How New Knowledge About Parenting Reveals the Neurobiological Implications of Intersubjectivity: A Conceptual Synthesis of Recent Research

Massimo Ammaniti, M.D., and Cristina Trentini, Ph.D.
“Sapienza” University of Rome

Observations of early mother–infant interactions have shown that intersubjectivity is a primary motivation and have underscored the importance of maternal competencies in this development. In our paper we propose a conceptual overview of the different perspectives according to which parental caregiving has been formulated. Psychoanalytical theory has fundamentally promoted the exploration of maternal and paternal intrapsychic constellation, by stressing the role of unconscious processes in parental attitude as well as in infant development. In contrast with psychoanalytical theory, the conceptual framework of attachment has mostly considered real interactions between parents and infant, underlining parental abilities in providing the infant with a secure base. Finally, infant research has explored the complexity of communicative system between parents and infants, which appears already active from the birth of the baby. Recently, these different viewpoints have been broadened by neurobiological research, which has begun to explore maternal brain functioning and structure, by means of new scientific instruments such as fMRI techniques. From these perspectives, we provide an overview of motherhood, underlining both neurobiological and psychological transformations, which begin from pregnancy and run through the first year of the infant, when the mother–infant intersubjective matrix is built. This matrix influences the construction of the infant’s Self and support the development of the sense of “we,” a sort of connective net, which ties the baby to parents, letting him feel as a part of the familiar world.

INTRODUCTION

The observation of parental caregiving during the first years of the infants has important theoretical implications in the field of intersubjectivity as well as clinical ones.

Recent findings from several fields are converging to show that there are numerous features of the maternal neuro-psychic organization that interact with the infant to support an adaptive, intersubjective matrix of “we-ness.” This matrix is the scaffolding for all subsequent development (Emde, 2007).

The recent extension of such research in such varied fields as psychoanalysis, cognitive neuroscience, infant mental health, attachment research, and others, further supports the emerging view of a dynamic, transactional sense of personality organized in terms of “self-with other.”

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Correspondence should be addressed to Massimo Ammaniti, M.D., Department of Dynamic and Clinical Psychology, Via degli Apuli, 1 Rome 00185, Italy. E-mail: massimo.ammaniti@uniroma1.it
In this paper we investigate these different viewpoints, exploring its theoretical and methodological specificities, areas of overlapping and contact, as well as divergences.

We revise the area of motherhood, beginning from pregnancy and running through the first year of the infant, when the mother–infant intersubjective matrix is built. This matrix sustains the child in acquiring social and intersubjective competencies necessary for joining the human community.

What about the origin of mother’s ability in taking care of her own infant?

Parental caregiving evolved in humans probably together with the achievement of bipedality, although, at this regard, some anthropologists, as Lovejoy (1981), suggested that bipedality itself originally resulted from a variation in genetic reproduction and developed because of advantages related to the care of immature offspring. The specificity of maternal bonding may be influenced by the necessity to protect the progeny against predators, as has been suggested by attachment theory (Bowlby, 1969/1982), but also by birth spacing and demographic propagation. By this point of view, the selection of parent–infant bonding may have been related to the particular capacities in human community necessary for social communication and learning.

Quite alike other primates, infants are relatively immature in locomotion, while they are precocious in communicative development. For this reason, humans must prepare themselves to become competent mothers and fathers in order to interact with their own children and communicate with them just from birth. It is a long training in humans, which starts from infancy (dolls play) and reaches the maturation during late adolescence through the identification with the parental figures.

For this reason, human infants are very social from the birth, if not before. As Tomasello (1999) outlines, “There are two social behaviors that might suggest that human infants are not just social like other primates, but rather are “ultra-social” (p. 59). In fact, from the birth, we can observe “protoconversations” (Trevathen, 1979) between parents and infants, and the competence of human neonates of mimicking movements of the mouth and head of adults (Meltzoff & Moore, 1977, 1999): such empirical evidences show that the emotional dimensions of social bond are controlled by highly conserved biological processes, guiding expressions of both parental and infantile feelings as well as dyadic behaviors (Panksepp, 1998).

MATERNAL MENTAL STATE IN PSYCHOANALYTICAL THEORY

In exploring the link between parental attitude and an infant’s development, psychoanalytical theory has fundamentally highlighted the role of maternal and paternal intrapsychic world, substantially influenced by unconscious processes. In his perspective, Donald Winnicott (1956) drew attention on the peculiar maternal mental state that he called “primary maternal preoccupation.” This mental state is “almost an illness” that a mother must experience and recover to create and sustain an environment that can meet the physical and psychological needs of her infant. Winnicott suggested that this special state begins toward the end of pregnancy and continues through the first months of the infant’s life. This important clinical and developmental concept has opened the chance to explore the mothers’ mental state during pregnancy and in the first year of life of the baby.

This theoretical construct about motherhood has its antecedents in Freud’s theoretical thinking, represented by the hypothesis that any relation experienced both on the conscious and unconscious level with one’s own parents during infancy will have a decisive influence on the develop-
ment of the baby’s personality. In his paper “On Narcissism: An Introduction,” Freud (1914) deals with the parental roles during the intergenerational process, focusing on the function of parental “compulsion to ascribe every perfection to the child” (p. 91), and in the subsequent lines he adds, “the child shall fulfil those wishful dreams of the parents which they never carried out” (p. 91). In a later essay, “Group Psychology and the Analysis of the Ego,” Freud (1921) faces the other aspect of this process: in fact, he considers the identification mechanism of the child which represents “the earliest expression of an emotional tie with another person” (p. 105). Although Freud refers to the identification with the father of one’s “personal pre-history” through which one “should like to grow like him and be like him” (p. 105), he describes this kind of link in a baby as the first relationship it has with its mother. It is interesting to notice that within the concept of compulsion to ascribe one may already foresee Klein’s later discovery of projective identification. This mechanism is not only intrapsychic but also intersubjective and may entail in itself the modification of the object, on which the projection takes place, not only in fantasy but also in reality.

Another contribution toward the comprehension of the intersubjective mechanisms has been given by Sandler (1976), who speaks about the concept of actualization or rather of “a wished for role interaction, with the wished-for or imagined response of the object being as much a part of the wishful fantasy as the activity of the subject in that wish or fantasy” (p. 64). Sandler’s concept of actualization highlights the mainly unconscious attempt to manipulate or provoke current intersubjective situations so as to reproduce in the present context aspects of past experiences and relationships. Applying this to parents and their infants, Selma Fraiberg (1980) wrote, “In every nursery there are ghosts … visitors of the unremembered past of the parents . . . These unfriendly and unbidden spirits are banished from the nursery . . . the bonds of love protect the child and his parents against the intruders” (p. 164). It can happen that in some cases the family appears to be possessed by its ghosts and the parents and their child may find themselves re-enacting a moment or a scene from another time with another set of characters. In this situation the baby is already in peril, showing the early signs of emotional starvation or malignant attribution, because he is burdened by the oppressive past of his parents.

Psychoanalytical theory has fundamentally highlighted maternal intrapsychic and representational constellation, which is deeply influenced by mother’s infantile experiences and by her vicissitudes with parental figures: in this context relational events and unconscious resonance are reciprocally connected.

It is interesting to notice the emphasis on narcissistic character of parental love and on drive investment of the baby, which influences maternal affective state especially during the first months of the infant. In fact, according to psychoanalysis, infant’s development is strongly influenced by drives that must be gratified by the mother in order to establish a basic homeostasis. Nevertheless, the infant’s basic needs are in contrast with the environmental organization.

### CAREGIVING SYSTEM IN ATTACHMENT THEORY

If these contributions we referred to are set within the psychoanalytical context, an important shift in understanding the development of the caregiver–infant relationship has been inspired by Bowlby’s attachment theory. There are important overlappings between psychoanalytic object relations theory and attachment theory (Levine, Tuber, Slade, & Ward, 1991), as they both focus on the caregiver–infant relationship and on the mental models of self and other that a child develops.
through interactions with the caregivers. In both theories it is stressed the importance of the representational models that are formed in childhood and modified in subsequent years, guiding the individual functioning and the construction of significant relationships.

According to attachment theory, the infants who receive basic regular care tend to select attachment figures, suggesting that closeness with an attachment figure is sufficient for the development of an attachment bond (Bowlby, 1969/1982). Bowlby assumed that the caregiving system is in mutual relationship with the attachment system, both evolving in parallel with each other, playing an adaptive function in protecting the offspring, and, ultimately, one’s reproductive fitness (George & Solomon, 1999). The ways in which the infant’s behavioral systems interact with those of the caregiver and vice versa are beginning to be explored.

Consistent association between maternal and infant attachment systems has been initially suggested by Mary Ainsworth, who emphasized the role of maternal sensitivity in fostering the development of a secure attachment relationship (Ainsworth, 1973; Ainsworth, Bell, & Stayton, 1971), confirmed later by the Baltimore sample of middle-class mother–child dyads, through the Strange Situation Procedure (Ainsworth, Blehar, Waters, & Wall, 1978). According to Ainsworth (1969, 1973) a sensitive mother can be described as capable of reading emotional signals coming from her infant’s overt behavior in order to respond to them in an appropriate way. These aspects are consistent with the recent research by Jaffe, Beebe, Feldstein, Crown, and Jasnow (2001) about the correlation between maternal contingent responses in the first months and the security of attachment in the infant.

Following Bowlby’s assumption that early experience directly contributes to differences in the organization and function of attachment bonds, Ainsworth documented that children whose mothers responded to them in a sensitive way during the first year of life were more likely to openly express both their anger and fear when observed during the Strange Situation Procedure. These children saw their mother as a secure base, that is as someone who is emotionally available to them in time of distress. Repeated experience with this type of caregiving allows the child to develop a sense of efficacy and agency and to use the full repertoire of emotional communication in a well-regulated manner (Tronick, 1989).

Such evidence on intergenerational transmission has been stressed by several research projects whose background is in attachment theory: the Minnesota Project conducted by Morris (1980); the Amherst Project conducted by Ricks and Novey (1984); and the Berkeley Project conducted by Main, Kaplan, and Cassidy (1985). These studies are certainly interesting for our understanding of the affective world and individual relational styles, and permit the investigation of the dynamics through which internal working models and parental mental representations influence the child’s attachment development (Main et al., 1985).

Not only retrospective studies evidence the strong association between maternal and infant patterns of attachment, but also prospective research has clarified the pathway of intergenerational transmission of attachment. As Fonagy, Steele, and Steele (1991) have shown in their sample of mothers expecting their first child, it is possible to predict on the basis of the maternal attachment during pregnancy—investigated with Adult Attachment Interview (Main & Goldwyn, 1997)—the pattern of attachment of the child (secure vs. insecure) at 1 year of age, in 75% of the cases. Such evidence emphasizes how mother’s representation of her own relationship with her parents is likely to predict the quality of her own infant’s attachment classification.

Mothers of secure infants have coherently worked out their own childhood relationships with their parents, recognizing in them a relevant value for their own personal history and their present
mental state. These mothers not only value their relations but also maintain a balanced view of themselves within their relationships with others, are capable of forgiving any injury, are coherent in describing early experiences, and do not idealize their own parents. This personal orientation enables the mother to respond affectionately to her baby’s demands for safety and his need for independence. Thus, the baby will interiorize a feeling of relational trust; in fact, the baby expects his mother to pay attention to his demands and communications and to be able to understand them.

Very different is the case of the mothers whom we may call enmeshed, who maintain a very strong dependence on their own original family. In fact, they seem to be incapable of deidentifying themselves from their own childish relations, they still show hostility and resentment toward what happened to them during infancy, and they still try to ingratiate themselves with their parents although they are already adults. These mothers are generally incoherent in describing their own attachment relations and their own childhood experiences. When we observe children brought in this affective climate, we notice a very marked ambivalence toward the mother, with an anxious seeking for a relationship with her and with reactions of anxiety, fear, and anger always directed toward the mother.

On the other hand, affectively detached mothers seem incapable of valuing their attachment relationships, find it difficult to remember early relational experiences, and don’t show affective responses to their memory of early and painful situations. We may explain this by saying that defensive mechanisms of splitting and denial which are being used effectively cancel painful memories and experiences and maintain an idealized vision of the self and of others. The same defensive style will be noticeable in their children, who will tend to escape from self-involving affective interactions, and who will adopt defensive strategies to eliminate any negative affect, such as anxiety and anger.

Last, mothers classified as unresolved are disoriented in their discussion about their infantile history of loss or abuse, as indicated by lapses in monitoring reasoning or discourse (Hesse & Main, 2000; Main & Hesse, 1990); their emotion regulatory strategies reflect a lack of resolution of these life events (Main & Hesse, 1990). This maternal attachment classification is linked with infant attachment disorganization (van IJzendoorn, 1995): such relation is due to maternal failure to monitor behavior during interactions and to regulate their children’ distress signals.

Thus, while the approaches to emotions adopted by detached and enmeshed mothers may reflect organized strategies for regulating emotions, unresolved mothers appear to lack a functional strategy for coping with intense emotional experiences, leaving them more vulnerable to emotional dysregulation.

The Role of Fathers

It has been stressed the particular role of mothers in protecting and upbringing the children: however, also fathers are capable—as Lichtenberg (1989) has discussed—of responding to the birth of their child with an “engrossment” that parallels the mother’s “preoccupation.” Fathers actively involve themselves in play with their child and demonstrate an equal sensitivity to his messages, being able to capture his interest. For this reason infants look also for the fathers, expressing sometime their preference to stay with them and to be protected. Of course, the way in which the fathers play is more vigorous, hands-on, physical games. As Lichtenberg wrote, “Intimacy, then, lies both in the pleasure of smoothly modulated exchanges (primarily mother) and in the excitement of horseplay games (primarily father)” (p. 109). These findings, then, call for a revision of exclu-
sively mother-centered theory of attachment and indicate that the attachment motivational system of the infant in the first year of life is activated toward both the mother and father, when each is available.

Recent findings about the effect of becoming parents on couples support a similar conceptual approach. More recent studies have explored the prenatal coparenting alliance (Carneiro, Corboz-Warnery, & Fivaz-Depeursinge, 2006), demonstrating that, during the first pregnancy, the couple undergoes a profound transformation, developing and differentiating two couple subsystems: the marital and the coparenting ones. At the same time, it has been observed continuity between the prenatal coparental alliance and the postnatal family one, although there is a decrease in positive exchanges in the couple and an increase in conflict after the child’s birth (Belsky & Kelly, 1994; Cowan & Cowan, 1992).

The conceptual framework of attachment mostly considers real interactions between parents and infant in clear contrast with psychoanalytical theory, which instead stresses the role of unconscious processes in maternal psychic attitude and in early infant’s development. These real exchanges are directed to provide the infant with a secure base, by regulating his sense of safety. From this perspective, the main maternal task is recognizing and meeting her infant’s needs of contact, protection and attachment. In contrast with psychoanalytic theory, which believes that conflict originates from the contrast between infant’s desires and maternal responses, attachment theory rather emphasizes in difficult situation mother’s incapability in responding to her infant’s need of security and protection.

**MATERNAL DYNAMICS DURING PREGNANCY**

As we have highlighted, the caregiving system is activated during pregnancy and the postnatal period. During pregnancy the woman confronts psychological and physical transformations and prepares herself to become mother in order to take care of a helpless and immature baby, who needs protection: in other terms, she learns to think for two (Ammaniti, 2008).

As the pregnancy progresses, the woman has to reorganize her internal representational world, facing and elaborating her relationship with her own mother, because she is not only a daughter in relation to her, but she is experiencing the chance to become a mother too, giving way to an identification with her (Pines, 1972). The process of becoming a mother is of course characterized by conflicts and ambivalence, especially if the woman has experienced an unavailability or rejection or hostility from her own mother. While the woman is trying to rework on her attachments to her own parents, she becomes attached to her child initially in a fusional way and then recognizing his or her separateness. Of course, this pathway assumes different dynamics: some mothers experience the fetus as a baby just from the first months; other mothers consider the fetus as a distant or stranger object to control and, in some cases, as a dangerous presence. Especially during the last months of pregnancy, the woman has the chance to have fusional experiences with the baby identified with his or her needs, but, at the same time, the baby should maintain separateness in her mind, distinct from her fantasies.

The achievement of a flexible and permeable boundary allows the mother to mentalize both the baby and her own maternal identity (Fonagy & Target, 1996), developing the capacity to consider the baby as part of herself and apart form her: this is a prerequisite for a relationship after birth which is, at the same time, reciprocal and intimate (Cohen & Slade, 1999). This process is strictly
connected with the development of maternal representations of herself as a mother and of the future baby (Ammaniti, 1994), as result of maternal projections, dreams, attributions, and conscious and unconscious fantasies. These maternal representations are rooted in the personal history of every woman from infancy to adolescence, specifically mirroring the actual life and the relationship with the partner and her own mother.

In the most typical situations, the maternal representations of herself as a mother and of her own baby are quite flexible and coherent and are coloured with joyful emotions: the baby actualizes the experiences of the couple and opens new chances. An important aspect is the mother’s capacity to distinguish her own fantasies and the reality of the baby, which means to tolerate emotions and actual experiences without making recourse to narcissistic projections on her own child. The quality of such maternal representations is influenced by the mother’s capacity to integrate and elaborate the psychobiological experiences of pregnancy, connected to the quality of the internalized object relations (Pines, 1972, 1988), to the capacity of tolerate regressions during pregnancy and to ambivalence and unresolved conflict and finally to the support of the partner and of the family.

Undoubtedly, the woman’s representation as a mother during pregnancy and after the birth of the child will amplify and integrate the maternal identity. By using a semistructured interview (Interview of Maternal Representations during Pregnancy; Ammaniti, Candelori, Pola, & Tambelli, 1995), we have documented that maternal representations during pregnancy may express different mental configurations of the mother–baby relationship (Ammaniti et al., 2002). When the pregnancy is considered as an important stage of developmental cycle, women mostly evidence a balanced and integrated representation of themselves as a mother and of the future baby: these representations are characterized by richness of perception, affective investment and by a coherent narration of their motherhood in the context of their personal history. Instead, maternal representations are restricted and disinvested when mothers are unable to involve themselves in the experience of pregnancy, showing detachment and rigidity of personal rhythms. Alternatively, the representations are unintegrated and ambivalent when women show contradictory aptitudes toward motherhood and the child, oscillating between excessive involvement and detachment.

It is interesting to notice that the birth of the baby can have a reassuring effect for mothers, promoting a psychological integration and a decrease of less functional representations. In fact, the birth of the baby can stimulate a resolution of conflicts and ambivalence, allowing women to elaborate their maternal role.

Maternal representations have an important value, not only because they describe the different ways of mothers to face motherhood, but also because they can predict the future interactions with the baby after the birth, influencing in a decisive way his or her development. In the last months of pregnancy and immediately after the birth until the third month of the baby, an altered mental state, termed by Winnicott (1956) “primary maternal preoccupation,” to which we have already referred. In this period mothers are intensely focused on the infant, thus limiting the influence of the outside world. This preoccupation increases the maternal ability to anticipate the infant’s needs sustaining the infant to develop a sense of self.

In a longitudinal study, Leckman and his colleagues (2004) showed that the peak of preoccupation is around the delivery, affecting both mothers and fathers (the last in a reduced degree). The mental contents of parents’ preoccupations frequently include recurrent thoughts about the possibility of something bad happening to their baby, at 8 months of gestation. After delivery and returning home, the most common concerns are one’s adequacy as a new parent, concerns about
feeding the baby, about the baby’s crying and thoughts about the infant’s well-being. During pregnancy, mothers develop an attachment bond with their baby, which increasingly becomes more significant in relation to the growth of the fetus and to a more differentiated representation of the son. At the same time, mothers prepare themselves to think for two building an intersubjective perspective, which includes the baby. This aspect is well documented by mothers’ attitude to refer to the baby with a nickname and to speak to him as if he could be an active social partner.

From a theoretical perspective, in this early stage we can observe a close connection between attachment motivational system and intersubjective one. In many ways, then, the varied research about parenting supports the perspective that there is an intersubjective motivational system characterized by active interpersonal communication and exchange that shapes the basic patterns of social experience, even when the infant is not yet able to explicitly decode maternal messages. In elaborating this, Stern outlines the existence of internal affective states that develop within an “intersubjective matrix,” in which the infant organizes his experience in terms of “self-with other.” Such processes are related to how infant’s biologically grounded self-regulation of internal state and self-conscious purposefulness is sustained through active engagement with sympathetic others.

MOTHER–CHILD DYNAMICS AFTER THE BIRTH OF THE BABY

Observational research, carried out during the first year of the life, has documented the complexity of communicative system between parents and infants, which appears already active from the birth of the baby. A remarkable questioning is about the interaction between intersubjective experience during the first months of the infant and the development of the attachment bond. After the birth of the baby, the mother’s essential task is to rear the child, protecting and caring him, as she desires that her child “should grow up to be healthy, happy and self-reliant” (Bowlby, 1988). At this regard, Ainsworth (1969) wrote, “A mother might be quite aware of and understand accurately the baby’s behavior and the circumstances leading to her baby’s distress or demands”: in other terms, the capacity to see the exchanges with the child from his or her point of view. In the rearing, the mothers’ capacity to respond in a sensitive and contingent way to their infant’s needs is critical for the development of the secure infant-mother attachment (Ainsworth et al., 1978).

In the perspective of caregiving, the parents not only provide protection and care toward the child but also function as a secure base (Bowlby, 1988), from which the child can face the outside world and to which he can return with the sense of being welcomed and comforted if distressed, and reassured if frightened. Maternal behavior is “reciprocal” (Bowlby, 1969/1982) to the infant’s attachment behavior, which develops in relation to the sensitivity of mothers in responding to their baby’s cues and to the amount and nature of their interaction: so, mother–infant relation is based on a “reciprocal interchange,” which opens interesting intersections with transactional theories. The transactional theories emphasize the central role of the primary caregiver in coregulating the dyadic regulation of emotions (Sroufe, 1996) as well the child’s facially expressed emotional states (Schore, 2002).

During the first year of life of the baby, not only the motivational system of attachment is activated, but also some forms of intersubjectivity appear right after birth. In fact, in human beings brain and mind are equipped in order to intuit possible intentions of other people by watching their facial expression or their goal-directed actions. In this regard, Trevarthen (2005) found primary
intersubjectivity in very young infants by observing the tight mutual coordination of mother–infant behavior during free play: in particular, the author examined the timing of their movements, the onset of their facial expressions, and their anticipation of the intentions of the other.

Also early imitation between mother and baby is another important form of intersubjectivity. At this regard, Meltzoff and Moore (1977, 1999) evidenced that neonates imitate actions seen on an experimenter’s face (e.g., sticking the tongue out); they argue that neonates are able to reproduce facial expressions in an early form of intersubjectivity based on cross-modal transfer of form and timing.

As development proceeds, coordinated timing is central for synchronicity and the access to another’s experience. Along these lines, Beebe and Lachman (1988) showed that the mother and the infant match reciprocal temporal and affective patterns. Jaffe and colleagues (2001) showed how preverbal infants and mothers precisely time the starting, stopping and pausing of their vocalizations, to create a rhythmic coupling and bidirectional coordination of their vocal dialogues. Specifically, they found that, at four months, the levels of coordination in vocal rhythm between mother and infant during face-to-face interaction can predict the quality of attachment at 12 months. These authors have observed that a high level of coordination, defined by an excessive parental control of infant’s behavior, restricts his opportunity to experience uncertainty and to propose interactive initiatives: in these conditions, the lack of mutual flexibility seems to be a predictive factor of insecurity in attachment. In fact, an excessive level of coordination limits the development of infant’s self-regulatory abilities, restricting his competencies in coping with aversive stimulations. On the contrary, very low coordination, characterized by a scarce maternal responsivity, lets the infant react with an excessive empowerment of self-regulatory processes, aimed at engaging himself in self-comforting behaviors. Thus, according to Beebe and Lachmann (2002), the quality of intersubjective exchanges is correlated to the balance existing between self and hetero-regulatory processes, which reciprocally interconnect in a flexible way. These patterns were correlated with security of attachment in the second year of life. Overall, it is now clear that affective reciprocity derives from mutual coordination between mother and infant, who modulate the timing, the form and the intensity of their own emotional expressions, to achieve harmonic and complementary interactive exchanges.

Within these domains, several communicative modes are coordinated between parents and infants; these include emotion, vision, and other sensorimotor pathways. Affective sharing is central in the intersubjective relatedness and catches the sense of parental mirroring or the empathic responsiveness, which have been regarded by psychoanalytic theorists, as Lacan, Bion, Loewald, Mahler, Jacobson, Kohut, and Winnicott. For example, the mother imitates the facial expressions and gestures of the baby, demonstrating that she is able to read the infant’s feeling state from the infant’s overt behavior. To accomplish these transactions, the mother must go beyond the strict imitation of mirroring, as Gergely and Watson (1996, 1999) have shown. According to Gergely, the mother not only is able to produce empathic imitative emotion displays corresponding to the infant’s affect expressions, but also performs a transformed, perceptually marked (which means exaggerated), version of the realistic facial expression of the baby. The resonating caregiver does more than reflect back the infant’s state: rather she co-creates a context of intersubjective resonance assuming the role of a “biological mirror” (Papousek & Papousek, 1979) or of an “amplifying mirror” (Schore, 1994). This special maternal mirroring would play an important role in the development of the baby, as Winnicott (1967) already suggested. In fact, in his paper, Winnicott suggested that the infant, when looking at her mother who is looking at him, sees himself in her
eyes: “The mother is looking at the baby … . What she looks at is related to what she sees there” (p. 131).

It is now well established that the face-to-face interactions of parents and infants are quite early and bidirectional. Facial mirroring illustrates that interactions organized by ongoing regulations and experiences of mutually attuned interactions are fundamental to the developing sense of the “we.” High-intensity mirroring exchanges create a “merger” experience, which acts as a crucible for the forging of the affective ties of the attachment bond. The context of a specifically fitted interaction between infant and mother has been described as a resonance between two systems attuned to each other (Sander, 1991).

Such visual experiences play a critical role in social and emotional development: in particular, the mother’s emotionally expressive face is the most potent visual stimulus in the infant’s experience. Gaze represents the most intense form of interpersonal communication and the perception of facial expressions is one of the most salient channels of nonverbal communication. Not only Winnicott, but also Kohut (1971) underlined that “the most significant relevant basic interactions between mother and child usually lie in the visual area: the child’s bodily display is responded to by the gleam in the mother’s eye” (p. 117). According to Bowlby (1969/1982), visual contact is a central element for the establishment of a primary attachment to the mother: in fact, from the beginning, mother and baby perform a protoconversation which is mediated by eye-to-eye orientations, vocalizations, hand gestures, and movements of the arms and head, in coordination to express interpersonal awareness and emotions (Trevarthen & Aitken, 2001). In a recent paper, Tomasello, Hare, Lehmann, and Call (2006) evidenced that humans have especially visible eyes, in fact they “are coloured in a way that helps advertise both their presence and their gaze direction much more saliently than in other primates” (p. 315). One hypothesis is that human-type eyes evolved in the context of pressures for enhanced cooperative-communicative abilities of the kind needed in mutual social interactions, involving joint attention and visually based communication, such as pointing. It is important to underline that human eyes often signal different emotional states (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).

In addition, through the eye-to-eye communication, the mothers use their own capacity to understand her child’s behavior, reflecting underlying mental states, feelings, and wishes, in order to anticipate her or his actions (Fonagy & Target, 1998).

As we have discussed, the process of keeping the baby in mind (Slade, 2002) begins early in pregnancy and develops after the birth of the baby activated by the close contact and the interactions with him or her.

As it has been already argued, at the end of pregnancy, a state of preoccupation (Winnicott, 1956) or a state of heightened sensitivity develops and lasts for the first few postnatal weeks. Mothers become very focused on the infant and this preoccupation has an important evolutionistic aim because it increases the maternal capacity to read infant’s signals, to protect him and anticipate his or her needs. It seems evident that, from an evolutionary point of view, these behavioral repertoires associated with early parenting skills would be subject to intense selective pressure (Bretherton, 1987), because pregnancy and early years of an infant’s life are fraught with dangers especially in the past. During pregnancy, mothers learn to represent themselves as a mother as well as the child in order to develop what is called intuitive parenting (Papousek, 2000) “a modular subsystem in the regulation of caregiving behaviors in humans, subserving crucial aspect of the care for progeny” (p. 305).
From a somewhat different angle, Daniel Stern (1977, 1985, 2004) has been interested in how mother and infant succeed in knowing about their reciprocal inner feeling states, with a shifting from the overt behavior to the subjective experience underlying it. As Stern (1986) has evidenced, parents spend a lot of time in the service of physiological regulation, but at the same time they do focus social interactions with the child and act, from the beginning, as though the infant has a sense of self. Parents immediately attribute their infants with intentions (“Oh, you want to see that”), motives (“You’re doing that so Mommy will hurry up with the bottle”), and authorship of action (“You threw that one away on purpose, huh?”). (p. 43)

EMOTIONS AND EMOTION REGULATION
IN THE PARENT-INFANT INTERCHANGE

The emotions play an important role in parents–infant interchange, as they are participants in intersubjective system (Tronick, 1989), characterized by inextricable links among infant’s and maternal affects and behavior. Intersubjective motivation system depends on the linkages of the hetero-regulatory, affective, motor, and intero-regulatory dimensions. The process of affect regulation is the optimal result between the child’s predispositions to produce self-regulation and interactive behavior and the mother’s ability to interpret his signals and respond appropriately to them. To face the changes of his emotional state the infant can use a series of behaviors the function of which is to regulate his emotional state, thus reducing his engagement with the external world, that is, lessening his perceptive receptivity, for instance, by withdrawal or avoidance and replacing this with self-stimulating and self-comforting behaviors.

At the beginning the baby needs some additional regulation abilities that are given to him by the mother who interprets the infant’s self-regulation behaviors and respond appropriately to them (Tronick & Weinberg, 1997). At the same time the baby is able to use regulation behaviors directed to others such as the smile to signal his mother to keep an interaction going or crying to stop an inappropriate behavior whose ultimate aim is to reach a shared positive emotional state (Speranza, Ammaniti, & Trentini, 2006).

A critical event in order to understand reciprocal regulation is the rupture and reparation process. In fact, there are moments of misattunement in the dyad which can be faced through the pattern of “disruption and repair” (Beebe & Lachmann, 1994). During these moments of mismatch, infant is able to propose several motor and expressive schemes (such as crying, protest, or funny faces) to re-establish a level of contingency with the mother. Sensitive mother attunes infant’s affective states, responding to his interactive initiatives. From a developmental point of view, the transient absence of interactive reciprocity has got a fundamental adaptive value for the infant, allowing him to empower his own extero-regulatory abilities and to feel competent within affective interactions.

Overall, then, a protected and secure environment is necessary for the baby especially during situations of danger, alarm, and tension, but at the same time low-level interactions intervene in promoting a common intersubjective matrix between parents and baby. Probably, these intersubjective interchanges influence the construction of the infant’s Self, as Stern (1985) emphasized, but they also have an impact on the development of the sense of “we,” a sort of connec-
tive net, which ties the baby to parental figures, letting him feel as a part of the familiar world (Emde, 2007).

MATERNAL BRAIN

Along with the psychological transformations which take place during pregnancy and in the first year of the baby, striking changes occur in mothers’ brain (Panksepp, 1998). Such evolutions have been highlighted by recent neurobiological research, employing new scientific instruments as functional Magnetic Resonance Imaging (fMRI). Neuroscientific research indicates that the intense hormonal fluctuations that occur during pregnancy, birth, and lactation may remodel the female brain, increasing the size of neurons in some regions and producing structural changes in others.

Recent experiments have shown that mother rats outperform virgin rats in navigating mazes and capturing prey. According to Kinsley and colleagues (1999), the hormonal change—induced by brain modification—not only motivate female rats toward caring for their newborns but enhance foraging abilities, giving their pups a better chance of survival. These data demonstrate that the regulation of maternal behavior requires the coordination of many hormonal and neurochemical systems and that the female brain is particularly responsive to the changes that occur during pregnancy. In particular, vasopressin and oxytocin (Insel & Young, 2001), both secreted in the hypothalamus, stimulate bonding between a mother and her infant. Besides hormones, other chemicals affecting the nervous system appear to play a role in triggering motherly impulses. The endorphins, at this regard, not only intervene preparing the mother for the discomfort of delivery but may initiate maternal behavior.

As Mayes, Swain, and Leckman (2005) underscored, the onset and maintenance of maternal behavior involves a specific neural circuit. With pregnancy or with repeated interactions with the child structural and molecular changes—not completely understood—occur in specific limbic, hypothalamic, and midbrain regions, partially reflecting the adaptive process to the demands associated with maternal care. Research also has identified the brain regions that govern maternal behavior: the medial preoptic area of hypothalamus is largely responsible for regulation of maternal responses, as well as the hippocampus, which regulates memory and learning. These changes of the brain are activated by large amounts of estrogens and progesterone produced by ovaries and placenta during pregnancy. Current brain imaging data have evidenced that right orbitofrontal cortex actively intervenes in modulating mother’s abilities to decode her infant’s emotional cues to respond to them in a sensitive way (Nitschke et al., 2004). It has been demonstrated that this brain region is actively implicated in the socio-emotional behaviors and affect-regulating functions which are specifically involved in attachment system (Schore, 2003).

Remarkably, recent brain investigation suggests that many of these same cerebral areas are also activated by other forms of passionate attachment, such as romance. In this regard, neurobiological research using neuroimaging techniques has evidenced interesting neural overlapping between romantic and maternal love as they are both highly rewarding experiences (Bartels & Zeki, 2004). By the evolutionary point of view, maternal and romantic loves share a common aim, namely, the maintenance and perpetuation of species. At the same, they ensure the formation of deep attachment between individuals promoting a rewarding experience and suggest a tight coupling between attachment processes and the neural systems for reward (Insel
& Young, 2001). Both maternal and romantic loves elicit overlapping brain set of deactivations in different areas connected in cognition, negative emotions and “theory of mind.” In summary, Bartels and Zeki (2004) have shown that these two forms of human attachment activate specific regions in the reward system and lead to the suppression of neural activity associated with the critical social judgment of other person and with negative emotions, which explain the sentence “love is blind.”

Also, recent studies have shown that the human brain may undergo changes in sensory regulatory systems: for this reason, human mothers are capable of recognizing many odors and sounds of their infants (Fleming, O’Day, & Kraemer, 1999). Mothers with high postbirth levels of the hormone cortisol are more attracted to and motivated by their babies’ odors and better able to recognize their infant’s cries. By raising cortisol levels, the stress of parenting may boost attention, vigilance, and sensitivity. These findings support the hypothesis that stress response systems are adaptively activated during the period of heightened maternal sensitivity surrounding the birth of a new infant.

Then, after the birth of the baby, the emotional dimensions of maternal nurturance seem to be controlled by highly conserved biological processes that guide expressions of both mothers’ and infants’ behaviors and the emotion that they develop for each other.

RIGHT HEMISPHERE: NEUROBIOLOGICAL IMPLICATIONS OF ATTACHMENT

Right hemisphere, defined as “the emotive brain,” faces its greatest growth especially during the first 18 months of life, having a dominant role throughout the first 3 years of life (Chiron et al., 1997; Schore, 1996, 2003). During this period, right hemisphere works as a unitary system, preparing organism to react to developmental challenges (Wittling, 1997), mediating individual’s ability to cope with distressing situations.

Affectionate contact between the infant and the caregiver activates the limbic and mesofrontal regions which undergo developmental changes for years after birth, starting with an early maturation phase which is lateralised to the right hemisphere (Joseph, 1996; Schore, 1996, 2003). Interconnections between the amygdala, orbitofrontal cortex, and cingulate provide the necessary integration between feelings, impulses to act, and experiences of the world, including experiences of individuals and their actions and emotions.

Several neuroscientific researches confirm that right hemisphere is significantly involved in maternal nurturant behaviors. From the psycho-neurobiological point of view, then, the attachment system can be considered an acquisition into implicit memory of affective and behavioral strategies, aimed to regulate states of aversive arousal (Carlson, Cicchetti, Barnett, & Braunwald, 1989; Sroufe, 1996).

Human mothers—both right- and left-handed ones—and many primates hold their newborns with the left part of the body (Sieratzki & Woll, 1996), and utilize left arms and left hands more frequently than fathers and nonmothers (Horton, 1995). This lateralized aptitude allows the position of the child in the left maternal visual field, directly communicating with the right hemisphere, which is in turn involved in processing affective and nonverbal communications and in producing intuitive comforting gestures (Schore, 2003; Sieratzki & Woll, 1996). Manning and colleagues (1997) suggested that these predispositions allow the flow of dyadic affective commu-
communications toward right hemispheres, considered as the cerebral centres of human social attachment processes (Ammaniti & Trentini, 2008; Henry, 1993; Horton, 1995; Trentini, 2008).

Overall, then, psychobiological studies are revealing that mother–infant systems are intercorrelated within a superordinate organization which allows mutual regulation of cerebral, biochemical, and autonomic processes: through these “hidden” mechanisms, the adult brain works as an external regulatory element, enhancing the development of the infant’s immature homeostatic systems (Hofer, 1990). Attachment is more than an overt behavior; it is internal, “being built into the nervous system, in the course and as a result of the infant’s experience of his transactions with the mother” (Ainsworth, 1967, p. 429).

**MIRROR NEURONS: A NEUROBIOLOGICAL EXPLANATION OF INTERSUBJECTIVITY**

It is thus clear that early intersubjective experiences are mapped into individual’s cerebral functioning. This aspect can be illustrated by referring to the recent discovery of the mirror neurons system (Gallese, 2001, this issue; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996). Mirror neurons map observed and executed actions, personally experienced and observed emotions or sensations within the same neural substrate, by means of “embodied simulation” processes. This concept of “embodiment” is used to explain how neurobiological events are sought to account for mental events (Emde, 2007). By means of “embodied simulation” internal representations of the body states associated with actions, emotions, and sensations are evoked in the observer, as if he or she would be doing a similar action or experiencing a similar emotion or sensation. These functional processes enhance individuals who are confronting the behavior of others, in experiencing a specific phenomenal state of “intentional attunement”: such condition generates a peculiar quality of familiarity with other individuals, produced by the collapse of the others’ intentions and emotions into the observer’s ones (Gallese, 2006). In this way, the mirror neuron system can be described as the neurobiological correlate of intersubjective system, since it represents the innate, and embodied, motivation to be in contact with others’ emotions and to share with them subjective experience.

On the basis of these considerations, we have carried out research to study intersubjectivity by exploration of mothers’ mirror neuron systems during the presentation of infants’ emotional stimuli. In our research, we have used fMRI techniques to investigate the neurobiological basis of empathy in mothers with children aged between 6 and 12 months (Lenzi et al., 2006; Lenzi et al., 2008). During these experiments, mothers were instructed to actively imitate or to feel empathy for pictures of their own or of an unknown child. Pictures were divided in distinct groups according to infants’ facial expressions (joy, distress, ambiguous and neutral). The fMRI data showed that when mothers felt empathy with infants’ emotional expressions, this significantly activated large cluster of the mirror neuron areas and of the limbic system. Furthermore, these areas were more active (particularly in the right hemisphere) when the mothers felt empathy with their own child. This may be the result of the increased maternal effort to understand their own children’s emotions in order to interact effectively with them (i.e., helping him in distressing situations). On the basis of these data, we could suggest that mirror neurons could represent the neurobiological substrate of maternal responsivity, playing a significant role during the first year of the baby, facilitating the dyadic exchange in a developmental stage when language has not developed yet.
CONCLUDING REMARKS

Intersubjective exchanges between mother and baby are part of “an innate, primary system of motivation, essential for species survival, and has a status like sex or attachment” (Stern, 2004, p. 97). These intersubjective exchanges develop from the birth between the baby and the mother, but also with the father, creating a triadic interactive context (Fivaz-Depeursinge & Corboz-Warnery, 1999). On the basis of neurobiological observations, it can be assumed that the parenting system is linked to the basic intersubjective motivation system, is an extension of it, and is essential to its reproduction over generations.

This is most extensively documented in regard to how entering motherhood promotes deep psychological changes in a woman during pregnancy and after the birth of the baby. There is a usually basic shift in the overall sense of self to include the maternal identity, including the activation of a particular psychic configuration, specific to motherhood, a “motherhood constellation” (Stern, 1995). Research concerning maternal neurobiological circuits has shown that specific brain regions are activated when different motivational systems involved in parental functioning are observed in the mother’s behavior (Lichtenberg, 1989; Nitschke et al., 2004; Schore, 2003).

The activity of the frontolimbic system intervenes in modulating social and emotional behaviors and affect-regulating functions which are specifically involved in the attachment system. An important role in attachment process is performed by orbitofrontal cortex of the right hemisphere. In addition, in our own research on maternal brain functioning, we find that maternal mirroring and imitation of the affective facial expressions of the child activate the classical areas of mirror neurons (ventral premotor cortex, frontal inferior posterior gyrus) and of limbic system—key emotion centres of the brain. In addition, hormonal modifications during motherhood occur with the activation of specific maternal circuits (Mayes et al., 2005).

REFERENCES


CONTRIBUTORS

Massimo Ammaniti, M.D., is a psychoanalyst; child psychiatrist; Professor of Developmental Psychopathology, Sapienza University of Rome; member of the International Psychoanalytical Association; and on the Board of Directors of the World Association of Infant Mental Health.

Cristina Trentini, Ph.D., is a psychologist and holds a research fellowship, Department of Dynamic and Clinical Psychology “Sapienza” University of Rome.