Early Social Cognition
Understanding Others in the First Months of Life

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ORIGINS OF SOCIAL COGNITION

Chapter 1

Social-Cognitive Development in the First Year

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Recent progress in infancy research demonstrates that early on, infants perceive physical objects and expect them to behave according to core principles. These principles include the fact that objects are substantial, occupy space, and cannot be in two places at the same time (Spelke, 1991). Because infants appear to apply these physical principles at an age when they cannot yet have much hands-on experience with objects (2 to 4 months), and unless we assume that these principles are prewired in the neonate, it is likely that they are acquired via active contemplation of things behaving around them (see the description of the "astronomer infant" by Lécuyer, 1989; or the " 'couch potato' infant" by Willatts, 1997). The numerous studies demonstrating precocious physical knowledge using preferential looking, habituation, or violation of expectation paradigms suggest that this knowledge does not develop primarily from active causation whereby infants learn about objects by analyzing the consequences of their own actions on them. Is this also the case for the development of early social cognition? In this chapter, we suggest that the developing understanding of people in infancy cannot be reduced to what we know regarding the precocious development of physical knowledge. People are more complex than objects, and the development of social knowledge is based on specific processes that reflect this greater complexity.

Intimate, one-to-one relationships are the craddle of social understanding. Although much can be learned from watching people at a distance and not being directly engaged in a social exchange, such learning

cannot replace the learning opportunity provided by shared social experiences. This is particularly evident when considering the developmental origins of social cognition. Infants do not develop a social understanding by merely engaging in social "voyeurism," observing and actively monitoring people behaving around them. Rather than as voyeurs, they learn by engaging in reciprocal exchanges with others. Some 50 years ago, René Spitz made this point clear with tragic footage of infants from crowded orphanages. Deprived of one-to-one contacts with caretakers, these infants showed pervasive behavioral stereotypes, rocking their head back and forth as if negating any contact with the outside world. These infants fell back within themselves rather than opening up to the world of people. Unresponsive to social solicitations, they lost the little social learning opportunity left to them.

In general, social cognition can be construed as *the process by which individuals develop the ability to monitor, control, and predict the behavior of others.* This ability entails various degrees of understanding, from the perceptual discrimination of feature characteristics and emotional expressions, to the complex represention of intentions and beliefs as determinants of behavior (theories of mind). In this chapter, we present our view on the early ontogeny of social cognition. This view tries to capture important transitions in the development of social cognitive abilities between birth and 12 months of age. Three developmental periods are described with a particular emphasis on two key transitions by 2 and 9 months postnatal age. We review recent empirical findings supporting our contention that these transitions correspond to radical changes or revolutions in the way infants interact with and understand others (for a summary, see Table 1.1 in the conclusion of the chapter). At birth and in the course of the first 6 weeks, infants manifest an essentially innate sensitivity to social stimuli. During this period (the newborn period), neonates display social attunement. We qualify their stance towards people as *attentional,* with no signs of intersubjectivity. By the second month, infants are presented as manifesting the first signs of shared experience (primary intersubjectivity). This manifestation coincides with the emergence of a novel sense of self as agent in the environment. This represents a first key transition in early social cognitive development (*2-month revolution*), marked by the emergence of a sense of shared experience (intersubjectivity) and reciprocity with others, as part of a new general stance taken by the infant, *the contemplative stance.* Based on recent empirical findings, we try to demonstrate that the early intersubjectivity manifested by young infants in a dyadic context (primary intersubjectivity), and social cognition in general, changes in significant ways between 2 and 6 months, announcing the well-documented social cognitive abilities that emerge by the end of the first year in a triadic context (*9-month revolution*) and the emergence of secondary intersubjectivity. Overall, we discuss social cognitive development in the first year as the transition from a tight coupling between

perception and organized action systems at birth to the sense of self and others as differentiated and reciprocal agents by 2 months that leads to the sense of self and others as differentiated and reciprocal agents who can reciprocate as well as *cooperate* by the end of the first year. At this point in development, infants are starting to take an *intentional stance* in addition to the contemplative stance they develop by 2 months of age. In a final discussion, we speculate on the possible mechanisms underlying this development. But first, we set the stage by presenting some general considerations regarding the specificity of social knowledge in comparison to physical knowledge and the specific processes underlying social cognition, namely intersubjective mechanisms.

SPECIFICITY OF SOCIAL KNOWLEDGE

The understanding of people determines special knowledge and entails much more than physical knowledge. Although people have bodies, and physical knowledge can account for part of their behavior (e.g., the fact that they can move on their own, can hide or fall, are subject to the forces of gravity, and cannot be at two different locations at the same time), monitoring people and predicting what they are going to do next entails skills that go far beyond physical understanding. Understanding people also defines special processes. Social cognition entails the reading of affects, emotions, intentions, and subtle reciprocities: all the things that make people fundamentally different from objects. In other words, it entails the understanding of a private or *dispositional* world, what people feel and what characterizes their individual inclinations. But how do we get access to such understanding?

To a large extent, people reveal themselves in the way they reciprocate to us and how, via reciprocity, they convey a sense of shared experience. The same is true for animals and pets. Understanding an animal of a particular species observed in the wild or at a zoo, even for extended periods of time, is different from the understanding of the same animal raised as a pet and with whom we share our life. A sense of shared experience adds to social understanding and gives deeper access to the dispositional characteristics of individuals, whether they are humans or nonhumans. The sense of shared experience that emerges from reciprocity is captured by the term *intersubjectivity.* We will use this term extensively in this chapter, because we believe that the emerging sense of shared experience determines the early development of social cognition.

Intersubjectivity entails a basic differentiation between the self and others as well as a capacity to compare and project one's own private experience onto another (e.g., the "like me" stance). Pet owners obviously un-

derstand the nonequivalence between themselves and their animal. In the meantime, there is a projection of shared experience (empathic feelings) that bridges the difference between them. Such projective ability is at the core of social understanding. It is instrumental to the understanding of others. Interestingly, the subjective projection appears to be a recent development in primate evolution. Primate species with closer evolutionary links to humans display more frequent and varied empathic behavior to either conspecific or individuals of other species (de Waal, 1996). There is a possible link in phylogeny between the capacity for intersubjective projection and levels of social cognition. We will see that evidence concurs in suggesting such a link exists in early ontogeny.

In reviewing the recent flow of experimental research on infancy, we learn much about the nature of physical knowledge at the origins of development (Baillargeon, 1995; Spelke, Breinlinger, Macomber, & Jacobson, 1992) and comparatively little about the nature of social knowledge. Based on clever experiments, we know about the early onset of object permanence, counting ability, adaptive actions toward objects, and the early understanding of how things move in the world. In comparison, we know little regarding what infants understand about people at the origins of development, what makes people attractive, recognizable and predictable for the infant. This is somehow ironical considering the commonsensical view that infants develop social skills from an early age (Stern, 1977) and that people are what babies seem to care the most about from birth. Infants' proclivity toward people is obviously adaptive, their survival depending on them directly.

Aside from the fact that people are the main source of nurturance for infants, early behavior and the distribution of attention in newborns also reflect the fact that people provide richer perceptual encounters compared to any other objects in the environment. Neonates display a particular attraction toward people, in particular to the sounds, movements, and features of the human face (Johnson & Morton, 1991; Maurer, 1985). Social cognition probably originates from this innate propensity to devote particular attention to faces. But attending to people is different from attending to physical things. They are more complex entities to learn about and to predict. So how do infants manage to know people? We suggest that they do so primarily by building a sense of reciprocity and developing a sense of shared experiences.

INTERSUBJECTIVITY AS SOCIAL COGNITION

The royal way to crack the surface of people's dispositional world, hence to access crucial information from which their behavior can be monitored, predicted, and controlled, is to *reciprocate* with them. We propose here that

the foundation of social cognition is a sense of shared experience or intersubjectivity developing in infancy in the context of intimate, face-to-face interaction. Before we discuss the importance and function of intersubjectivity in early social cognition, we define three basic categories of subjective experiences that are too often confused in the literature and that form the affective determinants of social exchanges from birth. These basic categories of subjective experiences correspond to *feelings*, *affects*, and *emotions*.

- *Feelings* are construed here as the perception of specific private experiences such as pain, hunger, or frustration. In comparison to affects (see next), this category of subjective experiences is in general shorter in duration and terminates following particular actions such as feeding for hunger, comfort for pain, or fulfilling a goal for frustration.
- *Affects* qualify the perception of a general mood or perceived private tone that exists as a background to both feelings and emotions (see next). Affects are diffused and protracted in comparison to feelings. They fluctuate along a continuum from low, general tone (depression) to high tone (inflation). To use a weather metaphor, affects correspond to the perception of the global pressure system at a particular point in time and as it fluctuates from high to low pressure, and vice versa, over protracted time sequences.
- *Emotions* are the actual observable (public) expressions of feelings and affects by invariant movement dynamics, postures, postural changes, and facial displays as in the behavioral expressions of pain, joy, disgust, sadness, surprise, and anger. Emotions have specific, identifiable features (Darwin, 1872/1965) that serve a communicative function and give public access to what is experienced privately, namely feelings and affects.

Feelings, affects, and emotions are three kinds of basic subjective experience that are part of infants' private sense of self, from birth and long before they can talk and theorize about them. Neonates clearly have feelings and affects that they express via specific emotional displays such as pain, hunger, or disgust (Hopkins & van Palthe, 1987; Steiner, 1974; Wolff, 1987). In addition to these private experiences, they also demonstrate early on long lasting temperamental traits and particular affective baselines (Kagan & Snidman, 1991). A central question regarding early social cognition is, How do infants start to relate their own private experience to the private experience of others? In our view, this question is central as we propose that intersubjectivity is the cradle of social cognition. If infants from birth have a subjective life, what they primarily develop in their first social relationships is intersubjectivity or the sense of shared feelings, affects, and emotions.

Intimate interaction with people is the ultimate probing ground of how infants feel and what they experience from within. It is the way by which the sense of shared experience or intersubjectivity develops. Reciprocal exchanges are associated with the coregulation of affects, feelings, and behavior (emotions). In such exchanges, the affects, feelings, and emotions of one person *echo* the affects, feelings, and emotions of the other, either by mirroring, contagion, or merely contingent reactions within a short-time window. This is what characterizes, for example, the mother–infant system while engaging in playful interactions and the emotional coregulation scaffolded by games such as peekaboo or "I'm gonna get you" plays.

The echoing of affects, feelings, and emotions that takes place in reciprocal interaction between young infants and their caretakers is at the origin of intersubjectivity, a necessary element to the development of more advanced social cognition, including theory of mind. Such echoing offers infants the opportunity to match their own private world of experience with the world of others, whether it is a diffuse feeling of well being, sadness, or the intense realization of a precise thought. Before language and the emergence of conventional symbolic systems that enable children to become increasingly explicit about their own experience and to match their private experiences with those of others, dyadic face-to-face interactions and nonverbal play games are the primary source of intersubjectivity. From birth, parents and caretakers nurture the opportunity for infants to match their own experience with theirs. Parents' initiations of face-to-face play interactions with repetitive gestures, particular vocal intonation, and exaggerated facial expressions are the main course of the social regimen imposed probably to all infants, and at least to all the Western middle-class infants who are overwhelmingly represented in our research. These interactions are typically a running commentary by the parent of how the infant should feel.

Here is a casual observation we made that illustrates the kind of emotional scaffolding young infants are typically provided with in a dyadic context: a father lowers his 2-month-old daughter toward the water surface of a swimming pool. He holds her in a way that he can have a clear view of her face and that she can see his face in full view. While staring at her intensely, the father gently lets one of her bare feet touch the water and briskly removes it while commenting with a loud, high-pitched voice, "Ootch it's cold!" In the meantime, he displays a greatly exaggerated expression of pain. This routine is repeated many times in a row, with appropriate pause allowing the infant to regain her calm.

In this observation, the parent creates an emotionally charged context in anticipation of particular feelings in his infant (fear, pleasure, surprise, etc.). He monitors the child to capture the expression of the anticipated feeling in order to echo its expression in an easily discriminable (exaggerated) and contingent manner. It is as if the father is interviewing his daughter to check on her feelings and to create a situation in which he can show empathy and demonstrate his sheer pleasure in being with her. It is doubtful that the father wants to give his daughter her first swimming lesson or to teach her about temperature, liquid, or the dangers of water. Note that this demonstration of empathy requires intimate, one-to-one contacts. It mobilizes the full attention of the adult and requires a great sense of timing and monitoring. What is remarkable is that the vast majority of parents demonstrate a natural talent for highly sophisticated interactional skills with their infant, sometimes referred to as *intuitive parenting* (Papousek & Papousek, 1995). The propensity to express empathy through the echoing of affects and feelings in highly scaffolded ways is part of normal parenting and, we propose, the primary source of intersubjectivity, which itself is at the origin of much social cognitive development.

But what is gained from shared experience? Why do young infants bother trying to match their own experience of feelings with that of other people? Feelings and affects are unquestionably major determinants of behavior and are crucial for the monitoring, prediction, and control of others' behavior, whether we please them or not, whether they are attentive to our actions or not. This can mean much for young infants who depend on others to survive. Because of the prolonged immaturity characterizing human infancy (Bruner, 1972), there is a pronounced necessity in human infants to relate to caretakers and to maintain proximity with them. Developing intersubjectivity allows infants to monitor and predict more accurately the behavior of those they depend on. Furthermore, the development of intersubjectivity is probably linked to the emergence of an understanding of intentions and beliefs underlying people's actions. Taking the perspective of others and predicting how another person would feel in a given situation is indeed a prerequisite to most theory of mind tasks children start to succeed in by the third year (Perner, 1991).

We propose that intersubjectivity is the foundational aspect of social cognition and that the early development of a sense of shared experience is a prerequisite for understanding what drives other people's behavior. Social cognition is based on the matching of self and others' experience within the context of dyadic reciprocal exchanges that infants can grasp the dispositional characteristics of others, and ultimately their intentions and beliefs. It is based on the early development of intersubjectivity that infants can eventually take into consideration the perspective of others, in addition to, or in coordination with their own. This ability is indexed by social cognitive skills emerging by the end of the first year, such as joint attention and symbolic gestures (Bakeman & Adamson, 1984; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). The mindblindness of autistic children (Baron-Cohen, 1995; Hobson, 1993) and its devastating

interpersonal consequences is linked to a lack or hindered development of intersubjectivity. The absence of intersubjectivity deprives individuals of the opportunity to develop prosocial behaviors, empathy, and moral judgments that are obviously important by-products of developing social cognition. But how do infants develop such ability? When does intersubjectivity start to develop as the foundation of infants' monitoring, control, and prediction of other people's behavior? We turn to these questions now, starting with the status of social cognition at birth and through the course of the first 6 weeks of postnatal development.

NEWBORN STAGE

In the past, newborns were often described as undifferentiated in their action (Mahler, Pine, & Bergman, 1975) and in a state of fusion with the environment (Wallon, 1942/1970; Piaget, 1952). Within the psychoanalytical tradition, Mahler et al. (1975) described newborns as in an initial stage of *normal autism*: ". . . the reaction to any stimulus that surpasses the threshold of reception in the weeks of normal autism (first two months) is global, diffuse, syncretic—reminiscent of fetal life. This means that there is only a minimal degree of differentiation, and that various organismic functions are interchangeable" (p. 43). This view is now seriously challenged in light of recent evidence suggesting that newborns do express some rudiments of a differentiation between themselves, people, and objects.

In a recent study (Rochat & Hespos, 1997), we found that newborns tend to respond differentially to either external or self-administered tactile stimulation. We recorded infants rooting responses following either self-stimulation of the perioral region via spontaneous hand–mouth coordination or following a stimulation of the same region by the experimenter's rubbing her index finger on the baby's cheek. We found that newborns tend to root more frequently to external tactile stimulation than to tactile self-stimulation. These results are the product of multiple analyses, most of them failing to show the phenomenon. However weak the phenomenon is, it suggests that infants at birth express rudiments of a differential responding to self versus externally caused tactile stimulation. Self-stimulation corresponded to a double touch experience (hand touching the cheek and cheek touching the hand) whereas the stimulation from the experimenter entailed a single touch experience (cheek stimulation only). Newborns appear to discriminate between these two experiences, hence suggesting rudiments of a differentiation between what originates from the self and from the environment.

In relation to people, the numerous studies reporting imitation in the newborn demonstrate that from birth, infants are capable of visually perceiving others as differentiated from the self, the behavior of others being used by the infant as a model for self-generated action (Meltzoff & Moore, 1977). The fact that newborns are capable of matching proprioceptively actions they see performed by others (e.g., tongue protrusion) does not fair well with the idea of an initial state of fusion and undifferentiation. In relation to objects, although newborns' ability to interact with them is drastically hindered by early postural, motor, and visual immaturity, recent research suggests that they do manifest visual discrimination and selective attention to certain object configurations. Facelike line drawings are tracked significantly more by newborns than is a scrambled drawing of a face or a blank display (Goren, Sarty, & Wu, 1975; Johnson & Morton, 1991). Newborns are shown to discriminate facelike patterns, and this discrimination provides evidence that they are capable of attending selectively to particular stimulus configurations, despite their poor visual acuity (Slater, 1997). This selective attention further suggests that from birth, infants behave as differentiated entities orienting and attending to meaningful features of their environment. Although a differentiation between self and environment is manifest at birth, it is still fragile, very limited, and linked to basic, probably prewired functional propensities to respond in particular ways to specific stimulus configurations.

The initial differentiation between infants and the environment is tightly linked to the general attunement infants bring with them at birth to tap into fundamental environmental resources, and in particular to people who provide food, care, and the comfort they need to survive (see also Blass, chap. 2, this volume). From a functional or ecological point of view, the behavioral repertoire of the newborn does include action systems that are goal oriented toward specific features of the environment affording particular acts. For example, the rooting response of newborns following a perioral tactile stimulation includes coordinated mouth opening and tongue protrusion, in addition to head orientation in the direction of the stimulation. This response is more than an automatic reflex arc. It is a complex act that is part of the feeding system, considering that the rooting response is hunger dependent and brought to completion when the mouth comes in contact with the nipple or something to suck on (Koupernik & Dailly, 1968; Rochat, 1993; Rochat & Hespos, 1997). There are functional goals underlying infant behavior at birth: calming as in the case of hand-mouth coordination (Blass, Fillion, Rochat, Hoffmeyer, & Metzger, 1989; Butterworth & Hopkins, 1988); communicating as in the case of imitation (Maratos, 1982; Meltzoff & Moore, 1977); exploring as in the case of visual, olfactory, taste, and oral-haptic discrimination (Crook & Lipsitt, 1976; MacFarlane, 1975; Rochat, 1983; Slater, 1997), and feeding functions as in the case of sucking and rooting (Crook & Lipsitt, 1976). Although newborns do not behave randomly but rather act in relation to meaningful

environmental resources, their apparent goal orientation corresponds to tight perception–action couplings within a limited repertoire of action (sucking, looking, grasping) and in relation to few objects (things to suck on, feed on, and get comfort from). These action systems are functional at birth and probably even before birth when considering fetuses' sucking behavior, hand-to-mouth ontacts, and sensitivity to particular features of the human voice (De Casper & Fifer, 1980; De Casper, Lecanuet, Busnel, Granier-Deferre, & Maugeais, 1994; De Casper & Spence, 1986; de Vries, Visser, & Prechtl, 1982; Rochat, 1993).

If there is goal orientation at birth, hence an initial infant-environment (including people) differentiation, it is prescribed by the codesign of action systems that are functional at birth (or before birth) and specific features of the environment that exist independently of the infant as goals or affordances for action. The prescribed goal orientation of newborn action means that at this initial stage of development, infant perception and action are essentially directly or tightly linked, in the sense that infants do not yet show any clear signs of an explicit awareness or decoupling between behavior and the goal that guides it. In other words, there is no strong evidence of planning and deliberate acts in neonates. They appear, on the contrary, to respond directly and selectively to particular stimulus configurations (e.g., facelike displays, self-stimulation, people, things in motion) with no clear signs of a differentiation between their behavior and the goal it is geared to, such as probing, coregulating, or anticipating the behavior of things and people in the environment.

At this initial stage of development, we propose that there is no evidence of an explicit awareness of self and others. Newborns might be sensitive and attuned to others, responding to others in a differentiated way, but they do not show many signs of genuine reciprocity and deliberate probing of the social environment. Their stance toward people and things in the environment is essentially *attentional.* The attentional stance is brought by the infant at birth. We will consider now how, at around 6 weeks of age, the attentional stance is complemented with a radically new stance: the contemplative stance that emerges—with a smile.

TWO MONTH REVOLUTION: CONTEMPLATIVE STANCE

We propose that up to approximately 6 weeks, the behavior of healthy term infants is analogous to the behavior of healthy fetuses in the last 2 months of pregnancy. The recent use of ultrasonic techniques for the study of fetal behavior revealed a striking continuity between pre- and postnatal behavior (de Vries et al., 1982; Prechtl, 1984). In a nutshell, the behavior displayed by the newborn infant during the first 6 weeks of life

resembles late fetal behavior and seems to be controlled by similar mechanisms. It appears that newborns up to approximately 6 weeks behave in many ways as externalized fetuses. Their wake and sleep cycle is comparable, and many of the sensory-motor coordinations expressed by neonates are remarkably similar to what they expressed in the womb: sucking, orienting, hand–mouth coordination, stepping movements, eye movements, and so forth (Prechtl, 1984). At the level of experience and information processing, studies have shown that fetuses learn and are capable of complex perceptual discrimination (De Casper & Fifer, 1980). There is not only a continuity between prenatal and postnatal development at the level of action but also at the level of experience. In their research, De Casper and Fifer provided evidence that what fetuses learn in utero probably transfers ex utero, reporting that few hour-old infants tend to prefer their mother's voice over the voice of a female stanger reading the same story.

There are no clear signs of a discontinuity in pre- and postnatal development until the beginning of the second month. By 6 weeks, some important behavioral transformations occur, the emergence of externally elicited smiling (as opposed to the "reflex" or automatic smile of newborns) being certainly among the most welcomed and evident index of a major transformation (Spitz, 1965; Wolf, 1987). To parents and attentive observers, the emergence of smiling as a positive emotional display that is oriented *outward,* toward a person or in response to an external event, this new behavior indexes a dramatic change. Parents commonly report that they discover a person in their infant. It is experienced by caretakers as a sort of psychological birth of their infant, the emergence of a new awareness and opening up to the outside world—a dramatic transition from a primarily inward to a newly outward control of behavior. Much converging empirical evidence supports the intimate impression of parents and caretakers regarding the transition indexed by externally elicited smiling.

By 6 weeks, infants demonstrate a sudden shift in state regulation and in particular a dramatic increase in the amount of time they spend in an alert-awake state (Wolff, 1987). Note that it is in this state that infants are shown to attend to and process much information regarding the outside world (Wolff, 1987). Interestingly, by 6 weeks infants also demonstrate a marked peak in crying and fussing duration (Barr, Bakeman, Konner, & Adamson, 1987; Brazelton, 1962; Rebelsky & Black, 1972; St. James-Roberts & Halil, 1991). This peak is another index of a change in state regulation and possibly a change in the communicative function of crying, which becomes more instrumental, newly modulated by environmental and social factors. Although much interindividual variability exists, the crying peak by 6 weeks postnatal age, the coemergence of externally elicited smiling, and an increased alert-awake state are remarkably robust overall and across very different caregiving practices (Barr, Bakeman, Konner, & Adamson, 1987).

The sudden increase in awake alertness by 6-week-old infants does not merely mark a change in state regulation but also a cognitive change. They attend more to the world around them and, more important, attend to the world differently. Infant visual inspection of facelike displays illustrates this point. Over 20 years ago, Maurer and Salapatek (1976) documented a marked change in the way newborn and 2-month-olds scanned visually a two-dimensional schematic representation of a face. Newborns scan principally the outer boundary of the display, as 2-month-olds start to explore systematically the internal features of the face. This transition corresponds to changes in the externality effect reported by Bushnell (1979) at around the same age. In particular, Bushnell reported that before 2 months of age, infants detect only external changes in compound stimuli such as a shape enclosed in another, larger one. They discriminated changes in the larger (external) shape but not in the enclosed (internal) one. In contrast, by 2 months infants start noticing both external and internal changes. In the context of face perception, the new focus of attention to internal features of a configuration allows the infant to pick up important perceptual cues from which people and their emotions, hence their affects and feelings, can eventually be recognized. We view this attentional shift as the variable controlling for the emergence and development of primary intersubjectivity, or the sense of shared experience developing in a dyadic context. We propose that this shift indexes the true origin of social cognition.

Newborn infants have been shown to turn their heads and eyes significantly more to track a two-dimensional facelike schematic display than a display with the same features but scrambled (Goren, Sarty, & Wu, 1975). These intriguing findings that suggest an early propensity for discrimination and enhanced tracking of faces have been replicated in more controlled conditions by Johnson, Dziurawiec, Ellis, and Morton (1991). Johnson & Morton (1991) proposed that what underlies the newborn discrimination of facelike display is an orienting subcortical mechanism (labeled *conspec* mechanisms, in reference to *conspecifics*). Accordingly, it is a discrimination expressed within a prewired subcortically mediated orienting mechanism toward faces. This mechanism and the apparent perceptual discrimination it underlies does not entail any detection of similarities or differences among faces. This latter function is assumed by another cortically mediated mechanism (*conlern*) that does not appear before the second month (Johnson & Morton, 1991). Again, this empirically based account of the early ontogeny of face perception and recognition is articulated around a key transition at around 2 months of age, consistent with our view of a 2-month revolution.

The 2-month revolution is also evident when considering the development of imitiative responses of young infants between birth and 6 weeks of age. In their classic research that was followed by a host of related

studies from different laboratories, Meltzoff and Moore (1977) demonstrated that newborn infants are capable of imitating facial movements performed by an adult experimenter, in particular tongue protrusion gestures. These authors proposed that early imitation is mediated by an active intermodal matching, in particular a matching between visual information (perception of the model) and proprioceptive motor information (reproduction and execution of the imitative response.) An alternative explanation of neonatal imitation is that this response is mediated by innate releasing mechanisms. According to this latter interpretation, rather than active matching by the infant, certain facial displays of the adult trigger a preorganized fixed-action pattern in the infant (Abravanel & Sigafoos, 1984; Bjorklund, 1987; Jacobson, 1979.) Contrary to Meltzoff & Moore's account, infants are not actively engaged in molding their response to the visual target. It does not call for any awareness on the part of the infant or the mediation of any higher cognitive and perceptual processes involved but rather an automatic release of prewired responses, without the involvement of any active matching for equivalence. As suggested by Meltzoff and Moore (1994), the crucial test in deciding which interpretation is correct is twofold. First, if the fixed-action pattern is correct, the stimulus–response system that underlies it should be time locked. In other words, the automaticity of the imitative response should correspond to a small time window between stimulus and response, enough to allow the triggering of the response. Evidence of delayed imitation and recall of a model beyond few seconds does not fair well with the fixed-action pattern theory. Second, active matching between model and response supports the idea that higher perceptual and cognitive mechanisms mediate the imitative response of the infant and that it is not automatic but rather involves some active probing and molding by the infant. Evidence of active probing indeed suggests that infants are somehow aware of the difference between themselves and the model to be imitated and are actively engaged in trying to match the two.

In one of their follow-up studies on early imitation, Meltzoff & Moore (1994) tested their own interpretation against the fixed-action-pattern view on 6-week-old infants presented with different models of mouth opening and tongue protrusions (to the side or at midline). Infants were tested for immediate and 24-hour delayed imitation. Meltzoff & Moore reported that 6-week-olds do show delayed imitation after 24 hours and do demonstrate active matching of their motor response. In the course of the immediate or delayed response period following the model of the facial gesture, infants tended to engage in a progressive motor approximation of the model. When presented with the model of a tongue protrusion to the side of the mouth, they first pulled their tongue at midline and in the course of repetive protrusions shifted their tongue to the side. This active matching

is clearly incompatible with the idea of a fixed-action-pattern account. However, if 6-week-olds unambiguously demonstrate higher perceptual and cognitive engagement in their imitative responses, to our knowledge this has not been demonstrated with newborns. We turn now to recent findings we collected in our laboratory suggesting that, indeed, by the second month infants do attend and respond in fundamentally different ways to the consequences of their own action compared to newborns. These findings strongly support the idea that the active, differentiated engagement of the infant Meltzoff and Moore observed with 6-week-olds in the context of imitation develops around this time and is probably not present at birth.

In a first experiment (Rochat & Striano, submitted), we recorded the successive positive pressures 2-month-old infants applied on a pacifier introduced in their mouth for nonnutritive exploratory sucking. Infants sat in between two audio speakers that fed back to the infants trills of discrete synthesized sounds contingent on the infants' sucking on a pacifier. A computer recorded the oral pressure applied on the pacifier by the infant, and when it was above a fixed (low) threshold, it generated successive discrete sounds varying in pitch frequency only. In other words, following a 90-second baseline period with no sound, each time infants sucked on a pacifier above threshold, they heard a perfectly contingent sound. Now, here comes the crucial manipulation. Infants were tested in two conditions. In one condition, each time they sucked above threshold, they heard a contingent sound that was analog or commensurate to the amount of pressure or effort they applied on the pacifier (Contingent + Analog condition). In this condition, the infant was presented with an auditory spatial and temporal equivalent of the action they performed on the pacifier. In another condition, each time infants sucked above threshold, they heard a contingent sound that was *not* analog or commensurate to the amount of pressure (effort) they applied on the pacifier (Contingent + Nonanalog condition). In this second condition, the infant was presented with an auditory temporal *only* (contingent only) equivalent of the action they performed on the pacifier.

The question guiding this experiment was whether infants would generate differential patterns of oral activity depending on the temporal only or temporal and spatial equivalence of the auditory consequences of their own action. The rationale was that such differential responding would indicate that infants are sensitive to and systematically exploring the consequences of their own agency. It would index their ability to take a *contemplative stance* in the exploration of themselves, in particular, the exploration of themselves as agent. We view this contemplative stance as analogous to the ability of imitative matching demonstrated by Meltzoff and Moore (1994) with 6-week-old infants. They both suggest that infants are capable of stepping back from the tight link between perception and

action and engaging in the active exploration of what they perceive in relation to what they are capable of self-producing: their own effectivity in the world whether it is the world of the self, people, or physical objects.

We found that 2-month-olds generate significantly different patterns of oral actions depending on the two experimental conditions. Overall, infants tended to generate more frequent pressures on the pacifier that were just at theshold in the Contingent + Analog condition compared to the Contingent only condition. Furthermore, they manifested significantly lower average pressure amplitude in the former than in the latter condition. These results suggest that (a) infants are sensitive to the auditory consequences of their own action, (b) they actively explore these consequences if the consequences are both temporally contingent and spatially congruent with their own action, (c) when the auditory consequences are both temporally contingent and spatially congruent with the effort they exert on the pacifier, infants tend to manifest more control and exploraton of their own agency. This last point is inferred from the fact that by exploring the proprioceptive and auditory threshold, infants show more controlled exploration of self-agency, which in turn depends on the condition. Whether the auditory consequences of sucking are both contingent and congruent or only contingent, infants appear to engage in a differential exploration of the threshold, hence of self-agency. Following our rationale, this is an index of their ability to take a contemplative stance.

This interpretation is particularly valid when we compare these results, found with 2-month-old infants, and those we found in a second experiment with newborn infants. In this second experiment, we replicated the research with a population of healthy less-than-48-hour-old infants. Although infants accepted the pacifier we introduced into their mouths and generated a good amount of oral pressures, we found absolutely no evidence of a differential pattern of sucking depending on conditions. In contrast to 2-month-olds, newborns did not show any differential oral responding whether it was followed by Contingent only or Contingent + Analog auditory consequences. Following the rationale of the study and our interpretation, newborns do not show any signs of a systematic exploration of the auditory consequences of their own sucking, hence no signs of systematic and controlled exploration of self-agency. This is important, particularly in light of the fact that newborns' auditory system is well developed at birth and they are capable of operant learning via sucking in the context of speech-sound discrimination tasks (De Casper & Fifer, 1980; Eimas, 1982; Juscyk, 1985).

Based on this research, we conclude that 2-month-olds but not newborns show signs of a contemplative stance or the stepping back from the tight link between perception and action couplings (learning the mere association between sucking and auditory events) to engage in the active explo-

ration of self-agency. In our view, this stance is revolutionary, opening up new ways of interacting with and understanding the world. In particular, we suggest that from the emergence of the contemplative stance that implies a first distanciation of the infant in relation to the environment (including the self), infants will develop a new range of expectations regarding people around them. These expectations are less direct, essentially more reflective (in the sense of reflexion, or reflective awareness) compared to the prospective control newborns might express, for example, in learning and conditioning in the context of their transactions with the human environment (Blass, chap. 2, this volume). By 2 months, infants begin to develop specific expectations about how people behave, who they are, and what they should do when interacting with them. They learn to systematically anticipate, control, and develop likes as well as dislikes of people. Such development requires the stepping back or decoupling that starts to be manifested by 2 months, a key transition that we like to equate to a revolution for its radical departure from what is expressed during the newborn stage. Again, this transition is validated by the remarkably robust experience reported by parents witnessing their infant smiling back at them at around this age. It is most likely that this experience often described by parents as the discovery of a person in their infant, modifies in radical ways their attitudes toward their progeny. From there, we propose, develops a radically new sense of shared experience (primary intersubjectivity) with novel social expectations and scaffolding initiated from both the baby and the parent or caretaker (Kaye, 1982; Papousek & Papousek, 1995). This forms the developmental origins of early social cognition. We turn now to what develops from here up to 9 months, when infants express yet another radical departure or revolution: the adoption of the intentional stance.

DEVELOPMENT OF SOCIAL EXPECTATIONS BETWEEN 2 AND 6 MONTHS OF AGE

Accompanying the emergence of the contemplative stance by the second month, face-to-face and, in particular, eye-to-eye interactions between infants and caretakers become prevalent, at least in Western middle class culture. As we illustrated at the beginning of this chapter with the anecdote of the father dipping his infant in the pool and establishing intersubjectivity regarding the soaking experience, caretakers start compulsively to present themselves in an *en face* posture to the infant. The face becomes a primordial theater, staging emotional and intentional cues that are used in the monitoring, control, and prediction of others. Caretakers read the infant's facial display of emotions obviously from birth, but when by 2 months

infants start to show signs of reciprocity in this reading, there is a dramatic shift in the dynamic of the interaction between caretakers and infants.

The socially elicited facial displays of the infant and in particular smiling, change the social scaffolding offered to the infant. From essentially comforting, calming, and accompanying infants in their fluctuating behavioral states, caregivers' interventions become more playful due to the reciprocity emerging by the second month. There is now a new implicit goal in the interaction, the establishment of shared, pleasurable, and playful experiences. Aside from feeding and calming, cares now include the necessity to check on the infant's well being and emotional attunement via games and routines that have in the past triggered smiling and other emotional displays of positive affects and feelings in the infant. It is as if there is a shift from essentially physical care provided to the infant to both physical and emotional cares. The diapers of babies continue to be checked, together with their emotional state, through tickling, perhaps, and some exagerated verbal commentaries. As their infant's ability to reciprocate becomes unambiguous, parents develop a new sense of their infant as a psychological entity in need of emotional attunement in the context of positive social exchanges. This sense is an addition to the comfort and physical cares they dispensed from birth. It is from this point that intersubjectivity can develop as a coconstruction between the infant and social partners. We view this coconstruction as the true (psychological) beginning of early social cognition. We turn now to the question of what develops from there.

We can assume that infants gain much knowledge about others in the dyadic, face-to-face context they are compulsively placed in by caretakers. It is in this context that caretakers scaffold the infant in routine games and particular patterns of interaction (Gergely & Watson, this volume; Kaye, 1982; Stern, 1977). But starting in the second month, what social knowledge develops in this context? In general, what develops is a primary sense of shared experience, or primary intersubjectivity (Trevarthen, 1979). We mentioned already that in engaging in routine face-to-face interactions, infants are provided with the opportunity to match their own feelings and affects of those of the social partner. By the second month, when infants start taking a contemplative stance with social, reciprocating partners, they probably also start to take a "like me" stance. We propose that the general contemplative stance infants start to adopt by the second month, taken in a dyadic face-to-face context, leads the infant to recognize herself in this object ("like me" stance). This happens because the object of contemplation is reciprocating with appropriate (invariant) timing and emotional displays. Contrary to Meltzoff & Gopnick (1993), who proposed that even newborns take the "like me" stance in their propensity to imitate, we suggest that this stance is a special case of the general stance shift (con-

templative stance) emerging during the second month and taken in the dyadic social context.

From the general context of emerging intersubjectivity, infants develop expectations regarding others and the way they should respond in face-to-face interactions. Routine games, mirroring, and parental frames form a dynamic field of contemplation for the infant from which invariants can be picked up and social anticipation can develop. People can be identified in addition to and beyond their physical attibutes in the way they relate to the infant: the timing of their reciprocity, the dynamic of their vitality (see Stern, this volume), the overall tone of their posture. These invariants specify the dispositional world of others in relation to the self. An infant might start to expect to be picked up in a certain way when engaging in a joyful, playful interaction with a particular person. Mom might be in general gentler, softer, and less systematically contingent in the way she reciprocates and handles her infant. Dad might be more forceful, vocal, and marking with excess his contingent mirroring when interacting with the same infant. Infants certainly pick up these invariant characteristics that specify persons in the way they relate to them. For example, the research of Ann Bigelow (this volume) suggests that by 4 months, infants have developed an attunement to their own mother's timing and relative contingency in interacting with them (e.g., frequency of contingent, reciprocal smiles), generalizing this attunement to stanger females who display more or less contingency.

Murray and Trevarthen (1985) reported that infants as young as 2 months of age interacting with their mother via a closed-circuit video system did manifest a differential responding to their mother when she was presented live or in a replay (See also Muir & Hains, this volume; Nadel & Trembley-Leveau, this volume). Infants were reported to display marked decrease in gazing and smiling as well as significant increase in negative affects in the replay compared to the live condition. This suggests that infants, by 2 months, start to be sensitive to their mother's relative emotional attunement to them. In other words, infants somehow appeared to discriminate between true (live) and false (replay) reciprocity of the mother. In the replay condition, the mother was noncontingent in the sense that although displaying much positive, hence engaging, positive feelings and affects, this display was supposedly detected by the infant as being *nonreciprocal*, violating the timing of response that specifies reciprocity, hence the sense of shared experience and intersubjectivity.

In a recent study (Rochat, Neisser, and Marian, in press), we tried to replicate Murray & Trevarthen's (1985) findings, controlling for possible order effect that might have accounted for the phenomenon they reported. In two different experiments, one of them testing 2- as well as 4-month-old infants, we were unable to replicate the basic phenomenon. We proposed

that the nonecological validity of the closed-circuit video system that removes important cues of reciprocity, such as distance regulation and touch, might account for the lack of evidence of young infants' sensitivity to social reciprocity and contingency within this experimental context (but see Nadel & Tremblay-Leveau, this volume). In Rochat, et al., and as a control, infants did react to the sudden still face we asked mothers to adopt in their live TV interaction. This suggests that infants, within this experimental set up, were sensitive to some aspects of the ongoing interaction with their mother but not the kind of subtle reciprocity cues that the findings reported by Murray and Trevarthen in their original experiment implied.

In order to capture what is detected by young infants in a more natural dyadic context than the closed-circuit video system set up, we explored in a recent study (Rochat, Querido, & Striano, submitted) the sensitivity of 2- to 6-month-old infants to the relative structure of the interactive frame offered by an adult stranger. The rationale for this study was to capture how infants from 2 months on refine their ability to detect regularities in ongoing social interaction and to develop specific expectations based on a sensitivity to the structure of the interaction. Based on our failed attempt to replicate Murray and Trevarthen's phenomenon, we hypothesized that by 2 months, although infants start to show signs of reciprocity, their sense of the other as reciprocal partner is yet diffused and undifferentiated. At this early age, the social skills and achievement of the infant might be merely the global monitoring of a social presence or absence of an attentive social partner, not yet the degree to which this partner is reciprocating. We hypothesized that from a global sense of a social presence, by way of intimate and animated tracking of eye-to-eye contact accompanied by particular speech sounds in the form of "motherese," infants beyond 2 months of age develop specific expectations in the dyadic context based on cues specifying the *quality* of the interaction (e.g., whether it is organized or disorganized, contingent or noncontingent, predictable or not). This development leads infants to differentiate people in the subtle ways people relate to them.

In our study, we videotaped 2-, 4-, and 6-month-old infants interacting with a female stanger in a face-to-face situation that did not include any touching. Aside from baseline periods, in two different experimental conditions, the experimenter introduced the infant with peekaboo routine that was either structured or unstructured. In the structured condition, the peekaboo routine was strictly organized into three phases articulating a total of eight subroutines: (a) an *approach* phase in which the experimenter leaned foward toward the infant while saying "Look, look, look," and maintaining eye contact; (b) an *arousal* phase in which once the experimenter was close to the infant she covered her face with her hands and then dropped her hand down while saying, "Peekaboo!"; (c) a final

release phase in which the experimener leaned back to the original posture while saying a long, calming, "Yeaaah" while nodding her head and smiling. In the unstructured condition, the experimenter was wearing an ear piece conntected to a tape recorder playing instructions of subroutines to be performed in a random, disorganized way. In other words, in the unstructured condition, the experimenter engaged in a scrambled peekaboo game, with unrelated subroutines that did not coalesce to form the crescendo–decrescendo or tension building and release script (Stern, 1985). Note that the stuctured and unstructured peekaboo conditions were equated in duration and number of events (subroutines), varying only in their narrative power, that is, power to provide the infant with a simple script of tension building and release. Also, note that in either conditions the experimenter displayed the same attention to the infant, with eye-to-eye contact and the display of exagerated positive affects. In each condition, the peekaboo routine was repeated eight times in successsion over approximately a 1-minute period. Then the normal interaction resumed. Each 1-minute condition was repeated twice in a counterbalanced order among infants of each age group.

In scoring the infant's smiling and gazing at the experimenter, we found that 2-month-olds looked toward the experimenter and smiled equally in both the structured and unstructured conditions. They appeared equally attentive in both conditions and displayed no evidence of differential responding. In sharp contrast, both 4- and 6-month-olds showed marked differential responding in gazing. Both groups of older infants demonstrated a significant increase in gazing in the unstructured compared to the stuctured condition. They stared longer and in higher proportion, particularly relative to the subroutines of the last, release, phase. In the structured condition only, infants tended to look away and smile during the three subroutines of the last release phase. Four- and 6-month-olds smiled significantly more frequently during the subroutines of the last release phase in the structured compared to the unstructured condition. Finally, we found that the average duration of smiling was significantly longer in the organized compared to the unorganized condition for the 6-month-olds only.

Overall, the results of this study demonstrate that from 4 months of age, infants start to be attuned and sensitive to the narrative envelope of the routines provided by social partners. They detect regularities and organized patterns in the dyadic interaction and respond to them in synchrony. From this developing sensitivity to organized patterns of interaction, infants develop more precise expectations about people and the way they should behave in relation to the self. This, in turn, provides new grounds for the social understanding of who people are and what can be expected from them in particular.

Another recent study we performed in our laboratory (Rochat, Blatt, & Striano, submitted) further captures the development of social expectations between 2 and 6 months. We studied infants response to the sudden still face adopted by an experimenter in a dyadic, face-to-face social exchange (Muir & Hains, this volume; Tronick, Als, Adamson, Wise, & Brazelton, 1978). In successive 1-minute still-face conditions, interspersed with 1 minute of normal interaction, the experimenter adopted either a *neutral* still face (typical of studies using a still-face paradigm); a *happy* still face, with mouth open and fixed smile; or a *sad* still face, with wrinkled forehead, frown eyebrows, and inverted U-shaped mouth. We scored the infants' relative smiling and gazing toward the experimenter in these various still-face conditions that provided different static emotional cues (neutral, happy, or sad). In particular, we compared the infants' responses to the still face in comparison to the preceding normal, affectively positive interaction (still-face effect) and the infants' responses to the still face in comparison to the following normal, affectively positive interaction (recovery effect).

In relation to gazing, we found an overall still-face effect (decrease in gazing duration toward the experimenter) in all conditions for the groups of 4- and 6-month-olds but not for the 2-month-olds. In other words, 2-month-olds did not show signs of averting gaze during the still face, regardless of conditions. In relation to smiling, all groups of infants showed decreased smiling in all still-face conditions. Regarding the recovery effect, 4- and 6-month-olds showed more recovery in gazing following the happy still face than either the neutral or sad still face. Two-month-olds showed equally low recovery in all conditions. In relation to smiling, 6-month-olds showed a markedly reduced recovery of smiling when the normal interaction resumed, independent of still-face conditions. In contrast to the groups of 2- and 4-month-olds, 6-month-olds appeared to resist positive reengagement and reciprocity following any of the still-face episodes. This again suggests that they are building different expectations about the social partner based on past, unusual experience (still-face episodes). In general, these observations indicate that by 4 to 6 months, infants are more sensitive to dispositional cues displayed by people and that these cues are the foundations for particular expectations regarding the way they should behave. Depending on age, the still-face effect changes, and the recovery from it appears more dependent on static emotional cues provided by the social partner during the still-face episode. It is as if infants develop an ability to consider the behavior of people beyond the here and now, progressively able to relate current behavior to past interaction.

In summary, what we are suggesting here is that between 2 and 6 months, infants develop social expectations in a dyadic, face-to-face context. This development finds its origins in the contemplative stance infants start to take by the middle of the second month. From this key developmental

transition that marks the end of the newborn phase, and can be considered the psychological birth (as opposed to the biological birth) of babies, infants develop new understanding of themselves, objects, and people. In relation to people, 2-month-olds start to reciprocate in an undifferentiated way, sensitive mainly to the overall presence and positive solicitations of caretakers. At this early stage, others are differentiated from the self but yet unspecified. In their transactions with others, 2-month-olds are mainly engaged in monitoring a presence, not who this presence is, what her dispositions are, and what can be expected from her. In contrast, we have seen that 4- and 6-month-old infants start to show signs of a growing sensitivity to subtle social cues, such as the organization of the social scaffolding or relative structure of the narrative offered in routine games by the adult as well as the dispositional (emotional) cues expressed by the adult in these games. It appears that by 6 months, infants are capable of relating present face-to-face interactions with the quality and characters of previous ones. This new "historical" perspective on people and the way people relate to them leads infants to develop rich social expectations based on increasingly subtle emotional and dispositional cues. This development accompanies the emergence of a new sense of shared experience in a dyadic context (primary intersubjectivity). It is from here that infants prepare themselves for their next major developmental step in understanding others—the adoption of the intentional stance or the understanding of others as *intentional agents.*

NINE-MONTH REVOLUTION: THE INTENTIONAL STANCE

By the end of the first year and starting approximately 9 months of age, infants demonstrate marked progress in social cognition, developing triadic social competencies and secondary intersubjectivity (Baldwin & Baird, this volume; Moore, this volume). Triadic competencies correspond to the emerging ability of the infant to monitor others in relation to objects. Infants start to manifest a sense shared attention to the physical world, *coordinating* their own perspective and attentional focus on things with the perspective and attentional focus of others. Gestural communication, in particular pointing, joint attention, gaze following, and social referencing are all indexes of secondary intersubjectivity emerging by 9 months (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Campos & Sternberg, 1981; Carpenter, Nagell, & Tomasello, in press; Trevarthen, 1979).

This inclusion of others' perspective in dealing with them and the world around radically changes the realm of communication: from the coregulation of feelings, affects, emotions and the establishment of basic expectations in routine plays during dyadic, face-to-face interaction to the possibility of learning through teaching and cooperation on things outside the dyadic relationship. Infants' awareness that they can attend jointly, and that others' facial expression and communicative efforts can inform them about the environment, makes teaching and learning with others possible. Cooperating on objects and on others radically enlarges the realm of social cognition in infancy, changing the way infants understand others: from interactive and emotional entities to intentional agents.

But how do infants get to this point? We believe that part of this developmental process is based on the early propensity young infants have in detecting invariant information specifying movement dynamic associated with intentional actions. The sense of their own planning and own intentionality probably develop from the perceptual analysis 2-month-olds start to engage in when showing first signs of a systematic exploration of their own actions' consequences (see previous and Rochat & Striano, submitted). Our contention is that the perceptual analysis of self-agency is at the origin of an understanding of self-intention. Likewise, we propose that at the origin of an understanding of intentions in others there is the perceptual analysis young infants engage in when exploring the consequences of actions originating from entities independent of the self: how animated things, including people, move and act in relation to objects and in relation to one another.

The research we present now suggests that starting at 3 months of age, infants engage in the systematic exploration and detection of movement information that specifies intentionality in animated entities that are moving independently of the self. The research illustrates that beyond 7 months of age, and not before, infants show signs of an intentional stance that goes beyond a mere perceptual discrimination of movement dynamic. We show that if a sophisticated perceptual analysis is evident in young infants, it is yet mysterious how they develop an intentional stance from this perceptual analysis. In relation to this question, we recently conducted an investigation that suggests some developmental links by the end of the first year between social-cognitive competencies developing in dyadic and triadic contexts (Striano & Rochat, submitted).

In adults, there is a robust, almost compulsive inclination to perceive meaningful physical and social causality in the motion of abstract objects, such as two-dimensional geometric figures moving on a screen. The seminal works of Heider and Simmel (1944), Michotte (1963), and more recently Basili (1976), and Dittrich and Lea (1994) documented that physical causality, dispositional qualities, and intentions were systematically perceived in the context of particular sequential movements of two or more geometric figures. Depending on particular patterns of dynamic interactions between these abstract entities is associtated with the phenomenal percep-

tion of causal and social events: for example, that one entity caused the other to move by entrainment or by launching; that one is chasing the other with the intend to get it. These impressions are systematic and depend on precise dynamic information specifying the relative movement of the figures on the display. This phenomenon rests on the basic perception of relational movement characteristics (i.e., how one entity moves in relation to the other) that is eventually dressed with the meaning of physical or social causality, including the attribution of intentions and dispositional qualities (e.g., the red square "pushed" the blue circle, or the "nervous" yellow triangle is "trying to catch" the black circle that is swiftly "fleeing away").

In one study (Rochat, Morgan, & Carpenter, 1997), we attempted to capture the developmental origins of a sensitivity to relational movement characteristics that, for adults, specify social causality.The rationale of these studies was that in order for the infant to take the intentional stance, they first had to develop a particular sensitivity and attunement to dynamic perceptual information that specifies social and intentional events for adults. We tested 3- to 6-month-old infants (as well as a control group of adults) for their visual preference for two different dynamic displays showing abstract objects that adults perceive as interacting either intentionally or randomly. Both displays were presented to the infant simultaneously on two computer monitors placed side by side. Each display consisted of a pair of colored discs moving either independently (*independent display*) or in systematic interaction with one another (*chase display*), never actually contacting one another.

The chase display was meant to specify an intentional social event. In the independent display, the movements of the discs were random. In the chase display, one disc (the chaser) systematically approached the other (the chasee) at a constant velocity. When the chaser came close to the chasee, the latter accelerated away from it until it reached a relaxed distance, at which point it returned to normal speed. Except for the relative spatio-temporal dependence of the discs' movements, all dynamic parameters on the two displays were controlled and maintained equal (see Rochat, et al., 1997, for details).

Results show that adults as well as 6-month-old attentive infants (as opposed to infants who did not pay much attention to the displays) tended to look significantly longer at the independent display than the chase display. In contrast, the group of 3-month-old attentive infants tended to look significantly more at the chase display. When ordering infants according to age in days and plotting the ratio of preference to the chase or the independent display as a function of age, there was a significant linear trend from chase to independent preference. Interestingly, posttest interviews of the adults indicated that they spent more time looking at the independent display, trying to pick up invariant dynamic features. Such

invariant features were reportedly quickly picked up as specifying a chase in the other display. This would explain their pattern of preferential looking for the independent display. We did not assume that the analogous pattern of preferential looking found with the group of 6-month-olds rested on a similar account. However, the results obtained with infants point to two facts: from 3 months of age, infants demonstrate a sensitivity to movement information specifying social causality for adults (i.e., chase vs. random movements), and this sensitivity is expressed differently and appears to develop between 3 and 6 months of age.

In order to test at what age infants might take an intentional stance in perceiving the chase display, we recently tested groups of 3-, 5-, 7- and 9-month-old infants using the following habituation procedure (Morgan & Rochat, 1997). Infants were habituated in looking at a red and a blue disc chasing one another on one computer display. Except for their color, the discs were identical. For half the infants of each age group, the blue disc was the chaser and the red disc was the chasee. For the other half, the colors were reversed. Once they reached a predetermined habituation criterion, infants were tested in successive posthabituation trials with either the same event or *a role-reversal event.* In the role-reversal event, the chaser became the chasee, and vice versa, through a color switch of the discs. In other words, in the role reversal event trials, the color label of each protagonist (chaser and chasee) was reversed. Remember that except for color, the discs were identical in forms and dimensions.

Results of this study yielded an interesting developmental trend. Infants younger than 7 months of age did not show any signs of dishabituation (i.e., significant regain of visual attention) when comparing trials with the role-reversal event and the habituated event. The group of 7-month-olds started to show signs of increase looking at the novel, role-reversal event, but looking time did not quite reach significance. However, by 9 months of age, infants show unambiguous (massive) increase of looking at the role-reversal event trials. When ordering all the tested infants according to their age in days, and plotting against their age the relative ratio of their dishabituation, there is a sudden change in this dishabituation ratio starting at around 7 months and jumping up by 9 months.

Considering that only the color labeled the role of each abstract protagonist on the computer display and that the protagonists were specified by the way they moved in relation to one another, we propose that the dishabituation starting to be expressed by 7-month-old infants and clearly expressed by 9-month-olds corresponds to the emergence of an intentional stance taken by the infant. This dishabituation is based, as for the previous experiment, on a discrimination of the pattern of relational movements of the two discs on the display, but also a discrimination of a change in *identity* of the protagonists (e.g., blue disc = chasee and red disc = chaser).

The discrimination of the identity change required the infant to take an extra step beyond the mere discrimination of movement dynamic that the first study showed is evident starting at 3 months of age. It required that the infant somehow construe the chase event on display in relation to the question of *who is doing what to whom.* This identification process is the extra step required by the intentional stance that 9-month-olds appear to take. It means that infants start to construe social events as transactions between planning and motivated entities *beyond* the fact that they are merely animated and move in different ways relative to one another (see first study previously described).

But what are the mechanisms underlying this developmental revolution in social cognition? What determines the transition from perceiving animated things in the environment as moving in particular ways based on the detection of particular dynamic invariants (i.e, self-propulsion, action at a distance, crescendo–decrescendo of velocity, etc.) to the understanding of animated things in the environment as planning and self-motivated entities? One possibility is that by 9 months of age, infants bring what they learn in the dyadic context of face-to-face interactions into the context of tryadic interactions. Accordingly, early on infants learn about their caretakers' affects, feelings, and emotions as well as their own in the dyadic context (see previous). When starting to take an intentional stance, infants transfer the understanding of others they develop in a dyadic context into the triadic context, attributing motivations, planning, and intentions to animated entities they perceive and understand beyond a direct, face-to-face interaction. Such interpretations imply a developmental link between social cognition developing in the dyadic and triadic context.

To test this interpretation, Striano and Rochat (submitted) recently compared 7- to 10-month-old infants' responses to a still-face situation in the dyadic context of a face-to-face interaction with an adult stranger to their responses to different triadic situations of shared attention, gestural communication (pointing), blocking and teasing, as well as gaze following with another adult stranger. Overall, we found some evidence of a correlation between the level of infants' responses in the dyadic and triadic situations at both ages. For example, more developed response to the still face, such as the infant's attempt to reengaged the still-faced social partner by poking her or calling her for attention (social probing), was linked to more advanced triadic responding. These results suggest that dyadic and triadic competencies do not develop in independence but rather in interaction. More research is needed to specify the nature of this interaction and to capture mechanisms underlying the emergence of the intentional stance in both dyadic and triadic contexts of social cognition. Because social cognition develops first in a dyadic (face-to-face) context, emerging triadic competencies by the end of the first year certainly depends on this

early development. The nature of this dependence is yet unclear. It is, however, an important consideration even when studying later development and, in particular, the emergence of theories of mind by 4 years of age (Perner, 1991). Emerging theories of mind and success in false-belief tasks imply not only the inference of rational thoughts and intentions in others but also the inference of motivations and dispositional qualities. The consideration by children of the affective determinants of people's behavior in a given situation (e.g., a false-belief task) rests in part on the original intersubjectivity children have developed in the dyadic context of early social cognition, starting at 2 months of age and, of course, also on the emergence of the secondary intersubjectivity an the intentional stance manifested by 9 months.

SUMMARY AND CONCLUSIONS

What we tried to convey in this chapter is that the developing sense of shared experience between infants and their caretakers is the craddle of social cognition. It is in the early development of an affective matching between self and others that infants lay the foundations of their social knowledge. Table 1.1 summarizes the basic developmental progression we have proposed. Accordingly, primary intersubjectivity emerges around 2 months postnatal age, when infants demonstrate an emerging capacity to step back and explore the consequences of their own actions on objects and people (contemplative stance). The emergence of social cognition is linked to the emergence of self-agency and the contemplative stance infants start to manifest by the second month. The amplified reciprocity offered by caretakers, reinforced by socially elicited smiles expressed by the infant, scaffold the rapid development of social-cognitive competencies, in particular, the development of basic social expectancies within the dyadic, face-to-face context of early social exchanges. By 9 months of age, infants appear to adopt a new stance, the intentional stance, engaging in coop-

TABLE 1.1
Proposed Developmental Progression of
Social-Cognitive Development in the First Year

Age	*Intersubjectivity Level*	*Social-Cognitive Stance*
0 to 1 month	Sensorimotor attunement	Attentional
2 to 7 months	Primary intersubjectivity: smiling, affective attunement, social expectations	Contemplative
8 to 12 months	Secondary intersubjectivity: joint engagement, social referencing, attention following, gestural communication	Intentional

eration with others in relation to larger functional goals. In the development of primary intersubjectivity that takes place between 2 and 9 months, infants learn about the dispositional world of others. By 9 months, this learning expands beyond the dyadic context to incorporate not only the affectivity of others in relation to the self but also their intentions in relation to the object world that surrounds one-to-one relationships. At this stage of social cognitive development, infants reach new operative levels in matching their own private experience with others'. Now, intersubjectivity serves not only the purpose of being affectively attuned and sensitive to others for the sake of maintaining social relationships but also becomes instrumental in the cooperation of the infant with others in relation to third entities or goals. This development is linked to much cognitive progress including symbolic functioning, communication, and emerging theories of mind.

Beyond the newborn stage and by the second month, infants develop their first knowledge about people and, in particular, what to expect from them and how they reciprocate. Caretakers are particularly attuned to young infants' contingent responding in the context of amplified and repeated interactive frames. They scaffold the infant by engaging in systematic mirroring and exaggeration of their emotional expressions, reflecting back to the infants their own behavior through compulsive running commentaries and exaggerated mimicking of their actions within face-to-face presentations. It is within this highly structured framework that infants start developing a sense of shared experience that, we proposed, is the developing core of social cognition. It is from this intersubjective core that infants develop skills to monitor people and anticipate their behavior.

Dyadic competencies developing first, they lay the foundation for the development of triadic competencies and prepare the infant to take the intentional stance at around 9 months of age. However, the mechanisms underlying the transition from the contemplative stance young infants adopt in a dyadic context of social interaction to the intentional stance they take by 9 months in a triadic context need to be further specified in future research. Beyond 9 months of age, dyadic social competencies continue to develop in interaction with triadic competencies. If infants start to understand people as intentional, their dispositional qualities will continue to be primarily specified in dyadic contexts. Theories of mind, the monitoring, control, and prediction of people behavior, are not merely based on cold, rational inferences. They are also based on social knowledge that develops first in the context of intimate, one-to-one relationships and pertains to the affective determinants of people's behavior. This knowledge is primitive and is based on the way private experience of feelings and affects match the experience of others. Intersubjectivity is indeed the cradle of social cognition.

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