



Intentional action arises from early reciprocal exchanges

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Abstract

Intentionality is defined as the cognitive ability to represent goals beyond the here and now of perception. First signs of intentionality appear by the second month after birth. A major mechanism responsible for such development might be the unique reciprocal and intentional ways humans communicate with each other, particularly their young progenies. I argue that starting in the second month, reciprocal exchanges, affective mirroring, and mutual imitations with others provide infants with the unique opportunity to differentiate as well as to compare and conjugate first (self) and third (others') person perspectives. This ability is a prerequisite not only for referential communication but also of intentionality. It corresponds to the emergence of a new contemplative and “meta” stance toward the world. An argument is made that the developmental origins of this stance are primarily social, not to be found in the individual infant interacting solely with physical objects.

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1. Introduction

The debate on the nature and determination of intentionality is as old as philosophy itself. It continues to be a central issue in contemporary philosophy of mind, cognitive psychology as well as current neurosciences. At the core, there is the question of what distinguishes intentional from accidental action. Here, I revisit the question asking how and

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when do infants become intentional, proposing an *externalist (triadic)* and *social constructionist* solution.

The word intention comes from the Latin “*intensus*” which means purpose or goal. To intend comes from “*intendere*”, the Latin verb for stretching out or to stretch for.

From this etymology, what we mean by intentionality is the mental state of having *an aim in mind* to direct any act, whether this act is materialized in action, or virtual as in thoughts. At a more metaphysical level, intention and intentionality in general stands for the mental capacity to *refer* to an object, whether this object exists or does not exist. From this, and in general, intentionality can be construed as *the cognitive ability to represent goals and to plan actions toward certain effects beyond the here and now of perception*. This is the meaning used throughout the paper.

Intentionality, as a concept, covers a variety of psychological functioning and therefore calls for a distinction of levels. These levels relate to degrees of sophistication and contexts, whether, for example, we think of intentionality in the realm of physical objects or social interactions. In this article, I put forth some possible answers as to when and how intentional actions emerge in human ontogeny, as well as what might be the mechanism contributing to such emergence.

My answers are two-fold: first I contend that intentional actions begin by two months after birth. Second, I propose that the mechanism responsible for such development is the unique reciprocal and intentional ways humans communicate with each other, particularly their young progenies. Starting by the second month, as infants begin to engage in reciprocal communication with others, in particular when they begin to smile socially, they open new and rich learning grounds. Reciprocal exchanges, affective mirroring, and mutual imitations with others provide infants with the unique opportunity to differentiate as well as to compare and conjugate first (self) and third (others’) person perspectives. This ability is the prerequisite for referential communication.

I propose that it is in reciprocal communicative exchanges that infants have the opportunity to learn how to adopt a new mental stance toward the world, what I coin here the *contemplative stance* borrowing from [Werner and Kaplan \(1963\)](#). The contemplative stance allows infants to suspend their mental processes from being locked into the here and now flow of perception and action couplings. My contention is that this contemplative (proto-reflective) stance arises in reciprocal exchanges with others, not simply in interaction with objects. Accordingly, reciprocal communicative exchanges with more advanced others are the necessary condition for intentional actions to unfold. The origins of intentional actions in human ontogeny, I propose, are to be found primarily in the social, interpersonal realm, as opposed to the individual interacting with physical things.

2. Thought problem and the theoretical argument

Let us imagine an infant who, due to extraordinary circumstances, grows in a social vacuum. Let us say that this child is fed and cared for by automatons, to which he adapts well, eventually becoming strong enough, that he can grow independent of the machinery, to roam around in a world of plenty in search for food and comfort. The question is: would such a child actually develop into an autonomous, intentional organism with aims in mind?

I suggest here that such child would *not*, or would at least be greatly hindered, never developing to be intentional in the full referential sense. He would certainly acquire new

behaviors via habituation and conditioning, as well as through the physical growth of his body that, with exercise and maturation, gives the child greater strength and postural control. However, he would not develop intentionality in the sense of being *referential*. He would not develop the ability to generate intentional actions that refer to things *out there*, real or virtual (re-presented) things that we can converse about or act upon with goals and expectations in mind.

Intentionality requires psychological distance between the subject and the object. It requires a contemplative stance or mental distance, the ability to pause and reflect about expected outcomes or ways of achieving goals. It entails a suspension or deliberate mental extraction from the here and now of perception and action, its ongoing flow. In the footsteps of George Herbert Mead, I propose that “aboutness” and the context of referential communication form the primary cradle of intentional actions in development. The difficult questions, of course, are why and how?

When infants open up to the social world from around 6 weeks of age, the age at which they normally begin to attend and respond to social solicitations in timely and identifiable fashion, they are provided with social cues that scaffold their way into a contemplative stance. This contemplative (referential) stance that has a primarily social-communicative origin would be generalized to physical objects.

Within this theoretical framework, intentionality emerges as the by-product of reciprocal social exchanges, first in the context of face-to-face exchanges (2–8 months), then in relation to things in the environment (9 months and up). Social reciprocation is viewed as the mechanism by which infants become fully intentional, eventually taking an intentional stance toward others. Social reciprocation is the mechanism that allows infants to dissociate first and third person perspectives on objects, people, and also on the self.

This idea is not new, proposed for some time by social “externalist” philosophers like Davidson, sociologists and social behaviorists like Goffman or Mead, developmental psychologists like Vygotsky or Bruner. But the general idea that intentionality does not arise from acts of the single individual in relation to physical objects remains radical in the current debate on the origins and nature of intentional actions. This conceptual approach emphasizing the social roots of intentional action finds new empirical support in current infant and child development research. Here, I try to revive the social externalist view on intentional action, in the perspective of early development and in light of some recent empirical facts that support this view.

Note that alternative, more internalist accounts on the origins of intentional action still prevail in the literature. Such accounts emphasize, for example, the maturation of particular brain regions of the individual child (i.e., the orbito-frontal region, see for example [Diamond, 2000](#)) or, in the tradition of [Piaget, 1952](#), the emergence of cognitive structures constructed predominantly in interaction with physical objects. They might also account for the emergence of intentional action on the basis of the single child’s ability to anticipate the result of an action (witnessed or self-produced) based on the maturing of new representational capacities or theories in the individual child’s mind ([Gopnik & Schulz, 2004](#); but see also articles in this Special Issue by [Csibra & Gergely](#); [Elsner](#); [Eenshuistra](#), [Ridderinkhof](#), [Weidema & van der Molen](#); [Meltzoff](#); [Reid](#), [Csibra](#), [Belsky & Johnson](#); [Song & Baillargeon](#)). In contrast to social externalist views, internalist accounts do not consider social interactions as the *necessary* context or central piece of intentionality development.

Historically, and in the footsteps of William James and Charles H. Cooley, George Herbert Mead (1934) was the most vocal proponent of the social externalist views on

the origins of intentional actions. Mead proposes that intentional actions, as for meanings in general, arise from, hence find their origins in triadic relations and does not exist in the experience of the single individual: “The meaning (i.e. the intention) of a gesture by one organism (..) is found in the response of another organism to what would be the completion of the act of the first organism which that gesture initiates and indicates” (Mead, 1934, p. 146).

The core of the idea adopted from Mead is that referential communication with others does entail some reading and production of intentional communicative acts (as opposed to mere signal exchanges that trigger pre-determined responses in a receiver, thus a communication that is not referential). When children begin and are enticed to communicate with others, they are constrained to develop shared meanings about things in the world, including the self. Such constraint is a primary force driving the development of intentionality, as a referential act in the context of communication, but also as purposeful, goal oriented acts in the context of physical object manipulation.

According to this framework, it is from the time infants begin to engage in reciprocal social exchanges (second month) that first signs of intentional actions would emerge. Legitimate questions are then what happens prior to 2 months and what are the characteristics of the adaptive movements generated by infants during the first 6 weeks of their life? In other words, what controls infants’ movements prior to the development of intentionality?

3. Distinguishing basic levels of movement control

Infants are not born intentional, nor do they begin life moving and acting at random. Newborn’s behavior is not just accidental and merely reactive as pioneer child psychologists tended to describe it. In addition, to automatic reflex responses, newborns act in certain organized and oriented ways that are not merely automatic in nature. Thumbs are brought to the mouth for sucking, eyes are moved to track objects selectively, and leg movements are organized in coordinated stepping or kicking patterns. Even in the womb, fetuses manifest actions with some invariant patterns and a compression of degrees of freedom that is oriented outward, toward the environment, making movements of the infant more than merely random or disorganized, like the “blooming, buzzing confusion” proposed by William James.

In recent years, research based on the ultrasonic observations of fetuses demonstrates the remarkable continuity between prenatal and post-natal behaviors. Fetuses and newborns show the same rich repertoire of organized patterns of movements that are not simply random, but rather pre-adapted to tap into vital environmental resources such as food or comfort (see for example, Prechtl, 1984). These movements are not of a solipsistic and endogenous nature like tics or twitches. Rather, they are outward oriented, coming to closure with particular external consequences (e.g., food or thumb in mouth, skin or eye contact with particular objects in the environment). Such movements are actions, not mere reflexes.

Next, I distinguish three basic kinds of bodily movements that correspond to radically different control systems, hence radically different “psychologies”. Of these three kinds, only the third qualifies as movements that are “intentional” in the literal sense introduced early in the paper. They are respectively (1) autonomic or reflex responses, (2) action

systems, and (3) intentional actions. These three kinds of bodily movements unfold chronologically during the first 18 months of life.

3.1. *Autonomic or reflex responses*

The beating of the heart, the movements of the lungs in breathing, the shaking of the whole body under a cold spell, the knee jerk response, or the blinking of eye lids in response to an air puff, all belong to the first kind of un-intentional bodily movements. They are autonomic and reflex responses of the organism. The control of such movements is endogenous and self-contained. These movements consist in highly predictable stimulus-response loops. They are in essence automatic, *triggered* by particular stimulations.

Following physiologist Sherrington's first account of this kind of bodily movement, the control is encapsulated and rigidly prescribed within the organism as reflex arcs. It clearly involves sub-cortical neural networks as surgically decorticated animals continue to express such movements (Sherrington, 1906). The control of such movements can be described as closed feedback systems like thermostats controlling for constant temperature inside a house. Closed control systems are simple when considered in isolation, but they are complex when considered in interaction with each other. Each is calibrated to respond to particular ranges of stimulation from the environment that are internal as well as external to the body. Each system controlling for a particular autonomic/reflex response is also adapted to interact with myriads of other similar systems that, in concert, maintain the integrity of the organism as a whole living and adapting system.

In brief, autonomic and reflex movements are controlled by closed loop feedback systems insuring basic physiological functioning. They keep the individual organism alive but such movements do not involve any perception, nor any particular higher order treatment of basic physiological signals or sensations. In a way, this kind of bodily movement is sensitive but psychologically blind to the environment it responds to. The movements are triggered by non-specified circumstances.

3.2. *Action systems*

The second of the un-intentional kind of bodily movement is *action systems*. They are more than autonomic or reflex responses, also expressed from birth and prominent during the first 6 weeks of life. Such movements are distinct from the first kind on two basic grounds. First, they are movement systems consisting of actions that are *oriented* toward particular functional goals. These systems are by definition adapted to tap into available resources that exist *outside* the individual organism, in the surrounding environment: food, surfaces, objects, or people. Second, these movements are organized into systems that are flexible, capable of changing based on previous experiences, and adjusting to novel circumstances. They allow room for learning, controlled by open feedback loop systems. Although still un-intentional, this second kind of movement entails perception and learning, some psychology, and presumably higher order cortical involvement.

Infants at birth show more than autonomic/reflex arcs (Rochat, 2001 for a general review). Sucking, grasping, stepping, rooting, or head turning are too often construed as reflexes or automatic responses triggered by non-specific stimulations. Multiple studies show in fact that such movements need to be construed as actions rather than reflexes,

actions that are already oriented toward particular features and resources in the environment: for example, faces or objects with a certain shape, texture, consistency, or smell.

Newborns, immediately after birth, track with their eyes, objects that move close by in their field of view. More impressive is the fact that they do so preferentially when the objects consist of face-like displays. Research shows that they tend to track more canonical face-like displays (two adjacent dots for eyes above vertically aligned two dots for nose and mouth) compared to non-canonical face-like displays with same features but scrambled (Morton & Johnson, 1991). Similarly, newborns tend to suck differentially on pacifiers that are more or less mimicking the biological nipple of the mother. They suck less and increase oral exploration as a function of the eccentricity of a pacifier compared to the biological nipple in terms of texture and consistency (Rochat, 1983; Rochat & Senders, 1991). We found the same kind of results when recording newborns' grasping of objects varying in texture and consistency that are placed in one of their palms (Rochat, 1987). More recently, researchers have even established that newborn infants are significantly more inclined to orient their face toward gauze impregnated with their own mother's amniotic fluid or breast milk as compared to gauze impregnated with the amniotic fluid or the breast milk of another women that just gave birth (Marlier, Schaal, & Soussignan, 1998).

If newborns orient and root to smells or face-like displays, if they suck and grasp at objects introduced in their mouth or in their hands, they do so with discrimination and preference. This kind of movement is not made of autonomic, reflex responses triggered by non-specific stimulation. It is under the control of previous experiences (learning) and intrinsically oriented toward particular environmental resources. It calls for some psychology engaging more than sub-cortical structures. However, such control is not yet intentional. It arises in the context of adaptive actions generated by the single individual in relation to physical objects and the physical aspects of people. It does not depend on reciprocal communication and shared experience with others.

3.3. *Intentional actions*

By the second month, there is a behavioral revolution. Infants open up to the world in unmistakable ways. When not sleeping or crying, they spend markedly more time in a wakeful state, actively and spontaneously tracking and exploring objects, and in particular faces in the environment (Wolf, 1987). When attending to faces, they begin to spend significantly more time exploring internal features, namely eyes and mouth, compared to outside features such as forehead contours and hairline, which are preferentially attended to by one-month and younger infants (Haith, Bergman, & Moore, 1977). More significant is the fact that by 6 weeks, in a face-to-face situation, infants begin to manifest smiling. Such smiling expression is elicited by the social engagement of others as they typically try to create a shared positive emotional experience with the infant.

From this point on, infants enter the give and take of interpersonal conversation – a privileged context in which they can differentiate their own, first person perspective, from the third person perspective of the social partner they converse with. They develop a sense of shared experience or primary inter-subjectivity. This primary sense of shared experience in face-to-face exchanges is a first form of triadic exchanges that is turned toward the self of the infant, the infant being the prime topic of the communicative exchanges with the adult. From 2 months on and until approximately 9 months, the main topic of communication is

the infant himself and not yet the objects that surround the infant and the adult (secondary inter-subjectivity, see Tomasello, 1995; Trevarthen, 1979).

When infants begin to open up to their social environment by reciprocating via smiling and cooing toward others interacting with them, and because of the obligatory propensity of others to mimic or *reproduce* with marked exaggeration what infants express (i.e., “affective mirroring” according to Gergely & Watson, 1999), infants have the unique opportunity to *objectify* themselves in relation to others. Face-to-face exchanges, turn taking, and the proto-conversations dominated by affective mirroring allow for self-objectification and the objectification of first vs. third person perspective. All this forms a privileged context in which infants can learn to distinguish their own and others’ perspectives on the self, the basic prerequisite of intentional and referential communication. This context is the template for the intentionality expressed in relation to physical objects, intentionality that starts to be manifested by infants by the time they begin to smile in the context of reciprocal social exchanges (see below, Rochat & Striano, 1999a).

Infants might learn also to objectify themselves in the exploration of their own dynamic traces in objects they acted upon: a mobile they kicked or a ball they pushed (Piaget, 1952; Rochat, 1995, 2002; Watson, 1995). The effect of self-generated actions on the object does indeed reflect the dynamic and the amount of energy produced by the infant who can pause and contemplate traces of himself in such effects. However, in this context, the differentiation between first and third person (object) perspective is possible only on a trial and error basis. Interactions with physical objects do not carry the bi-directionality of attention, the mutuality and tutoring guidance that a reciprocating adult typically offers to the child. Reciprocal exchanges are intrinsically referential in relation to each of the protagonists (infant and adult). They specify on-line, in a unique way, the alternating perspectives of each protagonist because of the give and take, reciprocal, and co-constructed format of conversational exchanges.

The learning of a differentiation between first and third person perspective is facilitated by reciprocal exchanges. Infants can eventually generalize what they learn in interaction with others to their interaction with physical objects, rather than the reverse. It is reasonable to postulate the precedence of one format of exchange (social interaction) over the other (action on physical objects) to explain the emergence of intentionality in development, assuming of course that we do not postulate innate module for such stance.

Social partners (caretakers, etc.) work hard from the outset at revealing themselves intentional in communication, quickly perceived as such by the infants. The child will eventually also perceive others as intentional *outside* of face-to-face communicative contexts, when observing them interacting and acting on physical objects. The generalization of an understanding of others as intentional with both objects and other people aside from the self opens up new, crucial opportunities for observational and imitative learning. These are often identified as basic mechanisms of cultural transmission that are considered, by some, to be as unique to our species (Tomasello, 1999; Tomasello, Kruger, & Ratner, 1993; see also the articles by Elsner and Meltzoff in this special issue for further details and discussion).

In brief, my contention is that the same process would apply to the self: *infants learn to become intentional first in communication, eventually generalizing this learning to their transactions with physical objects*. But what evidence exists to support such contention? Indirect evidence abounds and I will mention just a few that are telling.

4. Social correlates of intentional action development

Jaffe and collaborators recently published an impressive monograph on early adult-infant communication and its relation to later goal-oriented acts of intelligence in the physical realm (Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001). In their research, they show that 4 month-olds are more synchronized in their emotional turn taking exchanges while engaged in face-to-face interaction with a female stranger compared to their mother. The fact that young infants tend to be more in synchrony with a stranger is analogous to what is typically found in adults observed in communication with either a familiar or a novel person. When encountering a novel person, we tend to be more attuned to and in synchrony with all the cues (verbal and non verbal). In other words, we are more attentive and exploratory when encountering a novel as opposed to a familiar individual (Capella, 1996; Crown, 1991). In their monograph, Jaffe and collaborators report also that the tendency for communicative synchrony in 4 month-olds is enhanced when they interact with the adult (either the mother or the stranger) in the unfamiliar environment of the laboratory as compared to the familiar environment of their own home. In short, at four months, novelty of both social partners and location cause infants to be more synchronous in their communicative, face-to-face exchanges.

More interesting and to the point of the present paper, Jaffe and collaborators report that the degree of exploration in communicative exchanges (i.e., the degree of differential synchrony when communicating with the mother or a stranger) expressed by the infant at 4 months reliably predicts the competence of the same infant at 12 months when engaged in resolving *physical problems with objects* (Bayley test of practical intelligence). These findings suggest that the degree of active engagement in social exchanges displayed by infants at 4 months correlates with their competence to act with an aim in mind when trying to resolve a problem with physical objects at 12 months (i.e., stacking blocks of various sizes, matching shapes and containers, means-end tasks, use of tools, etc.). In short, these data indicate that what infants display in social interaction at 4 months is linked to the level of intentional actions shown months later with physical objects. They leave open the possibility of a generalization, possibly even of a causal link between what infants learn in early social exchanges and how they perform later as individual agents in the world of objects.

Although these findings are only correlative, indirect evidence they certainly do not dismiss the idea that the social context of early and highly scaffold communication in face-to-face proto-conversational exchanges with adults might be the primary context of intentional action development.

Other indirect (correlative) evidence of this contention comes from the fact that from the time infants begin to manifest socially elicited displays of emotions (i.e. social smiling by 6 weeks of age), they also begin to display a contemplative stance in relation to perceptual events they cause in the environment. Briefly, I will present observations illustrating that as infants develop an aptitude for social reciprocation, they also develop in parallel a new propensity for systematically exploring the consequences of their own actions on physical objects (i.e., an active contemplative stance scaffold by caretakers and learned in social exchanges that would generalize to the physical realm).

In one study, we compared newborns aged less than 48 h and 2-month-olds' sucking behavior on "musical" rubber nipples. In this research (Rochat & Striano, 1999b), every pressure applied by the infant on the nipple was associated with a perfectly contingent

succession of sounds that were more or less the auditory analog of the oral pressures the infants generated on the pacifier. In one condition (analog), the pitch variation of the successive sounds heard by the infant was proportional to the variations of pressures applied by the infant on the pacifier. In another (non analog) condition, the pitch variation of the sounds varied randomly. We observed that by 2 months (8–10 weeks), infants manifest a differential modulation of their sucking of the pacifier in terms of frequency and amplitude, depending on the analog or non-analog auditory consequence of sucking. In contrast, newborns did not show any evidence of such differential responding, hence no evidence of systematic exploration of the auditory consequences of their own oral (sucking) activities.

At around 6 weeks of age, at the time they begin to engage in reciprocal proto-conversation with others, infants also begin to manifest a novel, contemplative stance toward objects as well as toward themselves as agents in the environment. This novel stance is a contemplative and reciprocal stance, as opposed to the immediate stance of newborns immersed in the here and now of perception and action (Rochat, 2001). This new stance is linked to expectations and the systematic exploration of physical events. Furthermore, I speculate that this new stance is linked to and *arises* from the first reciprocal exchanges with intentionally others.

Exploratory activities on objects and reciprocal communication with others starting 2 month of age entail pauses or momentarily suspension (inhibition) of on-going action to contemplate the action's effects on either the object or the person. The basic template, once again, is the turn taking format of conversation that is scaffolded by adults in face-to-face exchanges, with each protagonist taking alternating roles as sign producer or sign receiver. Signs in face-to-face proto conversation correspond to emotional expressions, gestures, particular vitality and the timing of mutual exchanges. Taken altogether, these non-verbal signs specify particular degrees of social contingency and communicative styles between the protagonists (see for example the recent research by Bigelow & Rochat, 2006 on the relative stability of social contingency across different dyadic encounters of young infants with either their mother or a female stranger).

The role switching imposed by the communicative format constrains a “double loop control” in which first and third person perspectives need to be considered in alternation by each protagonist (e.g. infant and adult in proto-conversation). This alternation is first dictated by adults' scaffolding of proto conversation with the infant. From this primary context, infants rapidly learn and take a new stance towards people that they would emulate in their encounters of physical objects. By two months and from emerging reciprocal face-to-face exchanges, infants would begin to differentiate the actions they generate from their own *first person perspective*, and the consecutive effects these actions have on people as on objects from a *third person or allocentric perspective*. Both first and third person perspectives, once differentiated would be combined to form new triadic meanings. These new triadic meanings would transcend those arising from either one perspective in isolation. Consistent with this idea, Feldman and Greenbaum (1997) found a significant relationship between the temporal pattern of affective face-to-face interaction between 3 month-olds and their mother, and the symbolic development of these infants at 24 months. Relative maternal synchrony and attunement in early proto-conversation both contribute to predict symbolic play and talk of internal states by two years of age. Thus, the quality of early intimate exchanges appear to determine symbolic development when children become “meta”.

It is in this differentiation and combination that “meta” meanings, intentional actions and intentionality in general would find their roots. (i.e., the ability to generate actions in reference to a represented goal). From this point on, the self of the infant develop to become objectified relative to other people, as well as to objects in the physical environment. But this development will take months, with a crucial transition at 9 months corresponding to the emergence of secondary inter subjectivity, when infants begin to share experience with others about objects in the environment (Bruner, 1983; Tomasello, 1995; Trevarthen, 1979). This transition toward further triadic meanings in communication with others will lead the child by the middle of the second year toward symbolic functioning, language development, as well as the development of a conceptual sense of self.

5. Ecological vs. interpersonal self

One of the main arguments put forth so far is that infants, by 2 months, already begin to engage in triadic exchanges within the highly scaffolding context of proto-conversation with adult caretakers. Caretakers are compelled to scaffold young infants from the time they become socially alert. They do so by running affective commentaries that include mirroring and emotional amplification in face-to-face exchanges (Gergely & Watson, 1999; Stern, 1985; Trevarthen, 1979). Such mirroring and exaggerated imitation reflect back to the infants and allow a process of self-objectification that is significantly richer and more nurtured (tutored) than what the infants typically get back when exploring the consequences of their own actions on physical objects (e.g., the musical pacifier in Rochat and Striano, 1999 experiment).

In the latter case, infants gain information that specifies them as agents in the environment, an important part of the ecological self (Neisser, 1995; Rochat, 2003). In comparison, however, communicative exchanges with an imitating adult who is richly and intentionally scaffolding provide infants with self-specifying information that no objects acted upon can provide. Adults provide infants with a unique social mirror. This mirror provides information that specifies infants not only as agents, as in the case of their interaction with physical objects, but also as persons endowed with emotions they can *share* and *co-construct* in reciprocal communication (conversation) with others who presumably feel the same way (see Meltzoff in this special issue for further discussion on the issue of cognitive empathy, what he coins as the “like me framework”).

In social exchanges infants gain new meanings about the self, beyond an ecological sense of their own body acting in the physical environment. This new meaning is what Neisser (1991) calls the sense of the *interpersonal self* that develops in parallel with the ecological self. My contention here is that the interpersonal self actually emerges only by the second month when face-to-face reciprocal proto-conversations begin. The emergence of the interpersonal self is ear marked by socially elicited smiling that is highly reinforcing to adult caretakers. Face-to-face proto-conversation bootstraps infants’ sense of themselves, beyond an implicit sense of their bodies as a situated, differentiated and agent entity in the world (the ecological self).

The communicative and reciprocal context of face-to-face exchanges (primary intersubjectivity) emerging by the second month nurtures a new *triadic* meaning about the self in which first and third person perspectives are dissociated and can be loosely combined. This would be the constitutive element of a contemplative stance and the building block of intentionality.

The new triadic meanings about the self that arise from intentional communication with others would then be generalized outside of the social context, to physical problem solving situations as well as playful interactions in which infants become deliberate in exploring and seeking particular effects on objects. In the process, infants would also begin to dissociate and combine systematically what originates from their own actions (first person perspective) and the consequences or traces of these actions on the object (third, in this case “object” perspective).

Such dissociation and combination is at the root of intentional actions. It creates a mental distance between the child and the world, a contemplative space in which the world is re-presented, not just perceived and acted upon.

6. Criteria for an explicit sense of self as agent

The goals that infants are mentally aiming for become explicit or understandable for an adult caretaker based on the combination of three basic criteria:

The first criterion is when infants begin to explore objects with persistence, showing systematic attempts to achieve goals with objects as for example kicking to set a mobile in motion. The second criterion is when infants show joy in discovering a new effect or a novel affordance of an object. Also, and inversely, when they show anger and frustration failing to reach their goals. Finally, the third criterion is the propensity of infants to reproduce and even discover novel interesting consequences of their own actions on objects. It is with the combination of these 3 criteria that infants manifest a new, explicit sense of themselves as agent.

The propensity to reproduce actions is often accompanied by particular emotional expressions that make the infants' goals explicit. Infants begin to smile at their successes and frown at their failures, making public the goals they hold in mind and that guide their actions. For example, by 3 months, infants show anger and sadness when the string they learn to pull to activate a music box is suddenly disconnected (Lewis, Sullivan, Stanger, & Weiss, 1989). At the same age, and even prior, infants show similar emotional dismay when a social partner engaged in playful face-to-face proto-conversation suddenly freezes in a still face (Rochat & Striano, 1999a; Rochat, Striano, & Blatt, 2002; Tronick, Als, Adamson, Wise, & Brazelton, 1978). In both contexts, infants react explicitly to a violation of their expectations while performing actions that are physical in one case and social in the other. They send unmistakable social messages regarding how they feel about the outcomes of what they do and plan to do. They become explicit about their intentions.

One could certainly argue that newborns are explicit about their intentions, or at least needs, when crying for food or because they experience pain, expressing innate, pre-adapted explicit emotional messages readable to caretakers. However, emotions of elation or frustration expressed by the 3 month-olds upon succeeding or failing to either activate a toy or maintain a playful conversation differ in that they refer to self-generated goals; goals that infants contribute to create or goals that they come up with on their own as opportunistic creators in their encounters with the physical world.

The emotions expressed in such instances cannot be construed anymore as the direct expression of innate action systems. They are expressions of mental states while infants engage in new, self-generated and open ended exploratory activities that are goal oriented. To put it bluntly, infants are now driven by *curiosity* and playfulness rather than automa-

ticity. This new drive is nurtured and probably arises from intentional communication with reciprocating others starting the second month.

In the 1950's, pediatrician and psychoanalyst René Spitz provided dramatic footage of infants raised in crowded orphanages, deprived of regular face-to-face exchanges and intimate, interpersonal communication with others, both verbal and physical via holding. Spitz (1965) showed that deprived of such basic interpersonal care, infants become lethargic, withdrawing from the world, showing symptoms of stereotypical, repetitive behaviors that are turned inward rather than outward, with no apparent aims in mind other than moving. Playfulness and exploration are not apparent in these infants. This simple, yet telling observation that, sadly, continues to be replicated many times over in war and revolution ridden countries around the world, demonstrates that the emergence of playfulness and curiosity as well as the development of intentional actions on physical objects depend on social exchanges, and even arise from them as is proposed here.

7. From primary to secondary inter-subjectivity

The contemplative stance emerging by two months and the beginning of a dissociation between first and third person perspective arising from reciprocal exchanges with others are obviously just a start, a first departure in the development of intentional actions. They form an initial condition, the first budding crack that leads to an explosion.

One major development that has been extensively documented is the emergence of secondary inter-subjectivity, namely the emergence of referential communication with others about objects in the environment that occurs by the second half of the first year. By 9 months (9 month revolution or “miracle”, Tomasello, 1995), infants begin to engage in bouts of joint attention with others as they engage in the exploration of an object. They bring objects they are interested in to the attention of others and track others' attention in relation to what they do with objects. This new triangulation between the child, another person, and an object of shared attention breaks away from face-to-face exchanges. It makes these exchanges looser and more flexible.

When an adult, in the midst of ongoing proto-conversation suddenly adopts a still face, from two months of age infants show emotional distress and dismay. However, from 7–9 months of age, facing the same circumstances, infants begin to show initiatives in trying to re-engage the still faced person. They lean forward starring at her, call her, pull her cloth or clap hands, clearly with the aim in mind of having the person snapping out of her frozen state to re-instate the playful flow of proto-conversation (Striano & Rochat, 2000; Rochat & Striano, 1999a). By this age, infants will also bring to and present objects for shared attention. Infants will openly call for attention and frequently check whether others are attentive to what they do with objects. This is particularly evident in all children by 9 months, their relative propensity to engage in joint attention correlated with the developmental emergence of first words and symbolic functioning by the second year (Rochat, 2001; Rochat & Callaghan, 2005; Tomasello, 1995; Tomasello & Farrar, 1986).

But long before infants begin to engage in the active share of attention about objects with others, they are capable of acting intentionally on objects, on their own initiative. By 4 months, infants already show much prospective control of action toward objects they reach for with trunk, arms and hands forward. They explore and begin to systematically manipulate objects that are reachable (Rochat, 1989; von Hofsten & Lindhagen, 1979). By

5–6 months, they orient their hands in anticipation of grasping objects of various sizes and orientation (von Hofsten & Rönnqvist, 1988) or of contacting an unseen object they hear sounding in pitch darkness (Clifton, Rochat, Litovsky, & Perris, 1991).

With such display of anticipation and action planning, infants as young as 4–5 months clearly show that they can act with represented goals in mind, an ability that I propose is nurtured by early reciprocal exchanges with others. What changes by 9 months is that infants also begin clearly to show that they construe others as capable of doing the same as they do, with similar *intents*. That is, they see others on equal footing in terms of paying attention and being engaged in the same action. First and third person perspectives are not only dissociated and compared as in face-to-face exchanges, they begin also to be construed in relation to the equivalence of the information they convey, information about a shared world. In actively seeking the joint attention of others, infants implicitly assume that others can see the same things as themselves. Furthermore, they assume that others can get as excited or emotional about these things as themselves. Joint attention is also the clear sign that infants take a “like me stance” which has been assumed by some to be manifested even earlier, when very young infants engage in the imitation of others (Meltzoff & Moore, 1995). Whether signs of a “like me stance” are expressed early in development, even at birth, remains highly controversial. By 9 months, however, with the emergence of joint attention, it is hardly disputable. Questions remain as to what might drive the emergence of triadic attention toward objects at this point in development. Below, I present an account of what might contribute to this crucial change.

Infants have to solve a major dilemma beginning at around 4 months of age (Rochat, 2001, 2003). While still in need of proximity and attention from primary caretakers, they begin also to be intensely distracted from them. They immerse themselves in actively manipulating and acting on objects as well as in exploring the environment beyond the proximal space of caretakers. They gain postural control and eventually crawl around on their own, typically by 9 months. The dilemma is how to combine on one hand the need to be close to significant others, and on the other the need to explore the environment beyond interpersonal bounding?

Infants solve this dilemma by *integrating others* in their exploration of objects and their foray of larger regions of the physical environment. Accordingly, by 9 months and with the onset of locomotion, infants become jointly attentive to objects. When playing with an object, the infant will actively monitor, with quick back and forth glances between the object and the social partner, checking whether they are both interested in the same thing.

The integration of others’ attention in the exploration of objects by the infant is an important factor in the emergence of social referencing, where the infant actively attempts to incorporate others’ looks and attention in what she is doing for herself. On one hand, infants begin to lose their independence by becoming increasingly preoccupied by others’ attention towards their actions. On the other, infants gain control over the proximity of others while roaming the environment, continuing to explore and without compromising their infatuation with objects.

By the end of the first year, beginning of the second, the drive to control the proximity of others becomes a priority for the child. By 18 months, infants typically have a harder time entertaining themselves with toys or other physical objects for long periods of time. They quickly search for caretakers’ assistance and attention. At a later age, children eventually tend to organize their exploration and play with physical objects, sometimes in a

recreated or virtual social context in the form of imaginary dialogs and other symbolic plays (Tomasello, Striano, & Rochat, 1999). In these plays, first person perspectives are often alternatively played out and orchestrated by the child who becomes both actor and director of such reenactments or fantasy acts. Intentions and intentional actions are now played out, construed, and discovered by the child from everybody's perspectives. The child becomes like the novelist inventing characters in a story that gives meaning to their intentions.

8. Intentional actions observed

In this article, I discussed the developmental origins of intentional actions mainly from an infant's perspective, the perspective of a budding actor interacting with physical objects and people. I left aside a major aspect of intentionality which consists in the construal by the child of others' intention and intentional actions. How do children come to understand that others have plans in mind when they act? When and how do they become capable of discriminating that an action is accidental, or unintentional, rather than planned and deliberate?

There are many clever experiments that have been conducted with infants addressing these questions (see in particular articles in this Special Issue by Elsner; Eenshuistra, Ridderinkhof, Weidema & van der Molen; Meltzoff; Reid, Csibra, Belsky & Johnson; Song & Baillargeon). In a seminal research paper on imitation, Meltzoff and Moore (1995) demonstrate that by 14 months of age, infants tend to reproduce the complete action that an experimenter tries, but fails, to achieve. The infant sees two hands trying in vain to pull a dumbbell from the extremity of a dowel. When given the same dowel and dumbbell, infants manage to terminate the intended action suggesting that they figure what the hands of the experimenter were trying to achieve, the mindful plan that was guiding their movements. Interestingly, Meltzoff and Moore show that in contrast, infants of the same age do not try to reproduce the failed attempt at the same action when they see a machine with pincers instead of hands trying to pull the dumbbell off.

This clever imitation research suggests that by at least 14 months infants construe others as intentional actors trying to fulfill goals, and not acting randomly or by accident (see Meltzoff, this special issue). Questions remain, however, as to how this ability might develop. Obviously it is not innate or modular. If it is, then such a module would come on-line no earlier than 14 months, since 9 month-olds fail to imitate the complete "intended" action (but see Reid, Csibra, Belsky & Johnson as well as Song & Baillargeon in this special issue for other findings using visual attention and exploration instead of imitative responses). So, the question is where does this construal come from and what mechanisms can account for its emergence in development?

Here, once again, I propose that the construal of observed behaviors as intentional arises from the intentional acts of communication that are universally scaffold by adult caretakers starting from at least 2 months of age. It is in the context of communication that intentional actions by others are most conspicuous for infants. This context is the privileged terrain for learning and developing an awareness of what controls others' behaviors, like their own. In early face-to-face exchanges, infants are provided with a running commentary about how they feel and what they experience, whether joy, pain, sadness, or excitement.

From the onset of socially elicited smiling at around 6 weeks, adult caretakers are universally compelled to mirror the facial expressions and vitality of infants, entering in emotional resonance and conversation with them. They do so not only in the way they interact but also in the way they hold and situate infants in relation to them. They scaffold infants with intentional communicative “props” or routines that infants rapidly anticipate and expect (Rochat, Striano, & Querido, 1999). From two months of age, infants expect increasingly that people should behave in a certain way. For example, they expect them not to freeze unexpectedly as in the sudden still face paradigm mentioned prior. They show dismay when their social expectations within the pragmatics of intentional, reciprocal communication are violated.

Face-to-face and other intimate interpersonal exchanges provide infants with unique learning opportunities. Infants are catered, pampered, carried, and attended to by highly attuned and sensitive persons whose behaviors are as a whole *intentional* toward caring, entertaining and protecting the child. This is a highly reciprocal context that is exclusively staged for the infants. Within this context, infants are scaffold to pick up cues specifying actions that are intentional, as opposed to unintentional, toward the self.

Contingent gazing, smiling and other affective mirroring in proto-conversation are compulsively used as highlights by caretakers to offer contrast in relation to movements that might be accidental such as sneezing or coughing, or any other actions that might be intentional but not oriented toward the child (e.g., reaching for a bottle, talking to somebody else). It is within this context of reciprocal communication that the learning of intentional actions by others arises at the onset of development. This learning can then generalize to observational and non-interactive contexts in which infants observe others behaving with or without aims in mind. Before their first birthday, infants already perceive and anticipate social causality even in the movements of abstract geometric figures moving on a computer screen, one figure chasing the other. In a recent study, we showed that by 9 months, infants discriminate a role reversal in the chase pattern of geometric figures on a computer screen (a blue and a red disc moving on a screen), the chaser becoming the chsee, and vice versa (Rochat, Striano, & Morgan, 2004). Same age infants do not manifest any discrimination of a role reversal when the two discs move independently of each other and their signature vitality is reversed. By 9 months, infants detect and appear to infer who is doing what to whom on this kind of abstract 2D chase displays.

9. Conclusion

To conclude, the mechanism that leads infants from the primary detection of others as reciprocal in intimate face-to-face communicative exchanges, to the understanding of others as intentional agents based on observation remains elusive. Much more research is needed but promising discoveries are made in the realm of cognitive neuroscience demonstrating the existence of mirror systems in the brain that bridge self-generated action with the same kind of action observed in others. These mirror systems point to a biological substrate linking what is learned in the self-domain and what is learned by observing others. Questions remain as to when such systems might come on-line and what learning experience might nurture them in early development (Decety & Sommerville, 2003; see also Meltzoff, this special issue).

I propose that the development toward the discrimination of observed intentional/goal oriented movements, even when the protagonists are abstract geometric figures on a

computer screen, probably arises from reciprocal communication with others who tend compulsively to display their intention to captivate and get attuned with the infant.

In this article, I argued that it is from this rich interactive and richly scaffold context that, in general, intentional actions and acting with an aim in mind arise. Such actions are more than the expression of pre-adapted action systems. They emerge and develop from two months on-ward, in particular from the time infants begin to smile back at others. The origins of intentional actions in human ontogeny are indeed to be found primarily in early social reciprocity, not just in the individual interacting with physical things.

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References

- Bigelow, A. E., & Rochat, P. (2006). Two-month-old infants' sensitivity to social contingency in mother–infant and stranger–infant interaction. *Infancy*, *9*(3), 313–325.
- Bruner, J. S. (1983). *Child's Talk*. New York: Norton.
- Capella, J. N. (1996). Dynamic coordination of vocal and kinesis behavior in dyadic interaction. In J. Watt & C. Van Lear (Eds.), *Dynamic patterns in communication processes*. London: Sage Publications.
- Clifton, R. K., Rochat, P., Litovsky, R., & Perris, E. E. (1991). Representation guides infant reaching in the dark. *Journal of Experimental Psychology: Human Perception and Performance*, *17*(2), 323–329.
- Crown, C. (1991). Coordinated interpersonal timing of vision and voice as a function of interpersonal attraction. *Journal of Language and Social Psychology*, *10*(1), 29–46.
- Decety, J., & Sommerville, J. A. (2003). Shared representations between self and others: A social cognitive neuroscience view. *Trends in Cognitive Science*, *7*, 527–533.
- Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development*, *71*(1), 44–56.
- Feldman, R., & Greenbaum, C. (1997). Affect regulation and synchrony in mother–infant play as precursors to the development of symbolic competence. *Infant Mental Health Journal*, *18*(1), 4–23.
- Gergely, G., & Watson, J. S. (1999). Early social-emotional development: Contingency perception and the social-biofeedback model. In P. Rochat (Ed.), *Early social cognition* (pp. 101–136). Hillsdale: Erlbaum Publishers.
- Gopnik, A., & Schulz, L. (2004). Mechanisms of theory formation in young children. *Trends in Cognitive Sciences*, *8*(8), 371–377.
- Haith, M. M., Bergman, T., & Moore, M. J. (1977). Eye contact and face scanning in early infancy. *Science*, *198*(4319), 853–855.
- Jaffe, J., Beebe, B., Feldstein, S., Crown, C. L., & Jasnow, M. D. (2001). Rhythms of dialogue in infancy. *Monograph of the Society for Research in Child Development*, *66*(2), 265.
- Lewis, M., Sullivan, M., Stanger, C., & Weiss, M. (1989). Self-development and self-conscious emotions. *Child Development*, *60*, 146–156.
- Marlier, L., Schaal, B., & Soussignan, R. (1998). Neonatal responsiveness to the odor of amniotic and lacteal fluids: A test of perinatal chemosensory continuity. *Child Development*, *69*(3), 611–623.
- Mead, G. H. (1934). *Mind, self and society*. Chicago: University of Chicago Press.
- Meltzoff, A. N., & Moore, M. K. (1995). A theory of the role of imitation in the emergence of self. In P. Rochat (Ed.), *The self in infancy. Advances in psychology book series* (pp. 73–94). Amsterdam: North Holland, Elsevier Science Publishers.
- Morton, J., & Johnson, M. H. (1991). CONSPEC and CONLERN: A two-process theory of infant face recognition. *Psychological Review*, *98*(2), 164–181.
- Neisser, U. (1991). Two perceptually given aspects of the self and their development. *Developmental Review*, *11*, 197–209.

- Neisser, U. (1995). Criteria for an ecological self. In P. Rochat (Ed.), *The self in infancy. Advances in psychology book series* (pp. 17–34). Amsterdam: North Holland, Elsevier Science Publishers.
- Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.
- Prechtl, H. F. R. (Ed.). (1984). *Continuity of neural functions from prenatal to postnatal life*. Oxford: Blackwell Scientific Publications Ltd.
- Rochat, P. (1983). Oral touch in young infants: Response to variations of nipple characteristics in the first months of life. *International Journal of Behavioral Development*, 6, 123–133.
- Rochat, P. (1987). Mouthing and grasping in neonates: Evidence for the early detection of what hard or soft substance afford for action. *Infant Behavior and Development*, 10, 435–449.
- Rochat, P. (1989). Object manipulation and exploration in 2- to 5-month old infants. *Developmental Psychology*, 25, 871–884.
- Rochat, P. (1995). Early objectification of the self. In P. Rochat (Ed.), *The self in infancy. Advances in psychology book series* (pp. 53–71). Amsterdam: North Holland, Elsevier Science Publishers.
- Rochat, P. (2001). *The infant's world. The developing child series*. Harvard University Press.
- Rochat, P. (2002). The ego function of early imitation. In A. N. Meltzoff & W. Prinz (Eds.), *The imitative mind*. Cambridge University Press.
- Rochat, P. (2003). Emerging co-awareness. In G. Bremner (Ed.), *Essays in honor of George Butterworth*. Cambridge University Press.
- Rochat, P., & Callaghan, T. (2005). What drives symbolic development? In L. Namy (Ed.), *Symbolic use and understanding*. Mahwah, N.J.: Lawrence Erlbaum Associates Publishers.
- Rochat, P., & Senders, S. J. (1991). Active touch in infancy: Action systems in development. In M. J. Weiss & P. R. Zelazo (Eds.), *Infant attention: Biological constraints and the influence of experience* (pp. 412–442). NJ: Ablex Publishers.
- Rochat, P., & Striano, T. (1999a). Social cognitive development in the first year. In P. Rochat (Ed.), *Early social cognition* (pp. 3–34). Lawrence Erlbaum Associates.
- Rochat, P., & Striano (1999b). Emerging self-exploration by 2 month-old infants. *Developmental Science*, 2(2), 206–218.
- Rochat, P., Striano, T., & Blatt, L. (2002). Differential effects of happy, neutral, and sad still-faces on 2-, 4-, and 6-month-old infants. *Infant and Child Development*, 11(4), 289–303.
- Rochat, P., Striano, T., & Morgan, R. (2004). Who is doing what to whom: Young infants' developing sense of social causality in animated display. *Perception*, 33(3), 355–369.
- Rochat, P., Striano, T., & Querido, J. (1999). Emerging sensitivity to the timing and structure of protoconversation in early infancy. *Developmental Psychology*, 35(4), 950–957.
- Sherrington, C. S. (1906). *The integrative action of the nervous*. New Haven: Yale University Press.
- Spitz, R. A. (1965). *The first year of life: A psychoanalytic study of normal and deviant development of object relations*. New York: Basic Books.
- Stern, D. (1985). *The interpersonal world of the infant*. New York: Basic Books.
- Striano, T., & Rochat, P. (2000). Emergence of selective social referencing in infancy. *Infancy*, 2, 253–264.
- Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103–130). Hillsdale, NJ: Erlbaum.
- Tomasello, M. (1999). *Cultural origins of human cognition*. Cambridge: Harvard University Press.
- Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development*, 57(6), 1454–1463.
- Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioral & Brain Sciences*, 16(3), 495–552.
- Tomasello, M., Striano, T., & Rochat, P. (1999). Do young children use objects as symbols? *British Journal of Developmental Psychology*, 17(4), 563–584.
- Trevarthen, C. (1979). Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 321–347). New York: Cambridge University Press.
- Tronick, E. Z., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. *Journal of the American Academy of Child Psychiatry*, 17, 1–13.
- von Hofsten, C., & Lindhagen, K. (1979). Observations on the development of reaching for moving objects. *Journal of Experimental Child Psychology*, 28, 158–173.
- von Hofsten, C., & Rönnqvist, L. (1988). Preparation for grasping an object: A developmental study. *Journal of Experimental Psychology: Human Perception and Performance*, 14, 610–621.

- Watson, J. (1995). Self-orientation in early infancy: The general role of contingency and the specific case of reaching to the mouth. In P. Rochat (Ed.), *The self in infancy: Theory and research* (pp. 375–394). Amsterdam: North-Holland/Elsevier Science.
- Werner, H., & Kaplan, B. (1963). *Symbol Formation*. N.Y.: John Wiley & Sons.
- Wolff, P. H. (1987). *The development of behavioral states and the expression of emotions in early infancy: New proposals for investigation*. Chicago, IL, USA: University of Chicago Press.