

Social contingency detection and infant development

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The developmental origins and determinants of social contingency detection are discussed. Based on recent research, the author proposes that the origins of social contingency detection correspond to the early propensity developing in the first 6 months of life to differentiate between what pertains to the self (i.e., one's own body) and what pertains to others. Furthermore, from the second month of life, what infants appear to gain from contingency detection while interacting with others is a sense of shared experience or intersubjectivity. Research suggests that although the development of intersubjectivity is a central feature of infant behavior and development, the meaning of contingency detection, hence the source of intersubjectivity, changes radically between birth and 18 months of age. In general, it is proposed that the origins and determinants of social contingency detection must be construed in relation to (1) the developing sense of self in infancy, (2) the infant's developing sense of reciprocity with others, and (3) the infant's developing sense of participation with others. The author concludes by proposing a relevant map of changing social stances adopted by infants in the course of early development. (Bulletin of the Menninger Clinic, 65[3], 347–360)

The goal of this article is to discuss research documenting how typical infants grow into their social environment. In particular, we are interested in how infants come to develop the elusive capacity to perceive social contingency, especially what drives infants' development toward reciprocity and shared experience with others (i.e., the sense of intersubjectivity).

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Fuzzy concept of social contingency

What is contingency? What does it mean to detect contingency between perceived events, or contingency between the self and other individuals' behavior? In the physical realm, such questions are pretty much unambiguous. In the social realm, however, they are rather fuzzy. The movements of billiard balls hitting each other on a pool table are mutually dependent in predictable ways. Aside from friction, particular spins, and velocities, the dynamic of one ball is contingent on the dynamic of the other. The physics underlying such contingency is straightforward and allows precise predictions, hence for some, good and reliable pool playing. In the social domain, however, detecting the contingency between the particular behavior of one individual, including the self, and the behavior of another is infinitely more complex, therefore much more difficult to predict. Did she leave the room because I hurt her feelings or because she felt ill? Did I cause her illness or is it the food she just ate? These are the kinds of questions that inhabit our psyche, many of which pertain to the difficult and highly speculative construal of who did what to whom and why, an important aspect of social contingency detection.

To talk about social contingency detection is to talk about an elusive concept, as elusive as "social chemistry," "connectedness," or a "good vibes" feeling. As fuzzy and complex as it might be, social contingency and its detection are central features of our social life. But what are the developmental origins and determinants of social contingency detection, or the feeling of being more or less "connected" with others? In relation to this fundamental question, and based on my own research on infant behavior and development, I would like to articulate three main ideas:

1. The origins of social contingency detection correspond to the early propensity developing in the first 6 months of life to differentiate between what pertains to the self (i.e., one's own body) and what pertains to others.
2. What infants gain from contingency detection while interacting with others, from the second month of life, is a sense of shared experience or intersubjectivity.
3. If the development of intersubjectivity is a central feature of infant behavior and development, the meaning of contingency detection, and hence the source of intersubjectivity, changes radically between birth and 18 months of age.

The origins and determinants of social contingency detection need to be construed in relation to the various developmental phases characterizing infants' understanding of others as social partners. These phases, I submit, are marked by key developmental transitions at approximately 2, 9, and 18 months. They form a variety of contexts that fundamentally change the meaning of social contingency for infants.

In particular, I propose that the question of the origins and determinants of social contingency detection has to be construed in relation to (1) the developing sense of *self* in infancy, (2) the infant's developing sense of *reciprocity* with others, and (3) the infant's developing sense of *participation* with others. I will conclude by proposing a map of changing social stances adopted by infants in the course of early development.

Developing a sense of self

From birth, the body is a primary object of exploration. This exploration probably contributes to the early development of a sense of self as differentiated and discriminated from others. Long before infants start recognizing themselves in mirrors and begin to manifest embarrassment, they engage in much self-exploration, exploring body parts, bringing, for example, their legs into the field of view for long bouts of visual-haptic exploration. In fact, infants from birth, and even prior to birth, have perceptual experiences that are the source of unique information specifying their own body as a *differentiated* entity in the environment. This is probably the earliest source of an emerging sense of self. When infants bring their limbs into contact with other parts of their own body, they experience the combination of proprioception (the modality of the self "par excellence") and double-touch stimulation. Proprioception or interoception and double-touch stimulation uniquely specify one's own body, as opposed to either the body of someone else or another object. No one but "I" can experience the mutual feeling of my hand touching my cheek and inversely my cheek touching my hand. This, once again, is a uniquely self-specifying perceptual experience.

As a matter of fact, it appears that infants from birth are sensitive to and discriminate self-specifying perceptual experiences. This suggests that from birth infants have the means to develop a discrimination between what pertains to their own body and what pertains to nonself entities or perceptual events. In a recent study, Susan Hespous and I (Rochat & Hespous, 1997) showed that healthy newborns,

within 24 hours of birth, appear to discriminate between self- and non-self-stimulation or perceptual events. We systematically analyzed rooting responses by newborns in situations where either infants self-stimulated themselves by bringing a hand in contact with the right or left cheek (self condition) or an experimenter stimulated the infants' cheek with her index finger.

When stimulated by a tactile sensation on the cheek, newborns tend to turn their head toward the stimulation (rooting response). We found that newborns turned significantly more toward the stimulation of the experimenter's finger, compared to their own hand. These simple findings show that from birth infants appear already to discriminate between experiences that pertain to their own body and those that pertain to the body of someone or something else. In other words, they already seem to have a rudimentary sense of their own body as a differentiated entity among other entities in the world.

With Rachel Morgan, in recent years we have collected more data indicating that between 3 and 6 months, infants develop a sense of their own body, not only as a differentiated entity in the world, but also as an *organized structure*. This sense of the body as an organized structure is based on a precise intermodal calibration between proprioception and other perceptual modalities, vision in particular. In a series of studies, we placed infants in front of a large TV screen where they could watch on-line different views of their own legs from the waist down, dressed with black-and-white striped socks. From 3 months of age, infants look differentially at the image of their own legs that is discrepant with what is normally experienced when seeing and moving their own limbs. For example, they kicked significantly more and looked for longer episodes at the image of their own legs that violates regular visual-proprioceptive calibration in terms of movement directionality (Rochat, 1998). They also tended to look longer at distorted images that artificially reverse where each leg is attached to the rest of the body (Morgan & Rochat, 1997).

In all, these observations show that early on, not only do infants manifest a sense of their own body as a differentiated entity among other objects in the environment, they also manifest an intermodal sense of their own body as organized, hence manifesting some rudiments of a body schema. This early manifestation of a body schema is based on the intermodal experience of the body involving proprioception and other modalities, including double touch and vision.

Aside from a body schema and a differentiated sense of their own body, young infants also develop, from at least 2 months of age, a sense of their own agency and situation in the world. These two aspects are an integral part of the *ecological self* (Neisser, 1991) devel-

oped by young infants. The ecological self corresponds to a sense of one's own body, not only as a differentiated and organized entity in the environment, but also as *situated* and an *agent* in the environment (see also Rochat, 1997).

A sense of situation is clearly expressed by infants when they start to reach for objects in the environment. My colleagues and I (Rochat, Goubet, & Senders, 1999), as well as other researchers (e.g., Field, 1976), documented that as infants start to reach for objects, from approximately 4 months of age, they factor the distance that separates them from objects. They tend to reach systematically for objects that are within reach and tend to inhibit their reach attempts toward objects that are placed just outside their prehensile space. Furthermore, this perceived distance of reachability appears to change according to postural development and the infant's growing capacity for action on objects.

Long before infants reach proficiently toward objects, and hence manifest a sense of their own situation in the physical environment, they already express a sense of their own agency. The research we did in collaboration with Tricia Striano (Rochat & Striano, 1999) indicates that it is probably at around 2 months of age and not earlier that infants manifest a clear sense of their own agency in the world. In one condition, each time the infant sucked above a certain pressure threshold, he or she heard a contingent 2-second trill of random sounds. In another condition, each time the infant sucked above the threshold, he or she heard contingent sounds that, instead of random, were commensurate with the amount of pressure the infant applied on the pacifier. In other words, in one condition the auditory consequences of sucking were merely contingent, whereas in the other condition these consequences were both *contingent* and *analog*. We compared infants' sucking activity in either condition and in relation to baselines where sucking had no auditory consequences. By 2 months, infants were found to suck in significantly different ways in the contingent only and in the contingent-plus-analog condition. Two-month-old infants had differential average amplitude of sucking in the analog, compared to the nonanalog auditory feedback condition. Interestingly, the same research performed on less-than-24-hours-old newborns yielded no differential responding in either condition. In contrast to 2-month-olds, newborn infants did not manifest any signs of differential responding in either the contingent only or the contingent-plus-analog auditory feedback condition.

From this last project (Rochat & Striano, 1999), we concluded that something important happens developmentally at around 2 months of age: Infants apparently become newly aware of the con-

sequences of their own actions. At this juncture of development, infants appear to switch gears radically; the control of their actions becomes less tightly linked to rigid environmental circumstances, less stimulus-bound. There is a general decoupling between perception and action that begins to be increasingly manifest at this point of development. As in the case of the infant kicking the mobile in the crib and pausing to explore the consequences of his or her leg movements on the object set in motion, from this point on, infants demonstrate increasing composure, pausing to reflect and plan future actions. There is the beginning of a manifestation of what I like to call “mental hiccup,” or mental distance to reflect on what is happening.

There is much converging evidence that something radical happens in the developing organization of behavior at around 6–10 weeks of postnatal age. Peter Wolff's (1987) observations on infants' behavioral states point to such a transition. The proportion of wakeful time increases dramatically at around 2 months of age, and periods of active alert state, in which infants appear actively engaged in exploring their environment, increase substantially in duration and frequency.

More importantly, the second month of life marks the emergence of *intersubjectivity*, or the first clear sense that infants are actively sharing experiences with social partners. *This is a revolution with a smile*. Again, at around 6 weeks, infants begin to produce socially elicited smiling in face-to-face interaction with social partners. It is also by this age that infants begin to attend significantly more to the internal features of faces, focusing more on the eyes and mouth of other persons (Haith, Bergman, & Moore, 1977). This is also the time that parents and caretakers typically report that they discover a person in their infant, experiencing for the first time reciprocity with the child. This is, in all probability, the cradle of intersubjectivity and the beginning of a new stance in the life of infants: a *conversational stance* that extends beyond the self-world perceptual discrimination, the specification of the infant's own body and its effectivities. From the developing sense of an ecological self or developing sense of the body as a differentiated, situated, organized, and agent entity in the world, by 2 months infants begin also to develop an *interpersonal* sense of themselves.

Developing a sense of reciprocity with others

By the time infants are 2 months old, highly scaffolded (framed by adult caretakers) and ritualized face-to-face exchanges and protocon-

versations emerge between them and their adult caretakers. Others become a sounding board to infants, a sort of running commentary on what they feel and how they should feel: preferably happy-go-lucky, smiling, and cooing with joy. This is what adults, at least in our culture, when facing an infant of this age are typically fishing for and actively scaffolding in the young child: the “H” state, or happy state.

This is the time when infants begin to learn what to expect from others as social partners and communicative agents. This is also the time when conversational norms are set, allowing infants to determine the quality of their rapport with others—whether they are more or less emotionally connected with the person they face. This is a crucial developmental transition, a transition in which the infant begins to shape more or less privileged relationships with people. It is also probably the origin of the mysterious compulsion to view others as the reflection of what we are, the origin of self-consciousness, social embarrassment, and co-awareness.

Tricia Striano and I recently collected new data on early imitation that exemplifies the transition toward a conversational stance emerging at around 2 months of age. We tested in a group of 1- and 2-month-old infants the propensity to reproduce the model of a tongue protrusion performed by an adult facing them. The pioneer work of Meltzoff and Moore, as well as many others, has demonstrated that from birth, infants in highly controlled conditions with no verbal exchanges (i.e., with a mute experimenter showing a still face between tongue protrusions or other model episodes) have the propensity to reproduce systematically the tongue protrusions modeled by the experimenter. It has also been reported that the phenomenon of neonatal imitation tends to disappear at around 2–4 months of age, when infants become less inclined to reproduce movements modeled by a social partner in face-to-face interactions.

In our research, we tested 1- and 2-month-old infants in two conditions: (1) An experimenter modeled a tongue protrusion for 10 seconds and then paused for 20 seconds, remaining silent and still-faced, as in the original Meltzoff and Moore (1977) experiments with neonates; and (2) during and after the tongue protrusion model, the experimenter interacted and actively engaged the infant in protoconversation. Thus, in contrast to the first condition, the latter added communicative content. That is, the experimenter behaved as an engaged, socially communicative agent in response to infant behavior. The results we are just starting to analyze reveal an interesting interaction of age-by-condition. One- and 2-month-olds appear differentially sensitive to either condition. One-month-olds tended to gener-

ate an overall increase of tongue protrusion in the still-face condition, compared to the communicative condition. In contrast, by 2 months of age, infants tended to manifest the reverse. These results once again point to an important change at around 2 months of age, with infants appearing increasingly sensitive to the relative communicative attunement of the social partner imitating them. These findings point to a developing attunement of the infant toward the adult as a communicative and emotional partner. This affective attunement goes beyond the mere ability to reproduce motorically a seen gesture, as reported in very young infants, including few-hour-old newborns (see Meltzoff & Moore, 1997, for a review).

From the time infants become attuned and begin to reciprocate with others, they also develop social expectations. Within weeks, they begin to expect social partners to behave in certain ways. The still-face phenomenon is a good testimony to such development. From 2 months of age, when ongoing face-to-face social exchanges are suddenly interrupted by the social partners adopting a frozen emotional expression (poker face), infants typically become gaze avoidant, engage in self-comforting, smile less, and in some extreme instances begin to cry. Much research confirms that this response is not merely due to the sudden reduction of auditory and visual dynamic stimulation (e.g., Muir & Hains, 1999).

As an example of growing social expectations starting at 2–4 months of age, we tested infants presented with either an organized or a disorganized peekaboo game. We showed that from 4 months of age, infants did respond markedly differently in either condition (Rochat, Querido, & Striano, 1999). For example, infants smiled significantly less in the context of a disorganized peekaboo game, compared to an organized one. By 4 months, infants show that they become increasingly sensitive to the relative predictability of the narrative envelope that an organized peekaboo game provides.

Interestingly, Tricia Striano and I demonstrated that by 7 months, infants also become increasingly active as social partners, actively involved in repairing disrupted ongoing face-to-face interactions, as in a still-face experimental situation (Striano & Rochat, 1999). By this age, infants begin to manifest active *reengagement* attempts toward the suddenly still-faced adult, calling her, clapping hands, and touching her, while staring intently at the experimenter. We also established that such newly emerging social initiatives on the part of the infant correlate with the emergence of triadic competencies, such as following points, following gazes, or manifesting joint attention to an object with a social partner. This announces important changes in social, cognitive, and communicative behavior.

Developing a sense of participation with others

We have now good evidence that between 7 and 9 months, as infants become increasingly active and intentional (planful) participants in shaping and controlling social exchanges, they also begin to take an *intentional stance* toward others. This is demonstrated, for example, by yet another experiment done in collaboration with Tricia Striano in which we tested 7- and 9-month-old infants' propensity to refer to others when confronted with an ambiguous (kind of scary) situation (Striano & Rochat, 2000). In this experiment, infants sat in front of an experimenter who smiled and said an engaging "Yeah . . ." whenever the infant looked toward her. In between the infant and the experimenter was a stuffed dog, which, at regular 30-second intervals, started to move and bark via a remote control. In one condition, the experimenter looked toward the infant, displaying socially oriented attention to the situation. In another condition, the experimenter looked away, observing the infant via a concealed TV monitor. In both conditions, the experimenter was equally contingent in her response. However, in the look-away condition, the experimenter displayed no oriented or intentional attention toward the infant. We found that during and immediately following a barking episode, 7-month-old infants tended to look up toward the experimenter equally, regardless of condition. In contrast, 9-month-olds referred significantly more toward the experimenter in the look-toward compared to the look-away condition. Again, these observations strongly suggest that by 9 months, infants factor the communicative intent of social partners when socially referencing to them as they are confronted with an ambiguous situation (in this case, the sudden barking of a furry mechanical toy).

In general, the social referencing newly expressed by 9-month-olds is one among other indices of "secondary intersubjectivity" that emerges by the end of the first year. Infants tend to capture others' attention in reference to objects in the environment. These indices include joint attention, pointing, and gaze following, in addition to social referencing as illustrated in our experiment. At this juncture of development, the *fateful triangle* of Self, Objects, and Others starts to shape up. Infants begin actively to incorporate others in their exploration of the physical, object world. This is their way, probably, to solve the basic tension of exploring the environment via newly acquired skills (e.g., independent locomotion) while maintaining social attention, that is, maintaining a secure affective base while experiencing and foraging for novelty (Rochat, 2001).

Actually, the new attempts of infants to incorporate others into

their own action and exploration are more than merely affective and emotional in motivation. They are also opportunistic. It appears that infants become explicitly aware that others are a crucial source of help and progress. They start to understand others as resources for help and information in the face of obstacles, whatever their nature. By 9 months, infants develop a new kind of dependence on others, a dependence that entails the realization that others are more knowledgeable and advanced in their skills: others as a source of help and instruction. This is also probably when infants begin to construe and manifest self-consciousness (e.g., embarrassment in front of mirrors). It is at this developmental juncture, I propose, that the seed of self-consciousness is planted.

Recently, Nathalie Goubet, Sarah Poss, Céline Leblond, and I have collected some developmental observations on the emergence of requests for help, which entails a novel understanding of others as expert and potential teachers of new skills. In this research, we were basically interested in documenting the emergence, propensity, and nature of infants' requests for help in a problem-resolution situation. Here is a sample of what we did and what we found. We presented infants (ages 9, 14, or 18 months) with an attractive toy object placed in a transparent container. The object was always visible to motivate the child. We made the container increasingly difficult to open, which eventually became quite challenging for the infants. We recorded and analyzed systematically the infants' propensity to solicit help, either by pointing and vocalizing toward the container while looking at the adult, or by presenting the container to the experimenter. Considering the overall number of observed requests as a function of age, results show that from 9 months of age, infants begin to request help, with this trend increasing at 14 and 18 months. Interestingly, it appears that infants also become increasingly successful in using the outcome of a request to solve the problem at hand. Between 9 and 18 months, the proportion of requests followed by successful problem resolution (i.e., opening the container) increases markedly, with the experimenter typically modeling or scaffolding the right action when asked for help.

In all, it appears that from 9 months of age, infants become explicitly aware that others are potential teachers and informants to solve problems. A new level of dependence is established: the dependence linking student to teacher or novice to expert. Hence infants develop an awareness of a hierarchy in knowing that is inseparable from the awareness of the potential *power of others*. In particular, infants construe others as having authority with the power to judge because they know better. This new awareness, by the way, certainly participates

in and contributes to the emergence of self-consciousness by the end of the second year, as well as to the embarrassment, co-awareness, and the fictive audience of others in mind that remain so pervasive throughout the life span.

Another body of data we collected recently indicates that social maintenance and the active attempt to include others in problem solving increase markedly between 9 and 18 months. Nine-, 14-, and 18-month-old infants, sitting on their mother's lap, were placed between two experimenters, a teacher and a socializer. Infants had the choice of interacting with either one during a problem-solving task: getting to an object by pulling a blanket and opening a transparent box. Following an infant's request for help (through vocalization or bodily movement), the teacher would just model the action that would lead to a successful outcome and give the box back to the infant. In contrast, after an infant's request for help oriented toward her, the socializer would grab the object and comment with a smile and positive vocalizing while putting the object back in front of the infant. Thus one experimenter (the teacher) provided information about how to solve the problem but no affective feedback, while the other experimenter (the socializer) provided affective feedback but no information to help solve the problem. Preliminary analyses indicate that from 9 months, infants tend to orient more requests for help toward the teacher, compared to the socializer adult. Interestingly, this trend vanishes at 14 months and is reversed at 18 months, when infants begin to direct markedly more requests for help toward the socializer!

These results point to a trend toward the increasing importance by 18 months of age of communing and reciprocating (hence detecting contingency) with others over what would be in principle more rational for infants in order to solve the problem they are attempting to solve, namely, requesting some help from the teacher, who is actually providing relevant information by modeling the solution.

Finally, let me add another piece of recent empirical evidence demonstrating again that by 14 to 18 months infants have markedly more others in mind, even when engaged in tasks that in principle could be performed in the absence of any help from other people. We looked at the propensity of 9-, 14-, and 18-month-olds to solve the means-ends task of bringing an attractive object toward them that was placed at a distance on a blanket. Infants sat on their mother's lap and had to solve the problem either in the presence or the absence of the experimenter, who either kneeled beside the infant or left the room. We were surprised to find out that 9-month-olds were actually better overall at solving the problem right away, without having to

ask for help. With age, and particularly at 18 months, we observed a dramatic deterioration in the infants' performance in the presence of the experimenter, compared to when she was absent.

These results strongly suggest that by 18 months of age, infants construe as eminently *social* a physical and perceptuomotor problem they can easily solve on their own. From a means-ends problem, the situation is now construed by the infant as a task that incorporates others, a task that needs to be solved with the help and the participation of others, not alone. By 18 months, infants clearly appear to reformulate simple practical problems *with others in mind*. Simple physical means-ends tasks are reformulated as problems to be solved in *collaboration* with others.

Conclusion

How do infants connect with others? How do they construe others' behavior as more or less contingent on their own behavior? The research and facts briefly outlined here suggest that the origins and determinants of social contingency detection need to be considered in relation to at least three major features of infant development: (1) the early *sense of self* expressed from birth and developing in the first months of life, (2) the growing sense of shared experience, or *intersubjectivity*, that infants appear to express from the second month of life, and (3) the emergence of a sense of *participation* with others emerging by the end of the first year.

I propose that there is a changing context of social contingency detection in infancy. This context is the development of various stances that infants take toward others in the course of the first 18 months. I have identified 5 steps in the unfolding of such stances (see Table 1):

Table 1. *Five developmental steps and developing psychological stances toward others in infancy*

Developmental step	Psychological stance
Step 1: Self-others discrimination (birth)	Discriminative stance
Step 2: Intersubjectivity (2 months)	Reciprocal stance
Step 3: Social expectations (2–7 months)	Anticipatory stance
Step 4: Referential co-awareness (7–9 months)	Referential stance
Step 5: Collaboration (9–18 months)	Collaborative stance

STEP 1: From birth and within the first 6–8 weeks of life, infants establish—based in part on self-exploration—a basic discrimination between self and others.

STEP 2: By 2 months, infants manifest the first clear signs of reciprocity with others via smiling and other affective resonance. This marks the emergence of intersubjectivity.

STEP 3: Between 2 and 7 months, infants develop social expectations in face-to-face interactions that are highly ritualized and framed by caretakers.

STEP 4: By 7–9 months, infants begin to manifest co-awareness with others in reference to objects in the world, as in the case of social referencing or joint attention.

STEP 5: Between 9 and 18 months, infants develop a sense of collaboration with others, incorporating and maintaining proximity with others even in situations they could manage, explore, enjoy, or solve on their own. They develop a strong sense of social dependence.

My view is that these developmental steps correspond to the emergence of new stances toward others, hence a different ground for social contingency detection. Following the chronology described, these social stances are, respectively, discriminative, reciprocal, anticipatory, referential, and collaborative. The proposed stances are not mutually exclusive but coexist, although they unfold in the proposed developmental order. In summary, my point here is to emphasize the importance of construing the origins and determinants of social contingency detection against this developmental background. It is this background that ultimately gives meanings to social contingency detection and to the development of such ability early in life.

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