. There are three random parameters associated with this level 2 variation,

namely the intercept (initial status, denoted as O_0^2), variance (slope or linear growth rate, denoted by O_1^2), and covariance (relation between initial status and linear growth rate, denoted by O_{12}^2). Inclusion of the intercept variance is indicative of differences among dyads at their initial status. Inclusion of covariance reflects a significant correlation between intercept and slope across time. Inclusion of slope variance indicates individual differences in growth rate among dyads. The level 1 random parameter designated by O_2 is residual variance.

In order to find the most parsimonious model that describes the observed data, first, the degree (n) of the average growth curve is determined. A higher-order age parameter is added to the model when it exceeds twice its standard error (.05 significance level). This process is repeated until no more significant higher-order age parameters can be added to the model. Individual differences are tested by comparing the model with and without the level 2 random parameters (intercept variance, slope variance, and covariance). A likelihood ratio statistic is used for significance testing, which follows a chi-square statistic distributed with degrees of freedom equal to the difference between the number of parameters with and without the variances as well as covariance. Furthermore, covariates (other predictors or explanatory variables; such as infant reaching) can be added to the model to detect their association with the growth parameters of the response variable. Because of the small sample size, univariate analyses were performed to test the main effects of the explanatory variables on each of the response variables.

Polynomial growth curves were fitted to the data to depict the developmental trajectories of each frame over the twelve sessions of observation. The estimated fixed and random parameters for these polynomial growth curves are listed in Table 7.1. The predicted developmental growth curves of the four frames from the thirteen dyads were plotted by using the estimated parameters from the model against infant age (see Figure 7.1(a–d)). Significant individual differences among dyads in the growth curves of the four frames were found. These individual differences accounted for approximately 7.6 to 25.7 percent of the total variance of the models. We discuss the findings for each frame with respect to the developmental model in sequence (P_1).

Social frame

As shown in Table 7.1, the developmental trajectory of the duration of the social frame was modeled by a third-degree polynomial function indicating a cubic developmental trend over the age period investigated. As exhibited in Figure 7.1(a), the predicted trends of the growth of the

Table 7.1. *Developmental trajectories of frames*

Parameters	Frames			
	Social	Guided object	not-guided	Social/object mixed
Fixed (Group trend)				
Intercept	45.1 (10.36)	55.21 (6.883)		
Age (Linear)		−1.462 (0.509)		
Age^2 (Quadratic)		–	0.085 (0.025)	0.41 (0.152)
Age^3 (Cubic)	0.014 (0.006)	–	–	−0.014 (0.004)
Random (individual differences)				
O_0^2 (Initial status)	603.8 (290.3)	492.8 (243.4)	0 (0)	0 (0)
O_{12} (Relation of growth rate to initial status)	−31.47 (16.51)	−34.64 (17.56)	0 (0)	–
O_2^2 (Growth rate)	1.605 (0.971)	2.503 (1.317)	0.7 (0.301)	0.371 (0.183)
Error				
O^2	301.6 (36.6)	276.8 (34.05)	94.25 (11.15)	138.6 (16.39)
% of variance Explained by level-2 random Parameters (individual differences)	13.9	18.5	25.7	7.6

Note: Standard errors are in parentheses. Only significant fixed parameters are reported.

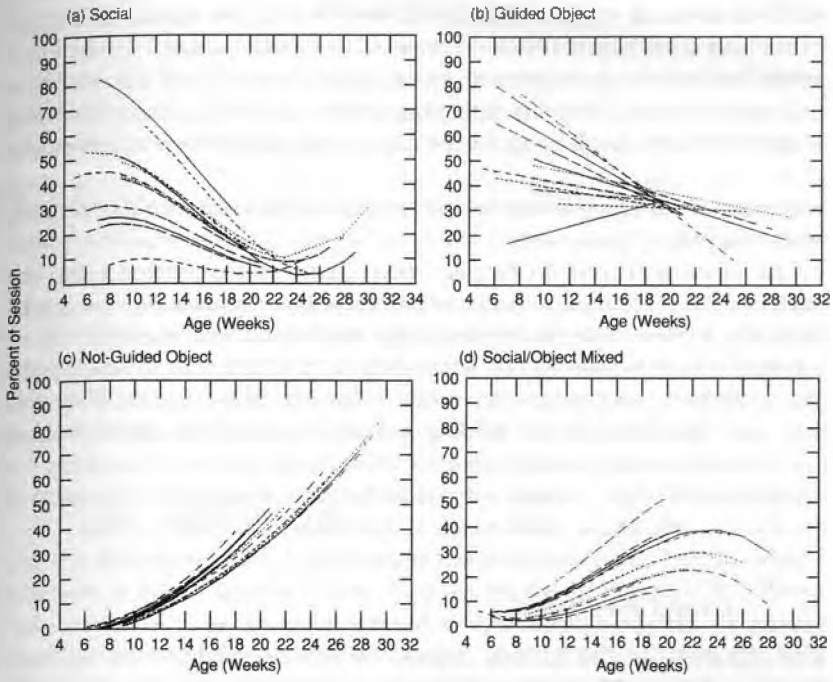


Figure 7.1. Developmental trajectories of the best fitting models for the proportional duration (percent of session) of each of the frames are shown. The average growth curve of all dyads as a group is modeled by an *n*th degree polynomial function of infant age. The individual developmental curves are expressed as deviations from the average developmental curve. The social frame is modeled by a cubic function of age, the guided object frame by a linear function of age, the not-guided object frame by a quadratic function of age, and the social/object mixed frame by a cubic function of age.

social frame remained approximately at the same level during the first few sessions. A dramatic decrease began around 9 weeks and then a slight increase was shown around 21–25 weeks. Inclusion of the level 2 random parameters (covariance and variance) revealed that there were significant age-dependent differences among dyads, $\chi^2(2) = 20.27$, $p < .0001$. There were individual differences in the initial status (intercepts) and growth rate (slopes). The thirteen dyads spent significantly different proportions of their time in social frames during the early weeks and demonstrated variations in their developmental growth across the twelve week observation period.

These findings suggest that for all but four of the dyads, the social frame was a historical frame because it was predominant in the early weeks – occurring between 40 percent and 80 percent of the session – and then declined. For the remaining dyads, the social frame remained at relatively low levels – under 30 percent of the session – across the observation period and therefore could not have served as a historical, bridging, or emerging frame for any of these dyads because it was never predominant.

One finding of interest for the social frame is that across time, the differences among dyads shown at earlier weeks dramatically decreased when the babies turned 21 weeks of age as revealed in Figure 7.1 and in the significantly negative O_{12}^2 term. This term means that the higher the initial level of the duration of the social frame, the faster the rate of decline with age. We interpret this finding as further support for the historical predominance of the social frame for some dyads. It shows that there is a significant difference between dyads in the early weeks in the duration of the social frame and a relative lack of difference in the later weeks.

Guided object frame

The duration of the guided object frame was modeled by a linear function of infant age (see Table 7.1). Inspection of Figure 7.1(b) showed that most dyads gradually reduced their time spent in the guided object frame across time, with the exception of one dyad that remained relatively unchanged and one dyad that increased across time. Inclusion of the level 2 random parameters revealed that there were significant age-dependent differences among dyads, $\chi^2(2) = 20.04$, $p < .0001$. Significant individual differences in the initial status (intercepts) and growth rate (slopes and direction of change) were found. Individual differences were greater in earlier than later weeks.

These findings show that for all but one of the dyads, the guided object frame was historically predominant – occurring for 40 to 80 percent of the session – and then declined. Depending upon the dyad, then, at least one and possibly two frames, the social frame or the guided object frame, fit the model of sequence (P_1) for a historical frame.

The O_{12}^2 term is significantly negative for the guided object frame, showing a similar pattern as for the social frame. The negative correlation between the intercept and the slope ($r = -.99$) indicated that the dyads who spent the most time in the guided object frame initially had a faster rate of decline. The result was that the differences among dyads, which were relatively large in the early weeks, reduced to the lowest point when infants were at 17–21 weeks of age. Thus, not only are the

social frame and the guided object frame historically predominant for many of the dyads, differences between dyads for these frames are most salient in the period when these frames are historically predominant.

It is also possible that the guided object frames may have served as developmental bridging frames for some of the dyads. Note that some dyads have a relatively slow rate of decline of the guided object frame which takes up about 40 to 50 percent of the session across the entire period of observation. If the guided object frame remains relatively high, it is unlikely to be the bridging frame. It may be that if the social frame for some of these dyads was initially predominant and then declined, the guided object frame would then increase and become the more predominant frame during the middle sessions. Examination of the trajectories of frames within dyads (see below) is the only conclusive way to determine which frame serves which function for a particular case.

Not-guided object frame

The duration of the not-guided object frame was modeled by a quadratic function of infant age (see Table 7.1). As shown in Figure 7.1c, during the early weeks, all dyads exhibited a very similar pattern of having relatively low durations of the not-guided object frame. During the later weeks, there was a dramatic acceleration in the duration of this frame. Inclusion of the level 2 random parameters (covariance and variances) revealed that there were significant age-dependent differences among dyads, $\chi^2(2) = 37.37$, $p < .0001$. Although no significant individual differences were found in initial status and the relation between initial status and growth rate, there were significant individual differences in growth rate. Although all dyads spent very little time in the not-guided object frame during the earlier weeks, they rapidly diverged across time showing that each dyad has a different developmental history.

These findings clearly show that the not-guided object frame was the newly emerging frame for all the dyads. It was relatively low in duration during the early and middle weeks, so it could not have served in the role of historical or bridging frame, at least not from the perspective of being predominant in duration. The rapidly accelerating trajectories for all the dyads suggest that this frame came to replace all the others as the predominant frame for all the dyads.

Social/object mixed frame

The duration of the social/object mixed frame was modeled by a cubic function of infant age (see Table 7.1). As shown in Figure 7.1d, all

dyads exhibited slow acceleration in the duration of the social/object mixed frame between 5 and 9–11 weeks and a more rapid increase until 21–23 weeks. After the growth reached its peak, a slow decrement was followed by a more rapid decline between 25–31 weeks. Inclusion of the level 2 random parameters (covariance and variances) revealed that there were significant age-dependent differences among dyads, $\chi^2(1) = 8.09, p < .01$. Significant individual differences were found in the growth rate only. Initially, all dyads spent little time in the social/object mixed frame. The acceleration of the growth of the social/object mixed frame for some dyads was more dramatic than for others. Thus, during the middle weeks, there were significant individual differences in the duration of the social/object mixed frame.

These results suggest that for at least some of the dyads, the social/object mixed frame was a strong candidate for being a developmental bridging frame. It fits the model for a bridging frame in at least two different ways. First, the duration was most predominant during the middle sessions for all dyads. The social/object mixed frame had an inverted U-shaped trajectory that was predicted in proposition 1. The trajectory peaked just after the acquisition of visually guided reaching. Second, as we found for the other frames, between-dyad differences were most diverse during the period in which this frame was the most predominant.

This latter finding suggests that during the bridging period, which is a turning point in the trajectories, there is increased variability between dyads. The first author, in collaboration with M. Lavelli, found a very similar pattern of divergence between developmental trajectories for face-to-face play (i.e., the social frame) occurring during a developmental transition in infant social engagement around two months of age (Lavelli & Fogel, 2002). This is consistent with the prediction, from dynamic systems theory, that variability increases during developmental transition periods and then declines thereafter.

In summary, the modeled trajectories provide at least initial support for proposition 1. They show that some frames were predominant in the early sessions, some in the middle sessions, and some in the later sessions. This result is more than trivial. The frames that we interpreted to be historical, bridging, and emerging are consistent with the findings in the literature for the changes expected to occur in mother-infant communication around the fourth month of life. Historical frames were those involving the most social participation of the mother, either for social play (social frame) or for socially guiding the infant's attention to objects (guided object frame). The emerging frame was for the infant's relatively independent exploration of the objects in the company of the

mother (not-guided object frame). The bridging frame (social/object mixed frame) combined qualities of both historical and emerging frames as objects were used for social play during the social/object mixed frame.

Links between frames

One problem with the analysis presented thus far is that each frame is considered by itself with no regard for how it changes with respect to other frames. To more completely test proposition 1, we need to show how the frames change over time with respect to each other **within** each dyad. One way to examine links between frames is using multiple correlation analysis. All frames sum to a total of 100 percent of the session, so there is clearly interdependency. The correlational analysis, however, can show which specific interdependencies are most likely to occur. In Table 7.2, we show correlations between frames for each dyad separately. From the correlations alone, we cannot say anything about development. We can, however, make developmental inferences by examining the correlations in light of what we know about the developmental trajectories. The raw data developmental trajectories for each of the frames within each of the thirteen dyads are shown in Figure 7.2. Note that the four representative dyads, which will be studied in more detail in Chapters 8–11, are Dyad 6 (Richard), Dyad 7 (Lewis), Dyad 9 (Susan), and Dyad 10 (Betsy).

The results show that there is a great deal of between-dyad variability. For most dyads, there are negative correlations between the duration of the social frame and the durations of all the other frames, although these correlations do not always reach significance. This suggests that as the social frame decreases in duration, there is a corresponding increase in duration of the other frames for most of the dyads. This pattern can be seen clearly in one of the four representative dyads, Dyad 9, Susan and her mother.

Similarly, most dyads had a negative correlation between the not-guided object frame and the guided object frame, suggesting that as the not-guided object frame increases in duration, there is a corresponding decrease in the guided object frame. These findings are all consistent with the model in sequence (P_1), that is, when either the social or guided object frames (historical frames) are high in a session, the not-guided object frame (emerging frame) is low, and vice-versa. This pattern is best illustrated in one of the four representative dyads, Dyad 10, Betsy and her mother.

The social/object mixed frame shows primarily negative correlations with the guided object frame and the social frame, suggesting that it

Table 7.2. *Correlations between frames by individual dyad*

	Dyads												
Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13
Between frames	Ben	Andrew	Peter	Gavin	Jerry	Richard	Lewis	Edward	Susan	Betsy	Linda	Ruth	Anne
Social/guided object	−.97***	−.27	−.37	−.68*	−.20	−.25	−.08	−.43	−.55+	−.33	−.33	−.45	−.05
Social/not-guided object	−.91***	−.79**	−.81**	−.43	−.36	−.59*	−.23	−.44	−.59*	.20	−.07	−.07	−.43
Social/social-object mixed	−.82**	−.73**	−.75**	−.62*	−.26	.37	−.41	−.41	−.53+	.07	−.43	−.74**	−.73**
Guided object/not-guided object	.81**	−.33	.13	−.28	−.82***	−.47	−.47	−.52+	−.18	−.85***	−.50	−.12	−.52+
Guided object/social-object mixed	.75**	−.19	.03	.47	−.52+	−.36	−.75**	−.46	−.37	−.67*	−.67*	−.18	−.45
Not-guided object/social-object mixed	.58*	.68*	.32	−.14	.49	−.47	.08	.49	.64*	.21	.29	−.20	.22

Note: N = 12; + p < .10
*p < .05
**p < .01
***p < .001

becomes predominant as a bridging frame when the historical frames are low in duration. On the other hand, there is no consistent pattern of correlations across dyads for the link between the social/object mixed frame and the not-guided object frame. This means that the social/object mixed frame may or may not remain an active part of the dyad's communication as the emerging (not-guided object) frame becomes predominant. One of our representative dyads, Richard and his mother (Dyad 6), has a negative correlation. As the social/object mixed frame begins to decline after its peak at session 8, the not-guided object frame begins to increase. For another representative dyad, Susan and her mother (Dyad 9), there is a correlated growth in both these frames beginning around session 6.

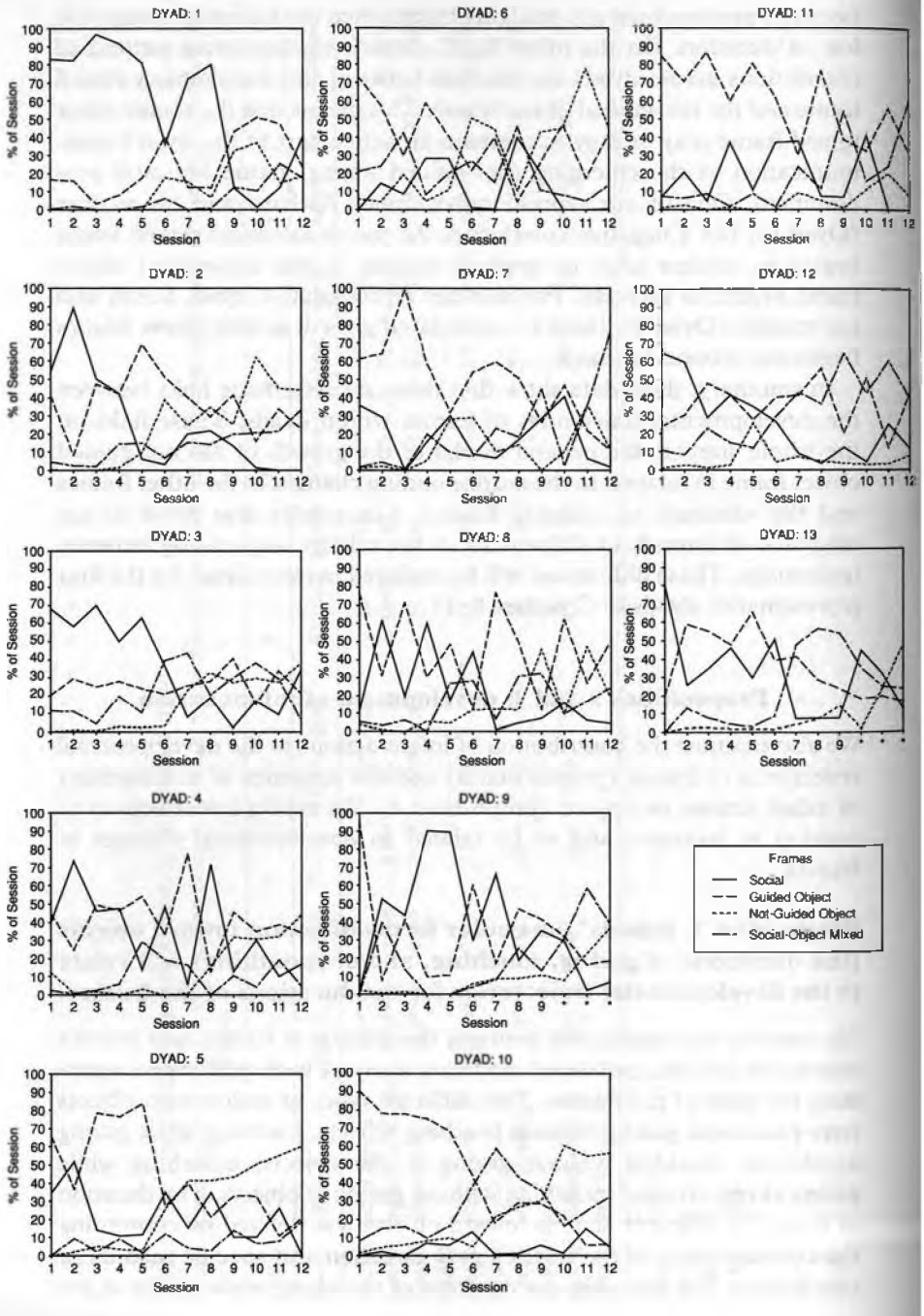
In summary, these data show that there are systematic links between the developmental trajectories of frames within dyads. These links on the whole support the general model of the growth of the not-guided object frame in relation to the corresponding changes in the other frames and the existence of bridging frames. The results also point to the existence of inter-dyad differences in the relative sequencing between trajectories. These differences will be explored in more detail for the four representative dyads in Chapters 8–11.

Propositions 3 and 4: development of infant action

We also examine the contribution of infant actions to the developmental trajectories of frames (proposition 3) and the sequence of development of infant actions on objects (proposition 4). We expect infant actions to develop in sequence and to be related to developmental changes in frames.

Proposition 3. Infants' particular forms of action toward objects (the durations of gazing, touching, and/or mouthing) will relate to the developmental trajectories for the durations of the frames.

To examine the association between the growth of frames and infant's actions on objects, multilevel modeling analyses were performed separately for each of the frames. Five different types of action with objects were examined: gazing without touching objects, touching while gazing at objects, touching without gazing at the objects, mouthing while gazing at objects, and mouthing without gazing at objects. The duration of these five different actions toward objects was derived by computing the co-occurrence of the infant's gaze direction and specific manual or oral actions. For example, the duration of mouthing while gazing at the


DYAD: 1
DYAD: 6
DYAD: 11
DYAD: 2
DYAD: 7
DYAD: 12
DYAD: 3
DYAD: 8
DYAD: 13
DYAD: 4
DYAD: 9
DYAD: 5
DYAD: 10
% of Session
Session
Frames
Social
Guided Object
Not-Guided Object
Social-Object Mixed

object was the total duration (expressed as a proportion of the session) of the mouthing action that was accompanied by visual attention to the object. The status of the infant's visually-guided reaching and one of these forms of infant action with objects were added as covariates to the best-fitting polynomial model of each individual frame to examine their contribution to the growth of individual frames.

Infant gazing at objects without touching them. As shown in Table 7.3, the status of infant's visually-guided reaching had no significant effect on the growth of frames. In addition, when infant reaching and gazing at objects without touching them were added as the covariates of the models, inclusion of the level 2 random parameters revealed that there were significant individual differences among dyads: $\chi^2(2) = 6.53$, $p < .05$ for social frames; $\chi^2(2) = 11.15$, $p < .01$ for guided object frames; $\chi^2(2) = 36.89$, $p < .0001$ for not-guided object frames; $\chi^2(2) = 7.64$, $p < .05$ for social/object mixed frames. The fixed parameters explained approximately 29.6 to 51.5 percent of the total variance, whereas individual differences accounted for approximately 8.1 to 26.1 percent of the total variance of the models.

Furthermore, there was a significant association between the duration of infant gazing without touching objects and the growth of social as well as guided object frames. When infants spent more time gazing without touching objects, the duration of social frames declined while the duration of the guided object frames increased across time. Moreover, the degree of the effect of gazing without touching on the development of the two frames (or vice versa) was significantly different between dyads. For some dyads, in other words, changes in gazing without touching objects were more strongly associated with the changes in these frames than for other dyads.

Infant touching objects while gazing at them. As shown in Table 7.4, when infant reaching and touching objects while gazing at them were added as covariates in the models, inclusion of the level 2 random parameters revealed that there were significant individual differences among dyads for all frames with the exception of social frames: $\chi^2(2) = 22.45$, $p < .0001$ for guided object frames; $\chi^2(2) = 29.94$, $p < .0001$ for not-guided object frames; $\chi^2(1) = 8.75$, $p < .01$ for social/object mixed frames. The fixed parameters explained approximately 13.9 to 55.1 percent of the total variance, whereas the individual differences

Caption for fig. 7.2 (*cont.*)
Figure 7.2. Raw data developmental trajectories of the proportional duration (percent of session) of each of the frames as a function of infant age for each of the dyads.

Table 7.3. *Association between frames and infant gazing without touching objects*

	Frames					
Parameters	Social	Guided object	Not-guided object	Social/object mixed		
Fixed						
Intercept	59.71 (8.985)	28.73 (5.695)				
Age	5.247 (2.232)					
Age^2	−0.805 (0.209)	—	0.082 (0.025)	0.395 (0.161)		
Age^3	0.023 (0.006)	—	—	−0.013 (0.004)		
Reaching						
Gazing at object	−0.635 (0.083)	0.709 (0.07)				
Random						
O_0^2	246.7 (137.2)	158.1 (92.1)	0 (0)	0 (0)		
O_{12}	−13.46 (8.765)	−13.98 (8.023)	0 (0)	0 (0)		
O_2^2	0.809 (0.604)	1.295 (0.733)	0.673 (0.289)	0.		
Error						
O^2	230.2 (28.22)	181.7 (22.39)	92.13 (10.9)	136 (16.08)		
% of variance explained by fixed parameters	50.0		51.5		44.1	29.6
% of variance explained by level-2 random Parameters (individual differences)	9.0	15.2		26.1	8.1	
% of variance reduced by addition of covariates ?		0		0	?	

Note: Standard errors are in parentheses. Only significant fixed parameters are reported.

Table 7.4. *Associations between frames and infant touching while gazing at objects*

	Frames			
Parameters	Social	Guided object	Not-guided object	Social/object mixed
Fixed				
Intercept	43.23 (9.441)	59.97 (7.884)		
Age		−1.465 (0.646)		
Age^2		–	0.084 (0.025)	0.388 (0.162)
Age^3		–	–	−0.013 (0.004)
Reaching				
Touching while gazing at object	−0.434 (0.149)		0.175 (0.082)	
Random				
O_0^2	106.3 (52.93)	523.6 (251.6)	0 (0)	0 (0)
O_{12}	–	−37.88 (18.59)	0 (0)	–
O_2^2	–	2.787 (1.416)	0.583 (0.254)	0.431 (0.206)
Error				
O^2	340.7 (40.29)	276.9 (34.03)	90.46 (10.7)	134.9 (15.95)
% of variance explained by fixed parameters	25.5	13.9	55.1	29.3
% of variance explained by level-2 random parameters (individual differences)	0	19.5	23.6	9.3
% of variance reduced by addition of covariates	?	–	4.0	–

Note: Standard errors are in parentheses. Only significant fixed parameters are reported.

accounted for approximately 9.8 to 24.0 percent of the total variance of the models.

Furthermore, there were significant associations between touching objects while gazing them and the growth of social as well as not-guided object frames, but not with the guided object or social/object mixed frame. When the infant engaged in more touching objects while gazing at them, the growth of social frames declined. Moreover, there were no significant individual differences in the negative relationship between the infant's touching objects while gazing at them and the growth of the social frame. On the contrary, touching objects while gazing at them was associated with an increment of the not-guided object frame across time and the extent of the effect was significantly different between dyads.

Infant touching objects without gazing at them. As shown in Table 7.5, inclusion of the level 2 random parameters revealed that there were significant individual differences among dyads for all frames when infant reaching and the duration of infant touching objects without gazing at them were added to the models as covariates: $\chi^2(2) = 17.55$, $p < .0002$ for social frames; $\chi^2(2) = 14.72$, $p < .0006$ for guided object frames; $\chi^2(2) = 35.69$, $p < .0001$ for not-guided object frames; $\chi^2(2) = 4.29$, $p < .10$ for social/object mixed frames. The fixed parameters explained approximately 21.8 to 44.6 percent of the total variance, whereas individual differences accounted for approximately 5.3 to 25.5 percent of the total variance of the models.

In addition, only the associations between infant touching objects without gazing at them and the growth of guided object and social/object mixed frames were significant. The growth of the guided object frame declined when the infant spent more time touching objects without gazing at them while the growth of the social/object mixed frame increased. Moreover, there were significant individual differences between dyads in the relationship between touching objects without gazing at them and the development of guided object and social/object mixed frames.

Infant mouthing objects while gazing at them. As shown in Table 7.6, when infant reaching status and mouthing while gazing at objects were added as covariates to the models, the inclusion of the level 2 random parameters demonstrated that there were significant individual differences among dyads for all frames: $\chi^2(2) = 19.54$, $p < .0001$ for social frames; $\chi^2(2) = 21.86$, $p < .0001$ for guided object frames; $\chi^2(1) = 37.42$, $p < .0001$ for not-guided object frames; $\chi^2(1) = 9.21$, $p < .01$ for social/object mixed frames. The fixed parameters explained approximately 14.2 to 44.2 percent of the total variance, whereas individual differences

Table 7.5. *Associations between frames and infant touching without gazing at objects*

	Frames			
Parameters	Social	Guided object	Not-guided object	Social/object mixed
Fixed				
Intercept	44.5 (10.35)	60.04 (7.048)		
Age		−1.179 (0.551)		
Age^2	−0.463 (0.222)	–	0.080 (0.026)	0.42 (0.157)
Age3	0.015 (0.006)	–	–	−0.014 (0.004)
Reaching				
Touching Object while not gazing at object		−0.364 (0.128)		0.208 (0.092)
Random				
O_0^2	524.1 (259)	399.3 (203.1)	0 (0)	0 (0)
O_{12}	−25.2 (14.04)	−26.32 (14.14)	0 (0)	0 (0)
O_2^2	1.153 (0.79)	1.795 (1.027)	0.665 (0.286)	0.335 (0.167)
Error				
O^2	307.8 (37.26)	269.7 (33.09)	92.17 (10.9)	133.5 (15.79)
% of variance explained by fixed parameters	24.3	21.8	44.6	33.1
% of variance explained by level-2 random parameters (individual differences)	11.4	15.2	25.5	5.3
% of variance reduced by addition of covariates	–	2.6	–	3.7

Note: Standard errors are in parentheses. Only significant fixed parameters are reported.

Table 7.6. *Associations between frames and infant mouthing while gazing at objects*

	Frames			
Parameters	Social	Guided object	Not-guided object	Social/object mixed
Fixed				
Intercept	44.84 (10.64)	56.38 (7.658)		
Age^2	−0.434 (0.227)	–	0.079 (0.025)	0.320 (0.153)
Age^3	0.013 (0.006)	–	–	−0.012 (0.004)
Reaching				
Mouthing while gazing at object				0.641 (0.161)
Random				
O_0^2	573.1 (278.9)	510.9 (246.3)	0 (0)	0 (0)
O_{12}	−29.41 (15.8)	−35.49 (17.58)	–	–
O_2^2	1.476 (0.928)	2.489 (1.292)	0.670 (0.288)	0.412 (0.195)
Error				
O^2	306.4 (37.2)	277.8 (34.04)	91.42 (10.81)	122.8 (14.52)
% of variance explained by fixed parameters	22.2	14.2	44.2	33.8
% of variance explained by level-2 random parameters (individual differences)	13.3	18.1	26.4	9.0
% of variance reduced by addition of covariates	–	–	–	11.4

Note: Standard errors are in parentheses. Only significant fixed parameters are reported.

accounted for approximately 9.0 to 26.4 percent of the total variance of the models.

Results showed that as the infant engaged in more mouthing objects while gazing at them, the dyad was more likely to be involved in the social/object mixed frame. Additionally, the magnitude of the relationship between mouthing objects while gazing at them and the development of the social/object mixed frame was significantly different between dyads.

Infant mouthing objects without gazing at them. As shown in Table 7.7, inclusion of the level 2 random parameters with infant reaching and infant mouthing objects without gazing at them as covariates revealed individual differences among dyads for all frames: $\chi^2(2) = 19.92$, $p < .0001$ for social frames; $\chi^2(2) = 21.7$, $p < .0001$ for guided object frames; $\chi^2(1) = 37.33$, $p < .0001$ for not-guided object frames; $\chi^2(2) = 7.39$, $p < .05$ for social/object mixed frames. The fixed parameters explained approximately 14.2 to 44.2 percent of the total variance, whereas individual differences accounted for approximately 8.1 to 26.4 percent of the total variance of the models.

Mouthing objects without gazing at them had a significant positive relationship with the growth of the social/object mixed frame. Considering the results from infant mouthing objects while gazing at them in the previous section, it seemed that when the infant was mouthing objects, regardless of the direction of the visual attention, the dyad was more likely to spend time in the social/object mixed frame. Furthermore, there were also significant individual differences in the degree of the association between mouthing objects without gazing at them and the growth of the social/object mixed frame.

In summary, the emergence of individual differences in the frames was closely related to the infant's actions with objects. When infants spent more time gazing at objects without touching, the mothers were more likely to demonstrate and scaffold objects (the guided object frame). When infants were gazing while touching objects, mothers were more likely to observe their infant's object play (not-guided object frame) and less likely to engage their infants in social play. Lastly, when infants were mouthing objects, the dyad was more likely to engage in social/object mixed games (regardless of the direction of infant gazing). These findings fit with the results for the development of frames.

For all dyads in the sample, the not-guided object frame was the newly emerging frame. Infant visually guided manual exploration of objects (i.e., touching and mouthing objects while gazing at them), then, developed primarily once this frame – in which mothers provided only verbal support for infants' actions on objects – began to increase in duration.

Table 7.7. *Association between frames and infant mouthing without gazing at objects*

Parameter	Frames			
	Social	Guided object	Not-guided object	Social/object mixed
Fixed				
Intercept	45.23 (10.68)	57.9 (7.616)		
Age				
Age^2	−0.461 (0.226)	–	0.083 (0.025)	0.376 (0.159)
Age^3	0.014 (0.006)	–	–	−0.013 (0.004)
Reaching				
Mouthing while not gazing at object				0.228 (0.111)
Random				
O_0^2	578.6 (281.4)	506.8 (245.0)	0 (0)	0 (0)
O_{12}	−29.69 (15.88)	−35.62 (17.66)	–	0 (0)
O_2^2	1.483 (0.929)	2.533 (1.311)	0.691 (0.296)	0.363 (0.178)
Error				
O^2	310.2 (37.63)	279.6 (34.3)	91.59 (10.83)	133.5 (15.79)
% of variance explained by fixed parameters	21.1	14.2	44.2	32.0
% variance explained by level-2 random parameters (individual differences)	13.1	18.4	26.4	8.1
% of variance reduced by addition of covariates	–	–	–	3.7

Note: Standard errors are in parentheses. Only significant fixed parameters are reported.

Although object mouthing while gazing has been shown to be directly linked to object exploration (Rochat, 1989; Ruff, 1984), our results show that at this age all forms of object mouthing, as well as touching objects without gazing at them, occurred in relation to longer durations of the social/object mixed frame. In this frame, objects are used as mediators of social play, rather than as direct foci of attention and exploration. Infants held or mouthed objects while engaging in more socially oriented play with mother or mother used the object to initiate social play with objects.

As discussed earlier, the social/object mixed frame reaches a peak in the middle weeks of our observation period, followed by a decline, and for some dyads it may serve as a bridge between guided object and not-guided object frames. The data presented in this section suggest that object exploration skills are not being developed during the social/object mixed frame. The bridging function of this frame may be more related to being a break from exploratory object play (in the guided and not-guided object frames) that allows the dyad an opportunity to re-connect in a more social way while still maintaining a contact with objects. These data suggest that developmental periods can be distinguished not only by the salience of particular frames but also by the occurrence of particular types of infant actions.

Proposition 4. The infant's acquisition of skilled actions with objects will emerge in a developmental sequence. The age of the onset of individual infant actions with objects was tallied across all thirteen infants (see Table 7.8). With the exception of infant reach, the onset age of infant actions on objects was coded under two conditions: (1) the mother was supporting and holding the object for the infant; and (2) the infant was holding the object independently. Some infant actions emerged earlier than others. Reaching, manipulation, grasping with one hand, and mouthing, for example, were more likely to be observed at younger ages than the actions such as shake, grasping with two hands, and squeeze. Some infant object actions (e.g., manipulation, grasp with one hand, mouthing, and squeeze) exhibited earlier onset ages during the condition when mothers held the object, whereas other actions (e.g., shake and grasp with two hands) emerged earlier when infants held the object. As will be seen in the qualitative analyses (Chapters 8–11), some of these same patterns emerge as innovations in the dyad.

To examine the differences in the onset age of infant actions in relation to its context (infant held object independently or mother held object for infant), a 2 (Context: Mother vs. Infant) × 6 (Infant Action on

Table 7.8. *Developmental emergence of individual infant actions under two conditions: when mother held the object for the infant and when the infant held the object independently*

Infant Action	Possession of object	Age (Weeks) 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Mean (SD)*
Reach	Mother		4/13	6/13	7/13	10/13	11/13	11/13	11/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	13/13			9.15 (4.47)
Manipulate	Mother	1/13	1/13	2/13	5/13	6/13	7/13	10/13	10/13	10/13	11/13	12/13	12/13	12/13	13/13							10.38 (3.57)
	Infant				3/13	4/13	7/13	9/13	9/13	11/13	12/13	12/13	12/13	12/13	13/13							11.00 (2.89)
Grasp with one hand	Mother	1/13	1/13	1/13	3/13	4/13	6/13	10/13	11/13	11/13	11/13		11/13	12/13	12/13	12/13	12/13	12/13	13/13			11.00 (3.94)
	Infant						3/13	7/13	8/13	9/13	10/13	11/13	12/13	12/13	12/13	12/13	12/13	13/13				12.69 (3.17)
Mouthing	Mother			1/13	2/13	2/13	2/13	4/13	5/13	7/13	7/13		9/13	11/13	12/13	12/13	13/13					13.31 (3.50)
	Infant			1/13	2/13	3/13	3/13	3/13	4/13	4/13	6/13	8/13	10/13	11/13	12/13	12/13	13/13					15.15 (3.69)
Shaking	Mother						1/13	1/13	1/13	3/13	5/13	7/13	9/13	10/13	11/13	11/13	13/13					16.46 (2.85)

	Infant						2/13	5/13	6/13	7/13	7/13	8/13	10/13	10/13	12/13	12/13	12/13	13/13			14.08
																					(3.57)
Grasp with two hands	Mother						1/13	2/13	3/13	4/13	5/13	6/13	8/13	9/12	9/13	11/13	12/13	13/13			16.62
																					(3.52)
	Infant							1/13	2/13	3/13	4/13	5/13	6/13	8/13	10/13	10/13	11/13	13/13			16.38
																					(3.28)
Squeeze	Mother+	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	3/12	3/12	3/12	5/12	5/12	6/12	10/12	11/12	11/12	12/12		16.58
																					(4.54)
Infant	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	3/13	3/13	4/13	5/13	6/13	7/13	10/13	11/13	12/13	12/13	12/13	13/13	16.85
																					(4.72)

Note: = At least half of the infants performed the action.
*= Mean and standard deviation of the infant's age when the action occurred for the first time.
+ = Squeeze action was never observed with one subject.

Table 7.9. *Post-hoc multiple comparisons of pairs of the onset age of individual infant actions*

	Reach	Manipulation	Grasp with one hand	Mouthing	Shake	Grasp with two hands	Squeeze
Reach	—	—	—	—	—	—	—
Manipulation	=	—	=	<	<	<	<
Grasp with one hand	=	=	—	<	<	<	<
Mouthing	>	>	=	—	=	=	=
Shake	>	>	>	>	—	<	<
Grasp with two hands	>	>	>	>	=	—	=
Squeeze	>	>	>	=	=	=	—

Note: Paired comparisons of the age of onset of infant action when the infant possesses an object are on the upper diagonal; and comparisons presented on the lower diagonal when the mother possesses an object.
"=" No significant differences between the age of onset of infant action.
"<" The age of the onset of infant action on the coordinate is significantly earlier than that of on the abscissa.
">" The age of the onset of infant action on the coordinate is significantly later than that of on the abscissa.
"—" No comparison is made.

Object: Manipulation, Grasp with one hand, Mouthing, Shaking, Grasp with two hands, and Squeeze) repeated measures ANOVA was performed. The results showed that there was a significant main effect of Infant Action, $F\ (12) = 12.79$, $p = .0001$. Although there was no significant main effect of Context, $F\ (12) = 0.24$, $p > .10$, the interaction effect of Infant Action on Object x Context was significant, $F\ (12) = 5.79$, $p < .01$. The post-hoc analyses revealed that infants exhibited grasping (with one hand) earlier if their mothers held the object whereas infants displayed shaking actions at younger ages when they were holding the object by themselves. There were no significant differences in the onset age of manipulation, grasp with two hands, mouthing, or squeeze regardless of whether the infant was holding the object independently or not. The post-hoc multiple comparisons test (see Table 7.9) also showed that the first group of infant actions to emerge were reach, manipulation, and grasp with one hand, and the second group of infant actions included mouthing and shake. Grasp with two hands and squeeze were the third and last group of infant actions to emerge.

In sum, despite the fact that there were individual differences in the timing of the emergence of infant object actions, the acquisition of different object actions occurred in an invariant developmental sequence. The sequence we found is similar to that reported in the literature and shown in Table 2.1. These findings show that the emergence of more complex infant actions along with infants independently holding objects (primarily during the not-guided object frame) depends historically on the earlier acquisition of more basic actions on objects while mother holds the objects (primarily during the guided object frame). As we examine the development of innovations in Chapters 8–11, it is worth remembering that the innovative infant actions occurring during frames and transitions are superimposed on a more general pattern of infant motor development.

Summary

In general, we find evidence supporting all of our propositions. First, the developmental trajectories of frames show evidence that there are historical, bridging, and emerging frames. What specific frame will serve each of these developmental functions (i.e., historical, bridging or emerging) will depend on the relational history of each mother-infant dyad which can only be revealed by a qualitative relational-historical analysis. Historical frames tend to be predominant early, bridging frames tend to be predominant in the middle sessions, and emerging frames tend to be predominant in the final sessions. Second, durations of infant actions on objects are generally related to the prior and concurrent durations of the appropriate frame. Finally, the infant innovations in actions on objects that we will describe in the next four chapters appear to emerge in an invariant sequence.

Decreases in the durations of historical frames and increases in the durations of newly emerging frames are only suggestive of a possible historical link between them. Only the qualitative analysis (Chapters 8–11) can reveal whether the newly emerging frames arise from innovation introduced into the historical background frames. History implies a meaningful relationship between events in a sequence and for that we must turn to qualitative research.

8 Results of the current investigation: qualitative analysis of Richard and his mother

In order to understand proposition 1 historically, we have to examine the patterns of change across frames within dyads. We illustrate these historical patterns and interdyad differences with a quantitative description of frames and transitions for the four representative dyads that will be used for the qualitative analysis, followed by a detailed qualitative description of the historical processes with each dyad. In this chapter, we focus on the first of the four representative dyads, Richard and his mother. In Chapters 9–11, we review the other three representative dyads respectively. In this chapter, we also give an overview of the analytical approach.

Our criterion for selecting the four dyads was based on the development of interdyad differences. We chose two dyads in which the infants developed a preference for object play as judged by relatively higher durations, compared to the other research participants, of the not-guided object frame in the post-reaching period (Richard and Betsy and their mothers). We chose two comparison dyads that showed relatively lower durations in not-guided object frames, and relatively higher durations in the mixed social-object frame during the post-reach period (Lewis and Susan and their mothers). These two pairs of dyads, therefore, correspond to the interdyad differences found in the literature (see Chapter 2): dyads that are relatively more focused on object play compared to dyads that are relatively more focused on social play. Betsy and her mother were African-American and the other dyads were Caucasian-American.

In Chapters 8–11, we first present the raw data developmental trajectories for each frame within each of the four dyads. The analysis is similar to the presentation of the modeled developmental trajectories in the previous section. We also present data on the frequency of each of the twelve possible transitions between frames as a function of age for each of the four representative dyads. According to proposition 1, there should be a higher frequency of transitions between historical and bridging frames and between bridging frames and emerging frames.

Conversely, there should be a relatively low frequency of transitions between historical and emerging frames. Bridging frames should mediate transitions between other frames during the period when the bridging frames are relatively high in duration. Because we are presenting observations within each dyad, the data are presented descriptively without any statistical analysis.

Testing research propositions with qualitative analysis

In Chapter 7, we tested our research propositions (refer to Chapter 5) using quantitative analysis. In Chapters 8–11, we return to those propositions on which a qualitative analysis can shed further light, in particular propositions 1, 2, and 3. These propositions refer to the predicted commonalities in the relational-historical development of the dyads. Our research design rests on the premise that general principles of relational developmental change can best be ascertained by studying each dyad separately. In this way, we can learn about both commonalities of the developmental process as well as differences between dyads in their developmental process. Using principles of case study research (Chapter 6), we take the view that general laws of development can best be understood by observing what is common across individual cases.

Proposition 1

Qualitative analysis on propositions 1, 2, and 3 was discussed in some detail in Chapter 5. Proposition 1 is tested by a combination of quantitative and qualitative analysis. In this section, we review the findings from Chapter 7 relevant to proposition 1 and suggest how qualitative analysis can contribute. Proposition 1 makes the prediction that relational-historical change will occur in three phases: (1) an initial phase in which there is one predominant historical frame; (2) a second phase in which a different frame becomes predominant and serves as a developmental bridge; and (3) a final phase in which a new frame emerges as predominant.

$$(P_1) \quad (\text{Historical} \leftrightarrow \text{Bridging}) \Rightarrow (\text{Bridging} \leftrightarrow \text{Emerging})$$

This was confirmed in part using the quantitative analysis in Chapter 7 which demonstrated that the social/object mixed frame had an inverted U-shaped trajectory, peaking in the middle sessions. Qualitative analysis can be used to further examine the relational-historical model suggested by sequence (P_1). For example, in what ways do the frames that fit the quantitative requirements for serving a bridging function differ in their patterns of co-action from the predominant historical and emerging

frames? Our theoretical model of bridging frames (refer to Chapter 3) suggests that they should contain actions that are common both to the historical frames and the emerging frames. We predicted this because we expected that realtime transitions between frames that shared actions in common (i.e., between historical and bridging or between bridging and emerging) would be relatively easier for a dyad than realtime transitions between frames that were relatively more different from each other (historical and emerging).

Methodological approach and narrative conventions

For each dyad, observers wrote detailed descriptions of infant and mother actions during each instance of a frame and a realtime transition. These are called sequence narratives (refer to Chapter 6). Next, based on the sequence narratives, observers wrote a description of the highlights of each weekly observation session, summarizing the main features of frames, realtime transitions, and infant and mother actions. These documents are called summary narratives. In the final step, the one presented in detail in this chapter, observers read the summary narratives across all the sessions and wrote historical narratives (refer to Chapter 6). The historical narratives that are written here were designed to accomplish two goals. The first was to reduce the complexity of the data by describing similarities and differences between sessions. The second was to describe the process of historical emergence of new frames out of historical and bridging frames.

For the first goal, observers read the summary narratives and noticed patterns of similarity between adjacent sessions. Sessions were judged to be similar if they showed comparable frame and realtime transition dynamics. In this way, we discovered that the twelve observation sessions of each dyad formed themselves into three or four developmental periods. Since each dyad was analyzed separately, there was no attempt to make the developmental periods uniform across dyads. For each dyad, there are a different number of sessions within each developmental period. Different realtime processes occur during each period across the four dyads.

The judgment of similarity in frame and transition dynamics between sessions was made using the constant comparative method, described in Chapter 4. In order to search for innovations in the sequence narratives, observers were trained to detect similarities and differences in the dynamics between instances of frames and transitions. Detecting similarities and differences between sessions is not conceptually or methodologically

different to comparing instances. The comparison between instances and sessions requires observers who are well acquainted with the data, as explained in Chapters 4 and 6. One measure of the reliability of the demarcation of developmental periods is that the observer for the transitions and the observer for the frames agreed after independent observations of the videotape. These developmental periods are not meant to be taken as discrete stages of development nor as indicating that there are four (as opposed to three or five) developmental periods during the social-to-object transition. They were used primarily for simplifying the data and for convenience of description.

In order to further simplify the description, the following conventions are used in the narratives. For each chapter, the developmental periods are described in sequence, followed by a developmental summary for the dyad. Within the description of each developmental period, first frames are described and then realtime transitions. The word transition in these chapters always refers to realtime transitions. Frames are described in the following order: the social frame, the guided object frame, the not-guided object frame and the social/object mixed frame. When used as examples, instances of sequence narratives are set off in indented paragraphs. Sequence narratives describe level 1 change (ordinary variability within frames and transitions). Level 2 changes (innovations in frame and transition dynamics) are described in the body of the historical narratives. Level 3 changes (developmental dynamics) are described in the summaries at the end of each developmental period and also in the developmental summary at the end of the chapter.

Developmental trajectories and transition frequencies

As shown in Figure 7.1 (raw data developmental trajectories) and Table 8.1, the historically predominant frame for this dyad was the guided object frame, which was predominant until session 5. The newly emerging frame was the not-guided object frame, which became predominant relative to other frames in session 7, just after Richard acquired visually guided reaching. The bridging frame for this dyad appeared to be the social/object mixed frame and the social frame combined. Both of these frames are more predominant in the middle sessions, illustrating an inverted U-shaped trajectory. For Richard and his mother, then, most sessions were dominated by object oriented play. Both the social frame and the social/object mixed frame remained relatively low in duration.

Table 8.1. *Descriptive statistics of frames by session: Richard*

Session	1	2	3	4	5	6	7	8	9	10	11	12
Age (Weeks)	16	17	18	19	20	21	22	23	24	25	26	28
Social frame												
Frequency	0	8	6	4	1	1	1	5	3	0	0	1
% of session	0.00	14.32	8.75	28.10	28.24	1.05	0.45	39.86	20.63	0.00	0.00	0.42
Mean duration*	–	8.59	7.00	33.72	135.56	5.04	2.18	38.26	33.01	–	–	1.63
(s.d.)	(–)	6.23	10.66	27.41	(–)	(–)	(–)	46.98	26.48	(–)	(–)	(–)
Guided object frame												
Frequency	7	10	3	9	7	4	12	4	7	15	8	14
% of session	73.31	57.56	29.57	58.84	40.43	21.68	39.67	4.24	25.79	47.01	17.41	41.57
Mean duration*	50.26	27.63	47.31	31.38	27.72	26.01	15.87	5.09	17.68	15.04	10.45	14.25
(s.d.)	(47.03)	(23.44)	(44.95)	(22.27)	(20.43)	(32.88)	(17.20)	(2.95)	(11.07)	(15.07)	(8.55)	(19.54)
Not-guided object frame												
Frequency	8	7	9	5	8	12	15	6	14	11	11	16
% of session	5.84	4.38	19.32	4.71	11.01	50.41	44.56	10.42	42.78	44.96	77.76	44.55
Mean duration*	3.50	3.01	10.30	4.53	6.61	20.17	14.26	8.33	14.67	19.62	33.93	13.36
(s.d.)	(1.92)	(1.69)	(7.52)	(3.49)	(5.21)	(27.47)	(10.64)	(3.74)	(13.31)	(15.66)	(35.76)	(10.09)
Social/object mixed frame												
Frequency	11	3	14	7	10	13	8	9	8	6	4	7
% of session	20.87	23.74	42.36	8.34	20.32	26.86	15.31	45.48	10.81	8.0354	4.83	13.55
Mean duration*	9.11	37.99	14.52	5.72	9.75	9.92	9.19	24.26	6.48	6.43	5.79	9.29
(s.d.)	(8.37)	(56.36)	(18.33)	(2.59)	(7.65)	(13.50)	(7.15)	(17.61)	(4.62)	(7.57)	(2.26)	(3.86)

Note: * seconds

Table 8.2. *Frequency of frame transitions: Richard and his mother*

Frame Transition	Session											
	1	2	3	4	5	6	7	8	9	10	11	12
1->2		6	1	2			1					
2->1		4							1			
1->4			2									
4->1			3			1						
1->3					1	1			2			
3->1		1					1					
2->3	6	3	5	3		4	8	3	5	9	7	8
3->2	5	2	3	3	4	2	7	3	8	8	5	10
2->4	3			3	4	2	2	1		2		1
4->2	5		1	3	2	2		1		1		
3->4	1		4			2	1	2	4		1	4
4->3		1	4		1	1	2	2	5	1	1	4

Note: 1 = Social frame;
2 = Guided object frame;
3 = Not-guided object frame;
4 = Social/object mixed frame

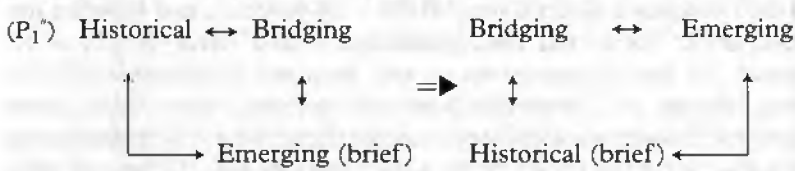
Table 8.2 shows that prior to and including session 6, most of the transitions occurred to and from the historical guided object frame (78 out 99 transitions in the first six sessions, 79 percent). For these first six sessions, the transitions were primarily between the guided object frame and the not-guided object frame (41/78 = 53 percent), and between the guided object frame and the social/object mixed frame (25/78 = 32 percent). Of the 44 transitions to and from the guided-object frame during sessions 1–3, 55 percent were with the not-guided object frame and 20 percent with the social/object mixed frame. Of the 34 transitions to and from the guided-object frame during sessions 4–6, 47 percent were with the not-guided object frame and 47 percent with the social/object mixed frame, suggesting an increasing frequency of transitions with the social/object mixed frame during these sessions. Of the 121 transitions during the final six sessions, 111 (89 percent) were with the not-guided object frames. Of these 81/111 (73 percent) were with the guided object frame and 27/111 (24 percent) were with the social/object mixed frame.

According to the model shown in sequence (P_1), there should be a relatively high frequency of transitions between the historical frame and a bridging frame during the early sessions and a high frequency of transitions between the emerging frame and the same bridging frame in the later sessions. The social/object mixed frame definitely fit this bridging

pattern: 32 percent of the transitions with the historical guided object frame in the first six sessions were with the social/object mixed frame and 24 percent of the transitions with the newly emerging not-guided object frame in the final six sessions were with the social/object mixed frame.

On the other hand, most of the transitions occurred directly between the historical guided object frame and the emerging not-guided object frame both in the early and later sessions. According to the model of sequence (P_1), there should be relatively few direct transitions between historical and emerging frames. The question is: how do these data change the model? During the first six sessions, not-guided object frames were of relatively low duration compared to their duration during the final six sessions. This may suggest that relatively brief instances of the not-guided object frame in the early sessions are qualitatively different from the longer instances of this frame in the later sessions. It could be that these brief instances serve a bridging function along with the social/object mixed frame. We will have to await the qualitative analysis below to discover what occurred during these brief frames.

On the other hand, the large number of transitions between the guided-object frame and the not-guided object frame in the final six sessions appears less likely to fit the model in sequence (P_1). The alternative model proposed in Chapter 5, sequence (P_1'), in which there are direct transitions between historical and emerging frames, also does not fit because these direct transitions follow a period in which there are transitions, and continue to be transitions, to the social/object mixed bridging frame. Thus, we propose an alternative hybrid model:



In this model, bridging frames (social/object mixed) and brief instances of emerging frames (not-guided object) occur simultaneously during the early sessions. This simultaneous occurrence is important because in this dyad we do not observe sequence (P_1'), that is, we do not observe direct transitions from historical to emerging frames in the absence of bridging frames in the repertoire. Also, the emerging frame (not-guided object), when it first appears alongside the bridging frame (social/object mixed), is relatively brief and perhaps qualitatively different than what appears later. The model also indicates that in the early period there are realtime transitions between the historical, bridging, and the brief emerging frame. In the later sessions, the historical frame (guided object) becomes

briefer as the emerging frame becomes longer. The bridging frame still serves an important function as it mediates the transitions between emerging and brief historical frames. It appears, therefore, that brief versions of the emerging and historical frames may play a role in the developmental bridging process.

Qualitative analysis

Ordinary variability of sessions 1 and 2

During sessions 1 and 2, Richard is 16 and 17 weeks old respectively. The dyad spends the most time in the guided-object frame, followed by the not-guided object frame and the social/object mixed frame. There is only one instance of the social frame in which Richard and his mother engage in face-to-face play. In this occasion, Richard is gazing at his mother's face, softly vocalizing, while the mother attempts to show objects to Richard. Richard, however, keeps watching his mother's face until she verbally acknowledges that he would rather look at her than the objects. Soon after, the mother smiles at Richard and he smiles back at her. She then tickles Richard's chin, and as he gazes at her face, he starts vocalizing loudly while the mother repeats back the sounds Richard produces.

During the guided object frame (the predominant frame of these sessions), the mother shows objects at a fast pace, changes objects often, and spends little time demonstrating and highlighting the properties of the object. Meanwhile, Richard watches objects intently. The mother also helps support Richard to hold an object in his hand, never steadying objects above Richard for him to reach. During these first two sessions, however, Richard holds objects only briefly while the mother talks to him about his activity of holding the object. Because Richard holds the object for only a brief period of time, the not-guided object frame is brief. The social/object mixed frame mostly occurs when the mother attempts to re-gain Richard's attention back to her by touching Richard's body while he holds an object. This frame is also brief, as it is often related to Richard's holding of the object.

A close analysis of the frame transitions during these first two sessions indicates that the transitions involve all frames, with an emphasis on the guided object frame, the not-guided object frame, and the social/object mixed frame. The infant's gaze is the primary action observed in the transitions. The transitions generally take place when Richard is looking in the same direction, holding an object, and his mother starts changing her actions such as stopping her talking to the infant or starting to touch

her infant's stomach. It is also noticeable (especially during the transitions involving the social/object mixed frame) that the mother attempts to attract Richard's attention to her by changing her actions. She uses auditory stimulation in different ways (e.g., shaking a toy, squeezing a toy, vocalizing, or talking to her infant). At times, this auditory stimulation is combined with visual and tactile stimulations. For instance, during the transition from the not-guided object frame to the social/object mixed frame the following is observed:

Richard holds a toy and looks at his mother while the mother talks to Richard about the toy held by him (not-guided object frame). *Richard and his mother keep looking at each other and the mother keeps talking to Richard about the toy.* The mother moves her body next to Richard's body, and touches his stomach with her right hand (social/object mixed frame).

This example illustrates a usual way in which this dyad makes transitions between the not-guided object frame and the social/object mixed frame. The mother appears to do most of the "work" during the transitions, while Richard watches the mother intently. Note that maternal vocalization and the sounds provoked by the object are salient elements used by the mother in the transition.

Innovations in sessions 1 and 2

A few innovations are observed in the frames and frame transitions where Richard presents himself as a more active participant in the dyadic communication. These behavioral changes described below constitute innovations in level 1 ordinary variability because, although not previously observed and markedly recognizable, they do not change the predominant ordinary variability of Richard's relative inactivity during the frames and frame transitions.

During the guided-object frame, for example, there are some occasions when Richard watches the objects presented by his mother while smiling, cooing, and moving his arms and legs toward the objects. There are some social/object mixed frames where the mother kisses and touches Richard's cheek and tummy with the red porcupine, instead of the usual talking and touching Richard while he holds an object.

In the second session, we can start to observe more activity in a few transitions where Richard vocalizes, moves his legs, or shakes the toy he holds. During the transition from the guided object frame to the not-guided object frame, for instance:

Richard is moving his arms and legs, looking at his mother, while she adjusts a toy in his left hand and talks to him. As Richard looks away, the mother stops

talking to him but keeps adjusting the toy in his left hand (guided object frame). *Richard vocalizes, grasping the toy.* The mother then releases Richard's left hand, saying "Yeeah!" and talking about the toy now held by Richard (not-guided object frame).

Richard's emerging ability as a more active participant in the dyadic communication can also be seen in another transition from the social/object mixed frame to the not-guided object frame.

Richard is holding a toy while the mother is playing with Richard's legs, talking and smiling (social/object mixed frame). *The mother then stops talking, smiling and playing with Richard's legs, while Richard keeps looking at his mother and begins to shake the toy he is holding.* The mother begins to talk about the toy (not-guided object frame).

These are two examples of transitions to the not-guided object frame in which Richard is slightly more active than usual. These occasional increases in Richard's participation in the transitions are innovations in the ordinary variability of the frame transitions and appear to constitute an historical prelude of the dynamics that will emerge in the next sessions.

Brief developmental account of sessions 1 and 2

During these first two sessions, the historical frame appears to be the guided object frame. During this frame, the mother shows objects one after the other without taking the time to demonstrate their affordances while Richard primarily observes them. The not-guided object frame and the social/object mixed frame are emerging frames as suggested by their durations. Specifically, the not-guided object frame seems to constitute a "natural" consequence of the guided object frame given that the mother often shows the objects in a fast pace, sometimes immediately placing them in Richard's hands. The social/object mixed frame has the flavor of being a break from the other two object oriented frames, including the historical frame. It appears to constitute the main opportunity for this dyad to engage in social play. In the second session, however, innovations are observed in the dyad's level of activity in the frames and transitions. This change in their relationship appears to occur in the ground of the existing frames dynamics and set the stage for the changes in the next sessions.

Ordinary variability in sessions 3, 4, 5, and 6

In the next four sessions, Richard is 18, 19, 20, and 21 weeks old, respectively. The predominant frames observed are the guided object

frame and the not-guided object frame. There is also a noticeable increase in the social/object mixed frame, perhaps, in part due to the increasing appearance of the not-guided object frame. One pattern developed during these four sessions is a social frame warm-up period at the beginning of each play session. Richard starts the face-to-face play by staring at the mother, smiling, and vocalizing loudly; sometimes squealing and laughing. The mother is delighted with her happy infant and appreciates his efforts to communicate with her by vocalizing back, smiling, laughing, and touching his body.

During the guided object frame, Richard continues to engage in watching objects demonstrated by his mother. This time, however, Richard also vocalizes and moves his arms and legs with delight. Even though Richard gets excited with each new object encounter, the mother continues to not allow a lot of time for him to observe or participate with the object before moving on to the next object. This change in the dynamics of the guided object frame in which Richard is more active with his body appears to be originated in the innovations observed during the previous sessions within the guided object frame and within the frame transitions involving the object frames where Richard presents himself as a more active participant of the interaction.

As a result of this new active ordinary variability resulting from innovations in Richard's activity towards objects during the previous developmental period, the mother innovates in reply. She amplifies upon Richard's activity by using a sequence of three-action object patterns (i.e., shake-rotate; shake-demonstrate; show-highlight property) in her demonstrations before she choose the next object to show. She appears to have developed different routines for each of the objects and she uses those same routines each week.

With Richard's increasing bodily participation in these four sessions, there is also an increase in the not-guided object frames since Richard now holds and manipulates objects for longer periods of time. He fingers, shakes, squeezes, actively mouths and even holds two objects at once. Similar to the previous sessions, however, when Richard actively manipulates objects, the mother supports his actions by either quietly observing his play or with object talk. For instance, when Richard's hand reaches out and touches a toy, the mother verbally encourages him by praising him with laughter, smiling, and leaning closer to him.

The social/object mixed frame occurs a little more frequently in these four sessions as Richard becomes more active in object play. The social/object mixed frame is now observed in two forms: (a) the mother touching Richard with an object as a game (as observed in the innovations within the social/object mixed frame during the previous sessions);

and (b) the mother tickling Richard with her hand to stimulate him and emphasize her words while he holds an object (as observed in the ordinary variability of this frame during the previous sessions). Thus, during these sessions, the social/object mixed frame emerges in a more active form such as when the mother uses objects to kiss Richard's cheek and belly or when the mother plays peek-a-boo with his feet, moving his legs like a bicycle while Richard holds an object. It is worth noting that the mother often uses the touching/more bodily active routines after long periods of object talk (i.e., not-guided object frame).

Compared to the previous sessions, a gradual preference for transitions involving the object-oriented frames emerges. This is especially the case for transitions between the guided object frame and the not-guided object frame as the dyad gradually becomes more focused on these two frames. Similar to the changes observed in the frames, Richard also contributes more actively to the transitions by performing manual actions on the object such as grasping the object and shaking it and by performing social actions such as smiles and vocalizations while maintaining eye contact with his mother. This change in the ordinary variability of the frame transitions can be traced back to the innovations observed during the previous sessions within the frames and frame transitions where Richard is more active with this body.

In most (if not all) of the transitions between the object-oriented frames, Richard actively moves his arms toward the object held by his mother, grasps the object, shakes the object, and vocalizes. In the transitions from the guided object frame to the not-guided object frame, for example, the following pattern predominates: as Richard quickly grasps an object held by his mother (guided object frame), his mother releases the object and starts talking about the object Richard now holds (not-guided object frame). In the transitions from the not-guided object frame to the social/object mixed frame, a pattern of increasing engagement of Richard's activity is also observed, as illustrated in the example below:

> Richard and his mother are looking at each other while the mother talks about the toy Richard is holding (not-guided object frame). *As Richard shakes the toy, the mother immediately stops talking about the toy, observing Richard quietly. As Richard begins to vocalize and smile to his mother, while holding the object,* the mother smiles back at him, touching him and talking about his "happiness" with the toy (social/object mixed frame).

In this and other similar transitions, the mutual smiling that leads up to the social/object mixed frame appears to be about Richard's relationship to the object rather than to the mother. This kind of mutual smiling

about the object often leads to transitions back to the not-guided object frame as Richard stops smiling and his mother stops talking about Richard's emotions, stops touching Richard's body, and begins talking about Richard's actions on the object. Although Richard does not understand the content of his mother's speech, the intonation patterns of social/emotional talk observed in the social/object mixed frame are clearly different from the object talk present in the not-guided object frame. These transition patterns suggest that the social/object mixed frame serves as a break between the two object-oriented frames, much as it did during the previous sessions but more frequently now.

Innovations in sessions 3, 4, 5, and 6

Innovations are also observed in these four sessions within both the frames and frame transitions. Specifically, during the social warm-up frame, there are a few occasions when Richard observes his animated mother while sucking on his hand and maintaining eye contact with her without smiling or vocalizing. Likewise, during the guided object frame, there are a few occasions when Richard sucks on his hand while observing his mother demonstrate objects. It is important to highlight that object mouthing emerges in the next sessions as one of the activities Richard engages in during the not-guided object frame.

There are also a few moments of the not-guided object frame in these four sessions where his mother passively rests her hand on Richard's leg while he holds an object. During the frame transitions (especially those involving the not-guided object frame), there are a few times when his mother is a more passive and quieter participant. Of particular note, his mother's more passive observation of Richard's activity on the object also becomes more noticeable in the sessions to follow with Richard doing more object exploration, including object mouthing.

Brief developmental account of sessions 3, 4, 5, and 6

During these four sessions, there is a gradual elaboration of the not-guided object frame as Richard becomes more active in both manipulating objects and in initiating transitions into the not-guided object frame. Correspondingly, during the not-guided object frame his mother becomes somewhat less active. This is particularly noticeable during the innovations involving the not-guided object frames. During the guided object frames Richard's mother demonstrates object affordances, followed by the placement of objects into his hands. Finally, changes in the format of the social/object mixed frame are observed to include

more animated use of objects. This frame, however, appears to maintain its function of a real-time break from both the not-guided object frame and guided object frame.

Ordinary variability of sessions 7, 8, and 9

In the next three sessions, Richard is 22, 23, and 24 weeks old, respectively. The not-guided object frame and the guided-object frame continue to be the primary frames observed. Very little social/object mixed frame, and almost no social frames occur in these sessions. Richard is now independently reaching for objects and turning over onto his tummy by himself. The consistent emergence of these two behaviors appears to change this dyad's patterns of communication.

Unlike the previous sessions where there was a social warm-up routine, most of the social frames are now spent repositioning Richard's body. There is only one social warm-up period where the mother blows raspberries and tickles Richard's tummy, but he only responds with gaze (no facial expression or movement of body) and the mother soon gives up and shows him the toys. This change in the social frame can be traced back to the innovations observed within this frame during the previous four sessions where Richard simply observes his animated mother, mouthing his hand, without smiling or vocalizing. Therefore, the social frame rarely occurs, perhaps because there is small mutual amplification of these kinds of social interactions coupled with an increase in Richard's focus towards objects.

During the guided object frames, the mother places objects within Richard's reach and provides plenty of objects for him to choose while he is manipulating another. Her goal seems to have him explore all objects. Richard is less vocal and his actions are extremely object-focused. This change in the tone of the guided object frame where Richard appears more intensely focused on objects can also be traced back to the innovations observed within the guided object frame during the previous sessions when Richard is more of an observer of his mother's object demonstrations while quietly mouthing his hand.

During the not-guided object frame, Richard's actions on objects continue to be elaborated. Richard squeezes, shakes, mouths, and manipulates objects, while the mother continues to use her words to encourage, suggest, and praise Richard's actions on objects. The mother's talk occurs most of the time within this frame and her talk is focused on object-oriented topics such as Richard's ongoing interaction with objects. Thus, the ordinary variability of this frame observed in the previous four sessions appears to continue to be elaborated during sessions 7, 8, and 9.

In the now less frequent social/object mixed frame, the mother continues in her attempts to re-capture Richard's interest to herself by touching him while he manipulates the object. Richard, however, does not respond to his mother's touch and remains focused on the object. This change in the emotional tone of the social/object mixed frame also appears to have emerged from the innovations observed within the social and the guided object frames during the previous four sessions when Richard observes his mother without smiling or vocalizing.

A close analysis of the frame transitions indicates an increase in the amount of transitions between the guided object frame and the not-guided object frame, and these are made at a much faster pace. Similar to the previous sessions, a few transitions including the social frame are observed, with some of these also made in faster durations. Richard's focused manipulation of the object becomes central in the frame transitions. For instance, during one transition from the guided object frame to the not-guided object frame:

> The mother presents a toy in front of Richard's eyes, talking, while Richard holds another toy, shifting his gaze between the toy held by him and the toy held by his mother (guided object frame). *The mother keeps presenting the toy in front of Richard's eyes, and stops talking to Richard. A long silence invades the scene. Meanwhile, Richard keeps manipulating the toy he is holding.* The mother then places the toy she is holding on the floor, and starts talking to Richard about the toy he is holding (not-guided object frame).

As illustrated in the example above, Richard's level of activity in the transitions is slightly different. Namely, he not only adds and/or stops some actions during the transition (thereby actively contributing to the frame transition), but he also keeps examining the object he holds (thereby changing the dynamics of his communication with his mother). At the same time, the mother continues to be active in the transitions, but also in a slightly different way. She now appears to be rapidly changing her actions as a way of coordinating her actions to the changes in Richard's actions. Finally, although maternal vocalization is still present during the transitions, maternal silence (i.e., stop of talking) becomes more pronounced in these three sessions. The transition from the guided object frame to the not-guided object frame described next illustrates this change in the mother's presence during her communication with Richard:

> The mother presents a toy within Richard's reach, talking to him, while Richard looks at the toy held by the mother with his right hand open and directed towards the toy (guided object frame). *When Richard touches the toy with his right hand, the mother stops talking to him, and starts adjusting the toy into Richard's*

hand, quietly. Richard quickly grasps the toy, and the mother immediately releases the toy, talking to Richard about the toy he is now holding (not-guided object frame).

This example not only illustrates the predominant type of transition between the guided object frame and the not-guided object frame, but it also portrays the emergence of a new transitional maternal action – maternal silence. Of particular note, this change in the mother's participation in the transitions can be traced back to the innovations observed within the frame transitions during the previous four sessions where the mother is a more passive and quieter participant.

Innovations in sessions 7, 8, and 9

Innovations are again observed during both the frames and frame transitions. It is in these three sessions where Richard becomes more object focused that there are occasional moments of the guided object frame where the mother begins to squeeze additional objects off to the side of Richard to get him to turn towards her. Although maternal attempts to re-gain Richard's attention back to her are not new, such a strategy has not been previously observed in the context of the guided object frame. There are also a few occasions during the not-guided object frame when Richard is more persistently immersed in object play. During these times, the mother simply watches her infant, quietly. Finally, during a few transitions, Richard is persistently focused on object mouthing. When taken together, these innovations appear to constitute a historical prelude to the object immersion observed in the following sessions.

Brief developmental account of sessions 7, 8, and 9

During these three sessions, there is a further elaboration of the not-guided object frame as Richard becomes more focused on the examination of objects, more persistent in his explorations, and his reduced rate of smiling and social engagement suggests a more serious demeanor. The mother begins to take more of a support role even in the guided object frame, in which she mostly assists Richard in reaching for objects of his own choice. The social/object mixed frame no longer serves as a break from Richard's work in the other frames. Instead, it is the mother who returns to this frame as a way of reconnecting socially with Richard. Because of Richard's serious persistence with object play, however, this frame decreases in duration. At times, Richard's examination of objects becomes immersion with almost no looking towards

the mother. The mother, in turn, begins to vocalize less during these sessions, as reflected in the increasing appearance of maternal silence during the transitions.

Ordinary variability of sessions 10, 11, and 12

Finally, during the last three sessions of the observational period (i.e., sessions 10, 11, and 12), Richard is 25, 26, and 28 weeks old, respectively. The guided object frame and the not-guided object frame are the two primary frames used by the dyad. For the first time, there are no social frames and very few social/object mixed frames are observed. Richard and his mother are more serious than before and Richard maintains a neutral face most of the time. He never vocalizes, smiles, or laughs in any frame.

In the guided object frame, the mother briefly demonstrates the objects as she places them on Richard's tummy or in front of him when he is sitting, while Richard gazes almost exclusively at objects (especially when he is on his tummy with his mother behind him). This rapid demonstration of objects within the guided object frame appears to constitute an elaboration of the dynamics of frame transitions observed in the previous three sessions where transitions from the guided object frame are made in a rapid fashion.

During the not-guided object frame, Richard is predominantly immersed in object exploration and active mouthing, and the mother seems to respect Richard's immersion by speaking less and even whispering at times. It is as if she does not want to disturb the immersed infant during object play. When the mother speaks (not very often though), her words are used to praise Richard when he performs a new action with an object. She also comments on his excessive mouthing and tells him how much fun he is having with the objects. It is important to highlight that the innovations observed within frames and frame transitions during the previous sessions include Richard's more persistent focus on object mouthing.

Finally, touch remains the primary action during the few social/object mixed frames. For example, the mother gently pats Richard's back or kisses and tickles Richard with the caterpillar while he is on his back, persistently mouthing an object. That is, the mother continues to use touch as a primary way to maintain a connection with her infant who is now mostly facing away from her, mouthing objects. Therefore, this frame dynamics appears to constitute an elaboration of the ordinary variability of the social/object mixed frame previously observed.

The transitions in these last three sessions primarily involve the guided object frame and the not-guided object frame, with very few including the social/object mixed frame. No transitions involving the social frame are observed. The transitions continue to be made in fast durations. Furthermore, Richard's persistent immersion in object mouthing appears to be tightly related to the mother's rapid changes in her behavior, including her brief attempts to re-gain his interest to a more mutually interactive form of object play. For example, in one transition from the guided object frame to the not-guided object frame:

> Richard is mouthing a toy and mother presents another toy within Richard's sight, talking (guided object frame). *Richard, however, keeps mouthing the toy he is holding, and the mother stops presenting the toy, stops talking, and holds the second toy steadily within Richard's reach. Richard keeps mouthing the toy he is holding.* The mother finally releases the toy she is holding, and starts observing Richard quietly (not-guided object frame).

Note in this example how Richard's persistent object immersion appears to be related to maternal silence during the transitions (i.e., the mother stops talking). Although the mother seems to respect her infant's object immersion, she also seems to present quiet efforts to captivate Richard's attention back to her.

Similar to Susan and her mother, innovations were not observed in these last three sessions for Richard and his mother. Perhaps, an historical analysis of the future patterns would allow us to identify potential seeds of the dyad's future communication dynamics in the context of the frame and/or frame transitions.

Brief developmental account of sessions 10, 11, and 12

The not-guided object frame changes once again. The infant becomes completely immersed in the objects to the point of rarely looking at or engaging the mother. At the same time, the mother creates the conditions in which Richard can indulge his interest in objects, at times vocalizing about Richard's mastery of object skills. The guided object frame is brief in duration with the mother rapidly demonstrating additional objects to Richard, while he almost exclusively gazes at them without much of a facial and/or body engagement. During the few moments of the social/object mixed frame, the mother invites Richard to disengage with the object and re-engage with her. These attempts, however, are largely unsuccessful. No moments of social frame are observed in these last three sessions.

Overall summary of Richard and his mother

An historical analysis of this dyad's relationship across the twelve sessions suggests that, during the first sessions, the historical frame is the guided object frame. At this point, the mother shows objects one after another without taking the time to demonstrate their affordances, while Richard primarily observes them. The not-guided object frame and the social/object mixed frame are emerging frames as suggested by their durations. The social/object mixed frame has the flavor of being a break from the other two object oriented frames, and it appears to constitute the main opportunity for this dyad to engage in social play. Therefore, the not-guided object frame is present from the beginning of the observation period, and, in theory, it does not constitute a newly emergent frame in this dyad. At the same time, however, a closer examination of the changes within this frame indicates that the not-guided object frame changes steadily across the twelve sessions in close relation to the changes in the guided object and in the social/object mixed frames. Specifically, the not-guided object frame first appears sporadically as opportunities for Richard to explore his emerging motor abilities (i.e., simple grasping) and gradually becomes the foreground of this dyad's relationship where Richard is persistently immersed in object mouthing.

The social/object mixed frame plays a developmental bridging role in this dyad as it consistently serves as a locus for transitions to and from other frames. Specifically, during the first six sessions, transitions are made to and from the social/object mixed frame from the guided or not-guided object frames when the dyad needs a break from the intensity of object play. They exchange smiles and social vocalizations. The increase in the duration of the social/object mixed frame in sessions 3, 4, 5, and 6 coincides with the gradual increase in the speed of direct transitions between the two object related frames. It appears that the positive emotional communication about objects taking place in the context of the social/object mixed frame observed in the first six sessions creates a ground for the dyad to develop more facility with object communication, leading to the increased seriousness of Richard's examination and immersion with objects. In fact, during the last six sessions, when Richard becomes more object focused, the social/object mixed frame is used less by the dyad and primarily at the initiative of the mother.

For Richard and his mother, we find four ways in which frames are related to transitions. First of all, there is a similarity in the mother and infant actions in frames and transitions within sessions. During the first

three sessions, for example, the guided object frame is mainly characterized by mother's continuous attempt to capture and maintain Richard's visual attention to different objects while Richard looks intently to the objects held by the mother. Comparably, the transitions involving the guided object frame in these first three sessions are mainly characterized by Richard's looking in the same direction over and over, holding an object, while his mother changes her actions in an effort to shift the infant's visual attention. This similarity between frames and transitions is the case for all twelve sessions, and it suggests that the same patterns of action that constitute frames also constitute transitions.

Second, we observe differences between the frames and transitions during the same sessions. The consistent pattern observed in the first three sessions, for example, involves Richard being an observer of his mother's demonstrations of the objects during both the frames and frame transitions. We note, however, a few transitions between the guided object frame and the not-guided object frame in which Richard becomes more of an active play partner and his mother becomes more of a facilitator. It turns out that this particular difference is a prelude to the predominant patterns of action during the frames and frame transitions of the following sessions. These findings suggest that, at the developmental time scale, innovations in realtime transitions (i.e., level 2 change) during earlier sessions may serve as the historical innovation that leads the dyad into communication changes observed in the following sessions. In this case, then, the relationship is between transitions in the prior sessions and the frames and transitions in the later sessions.

A third way in which frames appear to be related to transitions is the connection between the speed of the transitions and the changes in durations of frames. In sessions 3, 4, 5, and 6, prior to the predominance of the not-guided object frame, the transitions between the guided and the not-guided object frames begin to become faster and continue to be made in a rapid fashion throughout the remainder of the observation period. Thus, facility in making realtime transitions preceded, developmentally, the consolidation of the not-guided object frame.

A final observation unique to this dyad regarding the relationship between frames and transitions is that it became weaker during the last three sessions. Specifically, during the earlier sessions, realtime transitions tend to be mutually ratified. If either partner initiates a transition, the other goes along and the frame changes accordingly. During the last three sessions, however, we observe that the mother makes repeated attempts to engage Richard in the social/object mixed frame. By then, Richard has become so immersed and serious about objects that he does

not ratify his mother's bid and the dyad quickly returns to the not-guided object frame. This suggests that the dyad's facility with jointly managed transitions during the first nine sessions is directly connected with the dyad's developmental changes (i.e., level 3 change). By the last three sessions, the dyad had settled into a highly stable pattern of communication that appears resistant to change in realtime and possibly resistant to change in developmental time. Even though we did not observe the dyad after session twelve, we could not find any innovations in frames or transitions. In dynamic system's language, one could say that the dyad entered a rather deep attractor that permitted little variability and few innovations. Further observations on this dyad might have revealed how long this stable period lasted and the ways in which innovations eventually succeeded in moving them to new levels of object communication.

Taken together, both the quantitative and qualitative results suggest that proposition 1 (Chapter 5) has been supported. Proposition 1 proposes developmental sequence (P_1) in which bridging frames intercede both in realtime and developmental time between historical and emerging frames. With the modification proposed as sequence (P_1''), in which brief instances of the emerging frame appear alongside the bridging frame in the early sessions and brief instances of the historical frame link with the bridging frame in the later sessions, proposition 1 is strongly supported.

Proposition 2 proposes that innovations arise from ordinary variability and later lead to developmental change, as suggested by sequence (P_2), Chapter 5. We did not find any occurrence of level 3 developmental change, characterized by the re-organization of all the frames and a rapid increase in the emerging frame. Rather, change over sessions appeared to be more gradual, a series of accretions of innovations and small changes resulting from the innovations.

With regard to innovations, the data from this dyad suggest that the change model is more complex than sequence (P_2).

$$(P_2'')(\text{level } 1^{\alpha} + \text{level } 2^{\alpha})_{\text{period } \alpha} \rightarrow (\text{level } 1^{\beta}(+\text{level } 1^{\alpha} + \text{level } 2^{\alpha} + \text{level } 2^{\alpha'}) + \text{level } 2^{\beta})_{\text{period } \beta}$$

In this model, level 1^{α} is ordinary variability in the first observed developmental period, designated the α period. Level 2^{α} are the innovations occurring during period α which do not change the ordinary variability in this period. Level 1^{β} is ordinary variability during a second developmental period, β, and level 2^{β} are innovations during the β period which do not change ordinary variability during that period. This part of the

model, that is,

$$(\text{level } 1^{\alpha} + \text{level } 2^{\alpha})_{\text{period } \alpha} \rightarrow (\text{level } 1^{\beta} + \text{level } 2^{\beta})_{\text{period } \beta},$$

shows that innovations in period α lead to a new ordinary variability in period β, such that there may be a series of recognizably different developmental periods (α, β, γ, . . .), each with a new ordinary variability and new innovations.

The right hand section of (P_2''), that is,

$$(\text{level } 1^{\beta}(+\text{level } 1^{\alpha} + \text{level } 2^{\alpha} + \text{level } 2^{\alpha'}) + \text{level } 2^{\beta})_{\text{period } \beta},$$

represents the possibility for additional complexity in any particular developmental period. The term (+ level $2^{\alpha'}$) reflects the possibility that additional innovations may be introduced during this β developmental period that are responses to or amplifications of innovations introduced during the previous period, α. In the case of this dyad, the mother introduced innovations in her behavior that appeared to be direct responses to the infant's innovations in the previous developmental period. Note that these maternal innovations did not appear in the previous period. Instead, they emerged once the previous period's innovations, level 2^{α}, had become established into a new period of ordinary variability, level 1^{β}.

It is important to note that we did not observe any ordinary variability in the β periods (level 1^{β}) that did not derive from the α period. As expressed in the sequence above, whatever appeared in (level 1^{β}) was either:

- a replication of the ordinary variability in the α period (level 1^{α})
- a replication of the innovations in the α period (level 2^{α}), or
- an amplification of the innovations in the α period (level $2^{\alpha'}$).

This fits our prediction that changes in ordinary variability are preceded by innovations which do not change the ordinary variability at the time they first appear, but only later, when the system shifts to some new period of ordinary variability.

In summary, the qualitative data analysis adds historical details to the picture given by the quantitative data analysis. The developmental changes in the overall durations of time invested in particular frames in this dyad seem to be founded upon relatively small innovations established against the background of the patterns of action characteristic of the previous sessions.

9 Results of the current investigation: qualitative analysis of Betsy and her mother

In this chapter, we present a case analysis of the development of frames and frame transitions for another one of the four representative dyads, Betsy and her mother. Similar to the organization utilized in previous qualitative chapters, we present the raw data developmental trajectories for each of the four frames, the raw data transition frequencies between the frames as a function of age, and a qualitative analysis of the relational history. In the latter, we describe the change processes at two levels, ordinary variability (referred to as level 1 change in Chapter 3) and innovations (referred to as level 2 change in Chapter 3), followed by a brief developmental account of these changes that describes any evidence for a developmental re-organization (level 3 change).

Developmental trajectories and transition frequencies

This dyad had a pattern of frame duration trajectories that was very similar to that of Richard and his mother. As shown in Figure 7.2 and Table 9.1, the historically predominant frame for this dyad was the guided object frame, which persisted until session 5. The newly emerging frame was the not-guided object frame, which became predominant relative to other frames in session 8, soon after Betsy acquired visually guided reaching. The bridging frame for this dyad appeared to be the social/object mixed frame. There was a peak in the social/object mixed frame in sessions 6–9, illustrating the inverted U-shaped trajectory for this frame found in the multilevel analysis. The duration of the social-object mixed frame becomes slightly elevated again in sessions 11 and 12 but the inverted U-shape is the most prominent feature of this trajectory. The social frame, in this dyad, remains low during the entire observation period, neither increasing nor decreasing.

The correlations between frame durations for this dyad (see Table 7.2) give more insight into these developmental changes. There is no significant correlation of the social frame with any of the others, suggesting

Table 9.1. *Descriptive statistics of frames by session: Betsy*

Session	1	2	3	4	5	6	7	8	9	10	11	12
Age (Weeks)	8	9	10	11	12	13	17	19	22	23	24	25
Social frame												
Frequency	0	2	0	2	7	5	1	2	4	1	9	6
% of session	0.00	2.27	0.00	6.99	5.82	13.22	0.82	1.07	5.67	1.36	14.99	5.17
Mean duration*	–	5.44	–	16.77	3.99	12.69	3.93	2.57	6.80	6.52	7.99	4.13
(s.d.)	(–)	(2.36)	(–)	(12.81)	(2.79)	(20.52)	(–)	(2.60)	(8.06)	(–)	(9.80)	(4.24)
Object guided frame												
Frequency	7	16	14	16	15	17	7	10	10	8	5	8
% of session	90.57	78.15	77.88	75.22	68.00	43.19	18.18	29.05	28.68	21.98	5.70	6.28
Mean duration*	62.10	23.44	26.70	22.57	21.76	12.20	12.47	13.94	13.77	13.19	5.47	3.77
(s.d.)	(64.52)	(17.16)	(17.51)	(17.22)	(31.41)	(9.16)	(12.77)	(12.22)	(9.78)	(9.08)	(3.68)	(3.55)
Not-guided object frame												
Frequency	2	5	8	7	11	6	11	14	16	12	12	13
% of session	1.48	4.60	6.15	8.18	9.74	5.18	21.80	26.79	30.21	60.44	54.56	56.32
Mean duration*	3.54	4.41	3.69	5.61	4.25	4.15	9.51	9.18	9.06	24.18	21.82	20.80
(s.d.)	(2.08)	(2.97)	(1.50)	(5.96)	(2.16)	(0.73)	(8.32)	(6.36)	(6.91)	(22.97)	(14.43)	(20.25)
Social/object mixed frame												
Frequency	6	8	12	8	13	20	15	12	11	4	15	11
% of session	7.96	14.99	15.97	9.61	16.44	38.41	58.98	42.83	35.44	16.22	24.76	32.23
Mean duration*	6.37	8.99	6.39	5.77	6.07	9.22	18.87	17.13	15.47	19.47	7.92	14.06
(s.d.)	(3.00)	(7.97)	(3.36)	(3.38)	(3.26)	(12.42)	(23.08)	(30.38)	(23.31)	(22.49)	(7.20)	(21.44)

Note: * seconds

Table 9.2. *Frequency of frame transitions: Betsy and her mother*

	Session											
Frame transition	1	2	3	4	5	6	7	8	9	10	11	12
1–>2					1	1	1			1		1
2–>1												
1–>4					1							1
4–>1					1		1		1			1
1–>3												
3–>1					2			1		1		
2–>3		3	3		1	2	3	7	5	7	5	7
3–>2	2	3	2		1	3		5	5	7	6	6
2–>4	4	7	6	2	7	8	1	2	1			1
4–>2	3	8	5	1	4	3	3	2	2			2
3–>4						1	7	7	5	3	5	4
4–>3	2				2	3	5	6	5	2	3	2

Note: 1 = Social frame;
2 = Guided object frame;
3 = Not-guided object frame;
4 = Social/object mixed frame

that it may play a role that is relatively independent of the developmental changes in the other frames. The guided object frame was significantly negatively correlated with both the not-guided object and the social/object mixed frames. Figure 7.2 shows clearly that as the guided object frame decreased in duration (the typical pattern for the historical frame), the other two frames increased.

As shown in Table 9.2, the pattern of transitions was nearly identical to those of Richard and his mother. During the first six sessions, most of the transitions occurred to and from the historical guided object frame (eighty out of ninety-two transitions in the first six sessions, 87 percent). For these first six sessions, these transitions were primarily between the guided object frame and the not-guided object frame (20/80 = 25 percent), and between the guided object frame and the social/object mixed frame (58/80 = 73 percent). Of the 140 transitions during the final six sessions, 119 (85 percent) were with the not-guided object frames. Of these 63/119 (53 percent) were with the guided object frame and 54/119 (45 percent) were with the social/object mixed frame.

Similar to Richard and his mother, the social/object mixed frame clearly fit the bridging pattern predicted in sequence (P_1). First of all, the social/object mixed frame was relatively high in duration during sessions 6–9, showing an inverted U-shape trajectory. Second, 73 percent of the transitions with the historical guided object frame in the first six sessions were with the social/object mixed frame and 45 percent of the transitions with the emerging not-guided object frame in the final six sessions were with the social/object mixed frame. These percentages of predicted transitions with the social/object mixed frame were considerably higher for Betsy and her mother compared to Richard and his mother.

On the other hand, as we saw for Richard and his mother, many of the transitions occurred directly between the historical guided object frame and the emerging not-guided object frame both in the early and later sessions. It seems as if Betsy and her mother also fit the hybrid model shown in sequence (P_1''), Chapter 3, in which the bridging social/object mixed frame develops in conjunction with a short duration form of the newly emerging not-guided object frame. The fact that the social/object mixed frame remains somewhat elevated in duration in the final two sessions compared to the newly emerging not-guided object frame reflects a strong linkage between these two frames in the developmental change process. Further details on this process will be revealed in the qualitative analysis.

Qualitative analysis

Ordinary variability in sessions 1, 2, and 3

During sessions 1, 2 and 3, Betsy is 8, 9, and 10 weeks old respectively. The guided object frame is the predominant frame in these first three sessions, followed by the social/object mixed frame. There are few instances of the social and the not-guided object frames. In the guided object frame, the mother uses a variety of object manipulations (shaking, squeezing, rotating, showing, and twirling), demonstrating the most basic affordances of the object, especially the noise the object makes. The language used by the mother is social in nature as opposed to talking about objects or object's properties (except sound). Betsy is primarily motionless with short bursts of actions towards the objects or the mother. When Betsy moves, her body movements are jerky in nature and it appears to take her a long time to focus on a moving object or her mother. The ordinary variability of the guided object frame during these first three sessions thus includes the mother's active manipulation of objects combined with sounds, and Betsy's stillness with her body and head.

During the social/object mixed frame, the mother uses objects in a social manner through touching, tickling, kissing, and tapping Betsy while making a variety of animated sounds. Betsy is more responsive in these moments: she smiles, vocalizes, and moves her body. If the mother, however, persists too long with her actions, Betsy looks away as if indicating disinterest. The ordinary variability of the social/object mixed frame differs from the guided object frame in that Betsy appears to be more actively engaged with her mother in these social exchanges permeated by the object. During both frames, however, the mother smiles, laughs, and uses exaggerated body movements and facial expressions. It is as if the mother finds humor in many interactive exchanges.

A close analysis of the frame transitions indicates that the transitions are primarily between the social/object mixed frame and the guided object frame. Transitions involving the social frame are not observed at all during these first three sessions, and the transitions with the not-guided object frame are infrequent. During the transitions from and to the guided object frame, Betsy keeps looking in the same direction (that is, looking away from both the mother and objects). Betsy is mostly quiet during these transitions, and sometimes sleepy. The mother, on the other hand, tends to squeeze or shake objects out of Betsy's sight. It appears that the mother changes her actions as a way of attracting

Betsy's visual attention to the objects. Similar to the ordinary variability observed in the guided object frame, the mother emphasizes auditory stimulation during the transitions. This may have been, in part, because Betsy looks off to the side most of the time during these transitions. The transitions involving the social/object mixed frame are similar. The difference is that, with the transitions from or to the social/object mixed frame, a change in tactile stimulation is combined with a change in auditory stimulation. For instance, in one transition from the social/object mixed frame to the guided object frame:

> The mother is touching Betsy's nose with the rattle, saying "Gotcha!" each time she touches Betsy's nose, while Betsy looks off to the side (social/object mixed frame). *The mother stops touching Betsy with the toy and begins vocalizing. Betsy keeps looking off to the side. The mother then puts the toy on the floor and picks up another toy (the caterpillar), squeezing it on Betsy's right side out of her sight.* Betsy keeps looking off to the side, as the mother continues squeezing the caterpillar (guided object frame).

The example above illustrates the ordinary variability of the transitions involving the guided object frame and the social/object mixed frame across the first three sessions. Note that Betsy's mother tries to maintain different forms of auditory stimulation during the transition as a way of capturing Betsy's visual attention to the object while Betsy keeps looking off to the side. This segment also further illustrates the dyad's focus on auditory stimulation combined with tactile stimulation during the transition involving the social/object mixed frame. Specifically, the mother touches Betsy's nose with the rattle (an object that does not make much noise unless shaken) while synchronizing her voice with her touch. Note also in the example above that when the mother stops talking to Betsy, she starts squeezing the caterpillar, thereby making sounds with the object. Once again, this level of activity highlights the mother's use of sounds to attract Betsy's attention to the object or to herself.

Innovations in sessions 1, 2, and 3

Occasionally, during the guided object frame, Betsy focuses on the object held by the mother and responds with smiles, vocalizations, and body movement. In these instances, when Betsy looks away from the object, the mother immediately presents a new object as if trying to regain Betsy's attention. These behavioral changes in the predominant pattern described above constitute innovations in the ordinary variability of already existing frame dynamics. This is because these occasional changes, although not previously observed, did not change the

predominant ordinary variability of Betsy's relative inactivity during the guided object frame.

Similar to the innovation observed in the guided object frame, there are a few cases in which Betsy moves her arms or whole body during the transitions, instead of remaining inactive and gazing off to the side. For example, in one transition from the not-guided object frame to the guided object frame:

> Betsy is looking at toys on the floor while the mother talks to Betsy about the toys (not-guided object frame). The mother then picks up a toy, continues talking to Betsy about that toy, but Betsy does not visually follow the toy held by the mother. Instead, Betsy keeps looking off to the side. *The mother, however, accidentally causes the toy to make a noise. At this point, Betsy moves her whole body towards the sound of the toy, while the mother continues holding the toy.* Immediately after, Betsy looks at the toy held by the mother (guided object frame).

This example illustrates a non-salient pattern observed during the frame transitions in sessions 1, 2, and 3. The innovation in the transitions consists of Betsy not maintaining her gaze off to the side after she hears the squeaky object. Instead, Betsy moves her whole body towards the sound of the object, thereby getting a better view of it. Although this pattern of transition in which Betsy presents a more dynamic level of activity is rarely observed in these first three sessions, it becomes more predominant in the next sessions.

Brief developmental account of sessions 1, 2, and 3

During these first three sessions, the guided object frame is the predominant frame in the dyad's relationship, thereby suggesting that this frame constitutes a historical frame. The ordinary variability characteristic of this frame at this point in the dyad's history is to have the mother present toys to Betsy in an entertaining manner while Betsy appears to be mostly an observer of her surroundings. The social/object mixed frame, when it occurs, is an occasion for enjoyable social play permeated by objects. Betsy, however, continues to be a quiet observer (although a bit more active than during the guided object frame) while her mother appears to be primarily responsible for entertaining and captivating Betsy's interest. These two patterns constitute the ordinary variability of these frames during the first three sessions.

There are a few occasions when Betsy is not always quietly observing her surroundings. Instead, she turns her head to the side towards the objects as if the sounds made by the mother or the toy created opportunities for innovations in the dyad's predominant pattern of

communication. This is illustrated in the example described above where the accidental sound of the toy made Betsy move her whole body, and not just her head, during the transition. We speculate that these innovations may serve as a historical prelude to Betsy's more active role observed in the next sessions.

Ordinary variability in sessions 4, 5, and 6

In the next three sessions (that is, sessions 4, 5, 6), Betsy is 11, 12, and 13 weeks old respectively. The two primary frames observed continue to be the guided object frame and the social/object mixed frame. Again, the social frame and the not-guided object frame are infrequent. One can identify a continuation of the patterns observed in the first three sessions with additional interactive qualities being incorporated into the frames, thereby giving rise to a new ordinary variability.

Similar to the ordinary variability observed in previous sessions, the mother rarely slows down to show an object or highlight physical properties of the object. Singing, however, is added to object demonstrations. The object becomes a rhythm instrument when the mother sings, as if helping her to keep her tempo. While the mother sings and moves the object rhythmically, Betsy becomes very attentive, carefully watching her mother's actions. It is important to highlight that Betsy's attentive gaze towards the object first appears as an innovation within the guided object frame in sessions 1, 2, and 3. Also, the mother's singing is incorporated for the first time into the frame as Betsy becomes more consistently active in their interactions, suggesting that a change in one of the dyadic partner's activity further amplifies the other partner's level of engagement.

During the social/object mixed frame, changes in Betsy's activity are also incorporated into its current ordinary variability. Specifically, Betsy flails her arms out into an open posture and moves her legs while watching the object or the mother. She also vocalizes, smiles, and occasionally laughs when the mother stimulates her body with object-touch games. The mother continues giving life to objects through animation, using her voice and actions to speak and move for the objects (especially those with faces such as the caterpillar and the porcupine). These objects are consistently used to tickle, kiss, or talk to Betsy. It is important to highlight that Betsy's increased movement is first observed as an innovation during the transition in sessions 1, 2, and 3 when Betsy moves her entire body towards the object that her mother accidentally squeezes. Once again, a change in Betsy's activity level appears to further amplify

the mother's entertaining qualities as reflected in her more intense use of the object in the touching games.

In sum, during both the social/object mixed frame and the guided object frame, Betsy looks at objects and her mother for longer periods of time, with an increase in vocalizations, smiling, and for the first time, laughing. In addition to her creative and entertaining ways of interacting with Betsy, the mother also sings and imitates the sounds of the increasingly vocal infant. Betsy in turn mirrors her mother's facial expressions, with grimaces, mouth movements, smiles, laughter, and vocalizations. A feedback loop is thus observed where a behavioral change in one of the interactive partners (in this case, Betsy) further amplifies the activities of the other partner (in this case, the mother). These social/emotional games where both Betsy and her mother are actively engaged are ongoing during sessions 4, 5, and 6, and constitute the new ordinary variability of the social/object mixed frame **and** the guided object frame.

The transitions in visits 4, 5, and 6 are also similar to those previously observed. They continue to occur primarily between the social/object mixed frame and the guided object frame, with those involving the social frame being infrequent. Betsy's gaze remains the primary transitional action, but other actions that are observed as innovations in previous sessions (such as Betsy's movement of her body towards objects) begin to be consistently incorporated into the transitions. For instance, in one transition from the guided object frame to the social/object mixed frame:

> The mother is shaking the rattle in front of Betsy's eyes and singing in a synchronized way, while Betsy is looking at the toy held by the mother (guided object frame). The mother stops singing and starts changing the pace of her shaking (shaking the toy a little bit faster). Betsy keeps looking at the toy held by the mother. The mother then stops shaking the toy while Betsy keeps looking at the toy. *At this point, the mother starts bringing the toy closer to Betsy's face, singing in a way that is synchronized with her movement of the toy. Betsy waves her arms as if getting excited.* The mother starts slowing down the movement of the toy, touching Betsy's body with it (social/object mixed frame).

The example above illustrates a change in the dyad's level of activity in the transitions when compared to the three previous sessions. Specifically, Betsy becomes more active by gazing at the toy presented by her mother and by moving her arms (and, at times, her entire body) towards the object. At the same time, the mother continues to be entertaining with her actions, including her incorporation of singing, but she also starts to demonstrate the objects within Betsy's sight.

Innovations in sessions 4, 5, and 6

Innovations are also identified in sessions 4, 5, and 6 during the guided object frame. Compared to the ordinary variability of the mother entertaining and not facilitating object-related actions, there are occasions where the mother puts an object into Betsy's hand. In fact, this is done at least once in every session. On these occasions, Betsy responds with fingering, holding the object briefly, and slowly shaking the object once or twice, while looking at it. It is also within sessions 4, 5, and 6 that Betsy starts to suck on her hand.

The few transitions involving the not-guided object frame occur for the first time as an interval of the guided object frame or the social/object mixed frame. These instances rarely last more than three seconds and do not appear to alter the predominant pattern of activity of the historical frame (that is, guided object frame or social/object mixed frame). The impression the observer gets is that a new frame is emerging out of the historical frames. This quality is illustrated below in the context of the guided object frame:

> Betsy is looking at a toy held by the mother (guided object frame). Eventually, Betsy looks away *and the mother changes toys. As she does so, she talks to Betsy about the toy she is picking up (not-guided object frame)*. Briefly after, the mother shows the new toy to Betsy (guided object frame).

Additional innovations are observed in the transitions involving the guided object frame. Specifically, the mother's demonstration of the object becomes an important component of the transitions. Depending upon the object used, the mother attempts to facilitate Betsy's manual exploration of objects by placing it within her reach or even at her hand. Not surprisingly, Betsy's occasional grasping of the object and object mouthing are observed during these transitions. It is as if a new pattern of ordinary variability is about to emerge out of these mutual dyadic changes in the current pattern of transition.

Brief developmental account on sessions 4, 5, and 6

In these three sessions, the historical frame (i.e., guided object frame) becomes elaborated as reflected in the emergence of a new ordinary variability characteristic of this frame. The social/object mixed frame becomes equally predominant in these visits with elaborations similar to those observed in the guided object frame. That is, Betsy becomes more active during both the guided object and social/object mixed frames as well as during the transitions between these frames. At

the same time, the mother continues to be an entertainer of her more active infant, introducing singing to their exchanges. A feedback loop is thus observed in both frames where a behavioral change in one of the interactive partners further amplifies the activities of the other partner.

Innovations are observed in the frames (i.e., the guided object and the social/object mixed frames) and in the transitions between these frames during sessions 4, 5, and 6. First, the not-guided object frame makes its initial appearance as a break within the guided object frame or the social/object mixed frame. For example, the not-guided object frame emerges as Betsy looks away from the toy held by her mother and the mother changes toys, talking to Betsy about the new toy. A second innovation is observed within the frame transitions. There are a few occasions where the mother places the object within Betsy's reach and Betsy reaches for the object while looking at it. Within these occasional situations, one also observes a few episodes of Betsy mouthing the object she holds. Similar to sessions 1, 2, and 3, the innovations during sessions 4, 5, and 6 appear to be a historical prelude to the ordinary variability observed in the next sessions where the mother consistently demonstrates objects and Betsy more often grasps them, at times mouths them.

Ordinary variability in sessions 7 and 8

In sessions 7 and 8, Betsy is 17 and 19 weeks old. These sessions immediately follow the session (i.e., session 6) where Betsy, for the first time, reaches for an object while looking at it. Note that reaching for an object while looking at it constitutes one of the innovations previously observed in the guided object frame and in the frame transitions. The not-guided object frame, the guided object frame, and the social/object mixed frame become the primary frames pervading these sessions. Social frames are no longer observed. There are still reciprocal smiles, vocalizations, and laughs across the frames, but less than in pre-reaching sessions (i.e., sessions 1 through 6). Betsy often checks in visually with her mother during all frames and often produces a brief smile or vocalization when she sees her mother's face, thereby maintaining a connection with her mother. It is also important to highlight that these patterns of activity later become a part of the dyad's typical interactive dynamics during the not-guided object frame when Betsy checks in visually with her mother while mouthing an object.

It is the first time that the not-guided object frame emerges as "separate" from the other object-related frames. That is, the not-guided object frame no longer arises as part of the guided object frame or the social/object mixed frame. Betsy is now allowed time to explore objects without

direct interference from the mother. Betsy is alert and very active: she uses object manipulations with two hands, doing active fingering while gazing at the object as well as transferring, rotating, and shaking the object. Meanwhile, the mother talks about object properties while using a distinct voice to mark Betsy's object-related actions.

Note that these new activities of Betsy manipulating objects without the mother's direct interference as well as the mother's verbal commentaries on the object properties were originally observed as innovations in the frame transitions during sessions 4, 5, and 6. Specifically, there were a few occasions when the not-guided object frame emerged as a break of the guided object frame when the mother talked about objects as she switched objects. There were also a few episodes of the guided object frame when the mother placed the object within Betsy's reach. As her mother presented the object to her, Betsy reached the object offered by her mother, at times, grasping it and mouthing it (not-guided object frame).

Although the mother seems to allow Betsy uninterrupted time to manipulate objects (i.e., the not-guided object frame), she is still active in choosing the objects for Betsy by handing them to her during the guided object frame. These patterns of co-actions constitute the new ordinary variability of the not-guided object frame.

With the increasing growth of the not-guided object frame, the guided object frame continues to emerge in different forms. For example, there are times when the mother takes away an object that Betsy has been mouthing for a long time during the not-guided object frame, and introduces a second object into their interaction (guided object frame). At other times, the mother not only gives Betsy certain objects but also helps her hold them when needed. The mother's participation in the guided object frame has now changed to include facilitation as well as interruption of Betsy's object manipulation. Note that the mother's facilitation of Betsy's manipulation of objects was previously observed as innovations within the guided object frame during sessions 4, 5, and 6 when she occasionally places the object within Betsy's reach or at her hand.

It is also worth noting that the not-guided object frame and the guided object frame now occur in quick succession. Object manipulation follows a sequence composed of: Betsy actively mouthing an object (i.e., the not-guided object frame), the mother introducing a new object to Betsy followed by Betsy reaching for and grasping the new object (i.e., the guided object frame), and then Betsy manipulating the second object, at times actively mouthing it (i.e., the not-guided object frame). This sequential patterning between the guided object and the not-guided object frames appears to constitute a form of historical

recapitulation in which an already existing historical frame (i.e., the guided object frame) is maintained and makes transitions with a newly emergent frame (i.e., not-guided object frame).

Now that Betsy is becoming more skilled at manipulating objects on her own, a new ordinary variability characterizing the social/object mixed frame also emerges during visits 7 and 8. The mother now uses the object Betsy is holding, making it kiss Betsy's face without taking the object from her. It is as if Betsy is playing the object-touch games herself. Both Betsy and her mother are also becoming more serious, smiling and laughing relatively little and producing fewer vocalizations. The mother, for instance, uses far fewer sound effects with objects during visits 7 and 8. The impression the observer gets is that the social/object mixed frame is gradually becoming transformed as the not-guided object frame emerges as a new and distinct frame. In fact, certain characteristics of the not-guided object frame (such as helping Betsy play the object-touch games herself) appear to permeate the social/object mixed frame.

Similarly to the changes observed in the frames, the transitions between the not-guided object frame and the social/object mixed frame or the guided object frame present a new ordinary variability. Two predominant forms of ordinary variability are identified. There are the transitions in which Betsy is quietly concentrated in the manipulation of the object she holds while the mother quietly observes Betsy, and there are the transitions where Betsy and her mother are actively participating in the frame change by modifying their ongoing activity such as releasing an object, stopping smiling, or grasping an object. For example, in one of the transitions from the guided object frame to the not-guided object frame:

> The mother squeezes a toy while Betsy looks at the toy held by the mother (i.e., the guided object frame). *As Betsy starts moving her right hand toward the toy held by the mother, her mother stops squeezing the toy, holding it steadily. At this point, Betsy grasps the toy and vocalizes.* The mother then releases the toy and starts watching Betsy, quietly, while Betsy manipulates the toy with her hands (i.e., the not-guided object frame).

In another transition, however, Betsy and her mother appear to punctuate the change of frames by stopping their vocalizations, and then remaining quiet:

> Betsy manipulates a toy, vocalizing and looking at her mother, while the mother looks at Betsy, talking to her (i.e., the social/object mixed frame). *The mother then stops vocalizing and so does Betsy while manipulating the toy.* At this point, the mother remains quiet, watching Betsy manipulate the toy (i.e., the not-guided object frame).

The examples above illustrate the two predominant patterns of transitions observed during visits 7 and 8 where Betsy manipulates an object with her hands while the mother watches her infant quietly. Indeed, Betsy's mother gradually becomes more of a quiet partner – a partner who is focused on helping her infant in object-oriented activities. Part of this new ordinary variability of frame transitions where the dyad appears to become more focused in facilitating Betsy's object exploration can be traced back to some innovations identified in sessions 4, 5, and 6 when Betsy's occasional object mouthing was observed.

Innovations in sessions 7 and 8

A few innovations continue to be observed during the not-guided object frame and in the transitions involving this frame. Specifically, object mouthing continues to be a way for Betsy to explore objects. Meanwhile, the mother quietly watches Betsy play with objects or verbally praises Betsy's attempts to reach for objects independently and manipulate them (in these cases, mostly through mouthing). It is important to emphasize that object mouthing and the mother's more indirect facilitation of Betsy's object exploration later become predominant activities permeating the frames during sessions 9, 10, 11, and 12. That is, the not-guided object frame presents a distinct quality in the sessions to follow when Betsy starts to choose the objects for her to mouth on her own while her mother verbally praises Betsy's independent object choices.

Brief developmental account on sessions 7 and 8

The not-guided object frame begins to pervade these sessions, with the "support" of the guided object frame and the social/object mixed frame. Compared to previous sessions, all of the observed frames (i.e., not-guided object frame, guided object frame, and social/object mixed frame) undergo coordinated changes as reflected by the emergence of a new ordinary variability for each of these frames. Specifically, as Betsy becomes more object-focused and fascinated with the new activity of examining the objects around her, the mother adjusts her object-oriented behaviors and begins providing support to her infant's object exploration by handing them to Betsy.

The not-guided object frame begins to become elaborated into a fully developed frame as Betsy spends increasing amounts of time manipulating objects. This constitutes a newly emergent frame that arises out of the innovations within the guided-object frame and social/object

mixed frame during sessions 4, 5, and 6. At the same time, the guided object frame expands its forms as illustrated by the increasing variability in the way the mother presents objects to Betsy. The social/object mixed frame also changes from its earlier quality of enjoyable social play to becoming more focused on Betsy's more serious examination of objects.

Furthermore, the dyad's new ordinary variability during sessions 7 and 8 includes a patterned integration of the guided object frame and the not-guided object frame. In this case, it is as if frames (i.e., guided object frame and not-guided object frame) are blending together at the same time that a historical dynamics is recapitulated by the dyad. Note that this integration is first observed in the context of frame transitions during sessions 4, 5, and 6, and then observed as part of the frames themselves during sessions 7 and 8.

Occasionally, Betsy becomes immersed with objects during both frames and transitions while her mother verbally praises Betsy's independent reaching of the object or quietly observes Betsy's object manipulation. This seems to constitute an historical prelude for the next four sessions when Betsy's independent selection of objects followed by excessive mouthing of them becomes a characteristic that permeates the frames and their transitions.

All of these processes – the simultaneous re-organization of each of the frames in relation to each other and the emergence of a new frame in the context of the blending and recapitulation of frames – constitute what we consider to be the conditions of a developmental change. Innovations, as seeds for developmental change, alter the ordinary variability within frames on later occasions. This alteration, however, is of the same kind as the innovation when the infant becomes more active across multiple modalities. In the case of this developmental change, however, the entire pattern of communication changes across the whole system: all the frames and transitions are involved. For reasons we do not yet understand, the build-up and elaboration of innovations seems to reach a critical point at which time the "old" or historical system can no longer contain the innovations within ordinary variability. At this time, the system spontaneously shifts to a new system-wide organization that includes new frames, creative blending of old frames, and new actions within frames. It is important to note that we did not observe any single innovation or event that precipitated the developmental transition.

Ordinary variability in sessions 9, 10, 11, and 12

In the last four sessions analyzed (i.e., sessions 9, 10, 11, and 12), Betsy is 22, 23, 24, and 25 weeks old respectively. The not-guided object

frame, the guided object frame, and the social/object mixed frame continue to be observed – although with detectable qualitative differences within each frame.

During the guided object frame, the mother either places objects near Betsy or changes Betsy's position on the floor to help Betsy reach for the object on her own. Except for when Betsy is mouthing an object, the mother sets each infant-object scene without interfering directly with Betsy's ongoing actions. Elements of the previous ordinary variability are maintained where the guided object frame is utilized by the dyad as a context to facilitate the infant's object exploration. At the same time, however, the mother facilitates object exploration in a less direct manner – by placing objects within the infant's reach (instead of handing them to the infant) or by repositioning the infant's body. A new ordinary variability of the guided object frame emerges out of the innovations observed in the not-guided object frame during sessions 7 and 8 when the mother indirectly facilitated Betsy's object mouthing.

Not surprisingly, the not-guided object frame is also affected by the predominance of object mouthing. The mother more often attempts to take objects away from Betsy while Betsy mouths them. During this frame, the mother uses words of encouragement in the form of little cheers and claps when Betsy successfully reaches for an object independently and manipulates it (as in the innovations observed in sessions 7 and 8). Betsy is also becoming more skilled at manipulating objects independently as her hand-eye coordination becomes smooth. She spends longer periods of time exploring objects (not only mouthing them), thereby increasing the duration of the not-guided object frame during these last four sessions. She rocks side to side to move closer to objects and this appears to prompt her mother to put her in a prone position. This new position allows Betsy to more consistently choose her own objects to manipulate, and she does so in two new ways: banging the object on the floor or rolling the ball on the floor. While on her belly, Betsy also cleverly pushes up on her hands to gaze around at the objects and then reaches for one. It is important to highlight that, when lying on her tummy, Betsy looks over her shoulder to check in visually with her mother. Indeed even during mouthing, Betsy actively looks at her mother and other objects, thereby never "breaking" the connection with her mother or her surroundings.

During the social/object mixed frame, the mother continues to decrease the amount of her vocalizations and their social/animated games include Betsy as her own entertainer (similar to the ordinary variability observed in sessions 7 and 8). For example, while Betsy is squeezing the red porcupine, the mother reaches down and guides Betsy's hand to

make the object kiss or tap along her belly. At this point in this dyad's relationship history, this dynamics of social interaction with toys along with Betsy gradually becoming her own entertainer appear to be predominant.

With the increase of the not-guided object frame, there is also a gradual rise in the speed of the transitions, and Betsy appears to initiate most of them. One gets the impression that both interactive partners have a better mutual understanding of their "roles" during their communication: the infant becomes more autonomous and pro-active in setting her interactions involving the objects; while the mother becomes an observer and indirect facilitator of her growing infant.

The transitions primarily involve the not-guided object frame and the guided object frame, with the second most predominant transition occurring between the not-guided object frame and the social/object mixed frame. During these last four sessions, the mother no longer brings objects to Betsy's hands on a consistent basis. Rather she mostly places objects within Betsy's reach (not adjusting them into Betsy's hands), thereby allowing Betsy to make her own object choice. There are moments, however, when the mother holds an object within Betsy's reach. In these cases, the mother does not need to hold the object steadily for long periods of time as Betsy now quickly grasps the object presented to her. Betsy also becomes more immersed in her own actions on the object as the mother progressively becomes quieter and less vocal. Actually, the mother seldom changes her actions and, when she does so, she stops them in order to better watch Betsy's more independent manipulation of the object as illustrated in the following transition.

The mother is shaking a toy within Betsy's sight, smiling and talking to Betsy, while Betsy holds another toy, looking at the toy held by the mother (i.e., the guided object frame). *The mother stops talking, stops shaking the toy, and quietly holds the toy steadily within Betsy's sight. At this point, Betsy looks at the toy she holds and starts manipulating it.* The mother remains quiet, watching Betsy manipulate her own toy (i.e., the not-guided object frame).

Innovations in sessions 9, 10, 11, and 12

A few instances of peek-a-boo occur with an object in the context of the social/object mixed frame. During these instances, Betsy's vocalizations increase: she makes many grunts, gurgling sounds, and coos mostly at objects. Even though Betsy is quite active with objects, once again, there remains a sense of togetherness within the dyad. It is as if the dyad recapitulates an already recognized pattern of interaction as new forms of communication emerge.

There are also a few transitions when the mother starts squeezing the objects held by Betsy as if trying to become a part of the infant-object connection. The dyad then begins to reveal a new social use of objects as they create games around Betsy's new motor skills. For instance, there is an occasion on which Betsy is trying to grasp a toy on the floor while her mother observes her (i.e., the not-guided object frame). *The mother then says: "Go for it, baby! Go for it."* After Betsy gets the toy, the mother claps her hands, saying "Yeahhhhhh!" raising the intonation of her voice as Betsy looks at her mother (i.e., the social/object mixed frame). In this sense, the social/object mixed frame continues to serve a bridging function, providing a background of ongoing support for the actions that occur during the emerging not-guided object frame.

Brief developmental account of sessions 9, 10, 11, and 12

Betsy's increased facility with objects appears to be related to an increase in the speed of transitions between the object-oriented frames. It is as if innovations occurring in one frame (i.e., innovation in the not-guided object frame during sessions 7 and 8) affect the familiar dynamics of other frames in later sessions (i.e., ordinary variability in the guided object frame during sessions 9, 10, 11, and 12).

It is also important to point out that in some of the transitions to the guided object frame, the mother quickly facilitates Betsy's more independent grasping of an object as she used to do in previous sessions – it is as if the mother recapitulates familiar forms of dyadic interaction. Likewise, most of the transitions to the social/object mixed frame involve an ordinary variability similar to that observed in previous sessions. That is, the mother spends a great deal of the transition time trying to entertain Betsy while Betsy remains relatively occupied with the objects she holds.

At the same time, the social/object mixed frame develops a social quality with respect to the emergence of Betsy's novel actions on objects. Although there is a clear increase in their focus on object exploration, the dyad is able to combine mutual and playful enjoyment with Betsy's exploration of objects. The social/object mixed frame, instead of diminishing in importance, becomes the ground for the celebration of new infant developmental achievements. It is as if the permeation of "new" and "old" frames as well as the recapitulation of the "older" frames during the elaboration of the historical frame (i.e., the guided object frame) appears to have facilitated the dyad's navigation across the developmental shift from a primary focus on socially-oriented frames to a predominant focus on object-oriented frames.

Overall summary of Betsy and her mother

A historical analysis of this dyad's relationship across the twelve sessions suggests that, during the first sessions, the guided object frame is the historical frame for Betsy and her mother, with the social/object mixed frame as the second most predominant frame. Betsy's activity in both frames and transitions changes over time from a quiet observer in the first sessions to an immersed explorer of the object in the last sessions. The mother's activity also changes in relation to Betsy's: she starts out as a talkative captivator and entertainer, and then she becomes a referee and spectator of her infant's object-related activities. Over time, Betsy and her mother begin to engage for longer durations in the not-guided object frame and the guided object frame. Specifically, the guided object frame begins with the mother creating interesting visual and auditory displays for Betsy's observation of the object and this continues into sessions 4, 5, and 6 as Betsy shifts from a quiet observer of her surroundings to a more active play-partner. During sessions 4, 5, and 6, we see the first emergence, in the form of innovations, of the mother's facilitation of Betsy's object exploration, which later dominates the following sessions. Towards the end of the observation period, the guided object frame is mainly characterized by Betsy's immersion in object exploration while the mother watches Betsy's activities.

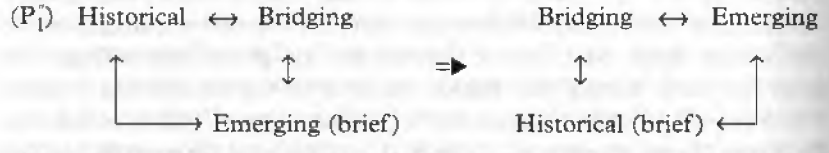
The social/object mixed frame is a time of enjoyable social play for both Betsy and her mother in all of the twelve sessions except for sessions 7 and 8. During these sessions, Betsy's examination and immersion in objects bring to this frame a more serious emotional flavor. By the last sessions, the social/object mixed frame becomes enjoyable once again and the dyad's focus is on a playful sharing of Betsy's emerging object skills. Furthermore, based on the quantitative analysis, we propose the social/object mixed frame as a bridging frame for Betsy and her mother and this appears to be confirmed in the qualitative analysis. First, the social/object mixed frame seems to be the locus of transitions first with the guided object frame and later with the not-guided object frame; and only then, the transitions begin to occur directly between these two object-oriented frames. Second, despite its change in frequency and duration across the twelve sessions, the social/object mixed frame maintains a familiar social connection between Betsy and her mother throughout the observation period. At the same time, however, this frame undergoes modifications in its quality consistent with the changes observed in the other frames, as observed in sessions 7 and 8 when the emotional tone of this frame becomes less playful with the increasing dyadic focus on object exploration.

The not-guided object frame first emerges as a short break in the social/object mixed frame or between object choices in the guided object frame during sessions 4, 5, and 6. During sessions 7 and 8, Betsy becomes more focused on object examination and this is in part reflected in the increasing appearance of the not-guided object frame. By the last sessions, the not-guided object frame becomes predominant and is mainly characterized by Betsy's immersion on object exploration while her mother observes her infant's activities. It is noticeable that the not-guided object frame makes use of the already established frames (guided object frame and social/object mixed frame) to foster its emergence. As mentioned above, when it first appears, the not-guided object frame is a brief interlude during the guided object and the social/object mixed frames as the mother lingered over changing of toys. This function of a brief transitional frame is also observed in transitions between the guided object and social/object mixed frames. This brief not-guided object frame is followed by its further integration with the guided object frame and elaboration during sessions 9 through 12.

We find a number of ways in which frames and transitions are related to one another. There is, first of all, a similarity of mother and infant actions in both the frames and transitions across all twelve sessions. During the first sessions, for example, the guided object frame is mainly characterized by mother's continuous attempt to capture and maintain Betsy's visual attention to different objects (i.e., captivator), while Betsy looked off to the side all the time. Comparably, the transitions involving the guided object frame are mainly characterized by Betsy looking in the same direction for a long time, while her mother makes primary use of auditory stimulation in different ways attempting to captivate Betsy's visual attention to the object.

We also find some differences between frames and transitions, and these differences are preludes to changes observed in the sessions to follow. Across the first three sessions, for example, there are a few situations in which Betsy's body movements, in addition to gaze direction, are part of the transitions. Although this pattern of transition in which Betsy is more active is rarely observed in these sessions, it becomes more salient in the next ones during both frames and transitions. At the same time, developmental innovations in one session (or set of sessions) that lead to growth during the next session do not appear only in transitions but also in frames. This suggests that, at the developmental time scale, the changes observed in the realtime transitions preceded transformations in the mother-infant communication system as reflected in the frames.

Taken together, both the quantitative and qualitative results suggest that the two models of change suggested by propositions 1 and 2 (Chapter 5) have been supported. The findings have similarities to those of Richard and his mother, but also important differences. Proposition 1 offers developmental sequence (P_1) in which bridging frames intercede both in realtime and developmental time between historical and emerging frames. For Richard and his mother, proposition 1 was modified as,



In this sequence, brief instances of the emerging frame in the early period and brief instances of the historical frame appear alongside the bridging frame and make realtime transitions with both frames. Because hybrid sequence (P_1'') fits Betsy and her mother, it suggests that proposition 1 is strongly supported.

Proposition 2 proposes that innovations arise from ordinary variability and later lead to developmental change, as suggested by sequence (P_2). Again, this also receives strong support in this dyad's history but the model is more complex than sequence (P_2) and more complex than sequence (P_2'') that was proposed to fit Richard and his mother. Instead, we offer sequence (P_2''') for Betsy and her mother.

$$(P_2''')(\text{level } 1^{\alpha} + \text{level } 2^{\alpha})_{\text{period } \alpha} \rightarrow (\text{level } 1^{\beta}(+\text{level } 1^{\alpha} + \text{level } 2^{\alpha} + \text{level } 2^{\alpha'}) + \text{level } 2^{\beta})_{\text{period } \beta} \rightarrow (\text{level } 3)_{\text{period } \gamma}$$

As for Richard and his mother, level 1^{α} is ordinary variability in the first observed developmental period, designated the α period. Level 2^{α} are innovations occurring during period α. Level 1^{β} is ordinary variability during a second developmental period, β, and level 2^{β} are innovations during the β period. This part of the model, that is,

$$(\text{level } 1^{\alpha} + \text{level } 2^{\alpha})_{\text{period } \alpha} \rightarrow (\text{level } 1^{\beta} + \text{level } 2^{\beta})_{\text{period } \beta,}$$

is identical to Richard and his mother. As a reminder, this model shows that innovations in period α lead to a new ordinary variability in period β, such that there may be a series of recognizably different developmental periods (α, β, γ, . . .), each with a new ordinary variability and new innovations. In the case of Betsy and her mother, this sequence does not

continue over time as it did for Richard and his mother but rather leads eventually to a developmental change (level 3).

The middle section of (P_2''), that is,

$$(\text{level } 1^{\beta}(+\text{level } 1^{\alpha} + \text{level} 2^{\alpha} + \text{level } 2^{\alpha'}) + \text{level } 2^{\beta})_{\text{period } \beta,}$$

represents the possibility for additional complexity in any particular developmental period. The second optional term in this middle section of sequence (P_2''), (+ level $2^{\alpha'}$), reflects the possibility that additional innovations may be introduced during this β developmental period that are responses to or amplifications of innovations introduced during the previous period, α. This is the same as we found for Richard and his mother. An additional term for Betsy and her mother, (+ level 1^{α} + level 2^{α}), represents the possibility for recapitulation, in which some aspect of ordinary variability and innovation from a previous developmental period, α, becomes incorporated into the ordinary variability during the current developmental period, β. In the case of Betsy and her mother, it was not added until the third developmental period, γ. Both of these terms are possible but optional.

As for Richard and his mother, the data fit our prediction that changes in ordinary variability are preceded by innovations which do not change the ordinary variability at the time they first appear, but only later, when the system shifts to some new period of ordinary variability. Finally, one of the key distinguishing features of this dyad compared to Richard and his mother is the presence of level 3 developmental change. This change fits our definition of a re-organization of all the frames and transitions. It appears that one of the clues to the recognition of level 3 change is a blending or permeability of one frame with respect to the others. The social/object frame, for example, becomes more serious, similar to the emerging not-guided object frame. Other clues are the emergence of a new frame of more than brief duration with its own unique features and the recapitulation of older frames. It is not clear from these data, because only one subject is studied, whether all of these features are necessary to constitute a developmental change. Clearly, there has to be an emerging new frame and the blending and changes of all the frames in the system, otherwise that change would not meet the definitional criteria of development. But, does there need to be recapitulation? This is an open question.

10 Results of the current investigation: qualitative analysis of Lewis and his mother

In this chapter, we present a case analysis of the development of frames and frame transitions for another one of the four representative dyads, Lewis and his mother. Similar to the organization utilized in previous qualitative chapters, we present the raw data developmental trajectories for each of the four frames, the raw data transition frequencies between the frames as a function of age, and a qualitative analysis of the relational history. In the latter, we describe the change processes at two levels, ordinary variability (referred to as level 1 change in Chapter 3) and innovations (referred to as level 2 change in Chapter 3), followed by a brief developmental account of these changes that describes any evidence for a developmental re-organization (level 3 change).

Developmental trajectories and transition frequencies

As shown in Figure 7.2 and Table 10.1, for this dyad the guided object frame persisted as the historically predominant frame until session 8, after which social, social/object mixed, and not-guided object frames became more salient. Social and social/object mixed frames were salient features of their communication throughout the period of observation. Unlike the other two dyads reviewed thus far, not-guided object frames for Lewis and his mother never became predominant on its own. Rather, the not-guided object and the social/object mixed frames seemed to share equal status as the newly emerging frames. The significant negative correlation (Table 7.2) between the not-guided object frame and the social/object mixed frame lends further support to this conclusion. Unlike Richard and Betsy and their mothers, in which social/object mixed frames seemed to serve as a developmental bridging frame between guided object and not-guided object frames, Lewis and his mother developed social/object mixed frames into more lasting features of their communication. No frames in this dyad appear to have the predicted trajectory of a bridging frame.

Table 10.1. *Descriptive statistics of frames by session: Lewis*

Session	1	2	3	4	5	6	7	8	9	10	11	12
Age (Weeks)	7	8	9	10	11	14	15	17	18	19	20	21
Social frame												
Frequency	7	5	0	4	6	2	4	3	9	3	3	1
% of session	35.53	29.13	0.00	16.06	30.06	9.17	6.88	17.15	28.77	40.53	5.27	1.72
Mean duration*	24.36	27.97	–	19.27	24.05	22.00	8.25	27.43	15.34	64.85	8.43	8.25
(s.d.)	(50.88)	(41.08)	(–)	(12.66)	(5.43)	(4.47)	(10.88)	(24.68)	(16.03)	(96.57)	(8.01)	(–)
Guided object frame												
Frequency	10	7	2	6	10	5	9	7	8	9	7	10
% of session	61.32	64.20	99.12	58.65	31.83	53.90	59.78	50.58	26.56	46.62	21.81	11.17
Mean duration*	29.44	44.02	237.88	46.92	15.28	51.74	31.88	34.68	15.94	24.86	14.96	5.36
(s.d.)	(33.22)	(42.21)	(309.24)	(20.76)	(11.56)	(56.96)	(30.19)	(33.66)	(14.59)	(43.20)	(14.41)	(2.80)
Not-guided object frame												
Frequency	2	2	0	2	9	6	5	5	0	7	13	6
% of session	1.26	2.20	0.00	5.54	28.28	29.04	10.30	14.05	0.00	10.43	35.97	11.23
Mean duration*	3.02	5.27	–	13.30	15.08	23.23	9.89	13.49	–	7.15	13.28	8.99
(s.d.)	(0.81)	(2.50)	(–)	(15.74)	(17.55)	(31.96)	(9.71)	(9.93)	(–)	(8.30)	(11.86)	(6.52)
Social/object mixed frame												
Frequency	2	4	1	5	7	3	13	7	7	5	18	11
% of session	1.89	4.47	0.88	19.75	9.82	7.89	23.04	18.23	44.68	2.42	36.96	75.88
Mean duration*	4.52	5.37	4.23	18.96	6.74	12.63	8.51	12.50	30.63	2.32	9.86	33.11
(s.d.)	(1.76)	(4.35)	(–)	(30.66)	(6.25)	(2.93)	(7.66)	(11.95)	(35.34)	(0.94)	(9.07)	(40.61)

Note: * seconds

Table 10.2. *Frequency of frame transitions: Lewis and his mother*

	Session											
Frame transition	1	2	3	4	5	6	7	8	9	10	11	12
1->2	6	2		2	3		1	1	3		1	
2->1	5	1		1	2	1	1		2	2		
1->4												
4->1								2			2	
1->3					3	1		1				
3->1		1			2							
2->3		3			3	3		3		2	2	5
3->2	3	2		1	4	1	2	4		6	1	4
2->4	2	2	1	3	3			2	3	3	1	2
4->2	2		1	2	2	1	1	2	4			3
3->4						2	2	1			7	2
4->3				1		4	3	2			7	3

Note: 1 = Social frame; 2 = Guided object frame; 3 = Nonguided object frame; 4 = Social/object mixed frame

For this dyad there was a predominance of guided object frames until session 9, when social/object mixed and not-guided object frames began to increase in duration. As shown in Table 10.2, most of the transitions occurred between guided object frames and the other three frames, especially during the first ten sessions. Following that, most of the transitions were with the not-guided object frame, either between the guided object frame or the social/object mixed frame. During sessions 5 and 6 in particular, there were no predominant transition frequencies. Rather, the dyad seemed to move equally between the different frames. This may be another way to creative bridging, not with a specific frame but a process in which new and old co-occur by "balancing" all possibilities.

The historical frames were the social and the guided object frames. Most of the transitions began or ended with the guided object frame, suggesting that it may also serve as a developmental bridging frame. In this case, then, a single frame may be serving two functions. There is, in fact, a relative peak in and otherwise steadily declining duration of the guided object frame, the peak occurring during sessions 6, 7, and 8. Thus, it may be that this dyad fits proposition 1, sequence (P_1) if we allow that one frame may act as both the historical and bridging frame.

In spite of the relative simplicity of the predominance of guided object frames transitions during the first eight sessions, there was a complex

session-to-session change in the patterning of transitions. Compared to Richard and Betsy, there were more transitions with the social frame and transitions involving social and social/object mixed frames were spread out across many sessions. We will seek further clarification of these patterns in the qualitative analysis.

Qualitative analysis

Ordinary variability in sessions 1, 2, 3, 4, 5, and 6

In the first six sessions, Lewis is 7, 8, 9, 10, 11, and 14 weeks old. All four frames are observed, with the guided object frame being the predominant one, followed by the relatively equal appearance of the social frame, the social/object mixed frame, and the not-guided object frame. It is worth noting that the mother's overall style of verbal communication during all frames is to ask Lewis questions and to answer the questions for him. For instance, the mother says: "Are you talking to the porcupine?" while demonstrating the object to Lewis during the guided object frame. Then, she replies for Lewis, saying: "Yea, I think you are going to talk to him. Do you think he understands?" while Lewis looks at the object presented by his mother, vocalizing. This pattern of verbal communication remains relatively the same throughout all twelve sessions, however there is more maternal talking in the first six sessions.

During the guided object frame, Lewis' gaze is a salient indicator of his attention. The mother seems to want to please Lewis by showing and manipulating whichever object he looks at. She chooses objects carefully and smoothly demonstrates them, allowing plenty of time for Lewis to look at the object she presents. The mother also highlights the object's properties, especially the sounds of the objects, while Lewis moves his arms and legs, smiling and vocalizing. The mother talks about the sounds the objects make, verbally asking Lewis to notice the object's properties. Furthermore, starting in session 2, the mother begins to put an object in Lewis' hand or helps support Lewis' actions on the objects. The ordinary variability of this frame is thus characterized by mutual attention towards the object as indicated by the mother's active behaviors emphasizing the object's properties and Lewis' visual and bodily orientation to the objects held by the mother.

The social frame is short lived and mainly characterized by visual contact between Lewis and his mother, exchanges of vocalizations, maternal touching of Lewis' face, tickling of Lewis' stomach, and holding of

Lewis' hand. The mother's touching of Lewis rhythmically corresponds with her vocal tone, thereby emphasizing her words. Most of the time, Lewis' head is turned to the side with the mother leaning over to meet Lewis' gaze. The social/object mixed frame involves the mother frequently using touch as a way of gaining Lewis' visual attention or highlighting the object she is showing. Touch allows the mother to feel connected to her infant, even when he appears more focused on the objects around him. During the not-guided object frame, Lewis' increasing interest in the objects is demonstrated through brief mouthing of the object held by the mother and through slow shaking of the object – also held by the mother.

A close analysis of the frame transitions indicates that all four frames are a part of the transitions during these sessions. Most of these transitions, however, involve the guided object frame with considerably fewer transitions occurring directly between the other frames. Similar to a bridging frame, the guided object frame has become so central in the dyad's relationship that it mediates the movement from one frame to another. Lewis' gaze direction and maternal talking are salient actions involved in the transitions. The ordinary variability of the frame transitions is illustrated below during a transition from the guided object frame to the social/object mixed frame:

> The mother is quietly squeezing an object while Lewis looks at the object held by the mother (guided object frame). *As the mother keeps squeezing the object, she starts talking to Lewis about the object she is squeezing. Meanwhile, Lewis keeps looking at the object held by the mother. The mother then stops squeezing the object, holding it in her hands, and keeps talking to Lewis about the object. Lewis, however, just keeps looking at the object held by the mother.* The mother then starts touching Lewis' body with the object, talking to him about the toy (social/object mixed frame).

As exemplified above, Lewis' gaze is the primary transitional action, giving the impression that the dyad's movement from one frame to the next is made mostly by the mother as a result of Lewis' visual and persistent focus on the object. It is worth noting that the mother alternates her vocal actions with her manual actions on the object as if attempting to maintain some kind of activity to keep her infant's interest. Besides the alternation between maternal vocalization and her actions on the object, the mother also appears to carefully watch her infant's actions, changing hers as a way of attending to his action request. In the transition described above, for example, the mother stops whatever she is doing in order to attend to what she interprets to be what Lewis "wants" to do.

Innovations in sessions 1, 2, 3, 4, 5, and 6

In these first six sessions, innovations take place in the context of frame transitions. These occasional changes are conceived of as innovations for two reasons: (a) they were not observed as part of the recurring pattern of frame transitions; and (2) when they appear, they do not seem to alter the current and ordinary variability of frame transitions. There are four transitions involving the not-guided object frame in which both Lewis and his mother present a pattern of activity different from the predominant one observed in these sessions.

Specifically, during these transitions, Lewis is not just watching the object held by the mother, but he actually holds an object in his own hands, looking at it intently while the mother does not assist Lewis. Instead, she simply verbally highlights Lewis' actions on the object. It is important to note that these innovations incorporate a new level of activity on the object where Lewis is more independent in acting on the object and the mother is more explicitly withholding her active assistance. These occasional transition patterns seem to serve as a prelude to the next sessions as this patterning of activity where Lewis becomes a more independent explorer of the object and the mother becomes more of an observer of her infant will emerge, in the next sessions, as central characteristics of the ordinary variability of the object-related frames.

Developmental account of sessions 1, 2, 3, 4, 5, and 6

Although all four frames are observed during the first six sessions, the guided object frame predominates, thereby suggesting it to be an already established frame in the communication system (i.e., historical frame). As Lewis becomes more interested in objects across the six sessions, the social frame becomes short lived and two new frames start to emerge in session 2: the not-guided object frame and the social/object mixed frame (both object-related frames).

It is also important to note that although the transitions involve all four frames, most of these transitions occur via the guided object frame, thereby suggesting that the guided object frame also carries a bridging quality. During the transitions, Lewis is quiet and visually focused outwards whereas the mother modifies her behavior as a means of attending her infant's action requests. There are a few transitions involving the not-guided object frame where Lewis becomes a more independent explorer of the object while the mother does not actively assist Lewis' object interaction, thereby becoming more of an observer of her infant. These innovations involving a newly emergent frame (i.e., not-guided object

frame) are of particular relevance, as they seem to be the prelude to the new patterns that become predominant in the sessions to follow.

Ordinary variability in sessions 7, 8, 9, and 10

In the next four sessions (i.e., sessions 7, 8, 9, and 10), Lewis is 15, 17, 18, and 19 weeks old respectively. Unlike the other two infants reviewed thus far, Lewis is fussy during most of these sessions (especially in the last two sessions). A few social frames occur during these sessions, with short periods of face-to-face social play during the fussy periods. Lewis often responds to this play with smiles, squeals, blowing bubbles, and vocalizations. The mother entertains her fussy infant by imitating his actions. Thus, the ordinary variability of the social frame observed in previous sessions is also observed here.

During the guided object frame, Lewis more actively holds and explores the objects while the mother either presents a second object or highlights the properties of the object Lewis is exploring. During the fussy periods, especially in sessions 9 and 10, the mother shows a variety of objects and in a faster pace as a means to soothe the infant. Note, however, that the new ordinary variability of the guided object frame where Lewis is a more active explorer of the object was initially observed in the form of innovations during the transitions involving the not-guided object frame in previous sessions.

The ordinary variability of the not-guided object frame now involves the mother talking about Lewis' ongoing actions on the object, instead of actively supporting Lewis' exploration of the object, while Lewis examines and manipulates objects on his own, actively mouthing his hand and objects. It is relevant to note that these changes in the ordinary variability of the not-guided object frame can be traced back to the innovations previously observed in the frame transitions involving this frame where Lewis explores the object more independently while the mother provides more indirect support to Lewis' activities on the object.

Another change observed in the system is the continual increasing appearance of the social/object mixed frame. This frame continues to occur mostly when the mother touches or moves Lewis' body while he manipulates an object. For instance, the mother has the porcupine kiss Lewis' cheek or she places the caterpillar on Lewis' tummy, squeezing it. Touch continues to be a way the mother feels connected to her infant (even when he is focused on the objects around him), but now it is integrated with animated games involving the object. With Lewis' increased focus on a more independent manipulation of objects, the mother develops new strategies (such as animation of objects) to

maintain her connection with her infant. These strategies involve the integration of a positive emotional tone primarily observed in the social frame (which is now declining) with the manipulation of objects (which is now increasing).

Changes in the dynamics of frame transitions are also observed. First, there is a slight preference for transitions among the object-oriented frames, i.e., the guided object frame, the not-guided object frame, and the social/object mixed frame. With the exception of sessions 9 and 10 where Lewis is fussy most of the time, much of the frame transitions do not involve the social frame. Second, Lewis more often initiates the transitions by breaking eye contact with his mother, by pulling his hands away from the object, or by simply grasping the object with both hands. It is interesting to note that as Lewis becomes more independent in his object explorations (initially observed as innovations during the frame transitions involving the not-guided object frame) and as the mother – in response to the changes seen in Lewis – begins acting more like an observer of her infant during the frames. Also, perhaps in response to the mother's less active role, Lewis is also becoming more explicit with his bodily requests during the transitions. This in turn creates the impression that the transitions are becoming more circumscribed by Lewis' action on the object. In one transition from the guided object frame to the not-guided object frame, for example:

> The mother is holding a toy next to Lewis' hands, talking to him, while Lewis adjusts his hands to the toy held by the mother (guided object frame). *The mother stops talking to Lewis and keeps supporting his grasp of the toy. Lewis finally grasps the toy with both hands.* As Lewis grasps the toy, the mother releases the toy and starts talking to Lewis about the toy held by him, while Lewis examines the toy with his hands (not-guided object frame).

The example above illustrates how Lewis' grasping of the object punctuates the transition to the not-guided object frame. It is also noticeable that the mother's actions on the objects do not involve shaking or squeezing, but instead supporting of Lewis' grasping, followed by quiet observation of his exploration of the object. This new dynamics of frame transition can be traced back to the innovations observed in the previous sessions where Lewis acted as a more independent explorer of the object and the mother acted as an observer of her infant.

Innovations in sessions 7, 8, 9, and 10

Innovations are again observed in the frame transitions involving the not-guided object frame, especially during session 8. These innovations

involve a few occasions where Lewis' persistent object mouthing is observed during the transitions. In these occasional transitions, Lewis' focus changes from manipulating the object through mouthing to being immersed in object mouthing while the mother continues acting as an observer and facilitator of Lewis' immersion. This persistent mouthing is different from the exploratory mouthing observed during the frames in that it creates less room for the mother to be a part of the object activity. For instance, in one transition from the not-guided object frame to the social/object mixed frame:

> Lewis is mouthing a toy, looking at it, while the mother is talking to Lewis about the toy he holds (not-guided object frame). *Lewis keeps mouthing the toy and starts producing some negative vocalizations. The mother stops talking to Lewis*, and starts touching his hands, saying "tch tch tch." Lewis stops producing his negative vocalizations and keeps mouthing the toy, looking at it, while the mother continues touching his hands (social/object mixed frame).

In this transition, Lewis appears to be getting fussy while persistently mouthing the object (i.e., immersed) and the mother uses touch accompanied by her vocalization as a way of comforting Lewis. Although maternal touch seems effective in soothing Lewis, it does not change or reduce Lewis' immersion in the object as Lewis keeps persistently mouthing the object without looking at his mother. It is worth noting that in the sessions to follow (i.e., sessions 11 and 12) Lewis' object immersion through persistent object mouthing becomes a central activity in the dyad's communication.

Developmental account of sessions 7, 8, 9, and 10

During sessions 7, 8, 9, and 10, Lewis is fussy for long periods (especially in sessions 9 and 10). In spite of that, changes occur in each of the frames as well as in the frame transitions. The social frame is becoming background in the dyad's relationship as demonstrated by its decreasing appearance and duration during these sessions. Although brief in duration, the social frame returns to the positive emotional tone seen during the first sessions and it becomes an effective way of soothing the fussy infant.

During the object frames, Lewis becomes a more independent examiner of the object while his mother highlights the properties of the object Lewis is exploring during the guided object frame or makes comments on Lewis' object-oriented activities during the not-guided object frame. The social/object mixed frame presents an ordinary variability similar to that observed in previous sessions with the mother using touch as a

means to maintain contact with her increasingly object-focused infant. The difference is that during these sessions when the mother touches Lewis' cheek or stomach with an object, she animates the objects, thereby blending social and object activities in one. Such change in the mother's use of objects during the social/object mixed frame emerges as part of Lewis' increased focus on a more independent object manipulation. The mother thus becomes more creative in her use of objects during the social/object mixed frame (such as animation of objects) to maintain her connection with her increasingly object-focused infant.

During the frame transitions, Lewis and his mother appear to have "equal" levels of participation. It is important to highlight, however, that in the transitions to the not-guided object frame, Lewis begins to take more initiative and to act more as the "leader" with the mother acting more as a facilitator. In contrast, in the transitions to the social/object mixed frame, the mother becomes primarily responsible for initiating the changes into the social/object mixed frame either as a means to comfort Lewis or to re-establish some kind of connection with her increasingly object-focused infant. In most cases, the mother's attempts to transition to the social/object mixed frame are rarely ratified by Lewis, and the dyad returns quickly to one of the other object frames.

Finally, a shift toward Lewis' persistent object mouthing (i.e., object immersion) is beginning to be observed during some of the transitions involving the not-guided object frames. Once again, the innovations observed in the context of frame transitions appear to be a prelude to the patterns of frame and frame transitions observed in the next sessions.

Ordinary variability in sessions 11 and 12

During the last two sessions (i.e., sessions 11 and 12) of the observational period, Lewis is 20 and 21 weeks old respectively. There is a decrease in the guided object frame, and an increase in the frequency and duration of the not-guided object frame and the social/object mixed frame. No social frames are observed. During all three frames Lewis is very active and coordinated in manipulating objects. Persistent mouthing of objects becomes his primary activity, followed by fingering, shaking, squeezing, visual regard, and reaching. Consequently, Lewis interacts with an object for a longer duration of time than previously observed, which is reflected in the increase in the frequency and duration of the not-guided object frame.

During the guided object frame, the mother more consistently acts as an assistant by helping Lewis hold or manipulate an object when

necessary. The seeds of this pattern of activity where the mother provides quiet assistance to Lewis can be found in the occasional frame transitions (i.e., innovations) observed in previous sessions where Lewis is more immersed in object mouthing and the mother assists her infant in such activity. It is also worth noting that the current guided object frame includes and recapitulates characteristics of the social frame – a frame that is no longer observed. Specifically, when the guided object frame occurs, Lewis seems more responsive to his mother's support of object exploration by gazing at his mother while he is mouthing an object.

The not-guided object frame occurs in two forms: (a) when the mother verbally highlights Lewis' actions while Lewis is actively gazing at and manipulating an object; and (b) when the mother acts as a spectator by silently watching Lewis play without any kind of verbal or manual interference. It is important to highlight that the mother's activities of assisting and verbally commenting on Lewis' object mouthing were previously observed in the form of innovations in the frame transitions involving the not-guided object frame itself. Now, these activities appear in longer durations during the not-guided object frame. Thus, the previous innovations found in the frame transitions are now becoming expanded during this frame.

Another visible change in these last two sessions is the increase in the social/object mixed frame that involves the mother's use of touching and animated games to engage Lewis, while he mouths or manipulates objects. As previously observed in the social/object mixed frame, the mother kisses, tickles, and moves Lewis' hand, feet, and legs, accompanying her touch with different sounds, while Lewis continues mouthing an object, smiling, laughing, and gazing at his mother. Similar to what is observed in the guided object frame during these sessions, components of the no longer observed social frame are recapitulated by being included in the gradually increasing social/object mixed frame. Now that the Lewis is more fascinated with his independent activity on objects, the social/object mixed frame serves the function to maintain the dyad's social connection.

Similar to the previous sessions, the transitions occur essentially between the object-oriented frames. Lewis, however, is much more immersed in his own object-related activities than before, especially persistent object mouthing. Lewis' grasping of the object followed by his persistent mouthing of the object is the primary action (or sequence of actions) involved in most of the transitions. Meanwhile, the mother continues to be an explicit participant in the transitions by assisting her infant's object interest. With Lewis' more persistent and independent exploration of the object, the mother begins to change her actions more

quickly, either as a way of more promptly attending to Lewis' action request or as a way of reducing Lewis' immersion in object mouthing.

For instance, during the transition from the not-guided object frame to the guided object frame, as soon as Lewis stops squeezing an object he holds, the mother immediately takes that object away from Lewis and presents another one. In another instance, during the transition from the not-guided object frame to the social/object mixed frame, the mother starts talking to Lewis and immediately after starts touching Lewis' body while Lewis keeps mouthing the object throughout the entire transition. Therefore, although the mother appears to be more of an assistant and spectator of Lewis' manipulation of the object, she also attempts to reduce Lewis' immersion by rapidly changing her behaviors during the transitions from one frame to another.

Innovations in sessions 11 and 12

Innovations are observed for the first time in the context of the frames. Specifically, there are a few occasions in the guided object frame where the mother demonstrates a second object while Lewis manipulates the first. Often in these instances Lewis watches the second object the mother demonstrates, while immersed in mouthing the first. There are also a few times during the not-guided object frame that the mother seems almost bored and plays with an object by herself as if in a waiting period for the infant to break from the immersed object play. Because these are the last sessions examined in the present study, we do not further explore the historical implications of these innovations in the dyad's future dynamics of communication.

Developmental account of sessions 11 and 12

During these two sessions, the social frame is no longer present. Qualities of the social frame, however, seem to be recapitulated and blended into the other available frames. Specifically, there is some positive emotional exchange during the social/object mixed frame and some mutual gazing during the guided object frame. With Lewis' increasing focus on object immersion it is not surprising that the not-guided object frame (i.e., the newly emergent frame) increases in duration and frequency. At the same time, however, the social/object mixed frame increases as a means to maintain the social connection between Lewis and his mother while objects continue to be a part of their communication. During the transitions, Lewis remains focused on his more independent object exploration, while the mother appears to change her actions quickly as

a way of distracting Lewis from his immersion or promptly assisting Lewis with an object he holds. Therefore, during the last two sessions, the historical frames are becoming background as the newly emergent frame rises.

A developmental reorganization in the system (level 3 change) is thus observed where the dyad's focus of communication shifts from the guided object and social frames where the mother has a more direct participation in the dyadic activities to the not-guided object and social/object mixed frames where the infant becomes a more independent and absorbed explorer of objects and the mother's participation takes place primarily in the animated games involving objects (i.e., social/object mixed frame).

Overall summary of Lewis and his mother

Across time, this dyad gradually becomes more focused on both the not-guided object frame and the social/object mixed frame. Based on the quantitative analysis, we had tentatively concluded that this dyad was more focused upon social uses of objects rather than the uses of objects for their own sake. The qualitative analysis shows, however, that even though Lewis and his mother begin with the social frame and the guided object frame as the historical ground and have a relatively higher proportion of the social/object mixed frame in the later sessions compared to Richard and Betsy, Lewis too moves toward immersion with objects by the last sessions in both the not-guided object and social/object mixed frames. Also, unlike the other two dyads, the quantitative analysis taken alone leads to a different conclusion than the qualitative analysis.

The social frame changes relatively little over the observation period as it mainly involves positively toned face-to-face play interrupted by Lewis' turning his head to the side or fussing. It declines in duration over time, gradually becoming background in the dyad's relationship. Starting in session 8, when the decline of the social frame is most noticeable in the qualitative analysis, its positive emotional characteristic becomes incorporated into the guided object frame and the social/object mixed frame. This suggests that the available frames in the system are becoming more permeable to each other, incorporating each other's characteristics, possibly to retain some qualities of the frames that are fading away (i.e., the social frame). Thus, although the dyad is in fact moving toward immersion in object play, the ongoing recapitulation of the social play may serve to buffer the change in a dyad that clearly enjoys their mutual social play.

During the guided object frame, the mother begins acting as an assistant by responding to Lewis' level of attention and waiting for his bids to change objects during the first six sessions. During sessions 7, 8, 9, and 10, the mother's activity changes to facilitator in relation to Lewis' increased interest in examining objects. Finally, in the last two sessions, the guided object frame becomes short-lived and it occurs mainly when the mother assists Lewis' manipulation of objects that he mouths. As mentioned earlier, starting on session 8, this frame incorporates components of the social frame (i.e., mutual gazing) during the time when social frames are declining and when the infant is becoming more focused on independent exploration of objects.

The social/object mixed frame appears to serve a similar function at all times, specifically, as a way to maintain the mother-infant connection and as a break from Lewis' fussiness. Starting in session 8, as Lewis becomes more immersed in object mouthing, the mother becomes more creative with her use of object and animated object games become a predominant characteristic of the social/object mixed frame. As mentioned earlier, the positive emotional quality initially observed in the social frame is now recapitulated in the social/object mixed frame.

The not-guided object frame emerges for the first time during sessions 2, 3, 4, 5, and 6. It is during these sessions that Lewis begins to show a few signs of a more independent object exploration, which culminates in persistent mouthing in the last two sessions. It is not until session 8, however, that the not-guided object frame begins to become more central and prevalent in the mother-infant communication.

Therefore, for Lewis and his mother, the qualitative analysis suggests that the frame with the bridging role was the guided object frame. The guided object frame has a similar profile of the bridging frames for the other dyads. First, while Lewis and his mother spent a lot of time in the social frame during the first session, the guided object frame already demonstrated signs of integration of these two historical frames (i.e., social frame and guided object frame) as Lewis smiled and vocalized to the mother while she demonstrated objects. Second, as new frames were emerging during sessions 2 through 6, the guided object frame mediated most of the transitions between these frames. And third, although qualitative changes were observed within the guided object frame, this frame was maintained by the dyad throughout the entire observation period and it incorporated elements of the social frame (i.e., mutual gazing) into its own dynamics during the last two sessions. The quantitative analysis does in fact show a peak in duration of the guided object frame during sessions 6, 7, and 8, where the peak is set against the background of a developmental decline in duration of the guided object frame. It is

the qualitative analysis, however, that provides more support for this claim.

Finally, similar to what we observe for Richard and Betsy, we find at least two ways in which frames are related to transitions. First, there is a similarity of actions between frames and transitions across the twelve sessions. During the first session, for example, the social frame is mainly characterized by visual contact between Lewis and his mother. The mother vocalizes, tickles Lewis' stomach, and holds Lewis' hand. Lewis, in turn, moves his hands/arms, smiles, and vocalizes, thereby engaging in the social play with his mother. Comparably, in the transitions to the social frame, Lewis shifts his gaze direction and smiles at his mother, while his mother releases the object she is holding and starts touching Lewis' body.

Second, there are some differences between frames and transitions within the same sessions and these differences appear to be a prelude to the patterns observed in both the frames and transitions in later sessions. Reconsider the first six sessions, for instance, when the guided object frame is primarily characterized by the mother's active presentation of objects while Lewis intently watches the objects held by the mother. During that time, there are a few transitions when Lewis is not just watching the object held by the mother, but he actually holds an object in his own hands, looking at it intently, and the mother does not actively assist Lewis but verbally highlights Lewis' actions on the object. In later sessions (specifically, in sessions 7, 8, 9, and 10), such pattern of interaction between Lewis and his mother is observed and it becomes predominant in the guided object frame.

In spite of some equivocal findings from the quantitative analysis, when taken together both the quantitative and qualitative results support the two models of change suggested by propositions 1 and 2 (Chapter 3). There is a clear and bridging frame, the guided object frame, that fits the originally proposed sequence:

$$(P_1)\ \text{(Historical} \leftrightarrow \text{Bridging)} \Longrightarrow \text{(Bridging} \leftrightarrow \text{Emerging)}$$

The findings on proposition 2 for Lewis and his mother are very similar to those for Betsy and her mother. Developmental sequence (P_2''') that fit Betsy and her mother also applies here:

$$(P_2''')(\text{level } 1^{\alpha} + \text{level } 2^{\alpha})_{\text{period } \alpha} \rightarrow (\text{level } 1^{\beta}(+\text{level } 1^{\alpha} + \text{level } 2^{\alpha} + \text{level } 2^{\alpha'}) + \text{level } 2^{\beta})_{\text{period } \beta} \rightarrow (\text{level } 3)_{\text{period } \gamma}$$

As a reminder, this model shows that innovations in period β lead to a new ordinary variability in period β, such that there may be a series of

recognizably different developmental periods (α, β, γ, . . .), each with a new ordinary variability and new innovations which leads eventually to a developmental change (level 3). The model also contains terms in period β for recapitulation (+ level 1^{α} + level 2^{α}) and amplification of prior innovations (+ level $2^{\alpha'}$) as part of the ordinary variability during period β. For the latter term in this case, both Lewis and his mother amplified each other, creating feedback loops of continuing invention and creativity that were sparked by innovations in the previous developmental period.

For all the dyads thus far, the data fit our prediction that changes in ordinary variability are preceded by innovations which do not change the ordinary variability at the time they first appear, but only later, when the system shifts to some new period of ordinary variability. Finally, the level 3 developmental change for Lewis and his mother fits our definition of a re-organization of all the frames and transitions. First, there is a blending or permeability of one frame with respect to the others. The social frame, for example, becomes incorporated into the not-guided object frame and the social/object mixed frames. Second, there is an emergence of a new frame of more than brief duration with its own unique features (the social/object mixed frame and the not-guided object frame) and third, there is a recapitulation of older frames. In answer to the question posed at the end of Chapter 4 – does there need to be recapitulation in a developmental re-organization? – we now have two cases in which this indeed occurs: Betsy and her mother and Lewis and his mother.

The major difference between this dyad and Betsy and her mother was that a single frame, the guided object frame, played a dual role as historical and bridging at different points across the observational period. In addition, two frames, the not-guided object and the social/object mixed frame, played the same role as emerging frames. This suggests that the dyadic communication system has considerable flexibility in the realtime processes into which the developmental change process is woven. These results raise the intriguing possibility that there may be some general principles or laws of change – sequences (P'_1) and (P''_2) – that are present as an invariant background in spite of a great deal of between dyad variability.

11 Results of the current investigation: qualitative analysis of Susan and her mother

In this chapter, we present a case analysis of the development of frames and frame transitions for the final case of the four representative dyads, Susan and her mother. Similar to the organization utilized in previous qualitative chapters, we present the raw data developmental trajectories for each of the four frames, the raw data transition frequencies between the frames as a function of age, and a qualitative analysis of the relational history. In the latter, we describe the change processes at two levels, ordinary variability (referred to as level 1 change in Chapter 3) and innovations (referred to as level 2 change in Chapter 3), followed by a brief developmental account of these changes that describes any evidence for a developmental re-organization (level 3 change).

Developmental trajectories and transition frequencies

As shown in Figure 7.2 and Table 11.1, social frames were salient until session 6. They appeared to be the historical frame for this dyad. As with Lewis and his mother, both social/object mixed and not-guided object frames were the newly emerging frames. They began to increase at session 6 and grew steadily together for the remaining sessions, as reflected by a significant positive correlation between these two frames (see Table 7.2). Table 7.2 also shows a significant negative correlation between the social frame and the other three frames, suggesting that it is predominant early and is gradually replaced by the other frames. Again similar to Lewis and his mother, the guided object frame for Susan and her mother appears to serve as the developmental bridging frame because it has an inverted U-shaped trajectory with a peak between 5 and 9 weeks. Thus, Lewis and Susan shared a pattern of preference for more socially-oriented frames throughout their history and the final emergence of both social/object mixed frames and not-guided object frames in the last two sessions. The main difference between the dyads was in the historical and bridging frames.

Table 11.1. *Descriptive statistics of frames by session: Susan*

Session	1	2	3	4	5	6	7	8	9	10	11	12
Age (Weeks)	6	8	9	10	11	12	14	15	16	17	18	20
Social frame												
Frequency	2	1	2	1	1	1	3	10	10	9	5	4
% of session	1.49	52.50	43.61	90.38	89.31	29.83	66.43	18.73	35.21	29.34	2.03	6.52
Mean duration*	3.58	252.01	104.67	379.58	428.71	143.17	106.28	8.99	16.90	15.65	1.94	7.66
(s.d.)	(0.07)	(–)	(144.16)	(–)	(–)	(–)	(179.56)	(10.60)	(25.48)	(32.67)	(1.26)	(8.66)
Object guided frame												
Frequency	6	4	8	1	1	6	6	21	15	10	15	10
% of session	95.70	7.44	41.21	9.62	10.69	60.37	16.95	47.24	41.24	32.07	16.30	18.34
Mean duration*	76.56	8.92	24.73	40.42	51.29	48.29	13.56	10.80	13.20	15.39	5.19	8.62
(s.d.)	(32.68)	(3.18)	(21.94)	(–)	(–)	(50.47)	(10.02)	(8.50)	(12.33)	(13.99)	(3.30)	(5.89)
Not-guided object frame												
Frequency	3	1	2	0	0	4	7	8	11	4	13	11
% of session	2.16	0.62	1.45	0.00	0.00	5.69	8.58	8.83	10.51	7.71	22.65	36.31
Mean duration*	3.46	2.97	3.49	–	–	6.83	5.88	5.30	4.58	9.26	8.33	15.52
(s.d.)	(0.49)	(–)	(0.16)	(–)		(5.44)	(6.08)	(2.96)	(3.12)	(10.06)	(5.14)	(17.28)
Social/object mixed frame												
Social/object mixed frame												
Frequency	1	4	8	0	0	5	4	15	15	15	19	16
% of session	0.65	39.44	13.72	0.00	0.00	4.11	8.04	25.20	13.05	30.88	58.77	38.82
Mean duration*	3.12	47.33	8.23	–	–	3.95	9.65	8.06	4.18	9.88	14.78	11.40
(s.d.)	(–)	(65.50)	(3.97)	(–)	(–)	(2.13)	(7.10)	(7.89)	(3.97)	(11.27)	(17.88)	(13.27)

Note: * seconds

Table 11.2. *Frequency of frame transitions: Susan and her mother*

	Session											
Frame Transition	1	2	3	4	5	6	7	8	9	10	11	12
1->2	1					1	2		5	1		1
2->1	2				1				3	1		
1->4									1	2	1	
4->1		1					2		1	3	1	
1->3								1	2		1	
3->1							1	1	2	1	1	
2->3	2					1	1	1	5		2	1
3->2	2					3		1	4	1	3	
2->4	1	4	4			3	1	3	3	3		1
4->2	1	2	1			1		1	2	3	1	1
3->4							3		4	1		1
4->3						2	2		3	3		

Note: 1 = Social frame;
2 = Guided object frame;
3 = Not-guided object frame;
4 = Social/object mixed frame

In general, as shown in Table 11.2, this dyad made relatively few transitions between frames, except in sessions 8–11. Note that the mean durations of the social frame in the early sessions (Table 11.1) was exceptionally long. Basically, each instance of the social frame lasted almost the entire session with no breaks. During the first six sessions, most of the transitions that did occur were with the social frame and social/object mixed frames. After session 8, this pattern is augmented with transitions between all the frames but especially with the guided object frame. In sessions 9 and 10, most transitions were with the guided object frame, suggesting that it may serve as a developmental bridging frame. The guided object frame had an inverted U-shaped trajectory between sessions 6 and 10 and transitions to the guided object frame seemed to signal a shift in both the pattern of transitions and the developmental trajectories of the durations. In sessions 11 and 12, most transitions were with the not-guided object frame.

Qualitative analysis

Ordinary variability in sessions 1, 2, 3, 4, and 5

During sessions 1, 2, 3, 4, and 5, Susan was 6, 8, 9, 10, and 11 weeks old respectively. Within these sessions, this dyad is primarily engaged in social and social/object mixed frames, followed by the social nature of the guided object frame. The mother is very talkative across all frames and the topics of conversation often focus on Susan's sisters, father, grandparents, and how others respond to Susan and vice versa.

As part of the ordinary variability of the social frame, reciprocal face-to-face play occurred as the mother imitates Susan's smiles, vocalizations, and other facial expressions, often touching Susan's body and face. Although Susan is sometimes sleepy and fussy, when awake, she tends to be very expressive: she gazes at her mother, smiles, and vocalizes. Often Susan moves her arms and legs while her mother is touching and talking to her. During these first five sessions, Susan's gaze at her mother's face appears to be central to the dyadic communication during the social frame.

During the social/object mixed frame, the mother holds an object and touches Susan with her free hand or with the object while Susan gazes only briefly at the object, immediately returning her gaze to the mother. When the mother touches Susan with an object she is usually trying to stimulate a sleepy infant, or calm a fussy or crying one. As the mother squeaks the red porcupine up Susan's tummy, for example, Susan smiles

and the mother comments about loving Susan's smiles. It is as if the object becomes an extension of the mother's hand for touching. This pattern of activity constitutes the ordinary variability of the social/object mixed frame during the first five sessions. Typically, after a few moments of social/object mixed interaction, the mother puts the object down and the dyad returns to the social frame (face-to-face play).

During the guided object frame, the mother holds an object steady within Susan's sight. Her social talk, however, remains the focus of the interaction while the object is passively held by the mother's chest within the line of gaze of Susan. Overall, the ordinary variability of the guided object frame is characterized by the predominance of the mother's social talk with little emphasis on the object's properties while Susan rarely looks at objects, almost always focusing on her mother's face. One could say that the object is not actively a part of the interaction, and thus the social nature of the guided object frame. In this sense, the guided object frame appears to be a bridging frame because it combines aspects of both social and object frames. It was not coded as a social/object mixed frame, however, since the mother did not use the object itself for social purposes. In the case of Susan and her mother in these early sessions, however, the dividing line between the guided object frame and the social/object mixed frame is somewhat blurred.

A few frame transitions are made in these first five sessions. This seems to be in part because Susan and her mother spend a great deal of their time engaged in two specific frames (i.e., the social and the social/object mixed frames). When transitions do occur, however, they are made in long durations and almost always involve the guided object frame. It is as if transitions mainly emerge when the dyad is either attempting to move out of the guided object frame and back to their "preferred" socially oriented frames or when the dyad is attempting to re-direct their focus to objects.

Similar to what is observed in the frames, Susan's gaze is central in indicating her interest as the mother makes use of different actions to attract Susan's visual attention to a joint activity (often, a socially oriented activity). In one transition from the guided object frame to the social frame, for instance:

> The mother is shaking the rattle between her face and Susan's face, while Susan shifts her gaze between her mother's face and the toy held by the mother (guided object frame). *The mother stops shaking the toy, bringing it toward her chest and establishing eye contact with Susan. At this point, Susan looks at her mother's face intently.* The mother then touches Susan's legs with her hands, talking to Susan and putting the toy on the floor (social frame).

The example above illustrates a rather predominant pattern of transitions in these first five sessions: Susan's gaze is the primary transitional action indicative of her attention, whereas the mother stops her actions on the object (i.e., holding it passively) and adds touch to the dyadic communication, thus amplifying her social connection with Susan (i.e., concluding the transition to the social frame).

In addition to the transitions involving the guided object frame, we also identified instances where the not-guided object frame is so short in duration that this frame can be considered a transition between frames, rather than a frame in which the observer can identify a distinct pattern of activity. In one situation, for example, the dyad is engaged in the guided object frame, and as the mother starts putting away an object, she talks to Susan about the objects. The mother then picks up a new object to show Susan. This brief episode of the not-guided object frame is immediately followed by a return to the guided object frame. Thus, this period of time in which the mother is talking about objects as she picks up another one is referred to as a brief "pause" in the guided object frame, rather than the not-guided object frame itself. This characteristic of the "still to emerge" not-guided object frame is very common in these first five sessions.

Innovations in sessions 1, 2, 3, 4, and 5

Innovations are observed in these first five sessions in the context of the guided object frame. Specifically, there are occasional moments during the guided object frame that the mother slowly shakes or squeezes an object, attempting to have Susan visually follow it. Usually, on these occasions, Susan briefly follows the object with her eyes and then looks back at her mother's face. This change in the predominant pattern of interaction that characterizes the guided object frame constitutes an innovation because the change, although recognizable, does not seem to perturb the predominant ordinary variability of the frame. It is also worth noting that object demonstration accompanied by the infant's visual interest later becomes a key characteristic of the ordinary variability of the guided object frame.

There are also three transitions involving the guided object frame in which Susan and her mother include the object as part of their communication in a slightly different manner. In contrast to the predominant pattern observed in these five sessions, Susan's mother holds the object within Susan's reach, sometimes adjusting it into Susan's hand. On these occasions, Susan actually moves her arms towards the object, at times even touching it. In other words, during these innovations, the

dyad appears to focus on the object as an element whose properties are to be explored visually and/or manually. This variation in the predominant dynamics of frame transitions constitutes an innovation that will be later expanded by the dyad in the context of object-oriented frames.

Developmental account of sessions 1, 2, 3, 4, and 5

During the first five sessions, Susan and her mother are mostly focused on socially oriented frames. Although Susan is often sleepy or fussy, she gazes for long periods at her mother's face, smiling and moving her body; while her mother acts primarily as a captivator of Susan's attention to distract her from fussing or looking away. Even during the guided object frame, the mother uses primarily social talk and does not demonstrate the object's properties – except for the few occasions, identified as innovations, when the dyad focuses on the properties of the object.

A historical analysis of the dyad's relationship suggests that, at this point, the social frame constitutes the historical frame. Because most of the transitions during this period were between the social/object mixed frame and the guided object frame, the social/object mixed frame appears to be a bridging frame for the increasing emergence of the guided object frame. This is because in the sessions to follow the social/object mixed frame declines and remains low until the final sessions while the guided object frame increases its appearance and the social frame remains predominant. This suggests that the "main bridging" frame for the dyad, the guided object frame, uses a "sub-bridging" frame to facilitate its development. The continual predominance of the social frame suggests this frame has the function of providing the dyad with a historically familiar background for the emergence of a new frame – in this case, the guided object frame.

Although frame transitions are not frequent in these first sessions, when they do occur, they primarily involve the guided object frame. Susan's gaze is the highlight of their interaction while the mother changes her activities as a means to attract or maintain Susan's attention on a joint activity (mostly, social in nature). Two aspects of the transitions are worth highlighting, as these appear to serve as a historical prelude to later sessions. First, the not-guided object frame briefly emerges as a short pause in the guided object frame when the mother talks about objects. Second, there are occasional transitions where the dyad's focus is on object-oriented actions (specifically, infant reaching and grasping), as if leading the way into the pattern of the next few visits.

Ordinary variability in sessions 6, 7, and 8

In the next three sessions (i.e., sessions 6, 7, and 8), Susan is 12, 14, and 15 weeks old respectively. Although all four frames are now observed, the social frame continues to be the primary frame in the dyad's relationship, with the guided object frame now as a close second. The not-guided object frame and the social/object mixed frame are low in their appearance and occur about equally.

Similar to what was observed in the previous sessions, the ordinary variability of the social frame during these three sessions continues to be characterized by the mother talking about social topics and using a variety of rhythmic noises, chants and singing while also moving Susan's arms side-to-side. With the dyad's growing interest towards objects (as reflected by the increase in the guided object frame), the social frame is becoming expanded by the dyad to include many creative forms of social connection. For instance, Susan and her mother successfully engage in repetitive vocal play as Susan becomes more active with her cooing and smiling. Furthermore, Susan begins holding onto or manipulating her mother's fingers, thereby maintaining a social connection with her mother while at the same time exploring her new motor ability. It is important to highlight that this new component of the social frame (i.e., holding and manipulating) first emerged as an innovation in the frame transition involving the guided object frame when the dyad focused on the object as an element to be explored visually and/or manually during sessions 1 through 5.

At the same time, the dyad begins to spend a great deal of their time engaged in the guided object frame. The ordinary variability of this frame involves the mother spending most of the time helping support object interactions for Susan, by giving Susan objects to reach for and occasionally, highlighting the objects' properties. Susan in turn begins grasping and exploring the objects through fingering, shaking, squeezing, and gazing. Note that this object-focus originally emerged in the form of innovations in the frame transition where Susan actually touched the object presented by her mother. Although Susan begins to present a consistent interest in objects, she still prefers gazing at her mother's face during the guided object frame, showing a connection to their prior history where the dyad's social focus was predominant.

The not-guided object frame is now emerging as a distinct frame and not as a transitional pause within the guided object frame. Its predominant ordinary variability includes the mother's words of encouragement when Susan actively examines and manipulates objects. In these cases, the mother's words tend to be brief and mirror back what Susan is doing

with the object such as "you got it!"; "can you get it?"; "look, you got a hold of the toy!"; and "do it again." Such active examination and manipulation of objects from the part of Susan can be traced back to the innovations observed in the frame transitions involving the guided object frame during sessions 1 through 6 where Susan began touching objects presented by her mother. It is as if previous innovations became amplified by the dyad, thereby leading to the emergence of the not-guided object frame. It is worth highlighting, however, that although the dyad appears to be more oriented towards the object than they were during the previous sessions, they continue to prefer their social connection as reflected, for instance, in the mother's behavior of leaning down over Susan's face during each session, even when Susan actively manipulates objects.

Finally, a change in the ordinary variability of the social/object mixed frame is observed. The new ordinary variability of this frame includes the mother touching Susan's body while Susan holds an object she is actively exploring through fingering, shaking, squeezing, and gazing. The mother also bicycles Susan's legs, commenting on Susan's increasing kicking movements, while Susan holds an object in her hands. Once again, with the dyad's increasing interest in objects, that emerged out of the innovations in the guided object frame and the frame transitions involving this frame during sessions 1 through 6, a re-organization in the ordinary variability of the social/object mixed frame is observed to include Susan's more active manipulation of the object and the mother's efforts to maintain a social connection with her infant through touch.

Close analysis of the frame transitions indicates an increase in the number of transitions involving all four frames. As the dyad expands their patterns of communication (as reflected in the appearance of all four frames), they have also become more open to navigating across these frames. Unlike what was observed in the previous six sessions where the dyad made fewer transitions between the frames, the emergence of a new frame (i.e., the not-guided object frame) and the augmentation of the guided object frame increase the dyad's creativity in their ways of communicating, thereby proliferating transitions between frames. A pattern similar to the previous sessions, however, is still observed as many of the transitions occur via the guided object frame.

New characteristics also arise during the frame transitions, and these are linked to the innovations observed in previous sessions in that they incorporate elements of object exploration that first emerged during those innovations. Specifically, several transitions from the social frame

(i.e., the historical frame) to the guided object frame (i.e., the currently amplified frame) involved the mother's use of social actions as a means to getting Susan's focus on an object-related activity. In other words, there is a blend of the familiar activities (e.g., touching) with the new activities that are being explored by the dyad (e.g., visual inspection of an object). The example below illustrates such a blend of activities:

The mother is touching Susan's cheeks while Susan is smiling (social frame). *Susan stops smiling and looks at her mother's hand. Her mother then uses the same hand to touch Susan's right hand while Susan continues to watch her mother's hand. The mother stops touching Susan's hand* and begins to move her fingers for Susan to watch, using her hand as a toy while Susan continues watching her mother's hand (guided object frame).

Therefore, in contrast to the previous sessions where Susan and her mother focused on their social connection, the dyad's actions during the transitions now involve the coordination of gazing with other object-related actions. This pattern of frame transition characteristic of these three sessions is further illustrated in the next example:

The mother is touching Susan's belly with a toy, quietly (social/object mixed frame). *Susan then grasps the toy the mother is using to touch Susan's belly.* At this point, the mother releases the toy saying, "Look at your hand! You can do it!" Susan keeps holding the toy with both hands while her mother talks to her about Susan's ongoing action on the toy (not-guided object frame).

In sum, the changes in the dynamics of frame transitions can also be traced back to the innovations observed in the guided object frame and in the transitions involving this frame during previous sessions (i.e., sessions 1 through 5). Specifically, those innovations reflected a unique opportunity where the dyad for the first time focused on the object as an element whose properties are to be explored visually and/or manually.

Innovations in sessions 6, 7, and 8

Once again, innovations are observed in the guided object frame. There are a few occasions where the mother does brief object demonstrations in the context of this frame by shaking or squeezing an object before steadying it for Susan to reach – as it is usually done in these three sessions. With the inclusion of brief object demonstrations prior to steadying the object for the infant, a potential for further expansion in the way the dyad interacts with objects and further elaboration of the historical frames (e.g., social frame) is observed during sessions 6, 7, and 8.

Developmental account of sessions 6, 7, and 8

Several changes emerge in the frames during these three sessions. The social frame is still predominant and Susan and her mother continue to be mutually involved in socially oriented actions. On the other hand, both the guided object frame and social/object mixed frame are more focused on objects and their properties. Susan begins to focus on object manipulation and inspection, while her mother helps Susan examine the objects. Although most transitions continue to occur via the guided object frame, these are increasing in frequency and beginning to be made at a fast pace as Susan now quickly grasps objects.

The increasing dyadic focus on objects does not yet seem to interfere with the dyad's historical social connection. This is reflected, for example, by the mother's integration of social and object-oriented activities when she shifts from using her hand as a social action (touching the infant's face) to using her hand as an object (moving her fingers for Susan to watch). This shift seems to provide the dyad with an opportunity to explore their new focus on object exploration while maintaining their familiar dynamics of directly interacting with one another. It is important to highlight that this new component of the social frame first emerged as an innovation in the frame transition involving the guided object frame when the dyad focused on the object as an element to be explored visually and/or manually during sessions 1 through 5. The impression the observer gets is that these two frames – the social frame as a historical frame and the guided object frame as a newly emerging bridging frame – are becoming more permeable to each other, each incorporating elements of the other. This mutual incorporation of elements from each frame may in part explain the upcoming change in the emotional tone of the social frame where Susan appears less socially expressive in that frame (i.e., fewer smiles).

Ordinary variability in sessions 9, 10, and 11

During sessions 9, 10, and 11, Susan is 16, 17, and 19 weeks old respectively. The guided object frame becomes predominant while the social frame decreases in its frequency and duration, occurring about as much as the not-guided object frame and the social/object mixed frame. Changes within each of these frames are observed.

Compared to the previous sessions, the dyad's pattern of social play becomes even more sophisticated and creative. The mother now uses more touching games and new vocal sounds: she talks to Susan in a

pleasant, calm, cheery voice, laughing and smiling a great deal. She also blows raspberries, kisses Susan's feet, and tickles Susan. Although Susan actively watches her mother's entertaining face and actions, she is less expressive than before (i.e., few smiles and laughter are produced). It is as if the mother's social actions are becoming more varied in an attempt to elicit smiles or laughs from Susan during the social frame. These brief instances of the social frame may be considered a form of recapitulation of previous social activity in the midst of a change in the communication system as it becomes more oriented toward objects.

At the same time that Susan becomes less expressive during the social frame, she gets more focused on objects and very active reaching for objects on her own during the guided object frame, to the extent of even rolling herself side-to-side to reach a desired object. Also, she now looks at the objects as much as she looks at her mother's face. The mother in turn continues to steady objects for Susan to reach and helps Susan to hold onto an object. These more elaborated forms of object-oriented activities can be traced back to the innovations observed during the guided object frame in the previous sessions where the mother for the first time not only steadies the object for Susan but she also squeezes and shakes the object as if highlighting its properties.

During the transitions from and to the social frame, Susan's gaze direction remains the most salient transitional action. Specifically, by simply gazing at her mother, the dyad appears to easily transition to the social frame. Likewise, when Susan gazes away from her mother, the dyad quickly transitions out of the social frame. Although the social frame is declining in frequency and duration, the dyad can quickly recognize their previous history associated to the social frame.

On the other hand, during the transitions between the object-oriented frames, the mother gradually becomes quiet and mostly observant of Susan. She rarely facilitates Susan's grasping of objects and does not make comments about Susan's actions on the objects. At most, during the transitions from the not-guided object frame to the guided object frame, the mother places objects within Susan's reach and then quietly watches Susan manipulate the objects. This new form of frame transition is not directly linked to the innovations observed in the guided object frame during the previous sessions. Instead, this new dynamics of frame transitions appears to be a result of the re-organization in the dyad's communication where Susan is gradually becoming more focused on the exploration of the objects through object mouthing and the mother is becoming a quieter observer of her infant.

Innovations in sessions 9, 10, and 11

An innovation is observed in the not-guided object frame. There are moments during this frame that Susan becomes immersed in her object mouthing, allowing little room for her mother to participate in the object-interaction. These occasional immersions differ from the predominant pattern of frames and frame transitions observed in these sessions, as Susan's persistent object mouthing is not yet predominant. It is worth highlighting that Susan's persistent object mouthing (i.e., object immersion) accompanied by the mother quietly watching Susan become predominant in the next visit.

Developmental account of sessions 9, 10, and 11

During these three sessions, a developmental re-organization in the system (level 3 change) is observed where the dyad becomes mostly focused on object play (although Susan has not become completely immersed in her own object activities). This is illustrated in the changes in all four frames and in the increased number of direct transitions between frames. During the social frame, Susan is now merely an observer of the mother's attempt to engage Susan in social play. During the object frames, Susan is more self-guided, while her mother either provides objects without demonstrating them or simply stands as an observer of Susan's activities. The guided object frame is becoming short-lived, and its ordinary variability includes the mother handing a different object to Susan, followed by the dyad's almost immediate transition to the not-guided object frame. As opposed to the previous sessions when the not-guided object frame was often brief and presented a transitional nature, this frame now increases in its frequency and duration, becoming a more distinguished frame in the dyad's relationships.

Also, a new characteristic emerges in the not-guided object frame where the mother no longer leans down to Susan's face. This new quality was not observed in previous sessions in the form of innovations. Several other "new" actions are observed during both frames and transitions that were not preceded by innovations in the previous developmental period. In the other two dyads in which there was a level 3 developmental re-organization, we did observe changes during that re-organization that did not appear in prior developmental periods, but we could always detect a link to some innovation that was later amplified. It now appears, with Susan and her mother, that developmental re-organization may

be an opportunity for spontaneous creativity not preceded by previous forms.

There are a few occasions when Susan's object focus is transformed into persistent object immersion as reflected in the innovations observed in the not-guided object frame. These changes seem to reiterate the increasing decline of the guided object frame and the predominant rise of the not-guided object frame during the next session.

Ordinary variability in session 12

During the last session (session 12), Susan is 20 weeks old. This session differentiates itself from the previous sessions in that the not-guided object frame and the social/object mixed frame are the two predominant frames, whereas the guided object frame happens sometimes and the social frame rarely occurs. Susan is now extremely immersed in object play and more interested in gazing at objects. The mother appears to accept this change and adapts herself to Susan's increased interest in objects. Thus, the dyad has shifted from an object focus involving both the mother and the infant to an object focus where Susan almost always engages in unilateral exploration of the objects.

In fact, this session begins with the mother attempting to recapitulate their earlier forms of social connection by trying to engage Susan in social frames through tickling of Susan's belly and legs accompanied by noises. During the mother's few social attempts, however, Susan fusses, looking at and reaching for the objects. The mother immediately adjusts herself by giving Susan an object. The dyad then engages in the now brief guided object frame.

During these brief episodes of the guided object frame, the mother facilitates object exploration at a fast rate by quickly demonstrating the primary property of the object (i.e., quickly shaking or squeezing the object) and immediately handing the object to Susan, and occasionally helping Susan hold an object. The ordinary variability of this frame thus includes earlier forms of object demonstration (i.e., recapitulation) accompanied by facilitation of Susan's more independent object play, while Susan remains focused on the object that she will soon explore with her mouth.

Immersion is now a predominant characteristic of the not-guided object frame: Susan persistently and actively mouths and manipulates objects, gazing at the objects she explores, while her mother quietly observes Susan. During the few moments that the mother talks, the topics of her conversation are related to the objects, as opposed to more social talk observed in prior sessions. Susan is also less vocal and rarely

smiles. This new ordinary variability can find its roots in the transitions involving the object-oriented frames and in the innovation observed in the not-guided object frame during sessions 8 through 11. Specifically, during those transitions the mother begins to display a pattern of quietly observing Susan's activities and during the innovation of the not-guided object frame, Susan is more immersed in object mouthing for the first time.

The social/object mixed frame also happens while Susan is intensely and persistently mouthing an object (i.e., immersed). In these situations, the mother plays two tactile nursery rhyme games with Susan's body: she tickles Susan's feet and belly, chanting a familiar nursery rhyme, while Susan watches her mother and continues sucking on her object. In the other tactile game, the mother plays "three little piggies" with Susan's toes, and kissing and blowing raspberries on Susan's feet while Susan mouths an object. These patterns of touching and tickling Susan's feet, legs, and belly appear to be an expansion of the previous ordinary variability of the social/object mixed where the mother already attempted to maintain a social connection with her gradually object focused infant. Specifically, during this last session, the mother uses such tactile nursery rhyme games as a way to distract Susan from turning over while mouthing an object by recapitulating social games co-created by the dyad in earlier sessions. These may constitute an effective strategy utilized by the mother because Susan's object immersion can now become integrated into previous forms of communication where the mother tickled, touched, and blew raspberries.

Similar to what was observed in sessions 1 through 5, few transitions are made by the dyad in this last session. The difference between session 12 and sessions 1 through 5 is the frame that the dyad is focused on. Whereas during sessions 1 through 6 the focus was on the social frame, during this last session the dyad is now focused on the not-guided object frame. This seems to be in part because of the dyad's increased immersion in the infant's object mouthing.

When frame transitions occur, most of them are made in a fast way. Although Susan continues to be actively participating in the frame transitions, her actions are different from the ones observed in the previous sessions. Susan continues to easily grasp an object, looking at it, and she also holds an object in her own hands. However, in this last session, Susan's persistent mouthing of the object becomes the most salient transitional action involving all four frames as Susan now appears immersed in unilateral, non-mutual object play. The mother, on the other hand, continues to be the quiet observer of Susan's actions on the object, particularly, when Susan is absorbed in mouthing the object.

The mother also makes brief verbal comments about Susan's actions on the object and facilitates Susan's grasping of the object during the brief transitions from the guided object frame. Innovations were not observed in this session. Perhaps, a historical analysis of the future patterns would allow us to identify potential seeds of the dyad's future communication dynamics in the context of the frame transitions.

Developmental account of session 12

This session includes the continuation of trends of the dyad's object interaction that began during sessions 9, 10, and 11, except that persistent object mouthing is now predominant. The mother becomes a spectator of Susan's immersed object activities during the not-guided object frame. She also continues using the social/object mixed frame as a way of distracting Susan from her immersion by recapitulating and integrating earlier games into Susan's current object focus. The guided object frame involves brief demonstrations of the object property and occurs as a transition pause during the not-guided object frame. The social frame rarely occurs, except for the beginning of the session when the mother unsuccessfully attempts to recapitulate earlier forms of social interactions. Furthermore, Susan's immersion in object mouthing becomes so powerful that it appears to set the pace of the transitions with the dyad making quick transitions between the frames.

Overall summary of Susan and her mother

A historical analysis of this dyad's relationship across the twelve sessions suggests that the social frame is the historical frame for this dyad during the first five sessions, while the social/object mixed frame appears to serve the bridging function for the increasing emergence of new frames (i.e., first the guided object frame and then the not-guided object frame). The guided object frame appears to also constitute a bridge between the other frames as illustrated in the frame transitions during the first five sessions where the guided object frame is involved in all transitions.

It is not until sessions 6 or 7 that the frame transitions begin to take place directly, without bridging with the guided object frame. As Susan and her mother gradually become more focused on both the guided object frame and the social/object mixed frame, the not-guided object frame begins to emerge as a distinct and recognizable frame. Recall that its first appearance occurs in the context of the guided object frame as a pause of this frame during sessions 1 through 5.

Therefore, during the first five sessions the dyad's primary focus is on establishing and maintaining a social connection between them, as reflected in the predominance of the social frame and the social nature of the object-oriented frames (particularly, the guided object frame and the social/object mixed frame). The bridging function of the guided object frame is shown because it is permeated by social games between Susan and her mother. Objects are not used for demonstrations or highlighting affordances. Susan spends most of the time looking at her mother and paying relatively little attention to the objects surrounding her, while her mother engages in continual conversations and tactile games with and without objects. This illustrates the unique quality of this dyad – their maintenance of a strong social connection for at least the first five sessions.

Between sessions 6 and 8, familiar patterns of communication (i.e., social focus) begin to become integrated with new elements of the dyad's communication (i.e., interest in objects). The mother's hand is used as an object, especially in the context of frame transitions involving social and object frames. Another peculiar characteristic of these sessions is that innovations that were primarily observed in the context of object-related frames later became expanded in these frames as well as in the social frame. In other words, although the innovations were taking place during the object-related frames, such innovations were getting "picked up" by and expanded into all frames (and not only the object-related frames). This suggests that, during sessions 6 and 8, the frames were becoming increasingly more permeable to each other, each incorporating elements of the other. For instance, the social frame decreased during that period and fewer smiles and laughter were observed. At the same time, these changes in the emotional tone of the social frame were linked to the changes in the more object-oriented frames where object interest was arising as a predominant emotional tone of the frames.

During the final four sessions (i.e., sessions 9, 10, 11, and 12), a reorganization in the dyad's focus of communication, which began in sessions 6–8 is more clearly identified. By session 9, Susan begins to pull back to being merely an observer of her mother's attempts at social play, culminating in Susan's immersion in object mouthing in the last session. In fact, during the last session, the mother tries to recapitulate earlier forms of social connection by engaging Susan in joint activity with no success. The guided object frame becomes a transitional pause in the newly emergent not-guided object frame as the mother briefly demonstrates the properties of the object and then simply hands different objects for Susan to manipulate. Subsequently, the not-guided object

frame becomes the predominant focus of the dyad as Susan shifts from examining objects to immersing herself in object mouthing.

Similar to what was observed in the other dyads, there are a number of ways in which frames are related to transitions. First of all, there is the similarity of actions during the frames and transitions across the sessions. During the social frame, for example, reciprocal face-to-face play occurs as the mother imitates Susan's smiles, vocalizations, or facial expressions, while Susan gazes at her mother, smiling and vocalizing. During transitions in the same sessions, Susan's gaze is the primary action. Likewise, in later sessions, as Susan uses more examination and later immersion during the frames, similar actions become salient during the transitions.

Second, the differences between actions during frames and transitions across the sessions seem to be preludes to the patterns that are to emerge in the sessions to follow. For example, the predominant pattern of frame and frame transition involving the social frame during the first five sessions is characterized by Susan's gaze direction as the central action indicative of her attention while the mother is very talkative and focuses on capturing Susan's visual attention towards her face most of the time. However, there are three transitions in which Susan and her mother include the object as part of their social communication in a slightly different manner. Specifically, Susan moves her arms towards the object, at times even touching it, while she also introduces a new transitional action: she holds the object within Susan's reach, adjusting it into Susan's hand. Thus, in most cases, changes observed in frame transitions preceded transformations in the mother-infant communication system.

A third type of relationship between frames and transitions is that sometimes the transitional action becomes incorporated into the next frame. This is particularly noticeable between sessions 6 and 8, as the guided object frame is sometimes organized around the mother's use of her hand as an object. As suggested earlier in this chapter, this novel use of the hand seems to integrate two important elements of the frames that compose the dyad's ongoing repertoire – the historical social frame and the newly emergent frame at that time (i.e., the guided object frame).

A fourth type of relationship between frames and transitions is the use of a brief frame as a transition. This occurs in a reverse symmetry for the guided object frame and the not-guided object frame. Each occurs as a pause within the other at different points in the dyad's relationship history. The not-guided object frame is a pause of the guided object frame when it first appears between sessions 1 through 8, while the

guided object frame becomes a transition pause of the not-guided object frame as it is disappearing from the dyad's repertoire at the end of the observation period.

Proposition 1, regarding developmental bridging frames, was supported by the data. Based on the quantitative analysis, we had tentatively named the guided object frame as a developmental bridging frame for this dyad. The qualitative analysis suggests that the guided object frame appears to be a bridge for the more socially oriented frames during the first five sessions as it constitutes a locus of transitions first with the social frames and later with the not-guided object frame. Even the early instances of the guided object frame had a bridging quality. The "object" used by the dyad included part of the mother's body (her hand) and the talk was social in nature. Different from the other dyads, the qualitative analysis also indicated that the social/object mixed frame constituted a bridge for the increasing emergence of the guided object frame. This suggests that bridging is a general process that may fill the gap in the developmental transition of any two developmentally related frames.

This suggests that sequence,

$$(P_1) \quad \text{(Historical)} \leftrightarrow \text{(Bridging)} \Rightarrow \text{(Bridging} \leftrightarrow \text{Emerging)},$$

can be expressed as an iterative or embedded sequence that repeats itself over time.

$$(P_1'') \quad \text{(Historical)} \leftrightarrow (\text{Bridging}_1) \Rightarrow (\text{Bridging}_1 \leftrightarrow \text{Emerging/Bridging}_2) \Rightarrow (\text{Emerging}_1/\text{Bridging}_2 \leftrightarrow \text{Emerging}_2).$$

In this case, there is the first bridging frame (Bridging_1, the social/object mixed frame) which facilitates the development of the first emerging frame (Emerging_1, the guided object frame). The guided object frame becomes the new bridging frame (Bridging_2), which facilitates the development of the second emerging frame (Emerging_2, the not-guided object frame). It is possible that any frame could serve as a bridging frame for something that occurs later, although we would need a longer period of observation to test whether all frames eventually play a bridging role.

This dyad also displays a pattern similar to sequence (P_1'), Chapter 8, in which brief instances of the emerging frame (not-guided object) make realtime time transitions with the historical (social) and bridging frames (guided object) in the early developmental periods, while brief instances of the historical frame make transitions with the bridging and now longer emerging frame in the later periods.

The findings on Proposition 2 for Susan and his mother are very similar to those for Betsy and Lewis and their mothers. Developmental sequence (P_2''') applies here:

$$(P_2''')(\text{level } 1^{\alpha} + \text{level } 2^{\alpha})_{\text{period } \alpha} \rightarrow (\text{level } 1^{\beta}(+\text{level } 1^{\alpha} + \text{level } 2^{\alpha} + \text{level } 2^{\alpha'}) + \text{level } 2^{\beta})_{\text{period } \beta} \rightarrow (\text{level } 3)_{\text{period } \gamma}$$

As another reminder, this model shows that innovations in period α lead to a new ordinary variability in period β, such that there may be a series of recognizably different developmental periods (α, β, γ, . . .), each with a new ordinary variability and new innovations which leads eventually to a developmental change (level 3). The model also contains terms for recapitulation (+ level 1^{α} + level 2^{α}) and amplification of prior innovations (+ level $2^{\alpha'}$) as part of the ordinary variability during period β.

For most of the innovations observed in this dyad, we see the same pattern as the others, in which changes in ordinary variability are preceded by innovations which do not change the ordinary variability at the time they first appear, but only later, when the system shifts to some new period of ordinary variability. On the other hand, Susan and her mother showed some innovations that occurred during the same developmental period and which did alter the ordinary variability when they appeared. We only saw this occur, however, during the developmental period in which there was a level 3 developmental re-organization for this dyad.

Although it is only a single case, we are inclined to believe that this does not change our basic proposition regarding the prior occurrences of innovation leading to change only in later developmental periods. This proposition in fact occurs for most of the innovation found with Susan and her mother. Rather, we believe that these innovations show yet another feature of level 3 re-organization processes, a feature that can be added to the other characteristics of re-organization. In sum, the following are proposed to be potential features of level 3 change:

- a blending or permeability between frames,
- the emergence of a new frame of more than brief duration with its own unique features,
- a recapitulation of older frames, and
- spontaneous, creative innovations that contribute to the overall re-organization.

Regarding the proposed link between recapitulation and developmental re-organization, all three dyads that showed level 3 change also showed recapitulation during this same period. On the other hand,

recapitulation occurred for this dyad in the developmental period after which there was a level 3 change. We also observed permeability between frames in the developmental period prior to the one in which the level 3 change occurred. One possible explanation is that for this dyad, developmental change occurred gradually, across a number of different developmental periods. But if we break down these "smaller" level 3 changes, the main features of level 3 changes hold true. For instance, the guided object frame is recapitulated as a new frame emerges.

Perhaps this reflects flexibility in the change process which may allow dyads to avoid abrupt transitions and to smooth out the developmental change. This dyad was especially attached to their social communication, more so than any of the other representative dyads on whom we have qualitative analyses. A developmental shift toward more object focus may be inevitable for most infants who acquire eye-hand-object coordination skills and an inclination to investigate objects. This dyad, however, seemed to find a way to "stretch out" their social engagement well after the infant acquired visually guided reaching. It was as if developmental change took place in "slow motion."

12 Summary of findings on relational-historical change

In this chapter, we summarize the findings of our quantitative and qualitative analysis of thirteen mother-infant dyads, observed weekly during free play with toy objects, across the developmental transition that marks the emergence of mother-infant-object play. In addition, we discuss the limitations and possibilities for the research methods used here. In the first section of this chapter we summarize the findings on the research propositions about the development of frames and transitions. In the second section, we address the propositions about the development of infant actions as they relate to frame development. In the third section, we address the limitations of our study.

Each of the different methods used – statistical modeling of developmental trajectories and their covariates in infant action, and the quantitative and qualitative analysis of four representative dyads – give different views on the process of developmental change. The quantitative analysis is **developmental** in the sense that we model the shape of developmental trajectories within dyads over twelve weekly observation sessions. The qualitative analysis is **historical** because it examines particular successions of events through time in order to understand how developed actions grow from their earlier forms and how these project themselves towards possible future pathways. Our approach is called **relational-historical** because, in addition to developmental analysis, we study historical process in the context of a developing relationship. The relationship – the unfolding of communication patterns over time – is the focus of the analysis rather than the individual infant.

Analysis of frames and transitions

Proposition 1: There will be a three part historical sequence of the change process: historical frames, developmental bridging frames, and the emergence of new frames

Historical and emergent frames. For each of the four frames, we found a best fitting model for the developmental trajectories of the group

of thirteen dyads. In addition, there were significant between-dyad differences, expressed as differences in the regression coefficients for each of the frames. These trajectories (Figure 7.1) suggest that the historical frames were the social frame and/or the guided object frame. During the early weeks, some dyads were higher on social frames, some on guided object frames, and some on both. All dyads tend to decline in the duration of these two frames, with the dyads that had the highest durations in the early weeks declining the fastest. The social frame was modeled by a cubic trajectory, meaning that it stayed level for the first few weeks and then began to decline. The guided object frame declined linearly with age.

The social and/or guided object frames, depending which was the most prominent for a particular dyad, were gradually replaced by the not-guided object frame as the newly emerging frame. Every dyad developed toward infant examination and immersion with objects while the mother looked on or commented, regardless of which frame or frames were predominant historically. The not-guided object frame was modeled by a quadratic function of age. Thus, the rate of increase in duration accelerated with age, especially following the acquisition of visually guided reaching.

Although the quantitative models represented in Figure 7.1 analyze each frame independently of the other frames, the raw data trajectories for the group (Figure 7.2) show how the developmental trajectories of the four frames changed in relation to each other. Based upon the durations of the frames in this quantitative analysis, we concluded that for three of the four dyads, the historical frame was the guided object frame, while for Susan and her mother it was the social frame. These historical frames declined with age. This fits the pattern shown by the modeled trajectories. For all four dyads, as suggested by the modeled trajectories, the not-guided object frame emerged as predominant in the later sessions. For Lewis and Susan, the social/object mixed frame was salient along with the not-guided object frame as a possible newly emergent frame. In summary, as shown in Table 12.1, while each of the four dyads had the not-guided object frame as their emergent frame, the historical frame for two dyads was the guided object frame and for the other two dyads it was the social frame.

Bridging frames. We had predicted that the historical and newly emerging frames would be linked by a bridging frame. Did a bridging frame occur for these dyads and if so, what was it? The answer to this question was not as straightforward as the identification of the historical and emerging frames. From earlier research reviewed in Chapter 3 (Reinecke & Fogel, 1994), we had only a limited conception of a bridging

Table 12.1. *Developmental sequence of frames for each of the four representative dyads based on the quantitative and qualitative analyses*

Infant	Historical frames	Bridging frames	Newly emerging frames
Richard	Guided object	Social/object mixed	Not-guided object
Betsy	Guided object	Social/object mixed	Not-guided object
Lewis	Social	Guided object	Not-guided object Social/object mixed
Susan	Social	Social/object mixed Guided object	Not-guided object

frame that was based on a qualitative analysis of a single case. In that case, the bridging frame integrated abbreviated aspects of the dyad's historical frame and also elements of the newly emerging frame that had not yet been fully articulated.

As we moved through the data analysis in the present work, each step revealed a different possible perspective on a more comprehensive way to define and identify bridging frames. The identification of the four frames used in this analysis led us to think that, based on the work by Reinecke and Fogel, the social/object mixed frame would be the most likely bridging frame because it contained aspects of the social frame which we assumed would be the historical frame and aspects of the not-guided object frame which we assumed would be the emerging frame.

We also thought that bridging frames might have higher durations during the middle weeks of the observation period, that is, in between the periods in which historical and emerging frames were predominant. The modeled developmental trajectories for the entire group of thirteen dyads also suggested that the social/object mixed frame would be the most likely bridging frame because it had an inverted U-shaped developmental trajectory for some but not all dyads.

A frame might also qualify as bridging if it became a locus for realtime transitions to and from both the historical and emerging frames. There should be more transitions between the historical and emerging frame **via** a bridging frame than directly between them. A related characteristic of a bridging frame is its historical significance as judged from the qualitative analysis. In early developmental periods we would expect to see innovations in the bridging frame and transitions between the bridging frame and other frames, innovations that would serve as a prelude to the newly emerging frame. These latter criteria related to the transitional role of the bridging frame were the most important.

Frames that did not have an inverted U-shaped trajectory and frames other than the social/object mixed frame did serve as realtime transitional bridges, described in the previous paragraph. In this way – using an examination of the quantitative raw data trajectories, the quantitative transitions, and the qualitative data – we concluded that all the dyads had a bridging frame, as shown in Table 12.1.

The identified bridging frames for four representative dyads all satisfied the criterion of being a transitional bridge in realtime. Transitions between the bridging frame and other frames were more likely than transitions directly between the other frames. Each of the identified bridging frames also had historical links to the past and served as an historical prelude to future patterns of communication.

For both Richard and Betsy and their mothers, the social/object mixed frame played a developmental bridging role. This frame had an inverted U-shaped trajectory. During the first two developmental periods, transitions were made to and from the social/object mixed frame from the guided or not-guided object frames. The social/object mixed frames were periods of positive emotional communication about objects between periods of more focused attention on objects. This appeared to be an historical bridge into the increased seriousness of Richard's examination (third period) and immersion (fourth period) with objects during the not-guided object frame. In addition, the not-guided object frame seemed to be a developmental bridge for itself. When it first appeared, the not-guided object frame was a brief pause during the guided object frame which occurred as the mother changed toys. The not-guided object frame was also a brief frame to which transitions were made with the guided object and social/object mixed frames. Clearly, the early experiences with objects without the mother's assistance were an historical prelude to the later emergence of the not-guided object frame. As a brief frame during the bridging period, however, this frame did not have a predominant duration and did not have an inverted U-shaped developmental trajectory.

For Lewis and his mother, the bridging frame was the guided object frame. This frame had a modified inverted U-shape trajectory, set against the background of a general decline in duration. Most of the transitions to other frames during the early developmental periods occurred via the guided object frame. Since Lewis and his mother spent a lot of time in the social frame during the first developmental period, the guided object frame was an historical bridge because Lewis remained very socially-oriented, smiling and vocalizing to the mother as she demonstrated objects. It also became the historical prelude for transitions to the not-guided object frame.

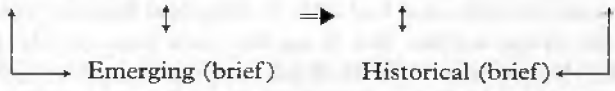
For Susan and her mother, the guided object frame was a developmental bridging frame in a similar way in which it was for Lewis and his mother. This frame was certainly a bridge out of the more socially oriented frames of the first developmental period because it was a locus of transitions first with the social frames and later with the not-guided object frame. Even the early instances of the guided object frame had a bridging quality. The "toy" was often part of the mother's body (her hand) and the talk was social in nature. This dyad also used the social/object mixed frame as an intermediate bridging frame that led to the guided object frame as a bridging frame. In addition, the not-guided object frame may have also been a bridge for itself. Similar to the case of Betsy and her mother, the not-guided object frame was a brief pause during the guided object frame as the mother changed toys.

In this book, we presented four different ways of expressing Proposition 1:

(P_1) (Historical $\leftrightarrow$ Bridging) $\Rightarrow$ (Bridging $\leftrightarrow$ Emerging)

(P_1') (Historical $\Rightarrow$ Emerging)

(P_1'') (Historical $\leftrightarrow$ Bridging) (Bridging $\leftrightarrow$ Emerging)



(P_1''') (Historical $\leftrightarrow$ Bridging_1) $\Rightarrow$ (Bridging_1 $\leftrightarrow$ $\text{Emerging}_1/\text{Bridging}_2$)

$\Rightarrow$ ($\text{Emerging}_1/\text{Bridging}_2$ $\leftrightarrow$ Emerging_2)

As shown in Table 12.2, none of the dyads fit sequence (P_1'), representing a developmental sequence without bridging frames. All dyads have some form of bridging. Only one dyad, Lewis and his mother, showed what we can call "simple bridging," as shown in (P_1). In simple bridging, only one frame serves as a bridging frame. The other three dyads showed a combination of simple bridging and "brief frame bridging," shown in (P_1''). Brief frame bridging occurred when realtime transitions are made between the other frames with brief instances of the (increasing) emerging frame in the early developmental periods and brief instances of the (declining) historical frame in the later developmental periods. Only one dyad, Susan, showed evidence for " multiple bridging," shown in (P_1'''). Multiple bridging occurs when one frame serves as a bridging frame for another emerging bridging frame. This

Table 12.2. *Proposition 1 sequences that fit each of the four representative dyads based on the quantitative and qualitative analyses*

Infant	Sequence (P_1) simple bridging	Sequence (P_1'') brief frame bridging	Sequence (P_1''') multiple bridging
Richard		Yes	
Betsy		Yes	
Lewis	Yes		
Susan		Yes	Yes

sequence resembles an "overlapping waves" model of developmental change (Siegler, 1996). In this model, development is represented by a series of partially overlapping inverted U-shaped functions. Because we studied only a small window of development, we cannot be certain if this model could apply more generally.

Summary of findings on proposition 1. We conclude that, in spite of the diversity in the developmental process for each dyad, there was regularity in the developmental sequence. Dyads appeared to be able to recruit any type of frame to play a bridging role. The key was the creation of new social routines that had links to historical frames. Once this happened, the dyads became free to explore new ways of relating without losing the relative security of established communication patterns.

Our observations fit with how others have conceptualized bridging processes in developmental change. Previous work on bridging from sociocultural and cognitive theory includes Vygosky's concept of zone of proximal development (ZPD, Vygotsky, 1978), Rogoff's (1990; 1997) ideas about building bridges from the known to the new in the transformation of participation, and Valsiner's (1997) and Granott's (Granott et al., 2002) observations about how novel forms emerge in development in anticipation of their realization in the future. In Siegler's (1996) overlapping waves theory there are both more and less advanced ways of thinking present at any given time, as children use older, dependable strategies to solve problems when the newer strategies fail to work as well as anticipated. Bruner described a "place holder" in communication as familiar conventions into which a partner can insert something new. Clinical theories also include concepts similar to bridging. Winnicott's (1971) concepts of an "intermediate area of experience" and a "transitional object" reflect psychologically "safe" locations in which a person can play with the emerging possibilities of the real world and at the same time not be challenged or threatened about losing the past.

In addition to the "simple bridging" models suggested by these theories, we found more complex models. The most unique model found here was (P''_1). This model especially reflects how relationships as complex systems can have multiple co-existing frames which serve different functions at different times during a change process. Further research is needed to reveal the more general conditions under which a relationship would rely on one or another model of bridging.

In general, however, bridging seems to occur regularly in relationships. It may serve the function of "smoothing out" the change process. The theories mentioned above suggest that bridging may facilitate the ability of participants to detect "safe" links between the known and the unknown. Without bridging, people would have to take a major developmental leap of faith in the absence of a safety net. As researchers, we had the opportunity to see the developmental course of each dyad: we knew where they were going. Participants, however, can't see the future. The future only exists in imagination. Before investing in any single future, participants likely "try out" possible futures through bridging. Bridging, then, is one way to experiment with the unknown by making it partially knowable in the context of the familiar. Another way to do this is by introducing innovations into an already established system.

Proposition 2: Innovations occurring during frames and transitions will serve as preludes for later developmental changes in the frames and transitions

Piaget (1954) was one of the first developmental scientists to observe the change process. He believed that innovations are always assimilated into an existing scheme and that schemes accommodate to encompass the innovation. At first, however, the scheme does not appreciably change. It simply becomes more adapted, more encompassing. Schemes change when the innovations reach a critical point where simple accommodation no longer is adaptive. At that point, schemes differentiate and/or integrate with other schemes and higher order structures begin to emerge.

In order for change to occur, there must be innovations in ongoing patterns of action. In their book on dynamic systems and development, Thelen and Smith list as the primary goal of a developmental theory, "to understand the origins of novelty" (Thelen & Smith, 1994, p. xviii). They also make the claim that "creation and exploitation of variability are key elements in the [developmental change] process" (p. 131). According to dynamic systems theory, stable attractors are dynamic and therefore variable within a range. Change in a dynamic system can

arise either from the inherent variability within the attractor or from outside the system. In either case, the change must be amplified via positive feedback within the constraints of the existing system. As the attractor becomes more variable, it may de-stabilize at a phase transition. Either the attractor becomes chaotic or it bifurcates, creating new attractors in its place.

According to a relational-historical perspective, innovations in interpersonal relationships are also thought to arise in the context of historically available patterns of communication. When they first appear, either as novelty from within the system or as a part of the ecology of the system, they are highlighted against the background of the familiar routines (Fogel & Lyra, 1997; Lyra & Winegar, 1997). We can think of innovations, therefore, as seeds for change because they are hypothesized to be planted within already available frames and in transitions between frames while those frame and transition processes remain relatively stable. On the basis of this theory, we proposed that there are three levels of change:

- Level 1: Ordinary variability within a frame or realtime transition.
- Level 2: Innovations within the frame or realtime transition that do not change the ordinary variability.
- Level 3: Developmental change, a re-organization of all the frames and transitions in the system.

Proposition 2 suggests that there is a developmental sequence in these levels of change, which was expressed in various ways.

(P_2) level 1 $\rightarrow$ level 2 $\rightarrow$ level 3

(P_2') level 1 $\rightarrow$ level 3

(P_2'') (level 1^{α}) + (level 2^{α})$_{\text{period }\alpha}$ $\rightarrow$ (level 1^{α} (level 1^{α} + level 2^{α} + level $2^{\alpha'}$) + level 2^{β})$_{\text{period }\beta}$

(P_2''') (level 1^{α}) +(level 2^{α})$_{\text{period }\alpha}$ $\rightarrow$ (level 1^{β} (level 1^{α} + level 2^{α} + level $2^{\alpha'}$) + level 2^{β})$_{\text{period }\beta}$ $\rightarrow$ (level 3)$_{\text{period }\gamma}$

Sequence (P_2) expresses the theoretical prediction in its simplest terms. Although the basic model fits all of our four representative cases, we found that it needed to be modified to better describe the details of the change process across the developmental periods. The most complete

model, which fits all the dyads except for Richard and his mother, was sequence (P_2'''). In this model,

- (α, β, γ, . . .) are the different developmental periods in sequence of occurrence
- $+$ is the observed or possible occurrence of a term in the same developmental period
- $\rightarrow$ is the change between developmental periods.

Applying these symbols to the levels, we get the following terms:

level 1^{α} is ordinary variability in the first observed developmental period, α
level 2^{α} are innovations occurring during period α
level 1^{β} is ordinary variability during period β
level 2^{β} are innovations during period β
level $2^{\alpha'}$ are additional innovations during period β that are responses to or amplifications of innovations introduced during the previous period, α.

Sequence (P_2''') says that during period α, there are both ordinary variability and innovations that do not change the ordinary variability. During period β, there is a new ordinary variability that may include some of the same ordinary variability and innovations that were observed during the previous period α as well as additional innovations that are direct responses to level 2^{α}, the innovations from period α. Period β also includes new innovations that arise in that period and do not change the ordinary variability, that is, level 1^{β}. The data fit our prediction that changes in ordinary variability in a later developmental period result from innovations in a previous developmental period which do not change the ordinary variability at the time they first appear.

Finally, we found that level 3 developmental change occurred in all the representative dyads with the exception of Richard and his mother. Level 3 change was too complex to express in symbolic form. In the sequences above, changes between periods α and β are primarily by accretion and deletion, something easily represented by symbols. The changes in ordinary variability across developmental periods observed for Richard and his mother were no more than this kind of simple accretion of prior innovations. The developmental process for this dyad was represented by sequence (P_2''), which does not include a level 3 term.

Level 3 change as observed in the other three dyads, on the other hand, was qualitatively different than what had been seen before. Although the historical links could be observed, the relation between period γ and the previous periods involved a transformation of the entire

system of frames in relationship to each other. We found four features that signaled a level 3 change:

- a blending or permeability between frames,
- the emergence of a new frame of more than brief duration with its own unique features,
- a recapitulation of older frames, and
- spontaneous, creative innovations that occur only during developmental re-organization and that cannot be traced back to prior innovations.

Each of the three dyads that showed level 3 change had instances of the first three of these features. Both Betsy and Lewis and their mothers did not show the fourth feature listed above. In addition, for both of these dyads, the first three features of level 3 change occurred in a single developmental period, the third or γ period.

Susan and her mother, on the other hand, were different. First of all, they had spontaneous innovations during the re-organization process that were not amplifications of prior innovations and they did contribute to a change in the ordinary variability during period γ. Since we had not observed this in any of the other dyads, and since these spontaneous innovations were only observed in this dyad during level 3 change, we concluded that they should be included into the description of what may possibly occur during level 3 developmental change. It appeared that because so much is changing during level 3, it leaves room for the system to be highly creative. Perhaps there is a shared sense of opportunity and possibility that permeates the system. On the other hand, the degree of creativity during level 3 changes varies between dyads. Some transitions may be seen by participants as times of caution while other periods are seen as opportunities to explore new possibilities.

A second difference between Susan and her mother compared to the other dyads is that not all the features of developmental change occurred in a single developmental period. Although we clearly identified period γ as the time of level 3 re-organization, we observed instances of recapitulation in this dyad in the developmental period following period γ. We also observed permeability between frames in the developmental period prior to period γ. We suggested that this reflects flexibility in the change process and perhaps a means – in addition to bridging – to avoid abrupt transitions and to smooth out the developmental change. Because this dyad was more social than the other representative dyads, they were able to "stretch out" their social engagement well after the infant acquired visually guided reaching.

Finally, sequence (P'_2) represents the possibility that developmental change may occur in the absence of innovation. This was not observed in

our data. Although innovations may or may not occur spontaneously during level 3 change as in the case of Susan and her mother, it was never the case that level 3 change occurred without innovations in the prior developmental period. There may be exceptions to this principle in situations of drastic, chaotic, unexpected or traumatic change, when factors in a situation are beyond the control of the participants. Such an innovation may be a long-term separation between a mother and infant, a hospitalization for example. This type of drastic innovation would probably lead to premature developmental change in the system surrounding the innovation. We did not study such innovations here but we raise the possibility that they may occur and that a different Proposition 2 sequence is likely to be required to capture such developmental changes.

Analysis of the development of infant action with respect to the development of the mother-infant relationship

In this section, we discuss the results of our study of the development of infant actions as they are coordinated with the development of frames. Again, both quantitative and qualitative analyses are used.

Proposition 3: The developmental trajectories of particular actions toward objects will relate to the developmental trajectories for the frames

We studied the contribution of infant actions to the trajectories of frames. Increases in the duration of gazing at objects without touching them was associated with increases in the duration of the guided object frame and decreases in the social frame. Increases in the duration of gazing at objects while touching them was associated with increases in the duration of the not-guided object frame and with decreases in the social frame. The duration of touching without gazing at the object increased with increases in the duration of the social/object mixed frame and with decreases in the guided object frame. Increases in the duration of object mouthing, with or without gazing at the objects, were associated with increases in the duration of the social/object mixed frame.

More gazing without touching objects could be expected to occur during the guided object frame in which the mother showed or demonstrated objects to the observant infant. Even though the mother supported infant touching objects during the guided object frame, the infants apparently did not learn to coordinate touching with looking

during this frame. Based on our data, this coordination between gazing and touching was related to the growth of the not-guided object frame when the mother was not holding the object. The qualitative analysis suggests that the effects of the not-guided object frame on the coordination of looking and touching probably occurred during the third developmental period while infants spent time examining the objects on their own. During the final developmental period, however, the infants became immersed in mouthing the objects and rarely looked at them during the not-guided object frame.

The trajectory of the social/object mixed frame was associated with touching objects without looking at them and mouthing the objects. This is curious because after the bridging period, this frame declined in duration for most of the infants while the not-guided object frame, in which the infants were immersed (touching without looking at the objects and mouthing), increased in duration. The qualitative analysis revealed, however, that during the third and fourth developmental periods, dyads often made a transition to the social/object mixed frame when the infant became immersed during the not-guided object frame. The mother was often responsible for initiating this transition, apparently wanting to get the infant's attention to herself or to some more socially inclusive use of objects. This transition attempt, with few exceptions, was not ratified by the infant. In other words, most of the time spent in social/object mixed frames in the later developmental periods was with the infant immersed in the object and the mother trying to convince the infant to do something else. When the social/object mixed frame was a bridging frame (Richard and Betsy and their mothers), then it was more likely to be social in nature and this was especially the case for Betsy and her mother. In these cases, there was relatively little gazing at the object but the infant gazed instead at the mother and often smiled.

Proposition 4: The infant's acquisition of skilled actions with objects will emerge in a developmental sequence

We charted the developmental sequence of emergence of infant actions on objects. This is the first study to report this developmental sequence based upon infants acting on objects in the natural ecology of social-object play. The sequence we found is similar to that reported in the literature for infants tested in controlled, non-social settings. Our results show that simpler actions on objects such as grasping and manipulating occur prior to the acquisition of visually guided reaching and therefore primarily during the guided object frame when the mother is holding the object. More advanced skills such as squeezing, shaking, and grasping

with two hands are developed later, primarily during the not-guided object frame when the infant is holding the object.

The qualitative and quantitative results were similar. Infant examination of objects, which developed in the third developmental period, consisted of the more advanced skills. The infant's actions during the earlier periods typically consisted of simple grasping and fingering of the objects. Although the quantitative analysis on all thirteen dyads clearly showed that the more complex actions emerged after the acquisition of visually guided reaching, the qualitative analysis, though only on four dyads, gave us more precision. It showed that the acquisition of more skilled actions on objects coincided with the emergence of the not-guided object frame following the bridging period. Thus, the developmental changes in infant actions were related to the development of frames.

Pathways across the four-month developmental transition

Although all of the dyads arrived at a similar developmental endpoint – the emergence of the not-guided object frame – each of them co-created a unique style of communication and actions on objects. Richard and Betsy developed skills for focal attention to objects and coordination of manual and visual means of object exploration. They gazed at, reached for, and manipulated objects whenever possible. A predominant inclination for making transitions between the object-oriented frames was found. The social frame was rare throughout the whole twelve-session period.

Despite these similarities, these two infants and their mothers differed with respect to their activities within the object-oriented frames. Richard and his mother primarily focused on the objects' affordances. The mother verbally highlighted the objects' properties, she encouraged Richard's reaching skills, and she talked only about object-oriented topics. The mother also developed different routines for each of the objects she used. Over time, the frequency of the social/object mixed frame decreased and the mother did not interfere with Richard's reaching, helping him to explore the toys. Also, they used the social/object mixed frame as a touching game with objects to highlight the objects' affordances.

Betsy's mother, however, used objects to help emphasize her words, singing, sounds, and vocal inflections, while showing, demonstrating or manipulating objects. The mother used an object as a rhythm instrument when singing. In earlier sessions, the mother frequently smiled, laughed, used exaggerated body movements and facial expressions,

and found humor in many exchanges during both the guided object frame and the social/object mixed frame. In these cases, Betsy looked for longer periods of time at objects and at mother, with an increase in vocalizations and smiling. The social/object mixed frame was mostly used as an object touching game for animation of objects as play, instead of for highlighting the objects' affordances.

Additionally, as Richard and Betsy became better in the coordination of manual and visual means of object exploration, the transitions between the guided object frame and the not-guided object frame became more predominant and were made in faster durations. In particular, Richard and his mother started making rapid transitions in session 10 primarily between the guided object frame and the not-guided object frame. Betsy and her mother started making rapid transitions in session 9 but some of these transitions also included the social/object mixed frame. Richard did not ratify his mother's attempts at transition to the social/object mixed frame in the last developmental periods, but Betsy and her mother were more coregulated during the transitions involving the social/object mixed frame.

Lewis and his mother and Susan and her mother also had similarities between them. These dyads developed an interim pattern in which objects were not things in themselves but rather served as mediators of social play. These dyads spent more time in the social frame compared to the other two dyads. The infants in these dyads developed forms of attention and action that appeared to be distributed between social and instrumental uses of objects. Although Lewis and Susan displayed less focal attention to objects, they seemed to present a more flexible pattern of attention that moved easily between objects and mother.

Both mothers in these two dyads used object-oriented frames to highlight object affordances, to demonstrate objects, and to help the infant hold, shake or squeeze objects. The social/object mixed frame increased in the last two developmental periods for both dyads. Lewis' mother used the social/object frame to help Lewis explore object affordances whereas Susan's mother used the objects to entertain or physically engage Susan in game playing. These two dyads tended to not make many transitions between frames overall. However, a gradual increase in the frequency of the transitions between frames was observed over developmental time, especially after the reaching session.

These two dyads also differed. Lewis' mother can be described as an assistant, helping her object-focused infant explore during the first two development periods. Lewis showed more initiative during the transitions than the other infants in the first developmental period. In the last two developmental periods, the mother acted primarily as commentator,

captivator, and entertainer. When commenting, the mother's conversation was object-focused, talking about object affordances. Susan's mother's primary roles were a combination of captivator, facilitator, entertainer in the first two developmental periods and spectator and captivator in the last two developmental periods. Susan's mother spent much of her time talking about Susan's father, siblings, and past/future events while facilitating object play.

Summary of findings on infant action development in the mother-infant relationship

Did mothers change their strategies, therefore changing the frames, because infant skill changed? Or did infant skill development depend upon the guidance provided by the mothers, at first manually during the guided object frame and later vocally during the not-guided object frame? In this descriptive study, we cannot sort out the cause and effect patterns. Our relational-historical research assumes, on the contrary, that in the natural ecology of these infants who could not locomote or sit upright unsupported, virtually all of the infant's exposure to objects occurred in the social context. The presence of a not-guided object frame depended upon the active support of an adult who arranged the infant in proximity to objects and brought objects into the infant's reach space. Likewise, the presence of adult support depended upon the activities displayed by the infant.

Piaget's concept of scheme and Gibson's concept of affordance explicitly recognize the ecology as an integral part of the individual's perception and action. For Piaget, the grasping scheme includes the object's properties and its affordance for grasping. Infants tend to grasp smaller objects with one hand and larger ones with two hands. Dynamic systems theory recognizes the role of gravity, for example, in the development of reaching, where the individual's action either compensates for or utilizes gravity as if it were a part of the body (cf. Thelen, Kelso, & Fogel, 1987; Thelen & Smith, 1994).

Our research lends support to these views and generalizes the ecology to include other people as well as the physical properties of objects and gravitational forces (Fogel, 1997; Zukow-Goldring, 1997). This work also supports sociocultural theory, showing for the first time that Vygotsky's concepts of guided participation applies to infants during the first half year in the acquisition of skills that had been previously explained by neurological maturation.

This work extends these four theories – Gibson's, Piaget's, dynamic systems, and sociocultural – by suggesting that the interpersonal

relationship is a living system that develops in an organized way from historical frames to newly emerging frames. If frames are roughly analogous to skills or schemes, this work transcends the individual in order to view the ecosystem – the social and physical ecology in relation to the infant – as the locus of developmental change.

The statistical associations of infant action and frame trajectories confirmed that both the infant and the relationship grew together. Those objects were historically imbued with social significance because they were first introduced during the guided object and social/object mixed frames. We conclude that "infant skills" were relational achievements, the product of a historical process of mutual regulation within the dyad.

In the same way that the infant perceives gravity and objects properties as an integral part of its body (Piaget, 1954; Thelen, Kelso, & Fogel, 1987), the infant most likely perceives the adult's voice, hands, and face as an integral part of the objects. In this way, the social and physical ecology become embodied for the infants (Fogel, 1993). Their meaning is always in relation to the kinds of actions the infant can perform. Our data on interdyad and individual differences suggest that the infants' awareness and use of their own bodies, then, depend upon the history of their life within this relational ecology.

Limitations of the data analysis

Limitations of quantitative analysis

In order to create and study a developmental trajectory, a number of analytic decisions must be made. First, the number of observations on each dyad over time must be chosen. Estimates of developmental trajectories increase in accuracy the more frequent the observations and the more total observations. In our case, we had twelve weekly observations of mother-infant play, a relatively limited number compared to the many daily encounters between mother, infant and objects in these families. If our data is a type of filmed record of change over time in these dyads, it has a very coarse resolution that probably misses many additional details of microlevel change.

Second, the purpose for using developmental trajectories needs to be considered. We were interested in the study of change across a known developmental transition. For this purpose, developmental trajectories are most meaningful if the period of observation encompasses an expected change in the level of the trajectory variable. This means beginning the observations before the expected change and continuing the observations after the change has occurred. We chose a corpus of

videotaped data that had weekly observations of thirteen mother-infant dyads during free play between five and fifty-two weeks. Because of our interest in the developmental transition related to the onset of visually guided reaching, we selected from the sample six weekly sessions prior to the onset of reaching and six sessions including and after the onset of reaching. Even against the background of our videotapes of these dyads, we have chosen a considerably limited segment of time.

Third, the variables of interest must be determined. We were interested in the change in the mother-infant communication system across the four-month transition and therefore chose frames as variables. The social frame was coded when dyads engaged in face-to-face play without the mediation of objects. The guided object frame consisted of times when the mother demonstrated or showed an object to the infant, or helped the infant retrieve, reach for, or grasp an object. The not-guided object frame was when the infant explored an object while the mother looked on and/or commented. The social/object mixed frame occurred when the object was used for social play, to get the infant's attention, or to calm the infant, most typically by touching the infant with the object. There were limitations to this approach. On the one hand, we ignored some frames such as soothing an upset infant. On the other hand, we collapsed many different types of play into a single frame such as including physical-motor play, face-to-face play, and quiet holding into the social frame.

Fourth, the variables must be quantified. The most robust measure of behavior in observational research is the duration of a particular category. We chose the total duration of each frame, expressed as a proportion of the total duration of the observation session. This measure is reasonably insensitive to the presence or absence of brief events which are often the result of coding error or transient shifts in the communication system. The total proportional duration across the four frames sums to 1.00, however, since the frames were coded defined as mutually exclusive and exhaustive. If one's goal is to treat each frame as an independent observation for the purpose of generalization to a population, this could violate statistical assumptions. In our case, however, we were trying to describe each frame in relation to the others to create a picture of the whole communication system.

Finally, one must choose a method of analysis. On the one hand, we used multilevel analysis to create ideal models of each trajectory for each dyad and for the group of thirteen. Statistical modeling allows one to discover whether there is order in the data that is not readily visible from the raw data. Modeling procedures assume that there is an ideal trajectory, typically expressed as a linear mathematical function of age, its

square and its cube. Non-linear (logarithmic, exponential) models were not appropriate to test because we had too few observations per dyad. Deviation from the best fitting ideal trajectory is modeled as random variability, or noise in the data. In addition, statistical models typically allow only one dependent variable, although covariates may be added to the models. The resulting modeled trajectories, therefore, must be interpreted from the perspective of each of the above considerations. These trajectories are representations of ideal mathematical functions. Each variable is decontextualized from the others in the same system and each is derived on the assumption that there is some validity to transforming meaningful dyadic communication patterns into numbers.

In the visual inspection of the raw data for the four representative dyads, we assumed that an ideal trajectory did not exist; that variability in the data represented potentially meaningful dyadic negotiation processes that may have been essential for an understanding of the developmental change process. This phase of the analysis, however, must still be interpreted from the perspective of the way in which the observations were sampled and the manner of quantification of the variables.

Limitations of qualitative analysis

The construction of the narratives of each of the four dyads rested upon a set of analytic procedures and assumptions. In this sense, narrative analysis is no different than the quantitative analysis. Interpretations of the data must be made from this perspective. For each type of analysis, we achieve different views of the developmental process. Each method is a lens that affords different insights but each lens carries its own form of distortion for the viewer.

The narrative method rests on the ability of the human observer to recount observed events in story form. According to Bruner (1990), human knowledge is constructed via two different modes: the paradigmatic and the narrative. The paradigmatic is the basis for quantitative research and logical reasoning, while the narrative is the basis of storytelling and qualitative research. In the paradigmatic mode, data is verified by reliability and validity procedures; in the narrative mode, by credibility.

Credibility is enhanced when there is a prolonged engagement of the researcher with the researched (in this case, the mother-infant dyads), a persistent observation of the phenomenon under investigation, and a use of a peer research team. In Chapter 6, we described the types of contact with the dyads and the videotaped data that the authors have had over the past twenty years and the details of the peer research team.

This prolonged engagement and persistent observation of the data allowed the observers to develop a unique sensitivity to the idiosyncrasies and commonalities among the four dyads which is reflected in the level of concordance between the historical narratives written by the two independent observers. There was also a concordance between observers in the identification of the four developmental periods for each dyad. The credibility of the demarcation of each of the four representative dyads into developmental periods is less clear. The two narrative observers agreed upon which sessions to include in each developmental period. There was, however, complexity in the change process itself that could not be resolved into simple divisions of each dyad's life into age periods.

One of the results of our study is that features of the next developmental period appeared historically, in embryonic form, in the previous one. Should we have demarcated the beginning of the new developmental period when those embryonic forms first appeared? The problem is that these embryonic forms were minor themes and the major themes of the earlier developmental period were still ongoing. As we noted earlier, the seeds of future change were always in the present, waiting for an opportunity to take root.

We conclude that the need to demarcate developmental periods arose as one of the distortions of the narrative lens. In order to be comprehensible to the human mind, stories require a dramatic structure: a beginning, middle, and end (Bruner, 1990; Ricoeur, 1983; Sarbin, 1986). The dramatic structure of a story about a life may not correspond exactly to the life as lived. On the other hand, humans are exceptionally good at taking those idealized dramas and applying them to lessons in their own lives.

Even though we have taken steps to insure consistency and credibility, we need to be aware that narratives are nothing more than stories. Faith in the conclusions derived from these stories rests upon similar evidential criteria that are used in eyewitness testimony, the collection of evidence, and the use of prior court cases in legal proceedings. Narrative analysis has been described as a **quasi-judicial** approach (Robson, 1993), in which stories are collected from different sources and their credibility is tested against each other. In spite of their limitations, human societies have been using some form of narrative analysis for centuries in order to decide upon matters of grave concern.

Even quantitative analysis is, in the end, a story. It would not appeal to a reader unless it resonated within the dramatic divisions of text dictated by the current culture of science: theory, hypotheses, methods, results, and conclusions. We have written this document within that

narrative structure even though the work did not actually develop in this sequence. Each phase in this narrative was written as a historical prelude to the next; the seeds of the conclusions were contained in the introduction.

Limitations of the case study approach

What can the reader take away from this rather long document on a handful of cases? We have been careful to avoid generalizing our results to the population since we did not perform any inferential statistics and the sample size is too small to justify such conclusions. Our concern, entirely, has been to convince the reader that our report on these thirteen dyads, and most especially on the four representative dyads, is credible and accurate. On these dyads we reported many small details about variability and complexity, resisting reaching conclusions about them based only on the generalized modeled trajectories.

These limitations, however, are inherent in doing a thorough historical analysis of developmental change on any relationship system: dyads, families, or societies. There seems to be no way to chart historical change other than the difficult and lengthy process of iterative construction of narratives. This, in fact, is the definition of "history" (Duby, 1994; Ricoeur, 1983). We believe that gains in our understanding of the complexity of change at all levels offset the limitations on generalizability. As we become more sophisticated about identifying types of change process, coding and analysis may improve in efficiency and therefore be extended to a larger sample.

Still, limits will be inherent in this type of work. It takes a lot of time and money to collect many observations on even a few dyads. In order to refine the mathematical modeling of the trajectories to embrace nonlinear functions, for example, we would need a great deal more observations of the same dyads across any particular developmental transition. Two or three observations per week would double or triple the number of data points for modeling, a significant gain in precision. It would also increase the cost of data collection and the task of coding for each dyad.

Another limit on the generalizability is that we studied normally developing, middle class dyads from the United States. We did not observe any serious developmental delays. Future research on different populations of developmentally delayed dyads and dyads from different cultural backgrounds may reveal more details about the relational-historical process. We believe that our work on developmental process will result in new ways to understand change. This may lead to the

discovery of new ways to understand how growth dynamics may become arrested and how therapeutic interventions can restore the potential for developmental change in a relationship.

Summary of limitations of the data analysis

Even though the qualitative and quantitative aspects of analysis have their limitations, the conclusions reached in this study are made stronger because of the mixed-method approach. It was often the case that the qualitative analysis clarified and elaborated the quantitative findings by providing more detail and focusing on historical, as opposed to statistical, significance. On the other hand, the simplicity of data that comes from its reduction to numbers often revealed hidden patterns that could not be seen readily from the relative density of the historical narratives. These narratives were much more difficult to read, understand, and keep in mind compared to a table of numbers or a set of modeled trajectories. The approximations to the data required to create modeled trajectories also lent itself to the uncovering of hidden patterns in the data, leading us to search in the narratives for clues to comprehend the underlying change processes in living systems. On the other hand, the qualitative analysis revealed new patterns in both real and developmental time. We must be cautious about generalizing these results beyond the dyads studied here yet we are hopeful that future relational-historical research will open new avenues for the understanding and enhancement of developmental change.

Laws of change: implications for theory and practice

Come gather 'round people
Wherever you roam
And admit that the waters
Around you have grown
And accept it that soon
You'll be drenched to the bone.
If your time to you
Is worth savin'
Then you better start swimmin'
Or you'll sink like a stone
For the times they are a-changin'
(*Bob Dylan, 1964*)

In this chapter, we review our findings from the perspective of consistencies of developmental change processes. We ask whether general laws of change in relationships can be inferred from our research. We also discuss the implications of such laws of change for understanding practices that foster developmental change in relationships. Such practices include childrearing, education and training, clinical treatment approaches based primarily on interpersonal relationships, change processes in organizations, and larger scale social and cultural change.

Are there laws of relational-historical development?

In this section, we recognize some of the consistencies of the developmental process that emerged in our work, knowing that these consistencies must await further study. Our research revealed different types of change, from the realtime fluctuations of communicative actions to the developmental changes in the patterns of communication. We also observed the paradoxical situation that change occurred in the midst of stability. The dynamics of change occurred with respect to frames that had a stable identity across the period of observation. While spontaneous, creative innovations were observed during periods of developmental re-organization, change was not

entirely open ended. It was constrained to occur in certain ways and not others.

Constraints as a basis for inferring laws

The concept of a law of change means that there are constraints on change processes: not all forms of change are possible. Consider two extremes of change: no change and unlimited change. No change would mean that nothing in the system changed. Each time a frame recurred it would be repeated exactly in all its detailed microscopic processes, like replaying a videotape. This is a description of an ideal physical machine operating in the absence of friction and material fatigue. Such a machine cannot exist. Any system in the real world must obey the second law of thermodynamics, meaning that at a minimum, there is a flow of energy through the system and hence some kind of change. In addition, most biological systems exist far from thermodynamic equilibrium. In this highly dynamic state, change continually emerges and information is continually created as energy flows through the system and dissipates (Capra, 1996; Kellert, 1993; Prigogine & Stengers, 1984). Thus, in the real world, some change must always occur.

At the other extreme, there are unlimited possibilities for change. A system could, at any moment, transform into something entirely different. This may be possible in the mythical imagination (frogs changing into princes, for example) but unlikely in physical and living systems. The same processes that bring continual change in far-from-equilibrium states also create dynamically stable attractors, recurring patterns in the midst of the flow of change, like eddies in the continuous flow of a river.

Change in living systems, therefore, falls somewhere in between no change and unlimited change. Even in the realm of ancient mythology, the types of changes documented in the ancestral imagination appeared to be constrained. Origin myths about the creation of the world, for example, tend to have particular themes – primordial chaos, earth and water, light and dark, form from formlessness – that recur across widely different cultures and geographical locations (Campbell, 1991).

Level 1 change. In our work, we have discovered only particular kinds of change and some of the constraints that appeared with these changes. Within the constraints of maintaining a frame, there were changes that we called ordinary variability. What constitutes ordinary variability and how is it constrained? Where does ordinary variability originate? The answer comes from the fact that *behavior is inherently temporary.* Any action lasts a finite amount of time. Grasping an object arises from a realtime movement of the arm and hand toward an object, catching

the object, and moving the object to a desired location. Each time this behavior recurs, it is created anew from the same basic constituents of cognitive goals, motor synergies and perceptions. It is a simple fact of living systems that the "same" behavior is never exactly identical upon iteration. This fact alone was enough for dynamic systems theorists to challenge older views of behavior based in machine analogies such as neuromotor programs (Thelen & Smith, 1994). The inherent variability of behavior implies that there is not a machine in the person but a softly assembled dynamic system of neuromotor components that when activated tend to follow a similar pathway in time and space.

The variability of behavior within a frame suggests a social system that never exactly repeats itself. On the other hand, we perceive frames in social behavior because perceptually similar actions tend to recur. On further examination, we can see that any two instances of the mother shaking a rattle for the infant during the guided object frame are never precisely the same. There are variations in the speed, location, and rhythm of the movement of the rattle on the one hand, and the actions of the infant in relation to the rattle's sight and sound on the other.

The change in ordinary variability, however, is not so much as to make a significant difference for the participants. We call this ordinary variability because it is not usually noticed or singled out in the attention of the participants. It is not a difference that makes a difference. Ordinary variability, however, is a difference that can be noticed but it does not in any way alter the basic patterning of the frame.

It is not clear why this level of change is constrained to be "ordinary." What is clear, however, is that it comprised the vast majority of the changes in the relationships that we observed. There are probably thousands of iterations of ordinary variability for every single innovation (level 2 change) observed. In terms of the frequency of occurrence, we could say that the number of changes at level 1 is much, much greater than at level 2, which is much, much greater than at level 3.

$$\text{Freq.(level 1)} >> \text{Freq.(level 2)} >> \text{Freq.(level 3)}$$

The relationship systems we observed were much more generous in providing lower levels of change, and this in itself seems to be a law of change: that higher order change occurs less frequently and is probably considerably more energetically costly to the system.

Change also occurred as the ordinary variability of actions that change frames, the realtime transition. The concept of ordinary variability during a realtime transition is at first paradoxical. Transitions are inherently about change, from one frame into another. How could it be that

there was a consistency and regularity across similar transitions within a developmental period? One answer comes from dynamic systems theory. When transitions did occur, they were considerably briefer than the durations of the frames occurring before and after the transitions. According to some work in dynamic systems theory, the duration of transitions between attractors is considerably less than the time the system spends in stable attractors (Kugler, Kelso, & Turvey, 1982). In a sense, systems do not like to be in transitions and they tend to seek the stability of some kind of attractor in which to spend most of their time. Attractors are energetically more conservative. Frames and transitions between frames in an interpersonal relationship appear to fit this model. Thus, relative brevity of transitions is one apparent constraint. This helps also to explain the high frequency of realtime transitions between brief frames during the bridging process. These brief frames were apparently relatively unstable, as the system did not "like" to remain in them for very long.

Another constraint on change during the ordinary variability of realtime transitions is that the previous frame was disassembled in small pieces as the next frame was being assembled. We documented hundreds of transitions between frames for the four representative dyads (786 transitions, to be exact). In all cases, the added actions during the transition in the current frame served to de-stabilize that frame, leading to an opportunity for the self-organization of what will become the next frame. In some cases, transitions occurred when a single action changed, such as the infant's gaze direction changing from mother to objects or vice-versa. In other cases, a series of events occurred, each of which built upon the others to amplify the probability that a transition might occur.

Another form of constraint occurred because transitions were typically made between closely related frames. During the first two developmental periods, for example, the historical frame was more likely to make realtime transitions to the bridging frame than to the emerging frame. During the later developmental periods, the emerging frame was more likely to make transitions to the bridging frame than to the historical frame. When transitions were made between historical and bridging frames or between emerging and bridging frames, fewer components of action had to be added or deleted during the transition because the frames were more similar to each other. Historical and emerging frames had relatively few actions in common, which may help to explain why transitions between these frames occurred rarely. The exception, of course, are the transitions to and from the unstable brief frames mentioned earlier.

A final constraint on realtime transitions is that they required the regular and systematic participation of both mother and infant. During transitions, infants and mothers often (but not all the time) ratified the other's action as they moved jointly toward the next frame. We have called these types of communication processes symmetrically coregulated, a pattern in which each partner is continuously being affected by the other and open to the dynamics of change in the communication system (Fogel, 1993; Fogel & Lyra, 1997; Hsu & Fogel, 2001; Hsu & Fogel, 2003). On the other hand, there were asymmetries when either partner failed to ratify the other's transition bid. If one partner did not enter into a symmetrical communication with the other, this made the communication system less likely to change and more likely to remain stuck in a particular pattern of action. An example is the infant's immersion and withdrawal from social communication despite mothers' attempts to engage the infant in joint play.

Level 2 change. Another type of change was called Level 2 change, or innovations within ordinary variability. There appears to be a constraint on innovations because they emerged as part of the ordinary variability in frames and transitions but did not alter that ordinary variability at the time when they first appeared. Instead, innovations acted like seeds of change, it took some time for them to grow in such a way as to change the ordinary variability in the future. The effect of innovations was constrained by the apparent "inertia of stability" in frames and transitions. The ordinary variability in the frames and transitions we studied only yielded to change slowly, over several weeks.

In individual psychotherapy and on marital therapy, the inertia of existing frames, even though they may be maladaptive and painful, is a common occurrence (Mahoney & Moes, 1997; Ryan et al., 2000). In fact, it may be the inability to change this inertia that brings people into treatment. Similarly, institutional, organizations, and social frames have the inertia to far outlive their usefulness and they require special intervention to effect a change.

The system may conserve energy by maintaining itself in the same frame. It appears to be relatively inexpensive for the system to generate a lot of ordinary variability. This conservativeness suggests that innovations typically need to be examined and tested against the background of ordinary variability before they are "allowed" to garner more resources that would cause the participants to notice a difference that makes a difference.

There did not seem to be a constraint on whether innovations occurred in frames or in realtime transitions. On the other hand, there were constraints on the fate of innovations in later developmental

periods. First, innovations could be repeated more regularly as part of the ordinary variability of the subsequent periods. Or, innovations from a previous developmental period could spark additional innovations in the subsequent periods, as when a mother changed her behavior to amplify an innovation in the infant's behavior that occurred earlier or vice-versa. A final constraint is that any innovation initiated by one partner must be ratified by the other. Otherwise, this seed would not eventually grow to its maturity.

Level 3 change. Developmental change was marked by a re-organization of all the frames and transitions in the system. Because everything seemed to be changing during a level 3 change, one might suspect that unlimited change could happen. History implies a passing away of what went before and a movement toward a unique and undetermined future. History cannot be planned and depends upon a series of unexpected contingencies. The contingencies of the present may not be those of the past because as the system progresses, the conditions change and the options change (Gould, 1977). History implies that anything can happen, that we are subject to the whims of random variation, that there is inherent indeterminism (Fogel & Branco, 1997; Lyra & Winegar, 1997).

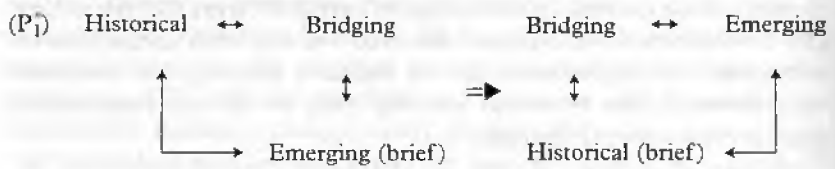
Even during level 3 developmental change, however, the system appeared to be constrained to change in particular ways and not others. The developmental changes we observed had apparent indeterminism because the new organization did not resemble anything that was previously observed. But there was also regularity in the four features that characterized a level 3 change:

- a blending or permeability between frames,
- the emergence of a new frame of more than brief duration with its own unique features,
- a recapitulation of older frames, and
- spontaneous, creative innovations that contribute to the overall re-organization.

Thus, even though the exact pattern of behavior in the re-organized system may not have been able to be predicted, there was a meta-regularity in these four features that acted as constraints on the change process. This closely resembles what Kellert referred to as "qualitative predictability" which "predicts properties of a system that will remain valid for very long times and usually for all future time. It gives the 'general information and the great classifications,' by dealing with questions such as the periodicity and stability of orbits, the symmetries and asymptotic properties of behavior, and 'the structure of the set of solutions'" (Kellert, 1993, p. 101).

At level 3, the system is the most conservative. A relationship will have only a relatively small number of level 3 changes in its lifetime. Level 3 change apparently consumes considerable energetic resources. It does not come out of nowhere but it is always the result of a relatively long historical process of evaluating the worth of innovations against the background of the immense sea of ordinary variability. Because anything could potentially happen in level 3 change, the system seems to prefer to act slowly. Bridging serves the function of doing test runs on a possible future without losing the past. Level 3 change is a difference that makes a very big difference for the participants.

Change in the relationship system. Aside from the constraints observed within each level of change, there appeared to be additional constraints that can be detected when one steps back and examines the entire relationship system changing over time. First of all, there was symmetry between earlier and later developmental periods. This symmetry is reflected in the models that resulted from Proposition 1. This is clearly seen in the simple model of bridging in which historical and emerging frames appear to be mirror images of each other if the mirror is placed at the peak of the bridging duration. Proposition (P_1'') shows an even more complex mirror image.



The participants do not know and cannot predict the future, and the specific behaviors found in the future frames are partially indeterminate and cannot necessarily be predicted. Yet somehow, this mirror image unfolding seems to recur regularly across dyads. Dyads seem to walk up toward the peak of the bridge on a slow and easy grade, and they walk down the other side in a similar way. It is as if they get themselves out of the change by retracing their steps but now those steps are in a new territory. In addition, all three types of frames (e.g., historical, bridging, and emerging) are embedded in the relationship system both before and after the developmental transition and changes in frames are mediated by the bridging frame.

One basic feature of dynamic systems theory is that each element of a system is related to each other element in the system. Our data suggest that the relationship between system components may occur across developmental time. If the universe is expanding now, for example, it might be expected to enter a contraction phase sometime in the very

distant future. Although the exact pathways of motion of the bodies in the universe during contraction could not be predicted, the general macroscopic move toward contraction in symmetrical relationship across time to expansion may be predicted. In the same way, under certain circumstances the macroscopic behavior of a change process may be constrained by some laws of change that imply symmetrical or asymmetrical patterns across developmental time.

Just because symmetry across developmental time is possible, it does not mean that the change will unfold in that way. There were asymmetries across the period of observation. All the dyads began making transitions more rapidly in the last sessions but not for all four frames simultaneously. For each dyad, rapid transitions were made only between specific frames. Lewis and his mother, for example, began making rapid transitions in session 8 and these transitions primarily included the guided object frame, the not-guided object frame, and the social/object mixed frame. For Susan and her mother, on the other hand, all four frames were involved in rapid transitions beginning in session 6. In addition, developmental change in the patterns of behavior appeared to be irreversible. Once a re-organized pattern occurred, the system did not revert back to earlier phases. Recapitulations occurred primarily during the same developmental period as the re-organization.

Developmental change, therefore, can be both relational and historical. Development is relational when it is symmetrical across time showing that there is an underlying constraint and lawful change. Development is historical when it does not repeat itself, when there is a continuously changing unfolding of the system over time.

Where does change come from?

Based on the relational-historical research method, it is possible to ask where change comes from. This simple question can be elaborated. Where does each level of change come from? Where do the laws of change come from? We cannot provide complete answers to these questions but we can suggest different ways of looking at the questions.

Levels of change

Level 1 change. Because ordinary variability is always there, a fundamental fact of everyday behavior, the question of where it comes from is hard to answer. One could say that the nervous system generates variability because it is adaptive. Neural Darwinism (Edelman, 1987; Thelen & Smith, 1994) parallels the ideas of Darwin's theory for

phylogenetic change, that the evolution of the nervous system in the life course is a process of natural selection from the spontaneously generated variability of the neural firings and connections. While this is a powerful and highly productive explanation that appeals to the function of variability, it still does not account for the ultimate question of where variability comes from. Variability is a pervasive fact of the universe, at every level of matter and energy and at all time scales from microseconds to eons. We could say that variability exists because nature is a dynamic system and dynamic systems are inherently variable but that is tautological. Variability is given, always present, inherent in the universe, and unlimited. Both theology and dynamic systems science are in agreement on this point: we might as well just accept that variability is a given and cannot be reduced to some other explanatory device.

Level 2 change. When we come to change at level 2, science may have more to say on its origins. This is because we can observe differences in when and how innovations arise in systems. While ordinary variability is always there, a constant background, innovations occur in particular ways, when conditions are favorable, and those conditions can be studied. Our study does not provide an answer to this question but a careful sorting of innovations in relation to other systemic factors could be carried out empirically.

A key question related to the source of innovations is how does the system "know" which innovations are worth the energetic investment of attention? The successful innovations, the ones that get noticed, remain in the system, and ultimately provoke a level 3 change, must somehow be perceived as "interesting," or "better," or "exciting," or "worthwhile." This implies that there is an inherent valuation of changes, that is, an emotional aspect to the information of what makes a difference. Value is the most basic form of psychological experience. It involves immediate, often automatic emotional appraisals such as good or bad, approach or avoidance, acceptance or rejection, tasteful or distasteful, pleasure or pain (Fogel, 2001; Frijda, 1985). Further research on innovations may require an examination of the ways in which participants' implicit valuations serve to regulate the fate of innovations.

So where do these innovative changes come from? One could not argue, as for ordinary variability, that innovations are just a fundamental property of nature. This is because we can observe many relationships that lack innovation and remain stagnant in endlessly repeating (though ordinarily variable) patterns. This lack of innovation can be perceived by participants. Stagnation – inertia – is often felt as aversive and leads couples and families to seek some form of therapeutic intervention or to

end the relationship (Antonofsky & Sagy, 1990; Bütz, Duran, & Tong, 1995; Fogel & Lyra, 1997; Lewis, 1995; Rogers, 1961; Stern, 1985).

When they do occur in a relationship, where do innovations come from? As we saw in our research, innovations may be invented by either participant or by collaboration between partners. Since innovations are by nature different from ordinary variability – they are differences that make a difference – how can we understand the apparent creativity of the system to invent something that was not there before?

The question is relevant not only to interpersonal relationships but all forms of social and cultural change. Why do some historical periods, such as ancient Greece, the European Renaissance, and the twentieth century, for example, seem to be over-populated with artistic, technological, and scientific innovations that lead to major social change compared to other historical periods? Why do some corporations become more innovative than others, and why are there periods of more or less innovation within a corporation?

There are at least four possibilities. First, innovations could bear some resemblance to the ordinary variability in the existing system and yet still be perceived as different. In some of our dyads, for example, persistent mouthing or immersion in the objects first appears as an innovation and later as a major theme of the next developmental period. Yet persistent mouthing is an amplification of something that already existed as part of the ordinary variability, that is, occasional mouthing. Thus, this first possibility is that innovations are amplifications of existing ordinary variability. The creativity in this case is to amplify by extending an action longer in time (as in the case of persistent mouthing) or by making an action bigger or more exaggerated or more intense. This occurs, for example, as existing computer microprocessor designs can be altered to become faster and more memory intensive.

A second possible source of innovations is actions that already exist in the repertoire of the participants but have not been used in the particular frames being observed. In our data, since we only observed the dyads in one limited laboratory setting, we cannot assess this possibility. But it could be that the infants begin mouthing objects persistently during their own solitary exploration of objects, or with their own hands and fingers while alone. The creativity here is to import an action from one context into another, that is, to perceive how an action may be extended across contexts in its usefulness. This happened, for example, when musical digital technology in the form of CDs became integrated into personal computers.

A third possibility is that innovations may become "available" because of developmental change processes in this or other contexts. Visually

guided reaching may be one such example. As visual and motor coordination improves in this and other contexts, reaching becomes more accessible to the infant. The creativity here is in the exploration and discovery of the possible uses of the new acquisition. The incorporation of CDs into computers led to new uses, including data storage on CDs instead of floppy disks, more complex programs packaged and sold on CDs, and the ability to create personalized music collections with a combination of hard drive catalogues and burning of CDs or building MP3 files.

Finally, innovation may also be a spontaneous, creative, invention with no precedent. There was nothing in our dataset that met this criterion but it may be possible. The other three possible sources of innovation are inherently creative but the creativity involves the playful expanding, combining and comparing of existing elements. In human history, most inventions were preceded by prior attempts and existing technologies that were creatively transformed into something "new." The invention of writing in the Sumerian civilization some three thousand years ago is often considered to be the only purely unprecedented human invention. Writing arose as a way to keep records of inventories and business transactions. One could imagine, however, that some other form of accounting such as straws, sticks, or beads (the abacus) may have preceded making marks in clay tablets. A careful empirical comparison of innovations with existing ordinary variability may one day lead to an answer of whether spontaneous innovations may or may not occur.

For the most part, however, we suspect that most innovations have the characteristic of bridging. They combine something old with something new. They sit in the midst of ordinary variability without changing the frame when they first appear. This perhaps could only happen if participants "recognized" the innovation as something inherently familiar: noteworthy but "safe," different enough to perceive but not so different as to disrupt.

The ready acceptance and rapid worldwide spread of cellular telephones is one such example. Cell phones are like other phones but portable and more convenient. On the other hand, the Internet was in existence for many years before it became widely used. Although the origin of the Internet can be traced to a number of prior technologies, from the perspective of ordinary users it was perceived as too unusual and unfamiliar and thus was not so readily adopted when it first appeared. And there have been many inventions in human history that have been lost. In order to be successful, the innovation must bridge past and future in a way that participants can perceive as a safe or useful difference that makes a difference.

Level 3 change. Where does developmental change come from? Our research clearly shows that developmental change is not spontaneous in the sense of arising without any historical roots. It occurs over a long period and grows out of a history of innovation. Developmental change, like innovation, occurs through a long process of bridging the old with the new. But unlike innovations, which can be created and either accepted or tossed away at relatively little cost, developmental change requires a considerable investment of resources and cannot be reversed. Once the system begins to re-organize, there is no going back. Developmental change is irreversible. In addition, participants at some point have to "commit" to the re-organization process without knowing in advance how everything will work out. Because so many parts of the system are changing at the same time and affecting each other in the process, there is an inherent indeterminism in developmental change from the perspective of the participants who cannot possibly know the entire map of the future.

No matter how much time is invested in bridging there is always some element of the unknown. Romantic partners may have long periods of engagement and/or living together (bridging frames) before getting married. Nothing, however, can fully prepare the couple for the challenges of married life. Some research suggests that the quality of preparation during the bridging period can predict the long-term success of the marriage (Gottman et al., 2002). Nevertheless, moving into the emerging frame is to some extent a leap into the unknown.

Why would participants make any developmental change at all, given that it takes a rather large investment and that there is an inherent uncertainty? The immersion of infants with their objects during the final developmental period for each of the four representative dyads may provide one clue. The infants clearly wanted this intense contact with objects and the mothers were willing to allow this to occur. Because immersion with objects first appeared as an innovation in the earlier periods, it may be that one or both members of the dyad endows the innovation with positive emotional value, as something good or preferred.

In the case of marriage, couples proceed in the face of uncertainty because they perceive some likely emotional gain or enhancement. They expect something better or more pleasurable or more fulfilling. Such valuations may serve to guide the dyad through the complexity and uncertainty of the level 3 change process. In addition, however, there may also be a different type of emotion involved with the relative certainty or uncertainty of the change process itself. During change, people tend to feel emotions such as security vs. insecurity or safety

vs. threat (Fogel, 2001). There may be some kind of complex appraisal in which the anticipated benefit is weighed against the perceived safety of taking the path toward change. Further research may be able to better illuminate the emotional processes surrounding level 3 changes.

So, one answer for where developmental change comes from is that the innovation leads to an expectation of something better in the future. The participants "agree" to move forward and the system re-organizes around the innovation. We can still ask two more "where does it come from?" questions. One is related to the change process itself: why does it take this particular form? The other is related to the emerging frame: where does it come from? We cannot provide answers to these questions from our data but we can offer some ways to think about the problems.

We suspect that the change process may be, like ordinary variability, a law of nature. The law does not have to exist concretely in any particular location. Rather, the law is a description of regularities that we can observe across many examples of change. According to dynamic systems theory, complex systems – from atoms to galaxies – all seem to evolve developmentally in a similar way.

- There is a gradual accretion, innovation, or amplification of existing variability.
- At some point in time, the existing system can no longer "contain" the growth within itself.
- The system seeks some new form of organization that can contain the change.
- This new form of organization requires a re-organization of existing elements in which virtually every part of the system is affected in relation to every other part.
- A new stable order emerges with a new ordinary variability.

Indeed, dynamic systems theory derives its explanatory power from this idea which apparently applies to all systems in the universe: that changes in microlevel processes (level 2) set the historical precedent for subsequent developmental re-organization. The other part of the theory worth noting here is that this "law" emerges from the mutual interactions among the elements as they are subjected to some amplification process.

This description suggests that once a re-organization process begins, it is very difficult to stop it. The old way of relating cannot contain all the innovations and there may be an inexorable pull into the relatively chaotic whirlpool of developmental change. There may be a "point of no return," a time when the irreversibility of the process becomes perceptually palpable. Too much has already changed. Too much has already been

invested. Some brides and grooms no doubt feel the overpowering host of forces, money, effort, and people that brought them to the altar while at the same time wondering what they may have gotten themselves into.

An even more challenging question is "where does the emerging frame come from?" There are a number of possibilities. First, it could be an elaboration and extension of an existing frame. In some ways, this occurred in our data because of the links between historical, bridging, and emerging frames. Each frame in this series shares some common elements with prior frames. In this sense, emerging frames evolve historically and with a clear link to the past, just like innovations.

When we look at interpersonal relationships, however, there appear to be very similar sequences of frames in the developmental series. Virtually all of our dyads evolved into the not-guided object frame, even though they may have taken somewhat different pathways. Most, but certainly not all, romantic relationships evolve into some kind of long-term partnership. This observation suggests that there may be factors other than the history of any particular relationship, factors in the larger biological or sociocultural system that may be the origin of the emerging frame.

One possibility is that there is some type of encoding of developmental pathways, perhaps in the genes, which set the stage for developmental outcomes. In this case, the genetically encoded preferences interact with the behavioral processes to produce universal developmental outcomes. In interpersonal relationships, we cannot ignore the role of culture in establishing norms, tools, and procedures for particular developmental changes. There would be no emerging guided object frame in the absence of a culture that deems objects suitable for an infant to hold and explore. There would be no marriage in the absence of a culture that sets expectations and rituals for its preparation and occurrence. Those romantic couples who do not evolve into some kind of long-term partnership are "labeled" as having "issues" or being commitment phobic individuals. So, the sociocultural narrative/system may be a source of constraint for emerging frames.

In practice, no relationship can exist apart from these larger systems. We can imagine that change in each interpersonal relationship is actually part of change in a larger sociocultural system of many relationships. The concepts and practices of childrearing, for example, have evolved over historical time in relation to cultural historical changes (Fogel, 2003). The culture is part of a multicultural society, which is part of human society, which is embedded in the biosphere of the earth. There are, no doubt, complex systemic linkages at all these levels of the lived world (Capra, 1996).

The perception of change

In this section, we address the persistent theme of this book: that the regularities or laws of change are partly in the eye of the beholder. In our discussion of qualitative research methods, we admitted that the researcher's training, relationship to the data, and cultural background could not be ignored in the construction of results and conclusions. Qualitative analysis becomes scientific when investigators strive to reach consensual credibility and to make their assumptions and cultural biases as explicit as possible. In addition, our definition of each level of change is entirely bound up with the presumed perception of the participants. In informational systems, change is perceived as differences that make a difference. Conversely, people can detect relatively invariant patterns within dynamically changing flows of events in time. Change and stability are each perceived as a significant difference or lack of a difference between one event and another (Edelman, 1987; Gibson, 1966; Kugler, Kelso, & Turvey, 1982).

In answer to the question, "Where does change come from?" we must conclude that it arises in the relationship between the observer/participant and the co-participants/observers. This means that change in interpersonal relationships is not concrete. Partly there are indeed behavioral changes that can be seen, and partly there is the interpretation of those behaviors as sufficiently noteworthy to be called a "change." It is somewhere on this very unsettled ground of scientific endeavor that we have chosen to work in this research project. Our results are not "true" or "false." Rather, they may be judged as "credible" or "incredible."

Summary of laws of change. Can laws be inferred from a handful of cases? We suspect there are laws because not all types of change were possible in our data. On the other hand, we also know that other types of laws will be discovered as relational-historical research is applied to other types of relationships. We remain convinced that general principles of developmental change can only be found from the specifics of case histories and not from summaries and averages. The laws of change that are accepted today are based on case studies. Embryonic developmental laws were derived from observing individual embryos over time. The laws of assimilation and accommodation in sensorimotor development rested upon observations of three infant siblings from the same family. The laws of biological evolution were discovered from a small number of bird species on a few islands in a single terrestrial ocean. One universe is all we have for finding the laws of cosmological change. Single cases are not limitations. They each represent a universe of possibilities.

The practice of change: people in relationships

A human interpersonal **relationship** is a historically developing communication system encompassing action, physiological processes, and the psychological meaning of those processes to each individual. In this section, we briefly touch on the topic of what it may mean to be a person-in-relation and how relationship change may affect the participants.

Being separate vs. being connected

In the discrete state model of communication (Chapter 3), relationships are linkages of separate entities. Virtually all theories of communication and human development – with the exception of Piaget, sociocultural, and Dynamic Systems Theory (Chapter 1) – rest on this Cartesian dualism. Some examples of a dualism between essentially separate entities are: senders and receivers who exchange signals; innate and acquired characteristics; and parents and children who have endowments to reach out toward the other. In this perspective, the entities are primary and relationships are secondary.

In the discrete state approach, separate entities come to "know" each other, or to "share" states of consciousness intersubjectively. Repeated signals from the "other" are decoded and interpreted by the "individual" and then re-coded into signals for sending back to the "other." The interpersonal relationship is composed of entities engaged in coding and decoding messages from "outside themselves." Growth in the discrete state model is the incremental mapping of codes to already known feelings or thoughts.

Piaget (1952) was one of the first to describe the limits of discrete state thinking. Mere associations between stimulus and response are not sufficient to capture development because there is no reason for the individual to "care about," that is, to place an emotional value on which associations are more or less interesting. Piaget claimed instead that the motive for change was a perceived incompleteness, what he called disequilibration. Discrete entities are by definition complete (or else they would not be bounded and discrete). And, if they felt incomplete they would be in need of something from "outside themselves." But to need something from "outside" one's being must mean that the "outside" is part of the individual after all (because the "outside" is needed to constitute and complete the individual).

Piaget's concepts of assimilation and accommodation are at the heart of his relational perspective. Individuals are inherently incomplete: they need "nourishment" action in relation to the environment in order to

move toward completion or equilibration. Since no form of nourishment is itself complete, the individual must accommodate to accept it, changing the form of the nourishment while at the same time changing the self. In other words, in the dynamics of the relationship, both the person and the environment change in relation to each other.

Levinas (1969) showed that Descartes' view of the essentially complete individual derived from Greek philosophy, which viewed each person as a complete entity in itself. Each person could be fully described and known if enough time and effort were expended to exhaust its list of characteristics. Levinas called this view of discrete entities "totalizing," in the sense that one could potentially know the totality of the person or object. The alternative he proposed is called "infinitizing." In this view, there is no way to know all the characteristics of the other, not even if one were to spend a very long time. This is because the other is conceived as incomplete, waiting to be defined by communication, communication that never completely exhausts the possibilities (see also Ganguly, 1976; Whitehead, 1978).

In Chapters 1 and 3 we suggested that from a systems perspective, people are always in some kind of relationship: with themselves, with other people, and with the ecology of living and non-living entities. To say that people are inherently relational means that they are inherently incomplete and indeterminate (Fogel, Lyra, & Valsiner, 1997). From a relational perspective, the "other" comes into being synchronically with the sense of "I." Because information in relationships is created or discovered in the process of relating as people come to perceive differences that make a difference based on the history of their communication (Chapter 3), information is the *result* of communication not the cause. According to Gergen (1991, p. 157), "If it is not individual 'I's' who create relationships, but relationships that create the sense of 'I,' then 'I' ceases to be the center of success or failure, the one who is evaluated well or poorly, and so on. Rather, 'I' am just an 'I' by virtue of playing a particular part in a relationship."

The relational perspective does not deny that people often perceive their part in a communicative process as "their own" contribution or "their own" failure to make an effective contribution. Each singer in a chorus manifests the group dynamics in a unique way, experiencing their own part in the larger musical creation that emerges from the choral relationship.

We interpret our research on these mother-infant dyads to favor the relational perspective. We suggest that "being" is always and at all times a "being-in-relation." The sociocultural perspective reviewed in Chapter 1 is the most clearly articulated view of this statement. All our forms of

communication and cognition evolved in interpersonal relationships. As suggested by Levinas' concept of infinitizing, "being-in-relation" in no way limits who we can become. Rather, relationships open us up to a multiplicity of possibilities and at the same time a sense of connection.

Interventions that foster change

A failure to establish a sense of connection with others is often the impetus for some kind of intervention. Depression and anxiety, for example, are symptoms of an inability to access and process strong emotions and are often accompanied by a withdrawal from or inability to rely upon the social world (Schore, 2003). Psychotherapeutic interventions can be helpful in re-establishing emotional connections within the self and between self and others. Marital and family discord is symptomatic of a breakdown of connections of attachment and trust between people. Family therapy can help people to find ways to re-establish effective communication. Aggression, crime, and warfare are also symptoms of failures to connect in mutually beneficial ways. These strategies of unilateral and coercive connections have been part of human society for millennia. Can an understanding of change processes in relationships help to put people and societies back into a more coregulated and mutually respectful mode of communication?

In this section, we suggest how our study of the microgenetics of change process may have implications for how change can be facilitated during interventions in all these types of relationships. The general laws of change that we have discovered may not give sufficient detail to carry out an intervention in any particular domain. Nevertheless, they may provide a useful lens through which one can view change. They may also provide a road map – the laws of change – that may help to reassure participants that an intervention is on track. At a minimum, we can set out the following guidelines.

- There must be an existing, stable historical frame: grounding or home base of the relationship.
- The relationship must have multiple frames active at all times to provide flexibility and room for change to occur.
- Innovations must be introduced carefully, as simple amplifications of existing ordinary variability and in a way that increases the likelihood of ratification.
- The ratification process is not instantaneous. It takes some time to negotiate ratification or rejection of innovations. No further change can occur until innovations are accepted and participants feel comfortable with them.

- Developmental change takes a relatively long time and is always based on the due process of innovations emerging gradually out of the ordinary variability of the existing frames of the relationship. Due respect must be given to the inherent inertia of existing frames. The system may require transformation through a series of incremental changes before a developmental change can occur.
- Bridging must be created at all levels: innovations must bridge between ordinary variability and novelty, and bridging frames must link and mediate the transition from existing to emerging frames while creating a safe environment to explore innovations.
- Once the re-organization process begins, the system must be given ample support to "let it happen" in order to maximize the possibilities for discovering the best route to the emerging future. The relationship must be allowed opportunities for recapitulation and relapse as a way of protecting against too sudden a change. Alternatively, when the system reaches a point of no return, participants can be supported by an understanding of the inherent creativity and opening of new possibilities of the moment.

In this section, we will briefly discuss a variety of change practices such as psychotherapy, education, and social change. In each case, we examine how these guidelines may help to "bring people to the table" in order to work through a change process. We also suspect that the bridging process, although not a guarantee of success, avoids catastrophic forms of change, making the change process less traumatic and potentially more beneficial to the participants. Understanding change may take some of the fear out of its inherent uncertainty. These guidelines may help people to allow the laws of change to work in their best interests so that they can "ride the wave" of change instead of drowning in the undertow.

Therapeutic interventions. As mentioned earlier, change is typically connected with emotional processes that lead us into and through the change process. Developmental change requires a balance of a sense of uncertainty or threat of the unknown in relation to a trust that the change will yield a better state of affairs. It is often useful to have a guide to facilitate the change process. A therapist, teacher or parent can help an individual to maintain creativity and openness during developmental transitions in the face of these emotional surprises (Antonofsky & Sagy, 1990; Block & Block, 1980; Csikszentmihalyi, 1990, 1996; Isen, 1990; Malatesta & Wilson, 1988).

According to dynamic systems theory, change is most likely to occur when the system is in a "far-from-equilibrium" state. This generally

means that the system is pushed out of its usual or habitual mode of functioning by some kind of innovation. Away from its stable frames, systems experience relative emotional disorganization and chaos. This disorganization is believed to be a fundamental part of therapeutic and developmental change that is not meant to be pushed aside and ignored. In fact, dynamic systems can only re-organize because of the heightened energy present in far-from-equilibrium states (Lewis & Junyk, 1997; Schore, 2003). On the other hand, there is inertia in the existing frames, no matter how painful they may be, a built-in resistance to change which arises because of a fear/avoidance of the uncertainty of disorganization (Mahoney & Moes, 1997; Ryan et al., 2000).

The existence of a relative chaos in the face of change is part of many mythological traditions and many forms of indigenous or shamanistic healing ceremonies. In some American Indian cultures, for example, the role of chaos is often played by the coyote, an animal spirit that represents the way in which life can sometimes play tricks on us. Healing or coming-of-age ceremonies are intended to provide community support as the person enters the "spirit world" beyond the ability of humans to intervene. These beliefs and practices embody the laws of developmental change in the form of animal natures or spirits and they make the uncertainty of chaos recognizable as part of human transformation (Bütz, Duran, & Tong, 1995).

In other societies, the therapist or teacher creates the bridge between the enhancement of flexibility and creativity, and the pain and anxiety of changing or unpredictable circumstances (Antonovsky, 1993; Rogers, 1961; Wilber, 1979). Therapeutic or educational guidance can help to facilitate developmental change by creating a bridge between the "safe" historical frames and the "uncertain" emerging frames.

> The relationship becomes a safe, caring, and informative "secure base" in and from which the client can experience, explore, and experiment with alternative patterns of activity. The therapist and therapeutic relationship serve as stabilizing processes during perturbations and the destabilization that follows. (Mahoney & Moes, 1997, p. 190).

There are individual differences in response to change, which can be experienced either as highly creative or as distressing and disorganizing, depending upon how individuals are supported while in the process of changing. Some individuals or groups seek change, magnifying their emotions of fear/threat or security in order to continue acting near the edge of uncertainty. Other individuals or groups may find change more aversive, keeping their emotions within prescribed boundaries and maintaining the stability of previously "safe" frames for communication when

faced with perturbations that are likely to lead to change (Antonofsky & Sagy, 1990; Bütz, Duran, & Tong, 1995; Fogel & Lyra, 1997; Lewis, 1995; Rogers, 1961; Stern, 1985). Therapeutically sensitive bridging is required to adapt to these individual differences.

In psychotherapy, for example, developmental change has been observed to occur when client and therapist experience "moments of meeting" or "now moments" (Sander, 1995; Stern, 1998). These are innovations in the form of novel insights and amplified emotions. A now moment can become a "hot moment of truth" in which participants are caught "off guard," requiring some unpredictable and ultimately creative act (Stern, 1998). Because these moments are times of heightened emotions, observations suggest that the emotional resonance between client and therapist is a major factor in leading the system toward more adaptive re-organization (Schore, 2003; Tronick, 1998).

Winnicott's (1971) concept of the " potential space" between partners that arises when each is completely open to the possibilities that arise in relation to the other suggests that there is a bridging process – in which both people are fully present and recognized – that supports the innovation. Because of the therapeutic safety of the bridging frame of mutual acceptance, the safety and usefulness of innovations can be explored without changing the historical frames. It is in this dyadic bridging state that innovations can be "practiced" by the client in a "what if" or imaginative manner (Harris, 1992). In this way, the therapist and client may eventually create a developmental change in the client's sense of the self in the world that transcends the therapeutic bridging frame (Beebe & Lachman, 2002; Bromberg, 1991; Fogel, 1997; Sander, 1995; Schore, 2003; Stern, 1998; Tronick, 1998).

The key to opening the way to the emergence of new more functional frames and the abandonment of dysfunctional historical frames seems to be to allow the client an opportunity to self-regulate (approach and avoid as needed) in relation to the interactive regulation with the therapist (Beebe & Lachman, 2002). The result is a "dyadic state of consciousness" that bridges the client and therapist into a dyadic system that can facilitate change for the client (Tronick, 1998).

A dynamic systems model of therapy or education, therefore, views disorganization and chaos as a necessary part of change. This means that in the midst of such change, neither the client nor the therapist, neither the student nor the teacher, knows what will occur. Both are present in the evolving system dynamics and no one is in "control." Therapists and teachers, in this view, are not all knowing gurus but rather people who are familiar with the dynamics of the change process and who can help to create the bridges to bring people through the chaotic period of

disorganization. Dynamic systems theory can emancipate the therapist or teacher by recognizing that their role is one of creating possibilities rather than controlling outcomes (Bütz et al., 1995; Mahoney & Moes, 1997).

Change in family systems

Maintenance of a long-term marital relationship requires continual negotiation and discussion. Research on marriage has revealed crucial differences between couples who remain married compared to those who divorce (Ryan et al., 2000). Long-term couples show positive problem solving behavior and they work toward showing positive emotion in daily interaction. Positive attempts were made toward the de-escalation of conflict and subsequent emotional soothing of both partners. This appears to be accomplished by a process that resembles bridging. During conflicts, couples will turn toward each other rather than away, recognize and accept differences (that is, bridging between their respective points of view), and actively seek to repair hurt feelings (Montgomery, 1994).

Surprisingly, successful marriages are no more likely to resolve long-standing conflicts than unsuccessful marriages (Ryan et al., 2000). The successful marriages, however, can create bridging frames for emotional dialogue that allows for amusement and affection and a commitment to seek change. Unsuccessful couples fail to find a bridging frame. Instead, they do not accept the other's perspective. They each treat the other with mutual contempt, criticism, defensiveness and stonewalling. This research also confirms our model because without the bridging frame, couples either fail to change or are slower to change: there is a resistance to change, an emotional inertia that holds the system in the historical frame.

Of course, the breakdown of a relationship, such as in divorce, is itself a change. It could be a developmental change if the couple's relationship continues to evolve and grow as some sort of partnership, for example, when a divorced couple actively collaborate to raise their children. Or, divorce could mean the death of the relationship with a complete cessation of further communication. Like individuals, relationships have a life cycle encompassing birth and death. Our model may also be able to help understand continuing imaginary relationships, as occurs when former partners who do not communicate continue to think about, feel, and remember their past life together.

A similar process of change and stability has been observed in mother-infant-father triadic family systems. During periods of high emotional

arousal, well-functioning families use what is called a "triangulation strategy" in which each person coordinates mutual attention and positive emotion with each of the other two partners. In stressed families, one or more of the dyadic alliances of the triangle does not show positive emotional communication. Parents may each have an independent positive relationship with the infant but not with each other. Or perhaps the father fails to connect with the infant. In these cases, there is no triangular bridging frame to keep the family together and developing as a unit (Fivaz-Depeursinge & Corboz- Warnery, 1999).

Global change

Some people see the earth as heading for a catastrophic apocalypse with the combined effect of global warming, pollution, warfare, and political unrest. Lazlo (2001) sees the potential for this type of non-linear developmental transition in what he calls the "breakdown" scenario. This involves the continued over-exploitation of resources. On the other hand, he also imagines a "breakthrough" scenario leading to the creation of a truly global community (see Table 1.1). The breakthrough scenario can only be accomplished by the use of carefully chosen innovations within a bridging process that balances the existing conflicts and human needs (historical frame) against the limitations of basic resources negotiated within a cooperative world community (emerging frame). A similar vision is shared by Greenspan and Shanker (2004), in which they explicitly propose educational and policy bridges that bring about their vision of an emerging world community (Table 1.2).

Warfare is another example of a dynamically stable frame in a relationship between the opposing social groups. How could this model help us conceptualize change for the better? First, peace may already be present within the larger current and historical dynamic system of the between-group relationship. Certainly, there were periods of peace in the past, and certainly there are individuals in each group who favor peace and seek out mutually constructive relationships with people from the other side.

One path to peace is to create bridging frames from the state of war to these already existing but relatively brief instances of a peace frame. If there is no clear winner in the conflict, as in the Vietnam War and the Palestinian-Israeli conflict, then the peace movement must acquire a political voice because of some innovation such as a change in leadership. Temporary cessation of hostilities while in a state of war is a bridging frame. According to our model, there will at first be a higher rate of transitions between the bridging frame and the existing frame of

warfare. As innovations take hold and become ratified by both sides, new information can be created that reflects a change of attitude toward the opposition.

The world has also seen that the bridging period often needs to be scaffolded by a third non-aligned party which becomes part of the bridging frame and fosters opportunities for peace negotiations. This transition, from war to peace, is developmental. It takes a considerable amount of time and there are no short cuts through the change process. There is also considerable inertia in the state of warfare, built in part by the enormous investment of money and lives and the emotional needs for retribution or vindication. The emotional information that is created and that sustains each particular conflict must be the historical ground on which innovations must be forged. Change, in other words, must come from an acceptance of the state of the system and the creation of innovations that are rooted in the existing state of affairs.

Compassion

Underlying the observed communicative bridging frame in all of the examples in this chapter is the free exercise of compassionate love, that is, the willingness to accept the other as the same as oneself and to love the other as oneself (Braden, 1997). The possibility for relational bridging frames can only arise if the participants are willing to reach out to each other with the intention to create a bridge that leads to a genuine meeting with the other person. David Bohm, noted for his contributions to dynamic systems theory in the field of physics and cited earlier regarding his notion of implicate order, suggested that true dialogue is not simply an open exchange of views but rather a compassion for one's own and the other's perspective even in the face of disagreement, the essence of bridging (Bohm, 1996). In his later years, Bohm traveled the world teaching his method of dialogue to many different groups. Bohm's view of dialogue includes an acceptance that I might be wrong, or that underneath my strong opinion there may be anger or hatred. Defending one's opinion to the end does not build bridges between people. Rather, admitting one's deeper emotions, fears, and biases in the community is the only way to reveal the sources of shared humanity. Only then is forgiveness possible, and only from forgiveness can new frames for cooperation and peace emerge.

This shared sense of humanity is an emergent bridging frame. When people can see how others are shaped by their history and emotions then disagreements can be tolerated, both points of view can co-exist in the bridging frame. Only if this occurs can there be hope for working out

the disagreements in peaceful ways. Only with such bridging can we be assured of a developmental change toward a newly emerging future of cooperation. When people act on their anger or hatred, when they mask their fear, the other's humanity becomes devalued and hostility is the likely outcome.

Going with the flow

We began this book with a quote from the *I Ching*, the ancient Chinese "book of changes." The basic wisdom of the *I Ching* is that

- everything in the universe is at some point in a continuous and lawful process of change, and
- the basic dimensions of the universe and human experience are inherently connected to each other as in summer-winter, day-night, yin-yang.

The *I Ching* is considered to be an oracle rather than a collection of bits of wisdom and advice. The purpose of the oracle is to reveal a fundamental underlying pattern in the way changes occur. The people seeking counsel are thus informed about where in the process of change they might find themselves at the moment. The seeker casts lots to select one out of a total of sixty-four "hexagrams," each of which represents a phase or pattern of change. Seekers are generally counseled to respect where they are in the process, in modern terms, to "go with the flow." The wisdom of the oracle is that those who attempt to alter these basic patterns of change are destined to an endless struggle against impossible odds.

The classic translation of the *I Ching* into English by Richard Wilhelm (1950) is accompanied by a foreword written by the psychologist Carl Jung. Jung wonders how he should present the ancient philosophy of the *I Ching* to Western readers. He decides to ask the *I Ching*, to consult the oracle by asking how he should present it. He casts lots using the coin method and readers of this book can easily discover what the oracle reveals to Jung (Wilhelm, 1950). We will follow Jung's precedent by asking that same oracle to identify the best way to illuminate the themes of this book on change processes to include at the end of this concluding chapter.

Jung comments on the method of casting lots to seek important advice. To the Western mind, this is just a matter of random chance, with all sixty-four possibilities equally likely. Why wouldn't any one of the sixty-four hexagrams be equally revealing? His conclusion is that the ancient Chinese had faith in the connections of all parts of the universe.

At any particular time, the hexagram chosen by casting lots was not thought to be random but rather an emergent manifestation – through the coins – of one's position on the wheel of change. They did not believe that anything was completely random.

At the time of writing this concluding section, the coin method of casting lots was employed and hexagram number 45 was the result, translated as "gathering together" or "massing." There are two parts to the interpretation of this hexagram. On the one hand, it suggests that when people are divided there is a need for a leader with the moral force to integrate the opposing forces in a way that they cannot be further dispersed. Such unification will inevitably lead to great achievements in the future. This seems to point to a bridging process based on compassion and mutual understanding of the sort discussed in the previous sections. It also suggests that as a direct result of this bridging integration between the opposing factions, new and desirable forms will emerge. The work of the leader, in other words, is to facilitate the bridging process rather than to make change happen. When the bridge is complete, the system will naturally develop according to the laws of change.

The second part of the interpretation has to do with the image generated by the two parts of the hexagram: the trigram meaning water above, and the trigram meaning earth below. This is a potentially dangerous situation, as the water may break through, flooding the earth. This implies that "when men gather in great numbers, strife is likely to arise." There are two possibilities: confusion and strife on the one hand, and gathering together on the other hand. The text speaks of letting events unfold in order to wait for opportunities to bring people together and for mutual understanding. Thus, while all strife cannot be prevented, there is a tendency for innovations to appear in the natural evolution of the system, innovations that can lead to gathering together. According to the oracle, the most effective route in a change process is to simply allow the change to unfold, to put oneself in alignment with the way the system "wants" to change.

In all change processes, then, the ordinary variability of the system is often sufficient to provide the innovations and bridges needed for optimal growth. Knowing this transforms our view of facilitating change. People are best understood as receivers of change processes rather than as agents of change. Change is part of the fabric of the universe, available as a resource of continually emerging possibilities. We cannot control change, nor can we predict the future. We can, however, learn to flow with change in ways that maximize desired outcomes while minimizing effort and dissipation.

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