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# AUTISM AS A DOWNSTREAM EFFECT OF PRIMARY DIFFICULTIES IN INTERSUBJECTIVITY INTERACTING WITH ABNORMAL DEVELOPMENT OF BRAIN CONNECTIVITY

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ABSTRACT. Autism is a 'spectrum' of conditions all of which disturb the development of interpersonal sympathy. We suggest that differences in behavior, emotion or brain functions are downstream effects of impairments in primary or secondary intersubjectivity. Several research projects have shown that the lack of intersubjective behaviors is the best way to discriminate children with autism from those with typical development during the first year of life. According to new findings on biological maturation of the brain after birth, it is supposed that these difficulties do not allow the neurological experience-dependent system to develop in autism. In this paper we consider early dyadic interactions observed in the home movies of children later diagnosed with autism, of sequential maternal approach and infant's responses to these approaches. We hypothesize that children with autism show fewer contingent responses to their mothers than non-autistic children, and that episodes of contingency are a function of the type of approach used by the caregiver. It is supposed that more contingent behaviors happen when the caregiver approach is high in intensity and rich in non-verbal behaviors, as motherese. Motherese is supposed to play an important role in creating interactive sequences which are the expression of new cortical and sub-cortical networks in brain development. When these linkages are not properly formed early in life, a variety of downstream effects may occur.

Keywords: autism; intersubjectivity; motherese; contingency; mirror neurons

Autism is a 'spectrum' of conditions all of which disturb the development of interpersonal sympathy and collaborative action. In our view, the well-known autistic impairments in language, cognition and social development as well as the tendencies toward self-absorption, perseveration and self stimulation (Volkmar & Pauls, 2003), are downstream effects of primary difficulties in the ability to engage in interactions involving emotional signals, motor gestures and communicative acts directed to others. Although first described by Kanner in 1943 as an inborn disorder of affective contact, information on autism in infants is still limited. Nevertheless, several research projects

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based on home movies recorded by parents before diagnosis (see Palomo, Belinchòn & Ozonoff, 2006 for review) and a more recent increase in literature on infants at risk for autism (Zwaigenbaum et al, 2005), have shown that the lack of social abilities are the best way to discriminate children with autism from those with typical development during the first year of life. Different ideas stemming from multiple research now seem to support a theory of autism that is not exclusively based on its secondary deficits. In this paper, we will develop this issue relying both on data that we have gathered from an original research on home movies (see Muratori & Maestro, 2007 for review) and on other biological and theoretical research. Throughout the paper we try to keep in mind the conceptual framework of the dialogical self where others are not simply external, but actually assume, from infancy onwards, a double position: both internal and external (Hermans & Dimaggio, 2004).

## Theories on Full-blown Autism

Over the past two decades, different theories of the psychological causes of autism have dominated literature. The theory of mind approach (Baron-Cohen, Leslie & Frith, 1985; Baron-Cohen, 1994) suggests that the underlying cause of autism is impairment of a dedicated mind-reading module, leading to extreme difficulties envisaging the contents of other people's mind. Investigation of the brain bases of this impairment focused on the identification of structural or functional abnormalities within what has been termed 'the social brain' comprising a diverse set of frontal, limbic (amygdala) and temporal lobe circuitry. Other theories have implicated more general information processing deficits (Minshew, Goldstein & Siegel, 1997) or a reduction in the normal tendency to process information in context, labeled as weak central coherence (Frith & Happe, 1994), or poor executive functioning (Ozonoff, Pennington & Rogers, 1991). Moreover, in the attempt to identify the cognitive deficit underlying the myriad of behavioral symptoms seen in autism, other researchers have focused their attention on deficits in imitation (Rogers & Pennington, 1991), impairments in social and affective relations (Hobson, 1993), and impairments in joint social attention (Mundy, 1995).

Each of these theories is a valid description of many aspects of the autistic syndrome but they promote research which too often seems a 'fragmented tapestry stitched from differing analytical threads and theoretical pattern' (Belmonte et al, 2004). Moreover, they describe autism as a consolidated pattern but they are less useful for describing autism at its earlier stages. For example, different authors (Dawson, Munson & Estes, 2002; Yerys et al, 2006) have proposed that the theory of autism based on a primary deficit of executive functions, could be a false notion derived from the knowledge about older children and that it should be considered secondary to an earlier primary deficit of joint attention.

*Autism as a disconnection disorder*

As we look at the various deficits described in older children, we can begin by asking whether they might stem from a common pathway and whether the nature of autism requires a model which looks beyond discrete brain functions and incorporates identification of disrupted dynamics in processing. Recent attempts at a theoretical synthesis have focused on abnormal neural connectivity, that is by looking at the mechanisms by which information from the outside world is taken in, processed and integrated in the brain (Frith, 2004). There is some disagreement as to whether this abnormality involves a surfeit (Rubenstein & Merzenich, 2003) or a deficit (Just et al, 2004) of connectivity. Most likely, in the autistic brain, there is a high local connectivity (within neural assemblies) which develop in tandem with low long-range connectivity between different functional brain regions (which can be assessed in terms of the extent to which variations over time in one brain region are correlated with activity in another brain region), perhaps as a consequence of widespread alterations in programmed cell death, cell migration and in synapse elimination and/or formation (Courchesne & Pierce, 2005b). The result is a failure of the orchestration of the balance between excitation and inhibition which usually determines the successful co-ordination of the transient coupling between local and distant assemblies.

This model of distorted information transfer as a consequence of local over-connectivity and long-range under-connectivity has been described by Belmonte et al (2004) as follows. In an over-connected network, sensory inputs should evoke abnormally large activation for attended and unattended stimuli alike, giving rise within sensory regions to an overall increase in activation but a reduction in the selectivity of this activation, and potentially incurring a high load at later stages of perceptual processing as distractors are differentiated from targets. Conversely, brain regions subserving integrative functions will be cut off from their normal inputs and should therefore manifest reductions in activation and in functional correlation with sensory regions.

The link between disorders of sensory regulation and autistic disorders is of particular interest in light of recent works by Casanova (Casanova et al, 2002) on the specific minicolumnar pathology in some prefrontal and temporal areas of autistic subjects. Based on necropsy findings showing more numerous, smaller and less compact cell columns in brains of autistic patients, Casanova argued that at the basis of autism there is a disorder of the arousal-modulating systems of the brain. According to this theory, infants with autism might experience a chronic state of over-arousal and exhibit abnormal behaviors to diminish it. This arousal theory is of interest because it is consistent with a reduction of inhibitory interneuronal activity, which would affect the ability to discriminate between competing types of sensory information.

Evidence now supports the idea that this local connectivity disturbance prevents the developmental formation of neural circuitry in frontal, temporal and cerebellar cortices that is essential for high-order social, emotional and cognitive functions (Courchesne & Pierce, 2005a; Courchesne & Pierce, 2005b). The reason that it is not until the third year of life before it is realized that a toddler has autism, is because these frontal, temporal and cerebellar circuits normally have a late and protracted development and do not normally come on line until the second and third year of life.

*Towards a non-static view of early autism*

Such evidence of an underlying abnormal neural connectivity suggests a dynamic view of early autism. In fact, connectivity patterns and defects change with development and they are both genetically-based and experience-dependent. This dynamic view of early autism is well represented by Mundy's hypothesis (Mundy & Crawson, 1997; Mundy & Neal, 2001) that autism has its roots in an Initial Pathological Process which only later leads to the secondary neurological disorder. This hypothesis suggests that autism reflects an ongoing dysfunction in a complex cortical-subcortical network, which is, however, partially modifiable through early treatment. It is also based on the fact that, at this early age, brain connections are growing rapidly through the first interactions and that the beneficial impact of intervention increases as a result of early neuroplasticity and of early experiences in shaping brain connections. In fact, the well-known increase in brain size, from birth to age 1, is due primarily to an increase in the number and the complexity of neuronal processes rather than to an increase in the total number of neurons.

The idea of an initial – not rigid – pathological process is also congruent with the early preautistic status as it emerges from the research on home movies. In fact this research has confronted, us and other researchers, with infants with a feeble symptomatic organization and in whom the autistic disorder is organizing around fluctuating deficits in intersubjective skills (Maestro et al, 1999; Maestro et al, 2001). Babies who have become autistic can look and smile at others, they can look back during protoconversation, can have eye contact and warm connections with others. The fact that infants later diagnosed with autism display some of these basic social behaviors once in a while during the first year of life could be the reason for the difficulty at this age to detect a disturbance by parents, and to make diagnosis by clinicians. In fact, parents, and especially clinicians, are prone to think that these single social behaviors will easily become more frequent and develop into more complex and collaborative interactions. Home movies research has also shown that these behaviors are less frequent than in typical babies and that they need to be provoked by others in order to surface. This means that infants with autism are able to respond when actively stimulated by their caregivers in the protoconversation situation, but only rarely do they take the initiative to provoke joyful reactions in others. In other words, there is a lack of an endogenous drive for other persons in the same way that typical infants who usually

seek others (for example they strive to be looked at by their mother) while the other is not stimulating them. Therefore, we suggest that our home movies finding - of infants with autism who can sometimes be engaged but always with no (or weak) intentionality - could be the expression of a very early lack of the desire to share experiences, activities, and feelings with other persons.

This lack of desire can be described, according to Nagy and Molnar (2005), as a lack of the drive to provoke other persons. These authors have demonstrated, through an elegant experiment, that even newborns are not only able to imitate but they are also able to initiate an action (i.e. tongue protrusion or finger movement) apparently seeking a response from the adult: they conclude that initiation (or provocation – 'Homo Imitans or Homo Provocans' is the title of the paper) is present from the very beginning of human life as an essential component of subjectivity and of motivational processes. What we want to underline here is that intentionality and provocation are key items when observing, at the very beginning, the development of the dialogical self which represents the motivational substrate for the development of brain connectivity. To conclude we hypothesize that classic autism could be the final step of a primary disorder of dialogical self which does not allow simple social behaviors to develop into dialogical competencies, so that also simple social behaviors, which can be present during the first year of life, subsequently tend to disappear. In the following sections we will compare this dynamic view of early autism with different research which may help to clear up the mystery of the core deficit in autism.

*The Affect Diathesis Hypothesis*

Studying frequencies of simple social behaviors, instead of just their presence or absence, has widened our research towards the understanding of the core difficulties of infants with autism to transform simple social behaviors into a series of successively more complex interpersonal relationships. This transition from one state to another includes the implementation of emotional and exciting interactions that are not hardwired into our brains. It seems that early simple social behaviors are expectant for those learning interactions to develop. Humans spontaneously intensify these types of critical emotional interactions in the second half of the first year of life and during most of the second year. Gergely (personal communication, 2005) has called markedness the specific ability of the caregiver to underline emotions during these interactions. Marking is typically achieved by caregivers through the production of an exaggerated version of the realistic human expression, and this exaggeration allows the infant to know that the affect-reflective emotion expression refers to his/her own state and not to that of the parent. Gergely (personal communication, 2005) has proposed that mothers are instinctually driven to saliently mark their affect-mirroring displays to make them perceptually differentiable from their realistic emotion expressions. Through these emotional interactions, brain connections improve and the experience-expectant areas of the brain can develop; at the same time the infant can anchor the marked mirroring

stimulus as expressing both his/her own self-state and self- and other-awareness inside a primitive dialogical self. We will see how this idea is not far from the primitive 'we-centric' space described by Gallese (2006) as a shared space that comes before the constitution of a full-blown self-conscious subject.

Markedness is also frequently suggested as a key method for early interventions in autism where the caregiver must intensify imitations, playful back-and-forth smiles and vocalizations in front of the infant to draw his/her emotion out. In the home movies we have observed how during these interactions the infant, through the various marked repetitions of social behaviors, can learn how to use correctly his/her basic competencies inside a more complex interpersonal relationship.

Among the approaches to autism involving a model based on the disturbances of connections and on their expansion through emotional interactions, the Developmental, Individual Differences, Relationship Based (DIR) model (also called 'Floortime Approach') has to be considered (Greenspan & Wieder, 1998; Greenspan & Wieder, 2006). It is a kind of treatment that underlines the importance of identifying the individual differences in the modality of sensory and motor information processing; and the kind of interactions that the child establishes with others. The core of this treatment is the strengthening of vivid interactive modalities appropriate for the child's specific difficulties in information processing and the establishment of more two-way circuits of communication. The theory underlying this approach is that autistic syndrome stems from the infant's inability to connect emotions or intent to motor planning and sequencing; it is hypothesized that the lack of this critical process, that is the connection between emotions and actions, leads to the symptoms usually seen in older children with autism.

Greenspan (1998) has labeled this hypothesis that explores the connection between affect, motor planning and sequencing, as well as other processing capacities, the Affect Diathesis Hypothesis. In this model a number of stages through which the sensory-affect-motor connections progress is described and it is proposed that what later looks like a primary biological defect may be a part of a dynamic process through which the child's lack of emotional interactions intensify specific early biological processing problems of sensory information. It is hypothesized that strengthening these interactions could be especially helpful in the development of brain connections in these children; as hightened affects are connected to simple motor actions, infants can become more purposeful and they can establish the capacity to carve the self and the other (or subject and object) out of the dialogical space.

*The second semester of life as a critical period for infant development*

The 9-12 months of age is of crucial importance for typical and autism development (Baranek, 1999). Prior to 6-9 months the infant is only able to engage with an object or with a person; he/she can alternate attention between objects (for example

the little butterflies upon the cradle) and persons (for example the mother who is approaching or calling the infant), nevertheless the objects are not a part of their interaction. Around 9 months a radical change happens, when the objects are included in interactions as an experience to share with the other. From then infants are not just able to alternate attention but also to coordinate attention between objects and persons. In the same period infants shift from simple to complex patterns of engagement because they become able to show reciprocity in their interactions. These reciprocal, two-way, dialogical interactions are considered a critical step for the development of connections between emotional intent and purposeful action, which can enable the child to begin participating in back-and-forth emotional signaling.

We have seen in the home movies that infants leading into autistic patterns did not fully make this transition from simple patterns of engagement into complex emotional and problem solving interactions. Even affectionate autistic infants who are capable of an early engagement, do not shift, for the most part, towards this early continuous exchange of signals. They are more often withdrawn and hypoactive, with poor social interaction, difficulties in eye contact, and lack of emotional modulation (Maestro, Muratori & Cesari, 2005a). Nevertheless, many infants who have later evidenced the autistic pattern, could focus, during the first year of life, on objects, experience some affection and warmth, and even enter into simple reciprocal interactions. Perhaps they are able to perform these tasks because these basic social patterns can be carried out by single brain areas; but to engage in complex reciprocal patterns need more complex connections between different brain area which seems the core feature of these children.

The second semester of life as a critical period for the development, or failure in autism, of these brain connections is confirmed by the Courchesne finding (Courchesne, Carper & Akshoomoff, 2003; Courchesne & Pierce, 2005a) of two phases of brain growth abnormality in autism: a reduced size at birth and a sudden and excessive increase in head size in the second semester of life. This neurobiological data is interpreted, by the author, as the expression of a disorder involving brain maturation, with abnormalities in the developmental pruning and apoptosis (or programmed cell death). We have suggested that the clinical correlate of this neurobiological finding can be found in the increasing symptom constellation during the second semester of life (Maestro, 2005a) when, in infants with autism, the shift from simple to complex social behavior does not happen.

Also Baron-Cohen (2005) in his recent revision of the theory of mind system stresses the importance of the 9-14 month period which is characterized by the emergence of the Shared Attention Mechanism or SAM. In the original model, when this mechanism comes in line it allows the overcoming of dyadic representations (that are determined by intentionality and eye direction detectors already present in the infant), and the building of triadic representations. In the new model, Baron-Cohen,

after admitting the key omission of affect in the previous model, proposes that, in the same 9-14 month period and thanks to SAM, the dyadic representation of an affective state can also be converted into a triadic representation allowing for the development of the empathizing system whose dysfunctions are seminal for the understanding of autism.

*Autism as a primary deficit in intersubjectivity*

Research on infants with autism as they are videorecorded in home movies, has shown that autism is organised around fluctuating deficits in intersubjective skills (Maestro et al, 2001). For example, the anticipation of other's aims is significantly lacking in infants with autism during the first six months of life. In other words, these infants have difficulties in foreseeing the aims of other people, in anticipating other's intentions and therefore they are less interested in the caregiver's actions.

It was about thirty years ago that Colwin Trevarthen proposed that purposeful intersubjectivity is fundamental for human mental development. He described a primary intersubjectivity (Trevarthen, 1979) that is the innate wiring of the newborn to interpersonal contact making synchronic exchanges possible, so that, from the very beginning onwards, infants and mothers show protodialogic behaviours in which they time their behaviour in a bidirectional coordinated way. The infant is thus shown to possess an immediately responsive conscious appreciation of the adult's communicative intentions. Around the middle of the first year, the baby's increasing interest in objects is observed to grow in competition with the earlier motives for protoconversational play, leading, during the second half of the first year, to the elaboration of more lively games with objects. Just before the end of the first year, there is a rather sudden development of joint interest on behalf of the mother and her infant in their surroundings. An important stage in mental activity is represented by the development of joint mother–infant attention towards external objects. The development of these joint attention sequences is, according to Trevarthen, an expression of secondary intersubjectivity (or person–person–object awareness) and has major consequences for the way the adult acts and talks to the child (Trevarthen & Aitken, 2001). Despite the fact that even in the first phases a certain kind of 'other awareness' exists, it is around the end of the first year of age that a discrete and strong sense of self and other is achieved. Along these lines, Stern (1985) has described an emergent sense of self since the beginning of life discriminated from the sense of other; such a sense of self would evolve around the second half of the first year into a sense of self-with-other, allowing more complex states of self- and other-awareness to develop.

As far as intersubjective skills are regarded, we have found that infants with autism showed a specific qualitative deficit in responding to social stimuli, while attention paid to objects did not distinguish autistic from normal infants during the first six months of life; later on, during the second semester of life, there is a tremendous

increase in behaviors involving attention to non-social stimuli (Maestro, Muratori & Cavallaro, 2005b). Therefore, at the end of the first year children with autism are significantly more attracted by objects than typical children. We propose to interpret the functional magnetic resonance imaging (fMRI) activation of the brain area typically devoted to object perception, during face discrimination in subjects with autism (Schultz et al, 2000) as a downstream effect of this atypical early preferential looking at objects in infants with autism.

*The object of desire*

Our research shows that the divergent and periodically competing development of object awareness and person awareness, during the first year, is derailed because of the clear preference, in autism, for physical objects. The early preference for objects becomes a specific characteristic of subjects with autism as described by Tony W who said: "I was obsessed with certain things and played in my own way. I make things with Garbage or Junk and play with them…I liked things over people and didn't care about people at all" (see Volkmar & Cohen, 1985, p.47). This distinguishing feature has many clinical and theoretical implications.

Firstly, due to the fact that physical objects cannot predict intentions and have no social relationship, the preference for physical objects can impede the development of both primary intersubjectivity (based on basic social motives of the infants) and secondary intersubjectivity (based on the person-person-object awareness).

As a second remark, the decreased interest in the human face has a devastating effect on the brain, which is programmed to assume that the face (of the mother) is the most powerful visual stimulus for the neurodevelopmental processes underlying infant intersubjectivity. Mother and infant in a face-to-face relationship can be taken as a model of performed intersubjectivity and of the co-construction of the dialogical space (Regina, Fonseca & Bussab, 2006) in which the primitive dialogical self defines self and other in a state of ongoing mutual exchange. Schore (1996) has stressed the importance of eye-to-eye contact in early affective transactions between mother and infant in order to develop the imprinting process. The eyes would be a window through which the infant would have direct access to the affective state of the mother, as well as her infant's eye's having the power to excite her. Eye-to-eye contact is the ideal means for acquiring a dialectical sense of union and of discrimination. So, if face-to-face regular interactions are impaired, the self and other are not carved out from the primary intersubjectivity and the dyad's ability to build up dialogicality could be jeopardised. This defect in the early dyadic social system seems to represent a core feature of autistic disorder, and it is now believed that strengthening dialogical sequences where the children are captured in warm and vivid face-to-face interactions, might provide an important remedial effect in autism. In fact, according to recent insight into the biological maturation of the brain after birth, difficulties in these processes do not allow

for the development of local and long-term connections through which the neurological experience-dependent system grows in typical development. In fact, complex functional brain systems are not ready-made at birth and do not arise spontaneously in development, but are formed in the process of social contact between child and caregivers and between child and itself (Schore, 1996).

As a third remark, the abnormal developmental trajectory of social and non-social attention pointed out in our research on home movies, could prevent joint attention from emerging, thus leading us to hypothesize that joint attention should be considered not only a precursor to later theory of mind development, but also a 'post-cursor' of earlier psychological processes (Tomasello, 1995). In typical development joint attention behaviours emerge between 6 and 12 months and involve the triadic coordination or sharing of attention between the infant, another person, and an object or event. The degree to which a child is monitoring and regulating the attention to person in relation to object determines the severity of the deficit seen in autism. This does not mean that joint attention impairments cause autism; however, it does suggest that joint attention is a critical downstream effect of earlier difficulties (Mundy, 1995; Charman, 2003). Recognition that joint attention is not a starting point but merely a staging post for early social communicative development - and hence a 'postcursor' of earlier psychological and developmental processes – sheds light on what earlier impairments underlie the weakened development of joint attention skills in autism. Tomasello et al (2005) have proposed a three-step ontogenetic pathway for joint attention as a product of the understanding of both intentional actions of the other and motivation and initiative towards the other. Firstly, around three months, infants understand other persons as animate agents, they share emotions and engage with them in a dyadic way. Behaviorally, they look at them. Secondly, at 9 months, infants understand other persons as goal-directed agents, they share goals and engage with them in a triadic way. Behaviorally they see the other. Thirdly, by 14 months of age, infants understand other persons as intentional agents, they share intentions - and attention – and engage with them in a collaborative way. Behaviorally they attend to the other. We suggest that at this point a loop is formed in which others are definitively incorporated into the self (Hermans & Dimaggio, 2004), while the previous steps can be conceptualised as its precursors. In this process towards the establishment of collaborative actions, the key skill is represented by the declarative motivation simply to share attention with others. This uniquely human social motivation is considered by Tomasello et al (2005) essential to transform the general ape line of understanding intentional action into the modern human line of shared intentionality. This intention and attention to share (feelings, experiences, activities), which in other words we would call a drive to the other or desire, is precisely what lacks in apes and is very weak in infant with autism. The attenuation of the typical capacity of the child to enter into motivated triadic engagement can deprive the developing child with autism of the amount of interactions

that are needed for normal shaping of neural connections involved in the early neurodevelopmental processes (Mundy 2001). We have already described that this transition from dyadic affective state into triadic interaction is also the focus of the revision of the mind reading system proposed by Baron-Cohen (2005), where triadic shared attention is necessary for the full acquisition of the empathizing system.

*May motherese help the child out of his autism?*

Our research could suggest that the deficit of integration of social and nonsocial attention, which is seminal for the appearance of triadic engagement and for the development of joint intention and attention, has his roots in the early diminished attention to social face-like stimuli. We know that in typical development social interest in faces is associated with specific attention provoked in the infant by the very distinctive manner of an affectionate adult's vocalizations and verbalization in the presence of a baby. Among parental behaviors, solicitations through vocal expressions are paramount. We have observed home movies sequences where, within a very short time frame, a withdrawn infant, who will later develop autism, may begin a joyful interaction when the parent implements a vocal expression using motherese; when this interaction is activated, infants and toddlers with autism can show a social focal attention, their faces light up, unexpected interactive skills can appear, and real protodialogues expand.

Paolo is a six-month-old baby who never looks at his mother, he doesn't orient to her voice, sometimes he looks at his father when he uses a vigorous voice. We have analysed the voice of the mother during an interaction in which she appears very anxious because Paolo doesn't pay attention to her call: 'Paolo, Paolo…look at me…my baby'. The spectrogram of the mother's voice is flat without any prosodic pitch or long pauses. After some minutes the video shows a totally different scenario where Paolo is in a rich verbal and visual dialogical interaction with his uncle. The analysis of uncle's voice show all the characteristic of the motherese. Differences between the spectrogram of the voice of the mother and of the voice of the uncle is plain.

This sequence, along with video sequences of other babies (Laznick et al, 2005) has taught us that the prosodic motherese (or better parentese) is able to capture in dialogical sequences also withdrawn infants with a very weak desire for the other.

Motherese (termed also 'infant-directed speech' because it is specifically and automatically displayed by caregivers when they are in front of an infant, and thus distinctly different from adult-directed speech) has a defined rhythmic, adagio-andante, and melodic feature as well as a prosodic intonation of the voice. It is organised in repeated phrases with heightened pitch, exaggerated intonations, hyper-articulated vowels, fewer syllables in each word or phrase, specific articulations and punctuations, longer pauses. It tends to create slowly changing cyclical narratives of emotion, and it has been found that mothers have a higher affect when addressing their infant with

motherese. A comparison of parent's speech to infants in different languages confirms that these rhythmic and prosodic features are universal (Fernald, 1989; Fernald & Mazzie, 1991). Fernald has also found that when infants listen to recorded words addressed by the mother to an absent child, the strong attention and increased sucking that occur when the mother talks directly to the child are absent, and he has shown that the reason why the infant showed so little interest in the mother language is because typical prosodic peaks were absent in the recorded voice of the mother.

Observations of more complex interpersonal relationships aroused by the motherese demonstrate the important role of motherese in supporting early integrative functions that are otherwise defective. In other words, these joyful interactions in response to motherese suggest that motherese can help the child out of his autism. Other parental behaviours, even though affectionate and responding with intuitive sympathy to the reduced social feedback of an infant developing autism, do not seem sufficient enough to ameliorate the state of abnormal withdrawal in the infant, because he/she does not possess the regulatory motive abilities to escape this withdrawn state; as a consequence the emergent dialogical capacities will become further undermined without the specific support resulting from a vivid and marked interaction as in motherese. Moreover, research at the University of Sidney (Burnham, Kitamura & Vollmer-Conna, 2002) on the prosody of the motherese in normal dyads, has shown that the baby's reactions to the mother ameliorate the prosodic pitch in the motherese of the mother; thus motherese emerges not just as a specific adult language which is activated in front of an infant but a true co-construction inside a very precocious development of dialogical self. It could be of interest that, in our research on social and nonsocial attention, the pathway of the two specular items 'vocalizing to objects' and 'vocalizing to persons' during the first year of life in children with autism has shown, differently from healthy children, a lower increase of social vocalizing and a higher increase of vocalizing to objects (Muratori, Maestro & Laznik, 2005).

Motherese plays a fundamental role in creating social emotional connections. Newborns, like our infant Paolo, while listening to motherese, have increased sucking activity, they focus more on faces, and their attention level increases parallel to the pitch frequency. For this reason motherese is supposed to play an important role for the expression of cortical and sub-cortical connections which are at work in the early development of the brain. When these linkages are not properly formed early in life, a variety of downstream effects may occur. Trevarthen and Aitken (2001) have focused their attention on the child's strong aptitude to motherese and on its central role for the development of neural circuits which allow language as well as emotions and intersubjectivity to emerge. Disturbances in the establishment of these neural circuits in the autistic brain was recently confirmed through different PET and fMRI experiments in adults and children with autism (Boddaert et al, 2003; Boddaert et al, 2004; Gervais

et al, 2004). The findings of these studies suggest that abnormal auditory cortical processing is implicated in the inadequate response to sounds typically seen in autism.

Our clinical observations and this neurobiological research on the perception of complex sounds, opens a new field of research in autism that needs to be focused on the musicality of language and on its relation with common verbal language. We suggest that the shift of attention from motherese to usual words without musicality, is impaired in these children because of a deep disconnection, or a non integration, between musicality and language. We can also hypothesize that while musicality has more to do with dialogical self, language has to do with the self/other distinction.

*Contingency*

Autism emerges from our research as a disorder of performed intersubjectivity, that is a pathology of secondary intersubjectivity which has his roots in dysfunctions of primary intersubjectivity and/or dialogical self. According to the concept of subjectivity as an attribute of acting agents (Trevarthen & Aitken, 2001), infants with autism seem able to exhibit some form of subjectivity; however, they are not able to adapt or fit this subjectivity to other people intentions, that is they are not able to develop actual intersubjective skills. The child's capacity to make this connection typically becomes more apparent around the ninth month, as the child moves into complex chains of emotional reciprocity, and passes from dyadic to triadic engagement. This is the reason why it becomes easier to suspect autism after this age. So, can we imagine that all the developmental deficits in autism are downstream phenomena of a core deficit which is already present during the first months of life? To respond to this question Gergely and Watson (1999) have proposed that autism may be related to a dysfunction of the contingency detection mechanism. According to these authors, typical infants, during the first three months of life, are very sensitive to perfect contingencies between responses and stimulus events which are typically provided by cyclic repetitions of body-centered activities during human interactions. It is hypothesized that perfect contingencies provide an important source of self-calibrating information; thus they are essential for the development of a primary representation of the bodily self as a distinct object, leading to the progressive differentiation of the self. However, selective evolutionary pressure is for adaptation to the external environment, and thus typical infant shifts orientation from these perfect contingencies to environment-based contingencies. In fact, by 3 months of age there is a transition in the preferred target setting of the innate contingency detection mechanism which is accomplished by resetting the contingency detection mechanism from perfect to something less than perfect. Thus, typical 5-month-old infants, in contrast to 3-month-old infants, show a clear preference for non-contingent interactions (Bahrick & Watson, 1985).

Successively, Gergely (2001) has suggested that in infants with autism this normal shift, triggered by maturation experience, in the target value of the contingency

detection mechanism does not take place. In fact, in an experimental setting (where 2-3-years-old children sat in front of two TV monitors each displaying a perfectly response-contingent or a highly but imperfectly response-contingent image of the child's hand movement), he has shown that while typical children preferentially orient toward an imitative feedback of their actions (that is a highly but imperfectly contingent feedback), children with autism spent significantly more time looking at the perfectly contingent feedback than at the imitative feedback. Gergely specifies that this does not imply that children with autism cannot detect the high-but-imperfect imitative contingency; in fact they may well do so, but they have difficulties in resetting their contingency detection mechanism. It is not an all-or-none matter but rather a matter of degree, and it is reasonable to say that the dysfunctional resetting of the 'contingency switch' in autism is a matter of degree of the development of dialogical self and of self- and other-awareness. In fact to prefer less than perfect contingencies means that the infant is developing a sense of the other as a more independent agent interacting with him/herself. On the contrary, the fact that children with autism continue to invest in perfect contingencies can be seen as an underlying factor for the difficulties in the co-construction of the dialogical self. The result is a failure in motives to move from dyadic (or contingent) engagement to triadic (or non-contingent) engagement and to collaborative actions. This is probably the reason because, in the home videos of children with autism, the expected joyful intersubjective interactions are both much less frequent and more dependent on the type of approach used by the caregiver such as motherese.

*Autism as a modifier of parent-infant interaction*

We can also reasonably sustain that the persistent infant's preferred contingent relationship rapidly alters the attitude of the parents towards the infant. In fact, we have seen in the experiment by Burnham et al (2002), that the baby's contingent reactions to the mother are able to ameliorate the prosodic pitch in the motherese of the mother. Doussard-Roosevelt, Joe and Bazhenova (2003) have analyzed sequential maternal approaches and the corresponding child responses to these approaches in a free play situation and have identified specific maternal approaches which are particularly effective in eliciting prosocial responses from the child. They have shown how children with autism showed fewer contingent responses to their mothers than typical children, and how their contingency was a function of the type of approach behaviors their mother used. In fact their responses were more contingent when the intensity of the approach behaviour was high and they were more engaged in the interaction when their mothers used nonverbal behaviours such as increased proximity or objects in the interactions.

The specific modification of parent-child interaction have been described in two recent studies that have utilised the home movies of two sisters, one of whom turned out to be autistic, while the other became typical. Trevarthen and Daniel (2005), through a

microanalytic study of less than one year old twins have pointed out disorganised rhythm and synchrony in the interaction as early signs of autism. They have described a father who, in his attempt to engage his autistic daughter, receives no reinforcement for the social, intersubjective elements of his behaviour, as he does consistently from the developmentally normal twin. The absence of these normal, regulated social rewards tacitly affects the father's rhythms of interaction, and, as a consequence, he becomes more and more insistent and irregular. With the autistic twin the father misses the shared stages of social tension and emotional build-up; he gives up trying to regulate these shared interactions in favour of frequent periods of physical stimulation. That parental behaviour is interpreted by Trevarthen as a natural adaptive response, on behalf of the father, to the non dialogical daughter.

In the other study, Danon-Boileau (2007) has undertaken a thorough analysis of two parallel situations, involving a mother giving her daughters a bath: the first, who will develop autism, at 5 months of age, and the second, who will have typical development, at 3 months of age. The two bath scenes, which were filmed at a distance of two years, are comparatively similar, and they are considered by the author as a particular moment of intimacy in the interaction where the goal of care is mixed with the goal of play based on pleasure and shared behaviours. The paper is focused on the child's behaviour and on the mother's discourse during this particular early interaction. Posture, facial expression and gaze are quite different in the two infants: the typical daughter clings to her mother's gaze, her body is relaxed and she produces signs that can be interpreted by the mother, and by the observer, as signs of pleasure; while the other has poor eye contact, absence of mimicry and queer posture so that she seems to cling to her own self without any signs of pleasure in the interaction. These differences are taken as an explanation of why the mother, whose language is usually marked by the universal ambition to consider the child as a true partner, doesn't behave and talk in the same way with the two infants. With the infant affected by autism, the mother probably feels that something is going wrong, she becomes insecure about her infant as a potential co-thinker, and consequently, compared to typical daughter, she uses a different type of language. She speaks more to this child, her speech is full of elements with a calling function (interjections, questions, rises, syllable lengthening), the use of the child's name has no vocative function but it is an effort to maintain contact, she uses emotive nicknames more rarely (such as 'my little baby' instead of the real name of the baby), the prosody is quite different for the higher intensity and intonation. Differently, with the typical infant the mother can maintain the contact without using speech, and this enables her to make more assertive statements and her prosody comes closer to what can be observed in adult conversation.

The general impression that arises from these studies is that the parent's attitude depends on the child. If the child is socially attentive and dialogical, the parent behaviour is more natural and there are fewer attempts to attract an infant, who is far

from being dialogical, with more physical or verbal stimulation. This general impression is comparable to those of our new ongoing study based on sequential analysis of parent and infant behaviours in a number of home movies of under-one infants with autism. In these videos, infants with autism receive significantly more solicitations to regulate up their mood and arousal compared to infants with typical development.

All these data seem to demonstrate that parents are 'aware' (very early in time and before any conscious concern) of the abnormal quality of the emotional interaction of their infant and of them as co-speaker and co-thinkers. We have seen that also motherese can be conceived as a co-construction inside dialogicality and it is now possible to hypothesize that it becomes impaired because of the genetically based dysfunction in the contingency detection mechanism.

*Autism and the mirror neuron system*

A further step in the understanding of the primary difficulties in autism has been achieved starting with the discovery of the mirror neuron system (MNS). This discovery also has many implications regarding the dialogical self and its neurobiological basis. First discovered in the ventral premotor cortex (area F5) of the macaque, mirror neurons fire both while a monkey performs goal-directed actions and while it observes the same actions performed by others (Rizzolatti & Craighero, 2004). This observation-execution matching system is thought to provide a neural mechanism that enables the simulation of the actions of others, thus leading to an understanding of the emotions and intentions associated with those actions. The existence of an analogous MNS in humans has been demonstrated and it has been proposed that its dysfunction early in development could give rise to the cascade of impairments that are characteristic of autism (Gallese, 2006; Iacoboni & Dapretto, 2006). Relevant to a MNS theory of autism is that this system, in concert with activity in limbic centers, may mediate our understanding of the emotional states of others. To examine MNS abnormalities in autism, a group of children underwent fMRI while imitating emotional expressions (Dapretto et al, 2006). Results suggest that, although children with autism performed the imitation task as requested, the neural strategies adopted are quite different compared to typical children. In fact, while typically developing children can rely upon a MNS, whereby the meaning of the imitated emotion is directly felt and hence understood, the MNS is not engaged in children with autism, who must then adopt an alternative strategy of increased visual and motor attention whereby the internally felt emotional significance of the imitated facial expression is probably not experienced. The lack of MNS activity during imitation of emotional expression provides strong support for the hypothesis that early dysfunction in the MNS may be at the core of the social deficits observed in autism.

Complementary to these studies on MNS and its dysfunctions in autism, another brain imaging study (Kennedy, Redcay & Courchesne, 2006) has demonstrated that

patients with autism fail to show differential activity in the 'default state' network (a set of cortical areas that shows tonic, high metabolic activity at rest and that typically reduces its activity while subjects are engaged in cognitive tasks) between rest and a cognitive task. This network is supposed to be related to both self-oriented thoughts and with the processing of external social stimuli. Self and other, similarly to two sides of a coin (Iacoboni, in press), are inextricably linked in the default system; for example the activity in the anterior prefrontal cortex (that fails to deactivate in autism during a cognitive task) is substantially identical when control subjects are performing judgements of self and judgements of others that are similar to self, thus suggesting that to judge others similar to us, we simulate judging ourselves.

The simulation process of the default system (which has to do with the internal aspects of self - and then of the other) provides a reminder of the simulation process in the MNS (which has to do with the external aspects of other - and then of the self). Thus the study on failing to deactivate the default system, together with the study showing MNS deficits in autism, are interpreted, by Iacoboni (in press), as suggesting a unifying principle of the social deficit in autism: what are disrupted are neural systems that support processes related to both internal and external aspects of self and other. We can easily suppose that this disruption represents a core deficit in the development of dialogical self and in the achievement of primary and secondary intersubjectivity.

The dysfunction of the MNS could be also the reason for the difficulties in the anticipation of other's aim which emerges, from our research on home movies, as one of the first behaviors that is able to distinguish typical infants from infants with autism by six months; in fact, at this very early age infants with autism show difficulties in foreseeing the aims of other people and in anticipating others intentions. We suggest that the lack of the anticipation of other's aim is correlated to the defective 'intentional attunement' which is considered by Gallese (2006) as the expression of a core deficit in the MNS of autistic individuals. According to this author, intentional attunement is experienced when confronting the intentional behavior of others and it generates a peculiar quality of familiarity with other individuals, produced by the collapse of other's intentions into the observer's ones. Gallese has proposed that intentional attunement plays a crucial role in intersubjectivity and that most of the social and cognitive deficits in autism are to be ascribed to the lack of a full-blown intentional attunement, probably underpinned by impairments in connectivity and/or functioning of the MNS.

Self and other emerge from the recent literature on MNS as inextricably linked: one cannot exist without the other. It means that in order to see ourselves we must appropriate the vision of others (see Holquist, 1990, about Bakhtin's ideas). Self and other are co-constituted and they are carved out of a more primary intersubjectivity (that is dyadic engagement, according to Tomasello et al, 2005, or a we-centric space, according to Gallese, 2006, or the dialogical self according to Hermans & Dimaggio,

2004). Thus, the neural system that deals with internal and external aspects of the self might be crucial for the coding of such primary intersubjectivity in the early developing brain. This set of ideas seems parallel to Bråten's (2003) concept of 'virtual other'; this means infants are born with the concept of other, but this necessary concept (or preconception) is not a sufficient condition for the acquisition of dialogicality. An environmental counterpart has to exist in order to allow for the full development of such a feature. Similar to this idea is the following statement by Tomasello et al (2005): "Although the precise nature of the interaction [between the general ape line of understanding intentional action and the modern human line of shared intentionality] is not entirely clear, our general view is that infants begin to understand particular kinds of intentional and mental states in others only after they have experienced them first in their own activity and then used their own experience to simulate that of others" (p. 688).

## Conclusion

Throughout this paper we have tried to explore the mysterious question proposed by Courchesne (Courchesne et al, 2006, p.577): "how could the desire for social connection not be there in an infant?" Or, even more mysteriously: "how could the desire appear strongly for a time, only to slowly dwindle away, leaving a strange void?"

Autism affects how a developing person moves and responds in the physical and interpersonal environment. Knowledge of the early stages of autism benefits from a scientific theory of intersubjectivity (Stern, 2004) and of its neurodevelopmental mechanisms. In fact, intersubjectivity can discriminate typical children from those with autism during the first year of life; all other deficits, which are usually described as criteria for diagnosis, develop only later in time, and we have suggested that they are downstream effects of earlier disturbances in the capability to transform simple social behaviors in a real and affectionate way. This theory is based on a typical developing child as an active and experience-seeking infant who grows to master the motives of sympathy in joint action from the newborn period (Nagy & Molnar, 2004). In the different psychological theories of early autism this original state is differently described as dyadic engagement, contingency, we-centric space, primary intersubjectivity, intentionality and eye detection detector, all of which are congruent with the concept of a primitive dialogical self (see Table 1). On the contrary, children with autism have difficulties being aware of and relating to others, and these difficulties interfere with the foundations of dialogicality and addressivity (Bertau, 2004). It is our hypothesis that primary deficits in intersubjectivity impairs dialogical capacity and the chance for caregivers to create dialogical interactions with the baby.

In this paper we have pointed out that this early core difficulty not only has increasingly negative effects on infant-parent-infant interactions but they are also

**Table 1. Key Events Marking Changes in Development of Dialogical Self During the First Year of Life**

| **Age** (Months) | **Brain & Behavioral Development** | **Intersubjectivity** (Trevarthen) | **Engagement** (Tomasello) | **Empathizing System** (Baron-Cohen) |
|---|---|---|---|---|
| 1-3 | From the sparse neural circuitry of newborn to the increase in the complexity of dendritic arborizations.<br>Local connectivity & neuronal migration.<br>Maturation of sensory & perceptual systems (maturation of visual focus).<br>At 3 months the neonatal palmar grasp reflex begins to disappear. | *Primary Intersubjectivity*:<br>Fixates eyes with smiling. Expressive with face, voice & hands in proto-conversation. Vocal & gestural imitations increase as oral imitations decrease. | *Dyadic Engagement*:<br>Shared emotions & behavior. Understanding of animate action. Looking at. | *Intentionality Detector*:<br>Automatically interprets an agent's self-propelled movement as a desire or goal directed action, a sign of its agency.<br>*Eye Detection Detector*:<br>Interprets eye-like stimuli as looking at me or looking at something else |
| 3-5 | Invasion of cortical dendrites by synapses. Neuronal differentiation & growth; dendritic & axonal growth; axonal myelinization. Minicolumn as a fundamental unit of information processing are growing.<br>Smooth visual tracking develops. The baby looks more at the new objects (recognition memory). | *Person-Person Games*:<br>Often looks away from partner in communication, attracted to objects. Enjoys body movement games & baby songs. Attracted to own mirror image. | | *Emotion Detector*:<br>Interprets affective states. Affective states in the observer triggered by recognition of another's mental state |
| 5-8 | Tremendous increase in synapse number. Pruning & apoptosis.<br>Reaching with hand is well-directed. Grasping objects. Manipulative play.<br>to reach a goal. | *Games with Objects*:<br>Watches partner's hands, attracted to games with toys moved by partner. Imitation of hands, pointing & clapping. | *Triadic Engagement*:<br>Shared goals & perceptions. Understanding pursuit of goals.<br>Seeing | *Shared Attention*:<br>Interprets if the self & another agent are – or are not – perceiving the same event |

(Table 1 continued on next page)

**Table 1** (continued)

| **Age** (Months) | **Brain & Behavioral Development** | **Intersubjectivity** (Trevarthen) | **Engagement** (Tomasello) | **Empathizing System** (Baron-Cohen) |
|---|---|---|---|---|
| 5-8 (cont'd) | Improvement in working memory: baby remember location of hidden objects. Beginning of the child's ability to control behavior | Playful & sociable with family; Timid with strangers. Combines objects in two-handed manipulation. Babbling, & rhythmic banging of objects. | | |
| 9-12 | Frontal & parietal cortices grow. The earlier maturating sensory & perceptual systems are integrated with the slowly maturing regions, such as frontal cortex, for higher social, emotional & cognitive functions.<br>Strategic, executive thinking. The integration of limbic (amygdala) & endocrine systems into the memory network creates the basis for separation anxiety | *Secondary Intersubjectivity*:<br>Shares tasks with objects. Shows pride in learned skills & possession of objects. Uses voice & gesture to seek other's attention; complies with gestural & vocal directives; follows gaze & pointing. Imitates first words. | *Collaborative Engagement*:<br>Joint intentions & attention. Underst&ing of choice of plans. Attending | *Empathizing System (TESS):*<br>Allows an empathic reaction to another's emotional state. Ensures that organisms feel a drive to help each other. |

inextricably linked to a deviant path of the biological maturation of the social brain. Among the most important we have considered unbalanced local versus long-distance connectivity, activation of neural networks distinct from those employed by non autistic individuals, particularly for socially relevant stimuli such as face and voice, and dysfunction of the mirror neuron system. All these pathways assume an important place in the development of the dialogical self and of the normal dynamic balance between motives for self-directed action and motives for engagement with others' motives. Of particular interest is the MNS hypothesis of autism which, due to its intuitive appeal, has been tested repeatedly in recent years. It provides many insights into the condition of autism and could inspire novel forms for its treatment. According to this hypothesis Gallese has proposed that 'intentional attunement' plays a crucial role in intersubjectivity and that its malfunctioning in autism is the expression of dysfunctions in the MNS.

As far as infant-parent interaction is concerned we have considered different studies showing that infants with autism display fewer contingent responses to their parents than non-autistic children and that episodes of contingency are a function of the type of approach used by others. In fact, different observations suggest that their responses are more contingent when the intensity of the caregiver's approach behavior is higher and when their parents use nonverbal behaviors such as increased proximity and objects in interaction. We have discussed sequences where infants with autism, when confronted with motherese, show unexpected dialogical competencies. Motherese seems to help the child out of his autism through the creation of dialogical interactions, and we can reason that these sequences are the expression of new cortical and sub-cortical networks which cannot take place in early brain development. But we have also underlined that motherese is a true co-construction between the infant and the mother, which is quite consistent with the conceptual framework of the dialogical self where others are not simply external, but rather possess, from infancy onwards, both an internal and an external position (Hermans & Dimaggio, 2004).

The framework we have proposed is a sort of unification of different levels of analysis; we think that it will not only provide a test case for theories of normal brain and social development but can also provide therapeutic targets for prevention and remediation of the core deficits in autism. We can imagine that an early intervention program delivered in the context of a dialogical interaction and providing compelling social input to the child, could decrease the cumulative effects of the primary dysfunctions of intersubjectivity and it can also ameliorate deficits in the biological maturation of the social brain. Therefore we need to evaluate how far the proposed framework for early autism dovetails with therapeutic approaches that are specifically designed to enhance the ability of children with autism to engage in dialogical interactions (for example anticipation of other's aim could be considered a key behavior that could be used as an effective form of treatment). We hope that to consider the dialogical self and dialogicality as critical targets for early treatment will enhance possibilities to set the stage for creating appropriate early interventions that could help to develop compensatory strategies and limit the downstream effects of the earlier dysfunctions.

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