

# THE ROLE OF DYADIC COMMUNICATION IN SOCIAL COGNITIVE DEVELOPMENT

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## **I. Introduction**

Before language takes over as the instrument of interaction one cannot interact humanly with others without some proto-linguistic “theory of mind.” (Bruner, 1990, p. 75)

“Communication is dramatically central in the lives of human adults, in diverse spheres of life, of non-human primates, of neurons in engagement with each other in an embodied world, of computer programs and machines

designed to ‘communicate’ and respond in the contexts they are embedded in, and above all, in the lives of very young infants” (Reddy & Legerstee, 2007). In this chapter, I examine communication for its importance in the development of infant social cognition. That is, how through dyadic, face-to-face communication infants reveal that they are people and become more so with development. They are people, because from birth they share simple emotional experiences with conspecifics, and they become people because through communicating with others they construct more complex representations of them that are important for the development of language and theory of mind. I address the questions of when communication can be said to begin and how it develops. While doing so, I highlight the theoretical controversies and debates that promote but also limit the study of dyadic communication in developmental psychology. I begin with a theoretical overview of dyadic communication and examine the relation between infant communication and social cognition. I then touch on the prerequisites to the development of dyadic communication, such as (a) the recognition of conspecifics and their behavior, (b) the ability to differentiate people from things, and (c) the processes that ensure that infants connect to the social world. Subsequently, I describe development during the first year of life when infants are engaged with responsive adults in dyadic face-to-face communication to highlight those aspects of sociality that may reveal the infants’ earliest communicative experiences, such as (a) meaningful dyadic communication, (b) mechanisms that promote development, and (c) relations between infants’ core abilities and later language and theory of mind.

## II. Theoretical Controversies

If infant members of a mind-reading species give us the strong feeling that they are doing some kind of mind reading, they probably are. (Flavell, 1999, p. 32)

Within the context of dyadic interactions, infants communicate with eye contact, facial expression, vocalizations, and gestures while assimilating the rhythm of their interactions to that of their caretakers. Together, the members of the dyad appear to engage in subtle turn-taking and co-constructive dialogues (Fogel, 1993; Stern, 1985). Because language and communication development depend fundamentally on being able to read the intentions of others, there is much controversy over the nature of infant social cognition that underlies the emerging dyadic communicative abilities. Some theorists propose that infants for the first 9 months

(Carpenter, Nagell, & Tomasello, 1998) or 18 months (Barresi & Moore, 1996; Perner, 1991; Piaget, 1954) are not aware of the mental states of others, and consequently during that time are incapable of communication. In contrast, others (Bruner, 1983; Legerstee, 2005; Trevarthen, 1979) argue that infants are born with a natural ability for primary intersubjectivity, and that development proceeds from simple to more complex communication. In general, intersubjectivity is defined as the process in which mental activity—including motives and emotions—is transferred between minds. It is transmitted by body movements (especially of face, vocal tract, and hands) that are adapted to give visual, auditory, or tactile information about interests and emotions (Trevarthen, 1999).

Advocates of these views differ in their opinion about the continuity of mental state awareness. Their theories have, therefore, been divided into continuous and discontinuous accounts. Because of the relevance of these views for the role of dyadic communication in infants' socio-cognitive development, in what follows, I describe and contrast these two theoretical approaches.

#### A. CONTINUOUS PERSPECTIVES

Infants (like most other mammals) are social creatures that spend the beginning of their lives in close proximity with their caretakers. Continuous theorists propose that human infants have some special socio-cognitive capacities that make them particularly social and distinguish them from other mammals. That is, because human infants not only differentiate members of their own species from inanimate objects (Bruner, 1973; Gelman & Spelke, 1981; Legerstee, 1992; Legerstee *et al.*, 1987), capacities which higher primates possess also (Tomasello & Call, 1997), but infants are born with a primitive awareness of the mental world that allows them to relate to others and to share emotions with them, and thus to exhibit their natural ability for intersubjectivity.

What does it mean to engage in intersubjective communication for the infant? Communication is by definition intersubjective (between two or more subjects) (Trevarthen, 1999). If one proposes that infants are born with an innate ability for intersubjectivity, then one argues that newborns relate to their caregivers on a person-to-person basis. According to Hobson (2007, p. 267) intersubjectivity is a uniquely human form of communication that has its roots in infancy, shapes cognitive development, and, more specifically, provides the foundation for symbolic functioning. It is concerned with interpersonal engagement rather than simply transmitting

information between people. The uniqueness of interpersonal engagement is the result of the human ability to identify with conspecifics from the beginning of life. This identification not only allows infants to perceive others to be like the self (i.e., “like me”) physically (Meltzoff & Brooks, 2001), but more importantly, to perceive people to be “with me” emotionally (Legerstee, 2005; Markova & Legerstee, 2006). Although this socio-cognitive ability becomes more complex with development, it is characterized *from the onset* by the desire to share experiences with others. In fact, continuous theorists propose that there is continuity between early and later social cognitive abilities of language and thought, because infants are born with *domain-specific abilities* that allow them to connect with the social world from the start.

Theorists interested in domain specificity view the mind as a group of specialized domains that process and represent specific kinds of information (Legerstee, 2005; Wellman & Gelman, 1998). With respect to social cognition, the domain contains representations and principles that direct infants to the necessary social input. Consequently, infants are not only sensitive to domain-specific information at birth, but they pick up concrete information through interacting with others and thus construct knowledge about people. These processes allow infants to deal with people’s actions in ways that are both precursory and continuous with more mature conceptual understandings of people.

Accordingly, continuous theorists propose that at birth young infants are pre-adapted to the early structure of communication (Bruner, 1983; Stern, 1985; Trevarthen, 1979). They argue that intersubjective sharing can be observed initially during *dyadic* interactions between caregiver and infant (Bruner, 1999; Fogel, 1993; Legerstee, 2005; Stern, 1985; Trevarthen, 1979; Tronick, 1981), and later during *triadic* interactions, which extends the communicative context to a third party or object (Bakeman & Adamson, 1984; Legerstee, Markova, & Fisher, 2007). Because both basic and complex abilities imply mentalist construal, there is a connection between the earliest pre-linguistic communicative behaviors during the first half year of life, and more complex communicative abilities such as triadic communication, intentional gesturing, and mental state language later on (Legerstee, 2008). According to Flavell (1999) such continuity makes sense “... because older human infants are making genuine mental state attributions in a few short months ... it is not unreasonable to suppose that they might be doing some precursory or early version of the same thing now” (p. 33).

In support of continuous theorists, extensive research has revealed that as early as the second month of life infants distinguish between people and objects when perceptual differences are controlled (see Legerstee, 1992,

for a review; Legerstee, Corter, & Kienapple, 1990; Legerstee, 1991). However, it appears that no studies have examined whether such conceptual differentiation is available to infants from birth. Consequently, the debate concerning the hypothesis that infants' understanding of people is domain-specific remains active. More research is needed that tests the idea that domain-general mechanisms, such as contingencies and analyses of perceptual features, guides infant' awareness of people (Baird & Saylor, 2006; but see Markova & Legerstee, 2006). Given that infants' limited response repertoire makes it difficult to assess whether they are able to engage in intersubjective sharing from birth, future studies combining behavioral with neurological evidence are needed to shed light on the truly initial state of infant knowledge in the domain of social understanding.

## B. DISCONTINUOUS PERSPECTIVES

The majority of cognitive developmental psychologists do not disagree that infant behavior is driven by mental states. If they did, there would be no reason to study the existence of such states. Instead, the debate surrounds the age of onset of an *awareness* of mental states. Some discontinuous theorists view triadic interactions emerging around 9 months as the beginning of meaningful communication in infants (Carpenter *et al.*, 1998). It is argued that at this age infants become aware of their own intentions, and because they are born with an ability to perceive others to be "like me," transfer this understanding to others. In contrast, other theorists (Moore & Corkum, 1994; Perner, 1991; Piaget, 1954) place the onset of an awareness of intentions even later, namely at the end of the sensori-motor period between 18 and 24 months, coinciding with the beginning of symbolic behaviors such as pretence and language. These classical cognitivists (Carpendale & Lewis, 2004; Perner, 1991; Piaget, 1954) and prepared learning theorists (Barresi & Moore, 1996) argue that during the first 2 years of life, infants do not infer the meaning of others' behavior, but rather focus on what they see people do. It is not until the end of the sensori-motor period that infants begin to perceive people's actions as driven by ideas in the mind. Within this view, an understanding of the self as an intentional agent only lays *the foundation* for an awareness that the other is an intentional agent who has internal experiences, such as emotions, beliefs, and desires. These theorists argue that the infants' socio-cognitive development is the result of innate biological processes (e.g., assimilation, accommodation, and interiorization) that prepare the infant to act intentionally around 8–10 months and to perceive others as intentional agents around 18–24 months. For instance, according to the domain-general

theory of Piaget (1954), infants are at birth devoid of any cognitive structures and knowledge about the world. Rather, the infant that Piaget described comes equipped with reflexes that only react to incoming stimulation for the first month of life. After much reflexive action on the world (e.g., sucking on the breast or a blanket) and with the help of biological mechanisms of assimilation and accommodation, infants learn to discriminate between various objects in the world (one provides milk and the other comfort, respectively). It is at that moment, around the second month of life, that reflexes turn into action schemas and cognitive structures develop, which direct infants for the first time to act on (rather than being acted upon) the environment. Infants now enter the second stage of the sensori-motor period, namely primary circular reactions, when their actions become discriminatory and voluntary. Although during the subsequent months of the sensori-motor period the cognitive structures allow for more enriched and refined experiences, they never enable the infant a glimpse into the mind of the other. People are experienced behaviorally but never psychologically. It is not until the end of the sensori-motor period that action schemas turn into mental schemas that allow infants to become aware that others have minds (see also Barresi & Moore, 1996; Perner, 1991). Thus, according to Piaget, before the pre-operational period the infant has no representations: she discriminates between people and objects behaviorally (based on perceptual aspects), but never conceptually (based on attributes one cannot see, such as mental states—emotions, feelings, goals, and desires). The infant recognizes her mother because of recognitory assimilation, which is a perceptual process of matching the action schema the child has with the one she sees, but not through matching what she sees with the image she has in her head. The infant does not have the ability to share experiences such as emotions and feelings with others (i.e., intersubjectivity) but responds purely to the stimulation emanating from the adult. It is only during the second year of life that there is a gradual shift from subjective to objective understanding, or from knowing the world perceptually to knowing the world conceptually. The end of the sensori-motor period then marks the beginning of thought. According to Piaget, infants at this stage are becoming social: people are differentiated from objects on their social dimensions (mental states) rather than their physical ones (Barresi & Moore, 1996; Carpenter *et al.*, 1998; Moore & Corkum, 1994; Perner, 1991; Piaget, 1954).

Although discontinuous theory is well justified in that it provides a well-defined ontogenetic trajectory, it is not without its problems. Most importantly, it is implied that during the first months of life infants have a perceptual, rather than a conceptual understanding of the social world (i.e., understand human communication in terms of physical actions rather

than sharing of experiences). Because mental state awareness is not continuous, but develops from an absence to its presence, there is no connection between early and later abilities. A particular problem with the perception/conception distinction is, how one can differentiate between these two cognitive processes (the conceptual or high-functioning cognitive mode and the experiential or low-functioning cognitive mode) and at the same time explain the emergence of both modes of processing from the same origin, as resulting from interactions among innateness (maturation) and experience (learning) (Pascual-Leone & Johnson, 1998).

Thus, although the strength of the discontinuous position is that intentionality is definitely present by one or two years of age, the three weaknesses are that (1) there is no discussion of the mechanisms that bring about developmental changes in behavior (e.g., how does the infant proceed from being a behaviorist to becoming a psychologist), (2) there is no explanation or description on what the origin of mental representation is (it is suddenly there), and (3) there are no theoretical assumptions about how sensitivity to others' psychological states develops (Legerstee, 2001; Zeedyk, 1996).

### **III. Prerequisites for Human Communication**

Let me begin with the ontogeny of the matter. If one adopts a continuous view of mental state awareness, then one can expect to find prerequisites to meaningful communication. That is, to engage in meaningful interpersonal exchanges infants must be able to (a) recognize people as similar to self and (b) differentiate them from non-social stimulation.

#### **A. RECOGNITION OF HUMAN STIMULI**

Before we can assume that infants are motivated to interact with social agents in dyadic communication, we need to establish that, rather than having to learn everything about people (cf. Piaget, 1954), infants have some endogenous factors by which they recognize people. What might this be? Research focusing on visual perception has shown that from birth infants are attracted to movement, contour, contrast, certain levels of complexity, and curvature (Banks & Salapatek, 1983; Haith, 1966), especially when they are arranged in a socially relevant face-like pattern rather than in random and abstract ways (Goren, Sarty, & Wu, 1975). In addition, it appears that 1-month-old infants recognize their mothers' faces because they spend more time looking at her face than at strangers' faces

(Barrera & Maurer, 1981; Bushnell, Sai, & Mullin, 1989). Maurer (2007) highlights how important face recognition is for the infants' socio-cognitive development. Apparently, when infant vision is blocked by bilateral congenital cataracts, they fail to develop normal face processing, despite treatment. These visual limitations have an impact on effective dyadic communication in infancy, and beyond.

Auditory perception also appears ready for processing socially relevant information in newborns. The auditory system is stimulated in utero (DeCasper, Lecanuet, Bushnell, Granier-Deferre, & Maugeais, 1994). Newborns recognize the voices of their mothers, to which they were familiarized in the womb, from those of female strangers (DeCasper & Fifer, 1980). At 1 month, infants make fine distinctions among speech sounds (Eimas *et al.*, 1971), discriminate linguistic contrasts not available in their mother tongue (Trehub, 1976), and retain information about syllables (Jusczyk, Kennedy, & Jusczyk, 1995). At 6 months, infants' phonetic perception predicts language development at 24 months of life (Tsao, Liu, & Kuhl, 2004). According to Kuhl (2007) this link between natural speech and language learning depends on children's awareness of the communicative intentions of others.

Another important prerequisite for meaningful dyadic interaction is that infants must separate themselves from surrounding environments. According to Piaget (1954) it is only when infants understand that people and things continue to exist when not perceptually discernable, at the end of the sensori-motor period (18–24 months) that infants truly separate self from the external world and begin to place themselves within a common space with other objects. However, numerous studies have demonstrated that infants are not only aware of their surroundings, but also perceive themselves as independent agents. They have shown that infants are conscious of their own bodies, thereby refuting the notion that infants begin life unable to separate self from others. For instance, newborns become distressed when hearing a recording of another infant but not when they hear a recording of themselves (Dondi, Simion, & Caltran, 1999). Moreover, by 5 months, infants in a preferential looking paradigm visually discriminate the moving images of themselves from those of peers and dolls, and by 8 months differentiate the non-moving, and thus more novel image of self and doll (Legerstee, Anderson, & Schaffer, 1998).

Although infants' ability to recognize faces and voices documents their capacity for storing and recalling information from memory, until recently, they were assumed to lack this ability (Bauer, 2006). However, the ability to reliably recall information improves rapidly between 6 and 20 months. That is, infants not only memorize items or actions, but they remember the order in which the events occur. After seeing a sequence of events, 25% of

the 6-month-old infants showed *ordered recall* 24 hours later (Barr, Dowden, & Hayne, 1996), 50% of 9-month-olds showed *ordered recall* 1 month later (Carver & Bauer, 1999, 2001), but by 20 months *all* infants recalled the order of events 1 month later (Bauer, Wemner, Dropik, & Wewerka, 2000). Moreover, emotionally salient events are better remembered by infants. For instance, Bornstein, Arterberry and Mash (2004), in a non-verbal communication paradigm, revealed long-term memory in 20-month-olds who had participated in a social interaction where an adult looked at them but refrained from communicating (a perturbation condition called the still-face procedure) at 5 months. These infants (experience group) fixated the face of the person who had instigated the still-face significantly less than the faces of two other novel persons. Control 20-month-olds (no-experience group) looked longer overall and fixated the target person equally or more than the two novel persons. The still-face response has been said to violate the expectations of infants that in face-to-face communication people will communicate with them (Tronick *et al.*, 1978). That 2-year-olds were able to remember something that happened when they were 5 months of age not only reveals their advanced mental capacity, but also their intersubjective nature and how communication is represented during the first months of life.

In summary, not only do infants' perceptual abilities draw them to the physical properties of people, such as faces, voices, and movements, but they also appear to have early inferential abilities that allow them to make sense of this information. Thus, rather than developing from a perceptual to a conceptual processing of human behavior, infants reveal that they have representations that guide their search for perceptual or concrete information from birth (Legerstee, 2001).

A particularly important question is whether infant responses to persons are different from their responses to objects, and whether this differential responsiveness is based on their different reasoning abilities (Legerstee, 1991, 1992, 1994, 1997, 2001; Legerstee, Barna, & DiAdamo, 2000; Legerstee & Bowman, 1989; Legerstee & Markova, 2008; Legerstee *et al.*, 1987). Indeed, given that the primary function of language is to communicate with one or several persons, distinguishing between people and things seems an important prerequisite.

## B. PERSON-OBJECT DIFFERENTIATION

As discussed earlier, several authors (Bruner, 1973; Gelman & Spelke, 1981) put forth the idea that infants are born with specific knowledge about people organized in domains as well as principles about how to

interact with them. People and inanimate objects differ in significant ways, and consequently the rules and regulations on how to interact with the physical domain should be different from those we use to interact with the social domain. Although people and objects are similar in physical properties (size, shape), they are different, because only people communicate, and have feelings and intentions. Objects do not have inner states and consequently we would only pay attention to the physical attributes of objects and their functions.

As a result of these differences, adults, but also 2-year-olds interact differently with the two classes: they talk to people, but act on objects. That is, when 2-year-olds want something from their parents they communicate a need to them. If the parent does not respond for some reason, they will continue with great persistence. Children may talk to their toys at times, but will not get upset when they do not receive an answer. Indeed, 2-year-olds take the absence of communication by non-social objects as a matter of fact. If, however, they want their toys to move, they will manipulate them. Young children clearly differentiate between people and things for purposes of communication. They know that the two classes have different functions and require different ways of interacting. One communicates with people and manipulates things.

When is the onset of this differential responsiveness? Some of the traditional observational work addressing this question showed that by 2 months, infants communicate with people and not with things. Faced with a responsive adult, infants produce expressive facial movements, make pre-speech sounds, and participate in conversational turn-taking. Faced with a graspable, non-social object, infants initiate pre-reaching movements defined as hand and arm activity directed toward it (Brazelton, Koslowski, & Main, 1974; Rader & Stern, 1982; Trevarthen, 1979). However, this research has been criticized as not systematic. For instance, the studies failed to control for contingent responding (Watson, 1972), familiarity (Ellsworth, Muir, & Hains, 1993), size, and facial features (Klein & Jennings, 1979) that might have influenced differential responding in infants. However, the many replications of others introducing more stringent controls (for a review see Legerstee, 1992; Legerstee & Markova, 2007) with typically developing infants as well as with infants with Down syndrome, at an age when the infants had approximately the same mental age or level of perceptual-cognitive sophistication as the non-delayed infants (Legerstee & Bowman, 1989; Legerstee, Bowman, & Fels, 1992), all revealed the same pattern of differential responsiveness in infants during the first year of life. In particular, this research showed that during their first month of life infants communicate with people and act on interactive dolls (Legerstee *et al.*, 1990). Between 2 and 3 months, infants

imitate mouth openings and tongue protrusions of people but not of inanimate objects that simulate these gestures. Moreover, at that age, infants expect people to share their affective states with them, but they do not have such expectations of inanimate objects (Legerstee & Markova, 2007; Legerstee *et al.*, 1987). Between 5 and 8 months of age, infants begin to recognize their own faces and voices as familiar stimuli and differentiate them from those of peers and inanimate stimuli (Legerstee *et al.*, 1998). By 6 months, infants expect *others* to communicate with persons and to manipulate inanimate objects (Legerstee *et al.*, 2000) and by 10 months, infants complete failed actions of people but imitate failed acts of inanimate agents (Legerstee & Markova, 2008). This early differential responsiveness together with important developmental changes during the first year of life suggests that infants are reacting to communication-related cues in the presence of social stimuli (Legerstee & Markova, 2007; Legerstee *et al.*, 1987).

Although infant's differential responsiveness to people and objects and their relatively advanced social relationships lend credence to the idea that infants have developed a concept of people, an important feature of a concept of a person is that it is distinguished from the self. "One's concept of self is a concept of a person; one's concept of persons cannot be a concept applicable only to a single individual (one-self), for the reason that in this case it would no longer constitute a concept" (Hobson, 1990, p. 165).

The ability to identify with others and to distinguish between self as different from others plays an important role in intersubjective relationships. Human adaptation involves an understanding of others, but also an understanding of the self as different from others. Indeed, the self cannot be viewed in isolation from our view of others, but relies deeply on how we represent people. Thus, the self is perceived in relation to the other (Fogel, 1993). Research shows that from early on infants recognize people as similar to the self, because they imitate mouth openings and tongue protrusions of people, but not inanimate agents simulating these gestures (Legerstee, 1991). In response to an elongated object that moved toward their mouths (simulating a tongue protrusion), infants produced mouth opening as if they perceived a bottle. When an inanimate object simulated mouth opening and closing (a box in the shape of a mouth) infants increased tongue movements as if they wanted to explore the object. Infant imitative responsiveness to people and not to physical objects not only suggests that imitation is a social response, but also supports the contention put forth by Gelman and Spelke (1981, p. 54) that "the infant implicitly 'knows' that he and another person can act in kind."

In summary, from birth infants interact differently with people and objects and have different expectations of them, because they have learned

about them through perceiving both the frequency of occurrence of particular actions (i.e., people communicate, objects do not) and the constraints on the particular relations among these occurrences. Although the precise nature of these constraints is unclear (they can range from innate intuitions to precise rules), infants could not have concepts without both components. They need associations to detect new information and theoretical inference to guide the inquiry (Keil *et al.*, 1998).

Although infants' sensitivity to social stimuli is an important aspect of learning about the social world, it is through the dynamics of social interaction that infants get to know people. Dyadic communication plays a central role in the development of the self because people not only react (contingency), but they interact and elaborate on the infants' emotions (Legerstee & Varghese, 2001; Markova & Legerstee, 2006). It is through these intersubjective forms of communication that infants construct a more complex conceptual understanding of their conspecifics, of which the self is a member (Chapman, 1992). As a result, dyadic communication has often been given a major explanatory role in infants' developing understanding of people (Bruner, 1973). Accordingly, one of the main roles of dyadic communication in infant socio-cognitive development is to establish connections with the social world. In what follows, I discuss a study that specifically addressed this proposition.

### C. FOUNDATION OF INFANT SOCIAL AWARENESS: CONNECTING WITH THE SOCIAL WORLD

A theoretical question that until recently has received little empirical investigation is how infants become linked with the social world. Or in Hobson's (2007) words, how do infants recognize a special form of occurrence, characterized by sharing, "that only occurs, in relation to some special kind of embodied thing, namely a person, ... and if they do, how are we to characterize the structure and psychological means to such relatedness" (p. 270). As explained earlier, empirical findings reveal that infants know more, and at earlier ages, than had been predicted by classical theory (i.e., Piaget, 1954). These findings have led to a call for a revision of Piaget's theory. As a consequence, new theoretical frameworks have developed that address the question of the foundation of infants' social awareness. Pertinent to the present discussion are the Social Biofeedback or Contingency Detection Model of Gergely and Watson (1999), the Active Intermodal Mapping theory of Meltzoff and Moore (1983), and the Affect Sharing Model by Legerstee (2005). Although all agree that the social partner is important for the development of social

cognition, these theories have different opinions about how infants become *connected* to the social world.

The Contingency Detection Model (Gergely & Watson, 1999) focuses on the detection of contingencies and social mirroring as explanatory tools for the infant's developing social understanding. Contingency detection theorists argue that intersubjectivity is a result of infants' perception of social contingencies. Specifically, these authors propose that in the beginning, infants are able to detect only the effect their own actions have in the world, which is important for the development of an awareness of the self (by kicking the sides of the crib I become aware of my body), but it is not until 3 months of age that infants begin to be sensitive to the type of "intermittent" contingent interactions provided by people (Gergely & Watson, 1999). As a result, infants do not orient toward people before the age of 3 months, and thus are not able to establish interpersonal connections with them in the first few months of life.

The Active Intermodal Mapping theory proposes that infants establish intersubjective connections with people by detecting similarities between own and others' actions (Meltzoff & Moore, 1983). How infants do that is the core of this theory. It is proposed that infants are born with multimodal coordination which allows them to operate with multimodal information, thereby recognizing equivalences in information across different sensory modalities. Intermodal coordination enables infants to imitate early communicative facial gestures of people. Imitation is an "attention getter" and through it infants begin to perceive others to be "like me." Thus the infant's ability for multimodal coordination allows them to recognize people as physically similar through imitation. This process lays the foundation for a later developing reciprocal communication system that allows infants to understand and sympathize with others (Meltzoff & Moore, 1983).

The Affect Sharing Model (Legerstee, 2005) provides a framework to explain how infants connect with the social world by relying on innate predispositions and attuned social relationships. Accordingly, infants are born with three important predispositions that allow them to learn about the minds of others: (a) the ability to recognize people as similar to themselves, (b) the awareness of their own and others' emotions, and (c) the recognition of the caregivers' attunement to the infant's emotions and needs. The interplay between these three predispositions results in affectively attuned relationships that are important mechanisms for infants' socio-cognitive development (Legerstee & Varghese, 2001; Markova & Legerstee, 2006). Thus, the Affect Sharing Model postulates that infants' connections with the social world develop through sharing emotional experiences with attuned adults, who reciprocate the infants' communicative behaviors. As a result, infants not only begin to perceive others to be "like me," but more

importantly “with me,” which is the gateway to the development of an awareness of other minds (Legerstee, 2005).

The assumptions of these three theories have been put to test. In Markova and Legerstee (2006), predictions about the role of contingency, imitation, and affect sharing in the development of social awareness were tested in infants during natural, imitative, and yoked conditions with their mothers at 5 and 13 weeks of age. During the natural condition (Figure 1a) mothers were asked to interact naturally with their infants. During the imitative conditions (see Figure 1b) mothers were instructed to imitate all infants’ behaviors, including movements and vocalizations. During the yoked condition (see Figure 1c) mothers listened to an earlier interaction she had engaged in with her infant at 4 and 12 weeks of age, which was now replayed over a portable cassette recorder into earphones only the mother wore. By repeating what they had said a week earlier, mothers produced the same emotions and the same amount of stimulation as during the previous normal interaction. However, mothers’ talk was not contingent, nor imitative, because it was not in response to the infants’ signals.

We further used the 3-min interactions at 4 and 11 months to assess mothers on their affect attunement. Maternal affect attunement was defined as maintaining infant attention, warm sensitivity, and social responsiveness (see Landry *et al.*, 1998; Legerstee & Varghese, 2001). *Maintaining attention* was defined as a maternal request, or comment that related to or elaborated on the activity the infant is currently visually engaged with, physically engaged with, or both. Maintaining can also be a maternal request, question, or comment that was in direct response to the infant’s attempt to attract the mother’s attention to an object or activity. *Warm sensitivity* was a composite assessment of the degree of sensitivity that mothers display to infants’ affective cues, including promptness and appropriateness of reactions, acceptance of the infants’ interest, amount of physical affection, positive affect, and tone of voice. Five-point rating scales were used to make global ratings for three separate behaviors: (1) positive affect, (2) warm concern/acceptance, and (3) social responsiveness. Three ratings were made for each of the behaviors, once every minute of the 3-min natural interaction and an average was calculated for each category. *Social responsiveness* was defined as maternal imitative responses to infants’ smiles and vocalizations, and as modulations of infants’ negative affect. Based on these measures, mothers and infants were divided into high- and low-attuned groups. To determine whether infants enjoyed their mothers’ interactions, infant smiles, vocalizations, negative face, and gazes were coded. This allowed for the assessment of “goodness of fit” of the interaction.

The various models have specific predictions about the paradigm in which the infants were observed. The Contingency Detection theory

(a) Natural Interaction



(b) Imitative interaction



(c) Yoked interaction



Fig. 1. (a) Natural, (b) imitative, and (c) yoked interactions with mother (Copyright @ Cambridge University Press).

predicts that both high- and low-attuned groups of infants prefer the imitative interaction at 5 weeks of age, because both are perfectly contingent. Because infant preference switches at 3 months from perfect contingencies to intermittent contingencies, infants in the high-attuned, but not the low-attuned groups would switch their preference to the natural interaction at 13 weeks of age, and react negatively during yoked interactions, due to the lack of sufficient contingency. The Active Intermodal Mapping theory predicts that infants of both high- and low-attuned groups prefer imitative behaviors of their mothers at both ages and react negatively during yoked interactions due to its decreased degree of match. Theories of affect sharing predict that infants in the high-attuned group favor natural interactions with their mothers over the imitative and yoked interactions at both ages because of the high level of affective attunement. In contrast, infants in the low-attuned group should not discriminate between the three conditions at both ages, because less-attuned mothers provide low levels of affective and responsive interactions.

The results supported the predictions put forth by the Affect Sharing Model. At 5 weeks of age infants of high-attuned mothers showed a preference for the natural interaction over imitative and yoked interactions, as indicated by elevated levels of gazes, smiles, and positive vocalizations. However, the infants increased negative vocalizations during the yoked interaction instead. Overall, infants of low-attuned mothers did not react differently to the three conditions (Figure 2a).

Similarly, at 13 weeks infants of high-attuned mothers clearly preferred the natural interaction, over the imitative and yoked interactions and increased their frequency of negative vocalizations during the yoked interaction. Infants of low-attuned mothers gazed significantly more at their mothers' imitative behaviors (probably due to novelty) but did not discriminate between the three conditions with smiles, positive, and negative vocalizations (see Figure 2b).

These findings support the Affect Sharing Model which predicts that infants' connections with the social world develop through sharing emotional experiences with attuned adults who reciprocate the infants' communicative behaviors. Although contingent responding and imitative games may draw infant attention to their social partner, *affective dyadic communication* appears to lay the foundation for infants' appreciation that others are not only similar to the self (like me), but also emotionally in tune with them (with me). Infants' early intersubjective capacities are facilitated by mothers who are attuned to the infants' communicative behaviors. Warm, responsive, and nurturing relationships with caregivers who harmonize their own behaviors with those of their infants enable infants to appreciate that others are similar, responsive, and attuned to

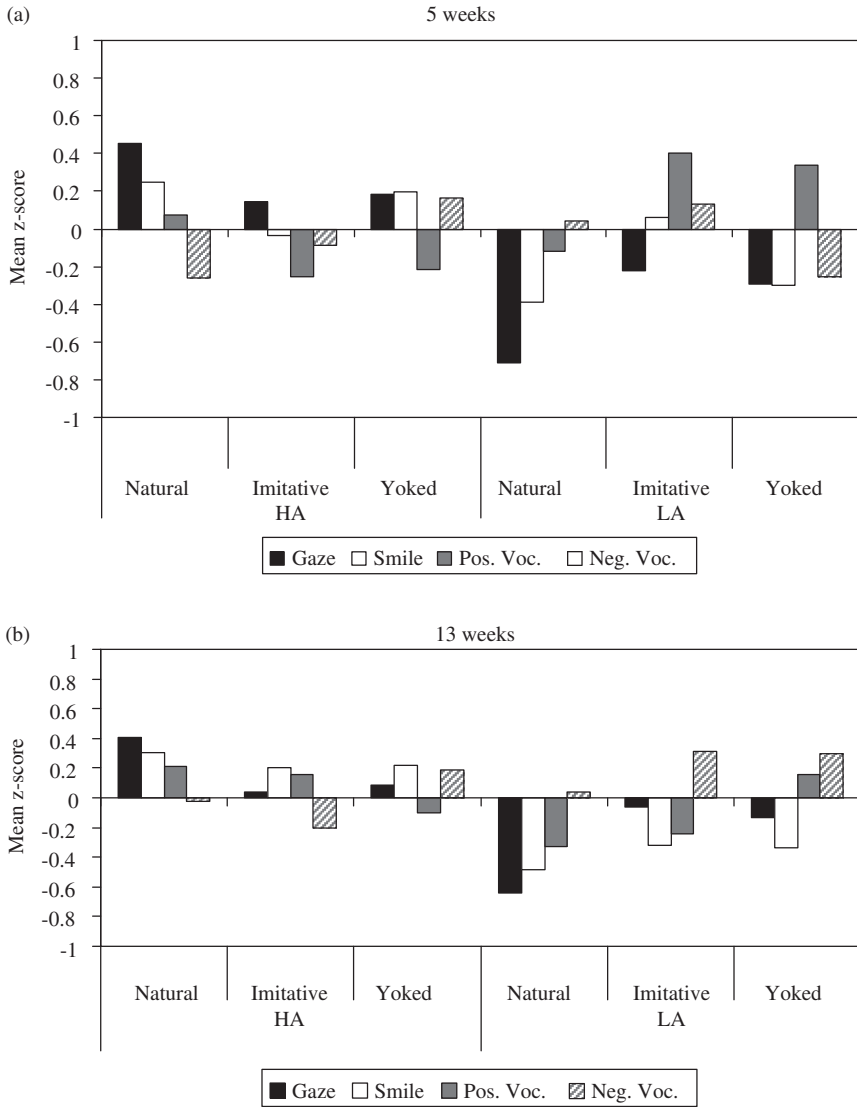


Fig. 2. Results at (a) 5 weeks and (b) 13 weeks (Copyright © Cambridge University Press).

them. The effectiveness of maternal attunement for infant socio-cognitive development has been confirmed in studies of dysfunctional mother–infant interactions. For instance, depressed mothers spend less time looking at, touching, and talking to their infants, show little positive and negative

affect, and often fail to respond contingently to infants' signals. Infants in turn show abnormal activity levels and little positive affect (Field, Healy, Goldstein, Perry, Bendell, & Schanberg, 1988; Legerstee & Varghese, 2001).

In summary, soon after birth, infants are (a) sensitive to social stimuli, (b) recognize conspecifics as similar to self and differentiate them from inanimate objects, and (c) connect with the social world through participating in affective relationships. I now turn to an examination of the development of communication during the first year of life, to provide evidence for those aspects of sociality that allow for the conclusion that (a) infants' earliest communicative experiences are meaningful, (b) affect attunement is the mechanism that promotes their development, and (c) early dyadic competencies provide the foundation for and are continuous with later language and theory of mind abilities.

#### **IV. Dyadic Communication: Is It Meaningful?**

If infants connect with others through the sharing of emotions during attuned interactions, then the question arises what infants understand of other's behavior during these early exchanges. Although much work has focused on what goes on during dyadic interactions in terms of describing the dialogue as proto-conversations (mutual gazing, touching, and vocalizing) that serve to share basic emotions, many questions remain about the meaning of these dyadic processes.

##### **A. STILL-FACE: WHY IS CONTACT BROKEN?**

We know that as early as 5 weeks, infants expect people to communicate with them when mutual gaze is established (Legerstee *et al.*, 1987) because when people refrain from communicating with them for no apparent reason, infants get upset. In a classic experimental procedure called the still-face paradigm (Tronick, Als, & Adamson, 1979) infants are studied in three conditions: a face-to-face interaction with their mothers; a still-face condition during which mothers maintain eye contact, assume a passive, unresponsive face; and the so-called reunion episode during which mothers and infants engage again in face-to-face interaction (Toda & Fogel, 1993; Weinberg & Tronick, 1996). Infants' reactions to the still-face paradigm are quite consistent. That is, during the normal and reunion conditions they smile and vocalize and alternate gazes. However, during the still-face condition, infants try to engage the adults with smiles and

vocalizations, but when repeated attempts fail they become dejected which they express with sad facial expressions and through averting their gazes.

The still-face paradigm has inspired much research to determine which features of the communicative partner are responsible for the still-face response. This research focused on infant sensitivity to various perceptual features, such as the face, voice, or numerous combinations of face, gaze, and voice. Through varying the parameters of the interactions with the help of a closed-circuit television set-up, it was shown that infants were mostly perturbed when their mothers' face was motionless, even though she retained eye-contact and continued to interact vocally (Gusella, Muir, & Tronick, 1988). However, by manipulating the face, voice, or gaze, the social interactive format within which infants' communicative competence is being investigated is distorted (Delgado, Messinger, & Yale, 2002). Reddy and Trevarthen (2004) point out that "emotional acts need emotional perception and one cannot do this easily without emotional engagement" (p. 14), thereby emphasizing the importance of socially interactive structures to gauge the social significance of infants' responses.

To address this methodological problem, Murray and Trevarthen (1985) presented 2- to 3-month-old infants with 3 conditions in which the natural interactions remained intact but the features under investigation were controlled, namely a face-to-face condition, a still-face condition, and a condition during which mothers tried to communicate with their infants, but for some obvious reason (e.g., a third person interrupted the mother) were not able to continue to do so. This time infants displayed more negative affect and withdrawal during the still-face than during the interrupted episode. Infants' lack of negative responsiveness during the interrupted condition suggested that they were aware of the reason why contact was broken. However, it should be noted that in Murray and Trevarthen's (1985) study mothers changed their eye contact during the interrupted condition, because they turned away to look at the person who interrupted them. Given the importance of eye contact as a signal for communication (Legerstee *et al.*, 1987), infants may have interpreted the lack of eye contact as a sign to terminate the communicative interaction.

To examine this hypothesis, Legerstee and Markova (2007) observed infant awareness of the reason why contact is broken in conditions that did not preclude affective stimulation and that controlled for gaze orientation. Infants at 3, 6, and 9 months of age were observed in 2 studies. In Study 1, infants were presented with (a) a natural condition in which mothers were instructed to interact with their infants as they usually would (Figure 3a), (b) a still-face condition during which mothers were asked to maintain visual contact and a friendly face but otherwise to stop communicating

(a) Natural condition with mother



(b) Still-Face Condition (mother)



(c) Masked Condition (mother)



*Fig. 3. (a) Natural, (b) still-face, and (c) masked-face conditions with mother (Copyright @ Maria Legerstee).*

with their infants (see Figure 3b), and (c) a condition during which mothers wore a mask to conceal their facial expressions, but were instructed to talk to their infants as usual (see Figure 3c). Thus, during the mask condition mothers were unable to communicate with their infants as they usually did, because something interfered with this activity, thereby providing infants with a cue or reason (mask) why there were changes in

their communicative repertoire. Only in the still-face condition was there no apparent reason why mothers refrained from communicating.

Although it is theoretically important to determine whether infant responses indicate that they distinguish between the various communicative conditions as a function of the different intentions of their communicative partners despite possible perceptual similarities, there remains a methodological problem. That is, to do so, it is necessary to manipulate certain features that differentiate these intentions. Thus, infants are not only reacting to the changing motives of their mothers (i.e., unwilling or unable to talk), but also to perceptual features (i.e., eye contact, affective stimulation, mask, etc.). To control for confounding stimulus features we included interactions with a non-social object, a large Raggedy Ann doll.

In the natural condition, the doll was moved as soon as the infant fixated the doll's face (Figure 4a) while bells that were fastened to the doll sounded in synchrony. In the still-face condition the doll remained immobile (see Figure 4b), and in the mask condition the doll wore the same mask as the mother (see Figure 4c).

Infants as young as 3 months differentiated between the social and non-social stimuli and also among the three social conditions, and continued to do so until 9 months. They produced a classic still-face response during the still-face condition, but not during the masked condition. Infants also produced significantly more positive affect during the natural conditions than during the masked condition and least during the still-face.

It could be argued that infants' differential responsiveness was due to the modulation of affective stimulation they received from people (i.e., most during face-to-face interactions, less during the masked-face, and least during the still-face). To investigate this suggestion, we continued the inquiry by presenting infants with two still-face conditions: one in which mothers kept eye contact, but presented no affective stimulation, and a modified still-face in which mothers appeared to drink from a bottle, maintained eye contact with their children, but did not speak (Figure 5). Consequently, mothers displayed a classic still-face and a modified still-face.

Because by 9 months there is strong evidence that infants perceive intentions in people's communicative behavior (see Carpenter *et al.*, 1998, for a review), in Study 2 we focused on the theoretically more important ages by studying infants at 3 and 6 months (Delgado *et al.*, 2002; Ellsworth *et al.*, 1993; Gusella *et al.*, 1988; Murray & Trevarthen, 1985). Again, to control for perceptual differences, infants were also presented with matching doll conditions.

The results of Study 2 confirmed our previous findings. Although the bottle condition in Study 2 did not allow mothers to actively engage with their infants (and thus was comparable to the classic still-face), infants did

(a) Natural Condition (Doll)



(b) Still Face Condition (Doll)



(c) Masked Condition (Doll)



Fig. 4. (a) Natural, (b) still-face, and (c) masked-face conditions with doll (Copyright @ Maria Legerstee).

not get upset. Overall, the results of the two studies revealed that across the ages tested infants responded consistently and appropriately to the various social and non-social conditions. They got upset when mothers refrained from communicating with them for no apparent reason (still-face), but not when mothers were unable to communicate (they wore a mask, or drank a refreshment). Thus in both studies infants discriminated between situations where mothers did not communicate with them because they had a reason from conditions where no reason was provided.



Fig. 5. Bottle condition with mother (Copyright @ Maria Legerstee).

To our knowledge, this was the first study that compared infant responsiveness in the classic still-face with responses to modified still-face conditions where mothers maintained eye contact and affective stimulation either remained high (i.e., mask) or was completely absent (i.e., bottle). The similarity of infant responses in the mask and bottle conditions indicated that infants were not simply responding to variations in stimulation. In addition, the lack of negative responses indicated that emotional distress could not have interfered with infants' abilities to evaluate the reason why contact was broken, confirming the hypotheses put forth by Murray and Trevarthen (1985).

The assumption that infants should discriminate with appropriate reactions among the three social conditions, but react differently to the non-social conditions, was also confirmed, and is consistent with the findings of studies discussed earlier (see Legerstee, 1992; for a review Legerstee *et al.*, 1998; Legerstee *et al.*, 1990; Legerstee *et al.*, 1987). Thus through proper controls, it was ruled out that simple perceptual features of people's communicative acts were the basis for early discrimination among the face-to-face, still-face and modified still-face conditions, and between social and non-social stimuli in young infants. Thus, "we can fool infants into engaging with clever stimuli as if they were humans, of course, just as we can fool adults with holograms, but that does not detract from the fact that there is a categorical distinction between person and personal forms of relatedness from early life" (Hobson, 2007, p. 270). As the above studies indicate, infants expect people and not puppets to relate to them and to share emotions when in face-to-face interactions. As a consequence infants

develop preferential relationships or social bonds with their caretakers. One way to examine the meaning infants assign to their relationships with others is to observe their reactions when faced with a possible loss of this relationship.

## B. THE IMPORTANCE OF SOCIAL RELATIONSHIPS

One of the earliest forms of losing a relationship is when infants are separated from their parents to which they react with sadness and if prolonged, panic. According to Panksepp (forthcoming): “The correspondence between the brain regions activated during human sadness and those activated during animal separation distress suggests that human feelings may arise from the instinctual emotional action systems of ancient regions of the mammalian brain” (Panksepp, 2003). Thus both the ability to form social bonds and the fear of losing this bond (separation distress) seem wired in the human brain. A more complex social exclusion situation occurs when infants’ relationships with caregivers are threatened by a third person.

The fear of losing a loved one to a third party is called jealousy. If this is what infants experience, albeit faintly so, when they are excluded by their mother because she engages with someone else, then this indicates that infants are aware of three relationships. The *primary* relationship, the one the baby has with the mother, called the social bond; the *secondary* relationship, the one between mother and the other (the rival), and the third or *tertiary* relationship, namely the aversive relationship the infants have with the rival (White & Muller, 1989). Thus, whereas separation distress and jealousy may have similar roots, for infants to feel jealous, they need to differentiate among the three people in the social triangle. Even though infants do not need to represent these relationships, they need to perceive and respond to the interpersonal dynamics of this social triad. According to Fogel (1993) infants come to know themselves and other people through ongoing relationships: “Infants are participants in these relationships from the beginning of life and they share with significant others in the creation of meaning” (p. 85). It is through these relationships that infants self-organize and construct new forms of interactions. Thus early in life, infants construct meaningful relationships with those they have frequent social encounters with such as their parents and discriminate between these relationships and other less important ones.

To determine whether young infants experience jealousy, they need to be studied in a social triad. In addition, controls need to be implemented that preclude alternative interpretations. To do that, infant reactions to the exclusion by a loved one in favor of another, the rival, should be contrasted

with the exclusion by the loved one in favor of someone the infant does not perceive as a rival. These conditions should be pitted against each other in *one* experimental paradigm. Consequently, we conducted a study with 3- and 6-month-old infants where infants interacted with a female stranger during a natural, still-face, and bottle condition, and two conditions where the female experimenter who communicated with the infant was interrupted by the mother. In one condition, the female experimenter, after being interrupted, began to talk to the mother in a continuous fashion, while explaining the experimental paradigm to her, while the mother looked on. We called this the *monologue* condition. In the other interrupted condition, the experimenter began to engage the mother in an exciting dialogue during which the two adults talked animatedly about the baby. We called this the *dialogue* condition. In both situations, the adults excluded the infant.

At both ages infants reacted with sadness and dejection to the still-face and with quiet interest during the bottle and monologue conditions, replicating earlier findings (Legerstee & Markova, 2007). However, when the experimenter engaged the mother in a dialogue, where they both talked excitedly and had lots of fun, the infants got upset, they kicked their legs, put their feet into their mouth (Figure 6a), vocalized intensely, tried to turn in their seats, and covered their faces with their arms (see Figure 6b).

The combination of the various infant responses was unique and unlike anything observed in the other conditions. Remember that in both the monologue and the dialogue conditions the infants were excluded by the mother, but only in the dialogue condition did mothers show an interest in a third party. The finding that infants reacted negatively to the dialogue, but not the monologue condition, suggests that the infants perceived the third party as someone negative, as a rival. These responses demonstrated “the affective precondition for the emergence of human jealousy, namely the existence of a social bond that is threatened by the perceived intervention of a third party” (Panksepp, forthcoming).

In summary, the various studies reported above show that from early on, infants do not react merely to the changing perceptual features of people (cf. Wellman, 1990), nor do they show inherent tendencies or deep-seated inclinations to communicate with others regardless of whether others intent to communicate with them or not. Rather, during early communicative exchanges infants actively participate in their partners’ emotional life, which seems to motivate them to share their own feelings (Hobson, 2007; see also Kugiumutzakis *et al.*, 2006). When maternal responses focus on the meaning of the infants’ expressions, thereby tuning in to the child’s emotions, infants’ communicative signals bring about desired outcomes. Successful dyadic communication depends on reciprocal following and enactment of communicative rules that specify how to interact with a

(a) Dialogue condition - Baby puts foot in mouth



(b) Dialogue Condition - Baby covers face



*Fig. 6. (a) Baby puts foot in mouth in dialogue condition, and (b) Baby covers face in dialogue condition (Copyright @ Maria Legerstee).*

conspecific. If in the mother–infant communicative system this process is engaged in by both partners, then both partners may share not only basic emotions, attention, and expectations, but communicative goals as well. The motivation to engage in communication with another person is a necessary condition for meanings to be exchanged (Tronick *et al.*, 1979), and overlooking the role the child plays in this interaction would leave psychological growth unexplained (Trevarthen, 1979). Although one should not assume that mother–infant communication is intentional by both partners all of the time, when mutuality appears, intentionality, or as Stern (1985) proposes, inter-intentionality, is there.

### C. DYADIC COMMUNICATION AND SOCIAL COMPETENCE

Dyadic communication involves exchanges of shareable feelings between infant and caregivers. *From the start*, it is the infants' awareness of the caregiver's attunement (Legerstee, 2005) that gives them a sense of connecting or "being with the other," and allows for the co-creation and regulation of these communicative exchanges which are then progressively integrated into the infant's internal representations to eventually become explicit. However, it is the *caregivers' attunement* to the infants' earliest communicative signals that serves as a crucial catalyst in completing the infant's representations of communication. Thus, the caregivers' attunement and the infant's awareness and acceptance of it drive infant socio-cognitive development, in particular (a) the infant's connection with the social world, (b) self/other differentiation, and (c) the experience that others are "with me."

In a study discussed earlier, Markova and Legerstee (2006) showed that 5- and 13-week-old infants of mothers who ranked high on affect attunement discriminated between the natural, contingently imitative, and random interactions, whereas infants of less affectively attuned mothers failed to discriminate among the various social interactions. This suggests that affective rather than contingent responding connects infants with the social world. Furthermore, Legerstee and Varghese (2001) found that affect attunement influences infants' social expectancy or helplessness at 3 months. According to Seligman (1975) maladaptive attitudes and beliefs in adulthood, such as helplessness, have their roots in early development. If mothers react *affectively* during communicative turn-taking episodes, then infants develop a sense of control or "social expectancy" which is imperative for future social, emotional, and cognitive health. Depriving infants of the ability to learn these affective sequences can result in learned helplessness, as Seligman's research with dogs illustrates. Dogs, who were

unable to escape from differentially emitted shocks (i.e., they received continued exposure to an uncontrollable event), were unwilling to escape the shocks, even when it was possible for them to do so. Seligman argued that the dogs had failed to establish a relation between their responses and environmental events, which resulted in learned helplessness and had profound consequences for the entire repertoire of behavior. Learned helplessness produces a cognitive set in which people believe that success and failure are independent of their actions, and they have difficulty learning that their responses or actions are consequential (Seligman, 1975).

Legerstee and Varghese (2001) conducted a study to assess the effects of various levels of maternal affect attunement on social expectancy in 3-month-old infants. In this context, social expectancy was defined as the ability to discriminate between natural and replay interactions with their mothers. During the natural interactions mothers engaged normally with their infants through a double closed-circuit television system. Infants were seated in an infant seat, approximately 50 cm in front of one of the video monitors. In an adjoining room, mothers sat in front of a television monitor tilted at a 90 degree angle, which projected the image of the infant onto an upright, transparent screen behind which a camera was positioned. The mother sat facing the upright screen and was filmed as she looked at her infant on the screen. Her image was then projected to her infant. Because the lens of the camera filming the mother was positioned directly behind the image of the infant's eyes and the mother was looking at the image of her infant's eyes while she interacted, both mother and infant had full eye contact and saw each other's face. These interactions were video recorded and in the subsequent condition replayed to the infants. Because mothers in the natural interaction could respond to their infants' signals during the replay interaction, they looked "natural" to their infants, but because their responses were played back or "yoked" they were not in response to the communicative bids of the infants. Mothers and infants were randomly assigned to receive either the natural or replay interaction first. Maternal attunement was measured during an earlier 3-min face-to-face interaction and was defined as the level of maintaining infant attention, warm sensitivity, and social responsiveness (for a full definition of maternal attunement see earlier discussion of Markova & Legerstee, 2006). A natural split was observed with 58% of mothers ranking high and 42% ranking low on these measures.

The findings were very interesting. Infants of mothers who ranked high on attunement seemed to reflect back this affect: they smiled, vocalized, and gazed at their mothers during the natural interaction. During the replay interaction when mothers displayed the same amount of smiles and vocalizations as in the natural interaction, infants reduced their display of positive

affect, suggesting that during the natural episode they were *sharing* affective states with their mothers rather than mimicking them. Infants of highly attuned mothers also ranked high on social expectancy because they discriminated with their responses (smiles, vocalizations, and gazes) between the natural and replay interactions, regardless of the order of presentation.

The responses of the infants of low-attuned mothers revealed a completely different pattern. These infants did *not* differentiate with smiles and vocalizations between the natural and replay interactions. However, this did not mean that these infants were not able to discriminate between the two interactions, because they looked significantly less at their mothers in the replay than in the natural interaction but only when the natural interaction was presented first. When the replay interaction was presented first, they did not recuperate during the subsequent natural interaction (as the infants of highly attuned mothers had), but instead appeared to avoid all further interaction.

Field *et al.* (1988) has developed the “unresponsive mother model” that allows for an interpretation of these results. In this model, infants of mothers who are responsive and sensitive to the infants’ communicative bids, develop a sense of control, or efficacy, whereas infants of mothers who are not, experience behavioral disorganization, lack of control, and efficacy. This model predicts that when infants of affectively attuned mothers are presented with a change in responsiveness of their mothers, they do not change their own behavior drastically because these infants have developed stable affective relationships with them, which results in efficacy. In contrast, when infants of mothers who are generally less responsive to the behavior of their infants are confronted with a change in the behavior of their mothers they become helpless (Seligman, 1975). These infants have not consistently experienced affective synchrony and attention of their mothers, and consequently they lack feelings of control or efficacy.

Researchers focusing on the importance of affect sharing often stress the social origin of infants. These authors postulate that infants begin life with an awareness of their own affective states and an ability to share these states with others (Bruner, 1990; Legerstee, 2005; Trevarthen, 1979). Consequently, they engage in mutually affective relationships with sympathetic adults from the beginning (Stern, 1985; Trevarthen, 1979). The hypothesis is that infant core abilities, such as an awareness of emotions, attention and intentions are related to later mental state understanding, such as desires and beliefs (Legerstee, 2005; Wellman & Gelman, 1998). If the earlier and later socio-cognitive abilities are related, then there should be a demonstrable link between the two. Brooks and Meltzoff (2007) revealed that gaze following and pointing at 10–11 months predicted accelerated vocabulary growth longitudinally through two years of age. Vaughn Von Hecke *et al.*

(2007) found that joint attention at 12 months was related to social competence and externalizing behaviors at 30 months, and Wellman *et al.* (2008) revealed that infant social attention at 12 months was related to performance on a false belief task at 4 years of age.

However, these studies did not examine the mechanisms that may promote the link between the earlier and later abilities. Mental state awareness takes place during social interactions where it transforms and is transformed by interpersonal relationships and by language (Hughes & Leekam, 2004). In the next and final section of this chapter, I address what type of parental skills play a role in the relation between the earliest dyadic communicative behaviors and later communication skills. These questions are important because they not only address the socio-cognitive continuity hypothesis, but also the mechanisms that promote this development (Legerstee, 2005; Legerstee & Varghese, 2001; Markova & Legerstee, 2006; Meaney, 2008).

## **V. Continuity Between Basic and Complex Communicative Abilities and Mechanisms of Change**

Traditionally, research focusing on *the mechanisms of change* in communication has been situated within Vygotsky's (1962) framework suggesting that social interactions play an important role in facilitating higher-order mental functioning. Within this context, Vygotsky proposes two fundamental principles of development. First, before infants can subject a function to intentional control, they must already be capable of exercising this function. Second, every ability appears in the infant's development on two planes successively, first on the social plane between infants and parents (intermental), and then on the psychological plane within the child (intramental). Andrew Locke (1980) provides a most interesting example on how these principles work. He describes, how, at one point the child has her arms lifted in the air (is exercising a function) and her mother turns to look at her, smiling she says "You want to be lifted up?" and proceeds to pick up her infant. Through these actions she attributes meaning to the outstretched arms of her child. After various repetitions of the stimulus (gestures) and response (being picked up) between mother and child (intermental), the child begins to produce these actions intentionally (intra-psychologically).

Although it is interesting, Vygotsky's theory provides little information about how infants become connected with the social world. If infant abilities initially exist between parent and child (intermental), before it becomes intramental (within the child), then infants' initial understanding

is based solely on experience or social learning rather than the product of endogenous and learning factors (Legerstee, 2001). Thus, Vygotsky perceives the infant initially as a little behaviorist rather than a psychologist.

In the beginning of this chapter, I made the case that the human infant has innate predispositions to recognize and interact with people. To document this, I discussed evidence indicating that infants are attracted to social stimuli and are able to discriminate between social and non-social objects. I further described research revealing that sensitive and attuned human interactions rather than physical parameters such as contingencies connect infants with the social world. I also discussed empirical studies demonstrating that the dyadic interactions infants engage in are meaningful because infants are aware of people's communicative motives and discriminate between them. That is, they recognize whether their caregivers are willing, unwilling or unable to communicate with them.

In all these studies it was shown that infants who had been reared in sensitive and warm relationships were more pro-social because they engaged in more positive interactions with their caregivers and were also more socially competent because they discriminated between the communicative motives of their conspecifics. Smiles, vocalizations, or gestures are social signals that provide information about another person's intentions as well as directions for one's own actions (Montague & Walker-Andrews, 2002). It follows that mothers who provide more information about their own intentions have infants who may begin to act intentionally themselves and to understand intentions in others sooner than infants of mothers who do not provide such information.

The presence of these early socio-cognitive competencies suggests that infants have domain-specific abilities to recognize conspecifics, to share simple mental states, such as basic emotions with them, and to perceive others to be like them physically, but also to be "with them" mentally. However, to assume that what infants reveal during dyadic communication with their caretakers is evidence of the origins of childhood social cognition, these basic understandings need to be continuous with later more complex abilities, such as language and theory of mind. I finish this chapter by providing such evidence. I discuss three studies showing that (a) infant mutual gazing during dyadic interactions at 3 months predicts coordinated attention during triadic communication at 10 months, but only for infants whose mothers are attuned (scaffold infant capacities; Legerstee *et al.*, 2007); (b) infant coordinated attention at 10 months predicts infant declarative pointing at 15 months when infants play with mature communicators (their mothers) but not when playing with same aged peers (Legerstee & Fisher, 2008); and (c) non-verbal gesturing about

the mind at 15 months is linked to talking about the mind at 30 months, and that maternal mental state talk at 15 months promotes this link (Legerstee, 2008).

## A. FROM DYADIC TO TRIADIC COMMUNICATION

Between 1 and 3 months, infants show a peak in social responsiveness during dyadic communication. However, after approximately 3–4 months of age and as a result of infants' developing motor and cognitive skills permitting more effective interactions and explorations with an expanding environment (Legerstee, 2005; Legerstee *et al.*, 2007; Legerstee *et al.*, 1987) infants begin to coordinate their attention between people and things external to the dyad (Mundy & Newell, 2007). Coordinated attention is the ability to alternate gazes back and forth between a person and an object (social or non-social) during social interactions and signals an interest in this object. This capacity demands that infants monitor other's attention in relation to self, and the other person's attention toward the same object or event, revealing infants' uniquely human representations. The emergence of this skill represents a critical socio-cognitive advance for the developing infant (Werner & Kaplan, 1963). It reflects awareness that meanings can be exchanged between people and it suggests an understanding that social partners can serve an instrumental function. As such, coordinated attention is considered an intention to communicate and to play a central role in the infants' communicative and subsequent linguistic development. Compared to typically developing infants with the same mental age, children with autism have difficulty making eye contact and tend not to monitor the gazes of others during triadic interactions. The lack of these skills in infants with autism has also been linked to their problems with language and theory of mind development (Baron-Cohen, 1991; Charman, *et al.*, 2000).

Bruner (1999) argues that the progression from primary intersubjectivity (dyadic sharing of attention) to secondary intersubjectivity (triadic sharing of attention—person/object/child) is facilitated through “narrative scaffolding” where caretakers treat infants as if “they have things in mind.” Bakeman and Adamson (1984) supported this reasoning. The authors found that infants produced significantly more joint attention with mothers and a female stranger than with same-aged peers. This suggests that coordinated attention is scaffolded by more mature social partners.

To investigate this hypothesis, we measured maternal scaffolding directly with the use of the maternal attunement scale (*i.e.*, Markova & Legerstee, 2006; Legerstee & Varghese, 2001) and through observing infant gazes during dyadic interactions at 3 months and to relate these to



Fig. 7. Five-month-old infant coordinates attention between mother and toy (Copyright @ Maria Legerstee).

the production of coordinated attention at 5, 7, and 10 months (Legerstee *et al.*, 2007). We expected that mothers who ranked high on maternal attunement would have infants who engaged in more mutual gazes at 3 months and that mutual gaze would predict higher levels of coordinated attention later on. At 3 months, the frequencies and durations of infant gaze monitoring of the adult's face was recorded each time the infant looked at the partner's face. At 5, 7, and 10 months, the frequencies and durations of infant coordinated attention were coded (Figure 7). Coordinated attention was defined as the infants' alternation of gazes between an object and a person's face and then back to the same object (see also Bakeman & Adamson, 1984; Carpenter *et al.*, 1998; Legerstee & Fisher, 2008; Legerstee, Van Beek, & Varghese, 2002; Legerstee & Weintraub, 1997).

A regression analysis revealed that gaze monitoring at 3 months significantly predicted coordinated attention at 10 months, but only within the highly attuned group. To our knowledge, this study is the first to show this relation and that maternal attunement is a mechanism that fosters this link.

## B. FROM SHARING ATTENTION TO REDIRECTING ATTENTION

As indicated earlier, coordinated attention is considered an intention to communicate, and to play a central role in infants' communicative and subsequent linguistic development (Werner & Kaplan, 1963). However, before infants use speech to communicate, they use gestures such as pointing, showing, giving, and requesting to direct people's attention to aspects of their environment (Bates, Camaioni, & Volterra, 1975; Legerstee & Barillas, 2003; Legerstee *et al.*, 2002). A particularly remarkable type of pointing gesture is a *declarative point*, when an indicated object or event is used as a means of making a non-verbal comment involving the recognition that one can share experiences with others about it (e.g., "Wow, look at that! It's beautiful;" Camaioni *et al.*, 2004; Legerstee & Barillas, 2003). Camaioni (1993) developed the "joint attention" hypothesis, postulating that declarative pointing is structurally and functionally different from other types of pointing such as imperative pointing, because a declarative point, just like coordinated attention, is used to share mental states with others. In contrast, imperative points are instrumental requests, such as "I want that thing there" and are used to direct another's behavior. Baron-Cohen (1986) revealed that declarative pointing is not used nor responded to by children with autism, whereas they do use imperative pointing. If the "joint attention" hypothesis is correct, then there should be a developmental relation between coordinated attention and declarative pointing, but not between coordinated attention and imperative pointing.

It appears that coordinated attention is less impaired in higher functioning infants with Down syndrome compared to infants with autism, but more impaired compared to typically developing infants. Whereas infants with Down syndrome may show a reduction in pre-verbal gestures, infants with autism often show a complete absence of these behaviors (Sigman & Ruskin, 1999). Iverson, Longobardi and Caselli, (2003) attributed the lower production of gestures by infants with Down syndrome and their subsequent delay in two-word utterances to the deficits in early gestural communication. These findings suggest that differences in the development of coordinated attention and pre-linguistic referential gestures during the pre-verbal period in infants with Down syndrome may shed light on language delays in these children later in development.

Surprisingly, although it has been claimed that coordinated attention is "the impelling force behind early indicating forms of communication"

(Bruner, 1990, p. 162), no past research has specifically investigated the relation between coordinated attention and declarative pointing, nor between coordinated attention and other types of indicating such as imperative pointing. Consequently, we examined the “joint attention” hypothesis in a longitudinal sample of typically developing infants and infants with Down syndrome (Legerstee & Fisher, 2008). Infants were assessed at two mean mental ages (10 and 15 months) across four visits (two months apart). Three predictions influenced the research. First, if infants with Down syndrome are delayed in coordinated attention (Beeghly, Weiss-Perry, & Cicchetti, 1990; Landry & Chapieski, 1990; Legerstee & Weintraub, 1997) and declarative pointing (Mundy, Sigman, Kasari, & Yirmiya, 1988), but not imperative pointing (Greenwald & Leonard, 1979), then we expect typically developing infants to produce more coordinated attention and declarative pointing, but a similar amount of imperative pointing compared to infants with Down syndrome. Second, if according to the “joint attention” hypothesis (Camaioni, 1993), coordinated attention is linked to declarative but not imperative pointing, then coordinated attention should predict declarative pointing only. Finally, if coordinated attention is scaffolded by mature communicators (Bakeman & Adamson, 1984; Bruner, 1999), then infants should produce more coordinated attention and also declarative pointing when interacting with mature communicators than with less mature communicators. These predictions were supported. Most interestingly, a regression analysis revealed that coordinated attention at Visit 1 ( $M = 10$  months) with mothers predicted declarative pointing at Visit 4 ( $M = 15$  months) for typically developing infants. No such findings were found for imperative pointing.

Overall, the results supported Camaioni’s (1993) “joint attention” hypothesis that coordinated attention and declarative pointing are triadic relations between two minds and an object, which are thought to be uniquely human representations (Baron-Cohen, 1995; Camaioni, 1993; Camaioni *et al.*, 2004; Legerstee & Barillas, 2003; Sugarman-Bell, 1978; Zinober & Martlew, 1985). The finding that infants produced these coordinated attention bids and declarative points more with mothers and peer’s mothers than with same aged peers supports the idea that infants’ psychological states benefit from maternal scaffolding as suggested by Bruner (1999). Research that shows that problems with joint attention (coordinated attention and pointing) are linked to problems with later language and theory of mind (Charman *et al.*, 2000) is directly relevant to the issue regarding which foundational skills are related to later cognitive and communicative abilities.

### C. FROM NON-VERBAL GESTURES TO TALKING ABOUT THE MIND

As demonstrated by Legerstee and Fisher (2008) by 15 months, infants begin to use intentional gestures to communicate. Feldman and Greenbaum (1997) propose that pre-verbal communication, language and mental state talk form a hierarchical model where pre-linguistic communication, which develops first, involves displaying abstract concepts while remaining within the framework of the here-and-now. Communicative gestures eventually unfold into language as words begin to label objects but also mental states such as emotions, desires and thoughts. Ultimately, the development of mental language, emerging around 30 months, marks the acquisition of a functional theory of mind. However, it will be at least another 12 months before infants begin to talk about the beliefs of others to indicate that they have begun to understand that these beliefs may be different from their own (Bartsch & Wellman, 1995).

Bretherton and Bates (1979) posit that infants' use of pre-verbal gestures "occurs in step with the construction of an internal model of the perceptions, intentions, and feelings of other human beings" (p. 97), suggesting that there is a link between these signals and verbal communication about mental states. Thus, although communicative gestures are restricted to situations in the presence, they are qualitatively similar to linguistic communication, because infants seem to use them in identical ways.

Studies have considered the social factors that might influence the development of mental talk (Tager-Flusberg, 1989; Hughes & Leekam, 2004). Meins and colleagues (Meins, Fernyhough, Wainwright, Gupta, Fradley, & Tucker, 2002) have shown that maternal mental talk at 6 months predicts children's performance on a battery of False Belief tasks at 48 months. However, mothers who talk much about the mind may also rank high on attunement and unless controlled for it is not possible to determine the independent contributions of these maternal skills. It is possible that maternal attunement may promote infant gestures during the primarily non-verbal period at 15 months, but when infants begin to talk at 30 months, maternal mental state language might facilitate child mental language.

In a study reported in Legerstee (2008), the aim was to provide evidence for the continuity between child gestures and later language about mental states, and to investigate whether maternal skills such as her attunement and mental language would promote this link. Children were observed longitudinally at 15 and 30 months during free-play interactions with their mothers. At 15 months, infant intentional communicative gestures such as pointing, showing, giving, and requesting were observed and were

accompanied by a look at the partner's face within 2 s before or after the gesture. At 30 months, child mental words such as desire, emotion, cognition/belief, and moral words were measured. To find out which maternal skill helped children make the connection between gestures and mental state words, maternal mental words (desire, emotion, cognition/belief, and moral words), and attunement (maintaining attention, sensitivity, and responsiveness) were also measured during the free-play interactions at both 15 and 30 months. At 15 months, infants were also given the Words and Gestures Scale and at 30 months the Words and Sentence scale of the MacArthur Communicative Development Inventory (MCDI; Fenson, *et al.*, 1994).

First, we examined the relations between maternal skills and child variables at each age. Partial correlations, controlling for child general language at 30 months showed that child gestures at 15 months related to child mental words at 30 months. Thus, through these gestures children begin to implicitly conceptualize their ideas about mental states (Bretherton & Bates, 1979).

In a second step we tested the independent contributions of maternal skills at 15 months to child mental language at 30 months. Maternal attunement and her mental talk affected child gestures at 15 months though only maternal mental language but not her emotional attunement, related to children's mental words at 30 months. Moreover, maternal mental talk at 15 months was a unique correlate of child mental words at 30 months independently of maternal affect attunement and child language at 15 months and maternal mental talk at 30 months.

Finally, based on the results of the previous analyses we investigated the moderating or mediating role of maternal skills on the link between gestures and mental language. We found that the initial relation between child gestures and later mental words (when only child language was controlled) became non-significant when accounting for maternal mental language indicating that maternal talk about mental states mediated this relation. Thus mothers reliably mapped infant gestures with mental talk (Figure 8a and b), which must deepen children's understanding of the communicative nature of these gestures and facilitate the process of relating them to mental language later on.

The unique and theoretically important contribution of the Legerstee (2008) study is that communicative gestures produced by pre-verbal children relate to later mental language and that maternal skills scaffold this link. Gestures, such as pointing, giving, showing, and requesting are acts of intentional communication because they are used to direct the attention of people to an object or some other interesting event. These gestures occur within a social context where responsive adults treat infants

(a) Mapping gestures (Point) with words: "You want that?"



(b) Mapping gestures (sharing) with words: "I think that is a nice dolly"



*Fig. 8. (a) Mapping gestures (Point) with words: "You want that?" and (b) mapping gestures (Sharing) with words "I think that is a nice dolly" (Copyright @ Maria Legerstee).*

as if they have a mind scaffold the link between these gestures and later mental words as part of a process of learning how and for what purpose words are used (Montgomery, 2002).

To conclude, the three studies just described show that early core abilities are related to later socio-cognitive achievements: (1) gaze monitoring during dyadic communication at 3 months is related to joint attention during triadic communication at 10 months (Legerstee *et al.*, 2007), (2) joint attention at 10 months is related to declarative pointing at 15 months (Legerstee & Fisher, 2008), and (3) non-verbal communicative gestures at 15 months are related to mental state talk at 30 months (Legerstee, 2008). It appears that the ability that underlies this continuity is mental state awareness, and that the mechanisms that promote this awareness are caregivers' interactive skills, such as their affect attunement and talk about the child's mind. These studies highlight the importance of dyadic communication in the development of infant social cognition, and support the idea that during dyadic communication, infants reveal basic core capacities that are the origins of childhood mentalist social cognition.

## VI. Conclusions and Future Directions

The first interactions infants engage in are dyadic in nature. During these interactions infants as young as 1 week monitor people's gazes and exchange facial expressions, vocalizations, and movements with them in a reciprocal fashion. Such interactions have been labeled proto-conversations (Bateson, 1979) because they have a turn-taking structure that very much resembles adult-like verbal communication (Legerstee & Varghese, 2001; Markova & Legerstee, 2006).

Adults not only interpret infant behavior as meaningful and communicative, but infants also perceive the adults' acts as meaningful and respond appropriately. Such sharing of experiences is the essence of what Trevarthen (1979) calls *intersubjectivity*, namely the "linking of subjects who are active in transmitting their understanding to each other" (p. 347). As early as 5 weeks of age (Legerstee *et al.*, 1987; Markova & Legerstee, 2006) infants recognize whether they are in tune with the other person. That is, infants have certain *communicative expectations* of their partners, because when people refuse to communicate (pose a still-face) infants get upset (Tronick *et al.*, 1978) and often try to get mothers to respond to them in order to re-establish the dialogue (Legerstee *et al.*, 1990; Legerstee & Markova, 2007; Papousek & Papousek, 1987). However, infants only have such expectations if their mothers are systematically attuned to their signals. If parents are not attuned, or are depressed, infants do not get

upset, revealing that they have not developed expectations of affect sharing with their mothers (Field *et al.*, 1998; Legerstee & Markova, 2007; Legerstee & Varghese, 2001). Thus affective sharing is a pivotal mechanism that links the infant with the social world, promotes subsequent meaningful communication, and assures that infants become aware that people are not only “like me” physically, but also “with me” mentally. An awareness that people are attuned to their emotions, leads infants to subsequently feel empathy for others (Baldwin, 1902; Hoffman, 1981; Markova & Legerstee, 2006).

With ontogeny, and through careful guiding of parents, infants develop an increasingly sophisticated understanding of the minds of others. At 3 months of age they distinguish among the different communicative motives of adults during interpersonal exchanges (Legerstee *et al.*, forthcoming; Legerstee, 2008; Legerstee & Varghese, 2001). The duration of gaze monitoring at 3 months predicts coordinating attention with others at 10 months (Legerstee *et al.*, 2007). This relationship, in turn, provides the basis for using declarative points to direct others’ attention to interesting aspects in the world (Legerstee & Barillas, 2003; Legerstee & Fisher, 2008). Gesturing about the mind at 15 months is related to talking about the mind at 30 months, when confounding variables are controlled (Legerstee, 2008). The continuity between early foundational abilities and later socio-cognitive achievements supports the idea that infants are born with domain-specific predispositions that contain core areas of thought (Figure 9).

Thus behavioral evidence shows that infants’ early communicative behaviors are not simply reactions to events in the environment or randomly occurring acts that others respond to, but instead are tools that infants use to connect with others and to share experiences with them (Newson, 1979). This finding is in sharp contrast with the idea that infants do not perceive mental states until the end of the sensori-motor period and therefore cannot play a determining role in development. Increasingly, developmental research is beginning to address the ontogeny of socio-cognitive development and to describe its function and developmental trajectory through examining the predispositions of the very young infants and relating them to later complex abilities. As discussed, findings from dyadic communication have revealed that soon after birth infants are aware of the intersubjective relations they establish with others and do so before the onset of more advanced socio-cognitive abilities. The “with me” experienced during dyadic communication connects infants with the social world, makes dyadic communication meaningful, and provides the foundation for continuity between basic foundational skills and later thought. These data validate the argument that dyadic communication of infants is continuous with later language abilities and theory of mind and

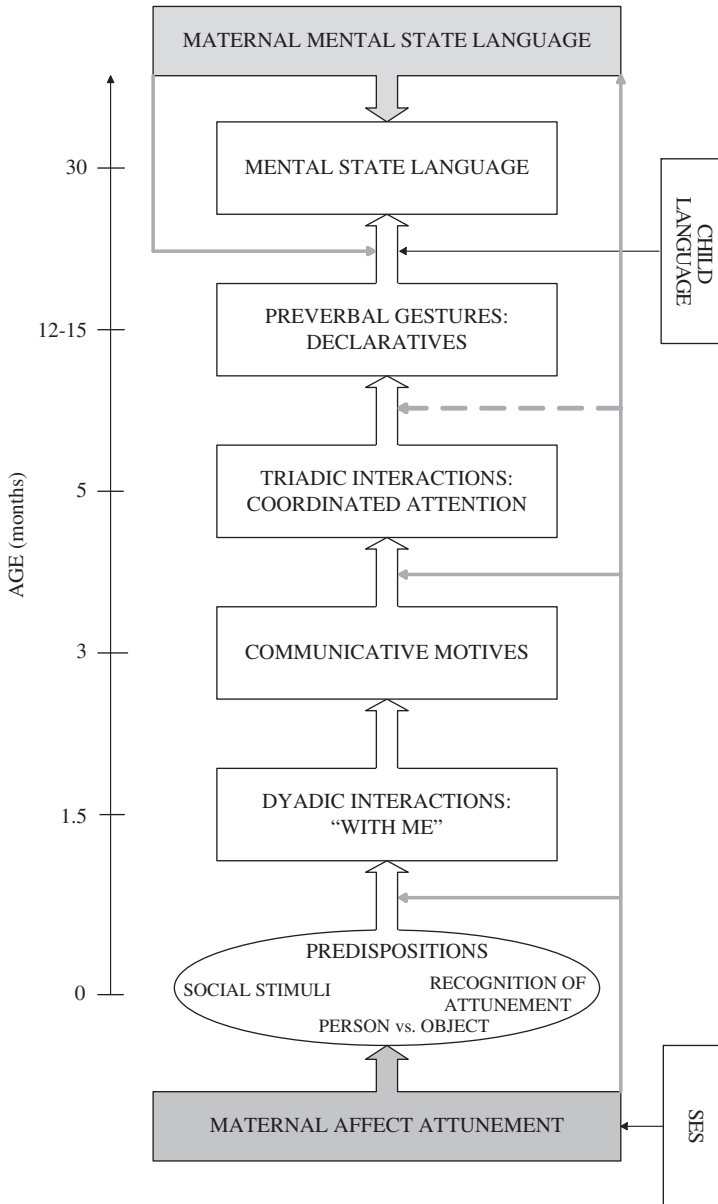


Fig. 9. Schema of multi-factorial interplay between infant dyadic communicative abilities, social cognitive development, and parental behavior (Copyright @ Maria Legerstee).

allows for making predictions about psychopathologies, such as infant failure to thrive (helplessness) and autism. For example, deficits in dyadic communication may help to understand the pattern of impairments exhibited by children with autism who have deficits in emotion sharing, coordinated attention and mental state talk (Charman, 2003; Hobson *et al.*, 2006; Mundy & Newell, 2007; Rogers & Pennington, 1991). Even though these developmental processes are becoming better understood, there is a need to continue the study of socio-cognitive development in children in order to provide theoretical frameworks and behavioral data for future research and deepen the potential for intervention.

Until now, the investigation of infant core abilities as revealed during dyadic communication, their relation to later socio-cognitive abilities, and the role the environment plays in this relation has relied on behavioral evidence. As a result of methodological and technological advances, future research will be in a better position to understand the biological underpinnings of this development. A growing interest in developmental social neuroscience is providing insights into how the brain reacts and processes information. Some important issues that might be informed by findings from cognitive neuroscience in infants are to what extent genetic factors might influence such abilities. As revealed in this chapter, infant social cognitive development is complex, involving a multi-factorial interplay between innate core abilities and parental behavior.

As argued earlier, the perception and recognition of social cues as containing socio-emotional meaning is the first step towards social cognition (Legerstee, 2005, 2007). There is evidence from developmental social neuroscience that there are specific areas in the brain collectively called the “social brain” that contain neural systems specialized for the processing of socially relevant information. Specifically, there are groups of neurons in the inferotemporal cortex that respond to human faces, gaze and head direction, and also specific information about faces such as emotions. For instance, when 4-month-olds are presented with facial communication signals, areas are activated in the infant temporal and prefrontal cortex that correspond to the brain regions implicated in these processes in adults (Grossman *et al.*, 2007). In addition, it is known from the still-face paradigm (Legerstee *et al.*, 1987, 1990; Weinberg & Tronick, 1996) that infants soon after birth react to eye gaze of others as an intention to communicate. Studies show that on a neural level, the medial prefrontal cortex becomes activated when gaze is directed at, but not when gaze is averted away from, the self (Kampe, Frith, & Frith, 2003; Schilbach, Wohlschläger, Newen, Shah, Fink, & Vogeley, 2006). Johnson, Grossmann and Farroni (2008) propose that because gamma oscillations measured with EEG are correlated with the BOLD response used in fMRI with

adults, eye contact detection in 4-month-old infants may well recruit very similar brain mechanisms as in adults.

Together, these findings suggest that infants have an early specialization of the cortical network involved in the perception of facial communication cues, which prepares infants to engage in communication with conspecifics and to learn from them (Grossmann *et al.*, 2007). In addition, the finding that similar brain activity is evident in infants and adults implies that these early core abilities are continuous with later socio-cognitive abilities. Thus, there appears to be more to the initial blueprint of the brain than classic constructivists propose (e.g., Piaget, 1945; Perner, 1991).

Although there is increasing biological evidence for infants' sensitivity to social stimuli, further research is needed to find neuro-physiological correlates for important behavioral data examined in this chapter, such as person-object differentiation, the role of emotions in social cognition, the relation between non-verbal and verbal communication about the mind, and the role of parents in promoting these abilities. Although there are theoretical models and studies with adults and animals, studies with infants are sparse, largely due to technical constraints. For instance, infants as young as 5 weeks differentiate between people and objects when important physical differences between the stimuli are controlled (see Legerstee, 1992, for a review). Apparently, different neural mechanisms underlie the processing of the two classes of stimuli in adults (see Blakemore, *et al.*, 2003). Evidence for the independence of social and non-social cognition points to neural components that appear to have a high degree of domain specificity in persons with autism (impairments in social cognition, but relatively preserved cognitive skills) and with Williams syndrome (preserved social skills, but deficits in spatial abilities; Adolphs, 1999). Research with infants may show whether this modularity in adults is the result of genes or the lengthy developmental interactions with the very distinct social and non-social environments (Gelman & Spelke, 1981; Legerstee, 1992).

There is evidence that areas of the brain that are important for emotional processing are also implicated for social cognition in adults (Adolphs, 1999). To comprehend another person's mental state, it is important to be able to feel what they feel and to represent what they represent or feel. Decety and Sommerville (2003) suggest that the right hemisphere, which is predominant early in life, is implicated in the ability for shared representations and thus may be responsible for the infant's feeling of empathy, namely that others are "with me" (Legerstee, 2005). Investigating the neural systems implicated in mother-infant interactions may support the behavioral data that maternal attunement to infant emotions is one of the mechanisms that promotes empathy and the subsequent developmental components of a theory of mind, such as

sharing attention (Legerstee *et al.*, 2007; Legerstee & Barillas, 2003), gesturing and talking about the mind (Legerstee, 2008).

Social or moral emotions such as jealousy, shame, guilt, and embarrassment only have meaning within a social context and may have their foundation in the infants' feel of being with the other (Trevarthen & Aitken, 2001). However, there are intense debates whether the social emotion of jealousy, might present itself in infants (see Hart & Legerstee, forthcoming). Although there is behavioral evidence for the existence of the affective precondition for the emergence of human jealousy in 3- to 6-month-old infants (Legerstee *et al.*, forthcoming), apart from very informative and stimulating theoretical models (see Panksepp, forthcoming), there are no studies that have examined what is happening in the human infant brain. Given that jealousy is not a single emotion, but is more appropriately labelled "a state" that one experiences and that depending the context, may conjure up emotions such as sadness (loss), anger (betrayal), fear/anxiety (loneliness), and so forth, jealousy does not have accompanying coherent infra structures in the brain and thus mapping jealousy onto a specific region is not possible (Panksepp, forthcoming). Future research may reveal whether infants feel the pain of social loss that adults speak of, when being excluded. Functional magnetic resonance imaging has shown that when adult participants were excluded from a virtual tossing video-game (the other players stopped throwing the ball to them) while blood flow was monitored by MRI, they experienced emotional distress as measured by substantial blood flow in the anterior cingulate cortex, an area associated with physical pain (Eisenberger, Lieberman, & Williams, 2003; see also Panksepp, 2003).

In this chapter, I have provided behavioral evidence to support the view that social cognition is both domain specific and the product of learning by examining the various child and parental factors as critical aspects in the developmental process. Drawing on core abilities, the neural architecture in which there is interaction between components that are innately specified and others whose operation emerges through experience, elucidate the importance of early social interactions and their emotional quality (i.e., affect attunement). For instance, coordinated attention is foundational to developing language and sharing emotions. Consequently, an important developmental milestone occurs when infants change between 3 and 5 months from sharing attention with others in dyadic situations (face-to-face) to sharing attention with others over objects in triadic situations. Legerstee *et al.* (2007) showed that this development was facilitated through maternal attunement. However, research addressing the brain structures and mechanism that support such change has not been conducted.

A deep controversy remains also about the onset of an awareness of intentions in others. Behne *et al.* (2005) addressed this topic by comparing

the responses of 6-, 9-, 12-, and 18-month-old infants towards an adult who was either unwilling (teasing) or unable (dropped) to give the infant a toy. The authors measured how often infants looked away from the adult and reached for the object, and showed that 6-month-old infants did not differentiate between varying intentions of the adult. However, if an awareness of intentions exists in very young infants, one might expect this understanding to be expressed in a different manner than in older infants. It would make sense to use measures such as gaze aversions and other emotional responses that are known to be indices of discrimination by infants when people refrain from engaging in shared contexts (e.g., Hsu & Fogel, 2003; Markova & Legerstee, 2006; Murray & Trevarthen, 1985). Consequently, Marsh *et al.* (2009) set out to replicate and expand the research by Behne *et al.* (2005). Interestingly, the results showed that infants in both age groups systematically discriminated between the unwilling and unable conditions if a different constellation of behavioral measures was used such as positive and negative affect. To shed light on these contrasting findings, behavioral and neural correlates of an awareness of intentions in others are needed at 6 and 9 months. If no different correlates exist at these ages then a continuous rather than discontinuous development of intention understanding is supported.

There are data on continuity between coordinated attention and later socio-cognitive skills such as language. Mundy and colleagues (Mundy, Card, & Fox, 2000) found that initiating coordinated attention skills in infants aged 14 and 18 months were associated with EEG coherence of left frontal and left and right central activity. In a subsequent study (Mundy, Fox & Card, 2003) measures of joint attention and EEG coherence at 14 months were related to language development at 24 months. Thus some form of coordinated attention skills (including pointing) that emerge early in infancy are associated with socio-cognitive processes that emerge later in development. These converging findings are certainly interesting and further support the behavioral data I reported here.

In summary, the study of the biological mechanisms that subserve social interactions, is based on the idea that identifying the biological, cognitive, and social levels of analysis contributes to more comprehensive explanations of human socio-cognitive development. Consequently, future research should focus on collaborations between traditional socio-cognitive developmental theory and developmental social neuroscience in order to provide a more detailed account of the relative contributions that innate and environmental components make to social cognition, with the goal of advancing an understanding of child development and behavior.

## Acknowledgements

The studies reported in this chapter were supported by grants from the Social Sciences and Humanities Research Council (Canada) to Maria Legerstee. Gratitude is expressed to the infants and parents who participated in the studies and to the research team of the Centre for Infancy studies at York University for help in the many phases of the research reported here. Thanks to Gabriela Markova, Vanessa Skrainka, and Giulia Zucal for providing interesting comments regarding an earlier draft of this chapter and to Gabriela Markova for preparing the Schema.

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