

# Early Development of Body Representations

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*Edited by*

Virginia Slaughter and  
Celia A. Brownell

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MARGARITA SVETLOVA is a doctoral candidate studying developmental psychology at the University of Pittsburgh and is a guest researcher in the Department of Developmental and Comparative Psychology at the Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.

MANOS TSAKIRIS is Reader in Neuropsychology at the Department of Psychology, Royal Holloway University of London, UK.

DAVID H. UTTAL is Professor of Psychology and Education at Northwestern University, where he studies spatial and symbolic development.

KAITLIN VENEMA is a research coordinator at the University of Washington Autism Center in Seattle, Washington. She formerly worked in the Early Childhood Cognition Lab under Jessica Sommerville.

HANAKO YOSHIDA is an assistant professor in the Department of Psychology at the University of Houston and directs the Cognitive Development Laboratory.

STEPHANIE ZWICKER is a doctoral candidate in the Department of Psychology, Dalhousie University, Canada. She is conducting her PhD research on the temporal parameters of visual-proprioceptive intermodal integration.

*Part I*

The bodily self

# 1 Primordial sense of embodied self-unity

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*Philippe Rochat*

## **Primordial sense of embodied self-unity**

Infancy research of the past forty years defies long-held ideas regarding the starting state of mental life. These ideas were justified by the fact that we do not have any explicit recollection of our own infancy. Infantile amnesia was symptomatic of an initial absence of experiential unity and self-awareness. Prior to language, children were regarded as some kind of larvae, eventually emerging from their blind chrysalides to find embodied selfhood, meta-cognition, and explicit self-identity in the light of symbolic functioning and conceptual representations. There is an abundance of evidence now showing that un-memorable infancy does not equate to mindless infants.

The long-held assumptions of mindless and self-less infants, devoid at birth of experiential unity (i.e. a unified embodied experience), can be explained by a lack of consideration of the variety of ways one can be aware, including levels of self-awareness that are more or less explicit and conceptual (Rochat, 2009). Infant studies call for a distinction between experiential and conceptual awareness: the awareness that accompanies being and acting in the world toward preferred goals, versus the awareness of a conceptualized and re-cognized world (a phenomenal consciousness that has, in addition, cognitive accessibility), following the recent discussion and distinction proposed by Ned Block (2007).

If in development experiential awareness precedes conceptual awareness, in the same way for example that independent sitting precedes bi-pedal locomotion, or that babbling precedes speaking, it does not mean that one is lacking coherence and unity, the other eventually endowed with it. It does not mean, either, that one kind of awareness calls for selfhood and the other does not.

The basic argument made here is that both conceptual (i.e. early body representation, the topic of this volume) and experiential awareness call for

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experiential unity and an ascription of selfhood, although at fundamentally different levels of mental functioning. Both conceptual and experiential awareness co-exist in development, particularly from the onset of language. From then on, our awareness tends to fluctuate from the experiential to the conceptual, in the same way that we sometimes sit and sometimes walk; sometimes babble and other times speak. In constantly transitioning through experiential and conceptual awareness, we do not each time lose or re-discover the sense of who we are, nor of what unifies our consciousness of the world.

### Embodied sense of self and unity at birth

Empirical observations suggest that infants at birth start off showing all signs of experiential awareness. They feel and are selective in what they feel. They show unity in learning, in representing, and in orienting toward vital resources of their environment: faces, food, caretakers they depend on to survive (Rochat and Senders, 1991; Rochat, 2001 for a review of such evidence). They manifest from the outset some sense of their own body as a substantial and bounded entity among other substantial and bounded entities. They show an experiential awareness of the body that is organized, multimodal, situated, differentiated, and purposeful in the environment, what would correspond to an implicit body schema that is the foundation of later developing explicit body representations (Gallagher and Meltzoff, 1996).

The argument proposed here is that all these features justify the theoretical ascription of embodied unity and selfhood to children from the outset of human development. The questions are, what kind and what changes in development?

Following Kant's classic proposal, for an experience to become conscious *about* something requires embodied unity in the sense that it requires that sensations from the world, including the body itself, be synthesized into intuitions and percepts, these percepts eventually coordinated to grasp patterns and ultimately form concepts (Brook, 1994). Based on these criteria, evidence suggests that infants from birth would manifest unity in the Kantian sense, to the extent that they respond to more than discrete and isolated sensations, and more importantly, to the extent that they differentiate sensations originating *from within or outside the body*. Infants from birth need to be considered as perceivers and actors, not just instinctive reflex machines. They behave as differentiated and organized embodied entities among other entities, and are not born in a primordial state of un-differentiation with the environment.

Recent empirical evidence allows non-trivial conclusions regarding the origins of self-consciousness and what it might be like to be a newborn, calling for radical revisions of strong-held beliefs and premises from which highly influential theories were built. These beliefs include for example the notion that the starting state of development is an exercise of discrete, not yet coordinated

hereditary "automatic" reflexes (Piaget, 1936), or Freud's seminal idea that beyond survival instincts, behavior at birth is reduced to some sort of blind, circular, non-objectified and autistic quest toward bodily excitation and suppression (Freud, 1905).

These notions do not allow ascribing to newborns the power of being conscious *about* something that is differentiated from their own bodily experience, hence of their own body as a differentiated entity among other entities in the environment. But, as I will try to suggest, research shows that there is apparently much more than reflexes, a-dualism, blind auto-eroticism, and primary narcissism at the origins of conscious life.

### Presumed mental weakness of the pre-verbal child

The fact that we do not have any explicit recollection of our own infancy makes the grasping of our origins in development difficult. Infantile amnesia prevents us from any direct reconstruction by way of introspection of what mental life might be at the origins and what our primeval experience is of being alive in the world. First coined by Freud, the phenomenon of infantile amnesia invites us to speculate that there might be a radically different mental organization at birth, or even *none* whatsoever. It leaves open the possibility of a different and incomparable experience to what we as adults experience of the world. Infantile experience would be yet un-repressed by conscious thoughts and without the awareness of others as "superego."

The memory black hole of the first months in the world outside of the womb has naturally enticed philosophers to think of a primary mental incompetence, the incompetence of infants to create memories, even memories stored for later retrieval. This absence of conscious recollection of our life prior to the third birthday is universal. It is pervasive despite the claims of highly speculative therapies and other rather unscrupulous psychoanalysts reconstructing from patient hearsay what young infants might feel and what might be meaningful events for them.

If we consider infantile amnesia as the symptom of an original incompetence, infants' inability to store and represent sensory information, it is also presumably the symptom of an original incapacity to synthesize sensory impressions into the concepts that give the mind its conscious unity. Children prior to 2–3 years would be incapable of giving sensory experience its unified "mindfulness." Translated in Kantian terms, infantile amnesia would be symptomatic of mental blindness. Babies' intuitions of the world and of their own body arising from sensory experience would be blind, not yet transcended into concepts and representations, not yet synthesized into bodies of knowledge that can be consciously retrieved.

This is what the founders of modern psychology assumed. Wilhelm Wundt, who established the first experimental psychology laboratory in Leipzig in the late nineteenth century, considered that infants could not help in the scientific understanding and conceptualizing of the adult mind. He writes in his *Outline of Psychology* (1897): "The results of experiments which have been tried on very young children must be regarded as purely chance results, wholly untrustworthy on account of the great number of sources of error. For this reason, it is an error to hold, as is sometimes held, that the mental life of adults can never be fully understood except through the analysis of the child's mind" (Eng. Trans. 1907, cited by Kessen 1965). Obviously, Piaget and his followers did not adhere to Wundt's intuition. Nor did the great number of infancy researchers in recent years decrying William James' (1890) idea that we are born into an initial state of "blooming, buzzing, confusion," interpreted as standing for an initial state of disorder and experiential chaos in dire need of organization (see Rochat, 2001 for a review).

Progress in neuroscience might also have reinforced this intuition as we now have ample evidence that the brain of the young child develops continuously in marked ways during the first 2–3 years of life, particularly pre-frontal regions of the neo-cortex that are involved in the higher order synthesis of neural information as in advanced executive function, inhibition in problem-solving and intentional actions (e.g. Zelazo, 2004). Furthermore, and this is what delimits infancy from childhood, by the second year children become symbolic, increasingly proficient with language and begin to manifest an unambiguous conceptual sense of who they are (Bates, 1990). Their vocabulary becomes full of personal pronouns and adjectives like "I," "me" and "mine." All of these mental changes that occur by the second to third year of life correlate with what is typically reported as our earliest, reliable memories.

From this point on, the veil of amnesia appears to be lifted. Memories are stored to become potentially retrievable and communicable in narrative forms (Dennett, 1992; Nelson and Fivush, 2004). From then on only, it would therefore be legitimate to postulate that the child possesses a mind that is explicitly conceptual, showing unity in the Kantian sense. This unity also implies a conceptual sense of who the child is as an entity among other entities, a person among other persons in the world. From the time they speak, children identify (re-cognize) themselves in mirrors and show embarrassment. They start to show off, begin to lie if necessary and to engage in pretense. Arguably, the child's experience rises to mindfulness proper. It is unified over time and space. Representations of representations are synthesized and organized into abstract concepts that can be mentally manipulated at will to generate new truths and true pre-visions about future states of the world.

In short, historically, there has been a natural inclination, albeit with good reason, for many thinkers of the mind to believe that there might be a lack of

unity at birth. The lack of unity would persist until children develop the ability to synthesize representations of the world that are memorable and organized along the continuum of time and space. If a concept of self is an a-priori condition of unity in consciousness – as was suggested by Kant – it would be erroneous to speak of any notion of "self" prior to language, prior to the explicit ability to remember, conceptualize, and re-cognize the world symbolically, in particular within symbolic conventions. This, of course, would extend to any other non-symbolic animals that do not possess language, namely creatures that are not capable of representing representations, not capable of organizing thoughts around a-priori truths and within a continuous timeline that gives hindsight to the direct sensory experience of the world.

There are marked qualitative shifts in how and what the mind processes between birth and the onset of language, particularly when the child starts to remember an increasing number of past events in the explicit narrative formats of autobiographical memories (Nelson and Fivush, 2004). However, much research shows now that the phenomenon of infantile amnesia is not due to a lack of unity or sense of self, as alluded to by the founders of modern psychology. In fact, infantile amnesia is becoming increasingly a "misnomer" given the flow of empirical evidence that demonstrates long-term procedural memory in infants of only a few months, infants who presumably should be deep into our memory "black hole" period (e.g. Bauer, 1996; Meltzoff, 1995; Rovee-Collier and Hayne, 2000). In addition, numerous studies show that the timing of first explicit memories (typically between 2 and 4 years) can vary greatly among individuals depending on memory content, gender, family structure and culture (Nelson and Fivush, 2004).

It thus appears that children develop autobiographical memory progressively, incrementally and in parallel to language development. It does not emerge abruptly as if children were overcoming the obstacle of a generalized amnesia, hence a disorganized mind incapable of having organized representations of representation, not functioning rationally on the basis of a-priori concepts, only finding unity and selfhood by their third birthday.

### **Distinguishing the experiential from the conceptual**

Newborns' experience of the world is rich from the start. It is rich within the polarity of pleasure and pain, restfulness and agitation, approach and avoidance. Newborns cry and fuss when hungry or tired. They show irrepressible smiles with eyes rolling to the back of their head after a good feed. They "feel" something, expressing unmistakable pleasure and pains. These expressions have adaptive functions, forming crucial signals for caregivers on whom newborns rely to survive. But how much unity and embodied self-awareness can be

ascribed to such emotional, obviously not yet objectified experience of being alive in the world?

To address this question, it is necessary to distinguish two basic forms of being in the world: the *experiential* and the *conceptual*. This is not a new approach, supported and proposed by recent research and theories in cognitive neuroscience, in the footsteps of William James proposing a distinction between the “I” or experiential self and the “me” or conceptual (objectified) self. Damasio (1999) emphasizes the fundamental difference between “core” consciousness and “extended” consciousness about the self and events that are construed over time and emerging with language. Similarly, Edelman and Tononi (2000) call for a distinction between primary and symbolic (language and narrative) driven consciousness. A large body of research in neuroscience supports the experiential diversity of being aware in the world, including blind-sight, hypnotic dissociation of pain and other highly relativist (as opposed to “real” or “core”) perceptual phenomena (see Gazzaniga *et al.*, 1998). There are different kinds of awareness, not all necessarily requiring re-cognition, language, or the capacity to represent representations as in meta-cognition. It is justified to talk about infra- or pre-linguistic awareness. There are indeed markedly different ways of being aware and conscious, as opposed to non-conscious or un-conscious (Rochat, 2009).

Newborns are not yet conceptually aware of being themselves alive in the world, obviously. However, they are *experientially* aware. Newborns, when not sleeping, are not merely in a wakeful state of confusion between what they feel and what causes them to feel. If they see a face or are struck by an object, they do not become this face or this object. Although not yet conceptualizing them as objects of reflection, they do not confound them with their own subjective feeling or sensory experience. This can be assumed to the extent that newborns’ feelings and behaviors cannot be simply reduced to automatic reflex responses, like the mechanical adjustments of a thermostat or any kind of automata.

Behavior at birth is more than a collection of automatic reflexes (Rochat, 2007). Rather than reflexes, it is more appropriate to talk about purposeful acts that are expression of innate action systems evolved to sustain infants’ survival in the state of prolonged immaturity (Bruner, 1972), what Montagu (1961) calls the human “*exterogestation*.” These systems include orienting, feeding, and exploring, all organizing children’s actions around features and resources in the environment that are relevant for their survival (Reed, 1982; Rochat and Senders, 1991).

Behavior at birth is thus more than the expression of highly predictable stimulus–response loops controlled by endogenous, self-contained and automatically triggered mechanisms. It is more than breathing or blinking. In addition to reflexes, newborns also manifest bodily movements that are *oriented* toward particular functional goals. These action 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. Furthermore, contrary to reflexes, these movements are organized into systems that are *flexible*, capable of changing based on previous experiences and adjusting to novel circumstances (see Rochat, 2007 for further discussion of the non-rigid and triggered aspect of behavior at birth). Orientation and flexibility are two aspects that argue against the reduction of behavior at birth to simple reflex mechanisms.

Infants are born predisposed to act with purpose, oriented toward indispensable resources in the environment, be it food, comfort, or protection. These innate functional action systems are what unify the experiential awareness of newborns. It is also what justifies the ascription of selfhood from the outset of development. For the rest of this chapter, I will attempt to provide empirical support for these claims (see also Butterworth, 1992 target article and follow up comments for a similar argument based on different perceptual and cognitive evidence).

### Criteria and evidence for basic experiential embodied unity at birth

As noted previously, following Kant’s view of the mind, sensory inputs from the world need to be unified to become conscious experiences “about something.” In other words, for the sense datum to become knowledge about the world, it needs to be synthesized within a temporal and spatial structure at three levels: (1) the transformation of sensory apprehension into intuitions or percepts; (2) the coordination of intuitions or percepts in reproductive imagination (what would correspond to mental simulation in today’s neuroscientific jargon); and (3) the recognition of concepts in coordinated intuitions (conceptualization of a-priori categories). Kant proposes that the unity of our conscious experience rests on these three kinds of synthesis, an idea that still prevails in current cognitive sciences.

Within this framework, one can argue that newborns do engage in the synthesizing of sense data, certainly at the first level proposed by Kant, and probably also at the second level. The third level seems to be evident only a few months down the road, possibly before the first birthday. For example, Jean Mandler (1988, 1992) provides some empirical evidence that by 9–12 months, infants might already manifest object categorization that is based on ontological concepts such as animate versus inanimate, self-propelled or not. Although such rich interpretation is disputed by other researchers (see Rakison and Poulin-Dubois, 2001), Mandler proposes that already in the first year infants engage in perceptual analysis that includes the three kinds of synthesis that for Kant are the foundation of unity in consciousness. But, what about newborns, what about

infants at birth? Do they show signs of unity in their experience? The most probable answer is yes.

If newborns were lacking unity, just bombarded by meaningless sensory stimulations, we would expect newborns' behavior to be fundamentally disoriented, just a collection of responses that would jerk them around in a disorganized manner. But ample evidence shows that this is not the case (Rochat, 2001). They learn and actively explore their environment, even showing evidence that prenatal experience and learning is transferred into postnatal life. For example, newborns a few hours old orient more toward the scent of their mother's amniotic fluid compared to the scent of the amniotic fluid of a female stranger. They also show active preference in hearing their mother's voice compared to another female voice (Marlier *et al.*, 1998a, 1998b; DeCasper and Fifer, 1980).

There is now substantial evidence demonstrating preference, active selection, learning (e.g. Marlier *et al.*, 1998), and even imitation in neonates (e.g. Meltzoff and Moore, 1977), all pointing to the fact that infants are born to a world they synthesize into meaningful features or affordances (Gibson, 1979). They are born endowed with the ability to detect these affordances and to synthesize them as invariant features of the environment (Rochat and Senders, 1991; Gibson, 1995). These invariants pertain equally to non-self objects and to the body. For example, a drop of sucrose on their tongue leads them to calm down and systematically bring hand to the mouth in the most direct trajectory for biting and sucking (Rochat *et al.*, 1988). The drop of sucrose engages the feeding or appetitive system of the infant that in turn mobilizes the whole body in orienting and rooting activities. These functionally purposeful activities come to rest only when something solid such as a finger or a nipple comes into contact with the face and eventually finds its way into the mouth for sucking (Blass *et al.*, 1989). Evidence of neonatal imitation of tongue protrusion, mouth opening, and finger movements (Meltzoff and Moore, 1977) is the expression of a body schema whereby the sight of active bodily regions in another person (the model) is mapped onto homologous regions of the own body. Another example of expressed body schema at birth is the systematic arm movements observed in neonates with their head turned to the side while lying supine in their crib and plunged in the dark with just a thin beam of light cutting across their visual field. In this condition, newborns are documented systematically bringing their ipsilateral hand and arm into the beam of light for active visual exploration (Van der Meer and Lee, 1995).

The behavioral orientation of newborns and their early propensity to detect invariant features in the environment (including the invariant features of their own body) all point to an experiential awareness at birth that is organized within a stable spatial and temporal structure. Newborns show quick learning, transfer, and use of prenatal experience into postnatal life. They memorize and recall procedural knowledge over time, orienting head and mouth significantly more

when, for example, the stimulation is food or any events associated with food and comfort (faces, posture, or certain tastes as well as smells; e.g. Marlier *et al.*, 1998a). Their behavior shows plasticity and is not limited to the here and now of random stimulation (e.g., Van der Meer and Lee, 1995). It is organized as a function of past experience, within an a-priori spatial and temporal structure (e.g. DeCasper and Fifer, 1980).

In short, newborns' behavior expresses an experience of the world that is unified by the detection of meaningful resources and by propensities to act in ways that serve their survival despite the neonate's initial altricial state of great social dependence.

### Primordial sense of an embodied self

The basic emotions expressed at birth are reliably identifiable by caretakers as pain, joy, disgust, interest, or anger. They are symptomatic of a rich affective life. Newborns express these emotions with their whole body, becoming spastic and tense in particular ways, emitting particular sounds, when for example crying out of pain as opposed to hunger (Formby, 1967). A rich palette of distinct affective motives underlies newborns' bodily movements and oral expressions.

In relation to the body as a whole, hand-mouth coordination systematically associated with the engagement of the feeding system, as in the case of the drop of sucrose on the tongue (Rochat *et al.*, 1988), is in itself suggestive that newborns possess rudiments of a body schema (Gallagher and Meltzoff, 1996; see Butterworth, 1992 for a similar argument). Such coordination implies some mapping of the body whereby regions and parts of the own body are actively and systematically (as opposed to just randomly) put in contact with each other, in this case hands and mouth with a straight and orchestrated spatio-temporal trajectory. Other expressions of a body schema include neonatal imitation and neonates' systematic exploration of their own arms and hands in the dark, as discussed earlier. In all, body schema and the active propensity of neonates to bring sense modalities and regions of their own body in relation with each other are now well documented.

This supports the idea that infants sense their own body from birth as an *invariant spatial structure*, even as rudimentary and in need of further refinement this spatial structure might be. This structure is obviously not Euclidean in the sense of being synthesized (represented) in the mind of the young infant as a precise map of accurate spatial coordinates and configurations. It does not yet entail that infants already have a re-cognizable image of their own body (a body image). This structure is essentially topological in the sense that it is made of focal attractor regions on the body surface that have many degrees of freedom and a high concentration of sensory receptors such as in the mouth and fingers.

This topology is embodied in action systems that are functional from birth and drive early behavior.

Evidence of a body schema at birth provides some theoretical ground for the ascription of basic selfhood from the outset. Research now demonstrates that neonates behave in relation to their own body in ways that are different, when compared to how they behave in relation to other physical bodies that exist independently of their own. They feel and unquestionably demonstrate from birth a distinct sensitivity to their own bodily movements via *proprioception* and internal (*vestibular*) receptors in the inner ears. Both proprioceptive and vestibular sensitivities are well developed and operational at birth. They are sense modalities of the self par excellence (Lee and Aronson, 1974; Butterworth and Hicks, 1977; Jouen and Gapenne, 1995).

Research shows, for example, that neonates root significantly more with head and mouth toward a tactile stimulation from someone else's finger than from their own hand touching their cheek (Rochat and Hespos, 1997). Other studies report that newborns pick up visual information that specifies ego-motion or movements of their own body while they, in fact, remain stationary. These studies indicate that neonates experience the illusion of moving, adjusting their bodily posture according to changes in direction of an optical flow that is presented in the periphery of their visual field (Jouen and Gapenne, 1995). This kind of observation points to the fact that from birth, infants are endowed with the perceptual, qua inter-modal capacity to pick up and process meaningfully *self-specifying* information.

Questions remain as to what might be actually synthesized or represented as an outcome of the self-specifying perceptual capacity manifested at birth. In other words, what might be the experience of embodied selfhood in neonates? What is the subjective experience of the own body considering that selfhood is first embodied, only later becoming re-cognized as "me."

### **Embodied self-experience at birth**

Neonates experience the body as an invariant locus of pleasure and pain, with a particular topography of hedonic attractors, the mouth region being the most powerful of all, as noted by Freud years ago. Within hours after birth, in relation to this topography, infants learn and memorize sensory events that are associated with pleasure and novelty: they selectively orient to odors associated with the pleasure of feeding and they show basic discrimination of what can be expected from familiar events that unfold over time and that are situated in a space that is embodied, structured within a body schema. But if it is legitimate to posit an a-priori "embodied" spatial and temporal organization of self-experience at birth, what might be the content of this experience aside from pleasure, pain, and the excitement of novelty?

Neonates appear to have an a-priori proprioceptive sense of their own body in the way they act and orient to meaningful affordances of the environment as well as in the way they detect visual information that specifies ego motion, adjusting their posture appropriately in direction and amplitude to compensate for surreptitious changes in gravitational forces (Jouen and Gapenne, 1995). The proprioceptive sense of the body is a necessary correlate of most sensory experiences of the world, from birth on. As proposed by James Gibson (1979), to perceive the world is to *co-perceive* oneself in this world. In this process, proprioception, or the muscular and skeletal sense of the body in reference to *itself*, is indeed the sense modality of the self.

From birth, proprioception alone or in conjunction with other sense modalities, specifies the own body as a differentiated, situated, and eventually an agentive entity among other entities in the world. This corresponds to what Ulric Neisser (1988, 1991) first coined as the "ecological self," a self that can be ascribed to infants from birth. As pointed out by Neisser (1995), criteria for the ascription of an ecological self rest on the behavioral expression by the individual of both an awareness of the environment in terms of a layout with particular affordances for action, and of its body as a motivated agent to explore, detect, and use these affordances.

Newborns fulfill the criteria proposed by Neisser for such awareness. In addition, however, it is legitimate to speculate that they also seem to possess an a-priori awareness that their own body is a distinct entity that is bounded and substantial, as opposed to disorganized and "airy." Newborns perform self-oriented acts by systematically bringing hand to mouth, as already mentioned. In these acts, the mouth tends to open in anticipation of manual contact and the insertion of fingers into the oral cavity for chewing and sucking (Blass *et al.*, 1989; Watson, 1995). What is instantiated in such systematic acts is, once again, an *organized body schema*. These acts are not just random and cannot be reduced to reflex arcs. They need to be construed as functionally self-oriented acts proper. Because they bring body parts in direct relation to one another, as in the case of hand-mouth coordination, they provide neonates with invariant sensory information specifying the own body's quality as bounded substance, with an inside and an outside, specified by particular texture, solidity, temperature, elasticity, taste, and smell.

The a-priori awareness of the own body as a bounded substantial entity is also evident in neonates' postural reaction and gestures when experiencing the impending collision with a looming visual object, an event that carries potentially life-threatening information. Years ago, Ball and Tronick (1971) showed that neonates aged 2–11 weeks manifest head withdrawal and avoidant behavior when exposed to the explosive expansion of an optic array that specifies the impending collision of an object. Infants do not manifest any signs of upset or avoidant behavior when viewing expanding shadows specifying an object



either receding or on a miss path in relation to them. Consonant with Ball and Tronick's findings, Carroll and Gibson (1981) reported that by 3 months, when facing a looming object with a large aperture in the middle, such as an open window in a façade, they do not flinch or show signs of withdrawal as they would with a full textured solid object. Instead, they tend to lean forward to look through the aperture. In all, the detection of such affordance in the looming object indicates that there is an a-priori awareness that the own body is substantial. There is a very early, possibly innate awareness that the own body occupies space and can be a physical obstacle to other objects in motion.

### Conclusions: from implicit to explicit embodied self-awareness in development

It is necessary to separate the experiential mind of the neonate from the conceptual, explicit, and symbolic mind that emerges with the first words and first reminiscing in narrative, more abstract forms of thinking. From birth on, research shows that infants act and perceive in a meaningful environment made of resources for comfort and satisfying needs as well as affordances for action. Behavior is best described as functionally purposeful from the outset, research showing that we are not born merely "automata" (Gibson, 1995).

I have tried to show that newborns' behavior demonstrates rudiments of an experiential awareness that has unity, this unity justifying an ascription of embodied selfhood. In relation to development, the question is *not* how we eventually become mindful from a starting state of confusion, *not* how we eventually become endowed with a strong mind pulling out of a primitive state of computational weakness, non-differentiation, and selflessness. Rather, based on what we now know about neonates, the question is how does the implicit awareness of the embodied self expressed already at birth come to be explicit and conceptual by the second year when children become self-conscious. How does the experiential *I* come to be also represented as the conceptual *me*? How does the breast that feeds me also become re-described as my mother, when embodied space and time becomes also objectified and measured? What might drive such development? That is the perennial question of developmental psychology.

In the footsteps of Piaget's seminal work, a host of new developmental theories and research try to document the unfolding of conceptual awareness early in life, sometimes trying to characterize corresponding levels of phenomenal awareness in the developing child that can be applied to the awareness of the embodied self (Zelazo, 2004). Trying to accommodate new findings on infant cognition, and as an alternative to Piaget's domain-general constructionist views on cognitive development, Karmiloff-Smith (1992) proposes that the implicit and procedural format of knowledge evident at birth in specific

domains of consciousness (e.g. face perception, imitation, number sense) would be *automatically* re-described at a representational level. According to this model, "representational re-description" is the inescapable consequence of practice and the behavioral mastery achieved by infants in their insatiable propensity to learn, master, and discover. Note that such a model applies equally to self-awareness in development (see Zelazo *et al.*, 2007).

Following the model, with practice and improvement perception and action that are first implicit and non-reflexive would be progressively re-described at increasingly abstract levels, each level opening up new intra- and inter-domain relations (see Karmiloff-Smith, 1992 for more details). The spontaneous re-description of implicit knowledge accompanying learning and procedural mastery would eventually lead the child toward explicit and verbalized consciousness. Here, the driving force behind developing consciousness from the outset would be spontaneous and recurrent re-description of representations across domains of knowledge into higher-level format of abstraction and communicability. These domains would obviously include self-knowledge and the own body representation.

What is interesting and relevant in relation to the argument of unity and selfhood at birth is the fact that a mechanism of representational re-description presupposes a representation to begin with (what Zelazo, 2004 labels "minimal consciousness" in his model of consciousness development). It is this minimal "embodied" consciousness in the newborn that I tried to account for in this chapter. However, aside from the empirically informed depiction of a starting state awareness and the distinction between various levels of experiential awareness and representation expressed by children in their development, the question of what might be the *causes* of processes such as the spontaneous representational re-description mechanism described by Karmiloff-Smith remains wide open. This is particularly true in light of the fact that such processes appear to exist prior to language which is often considered as the major determinant of reflexive consciousness and meta-cognitive capacities, what Lev Vygotsky (1978) viewed as internalized thinking derived from language acquisition.

Aside from behavioral evidence, developmental research in the neurosciences reveals neural markers of emerging and putative changes in experiential awareness at birth, and even prior during fetal development. For example, first evidence of consciousness might be attributed to the development of functional neural pathways that link thalamus and sensory cortex already by the third trimester of gestation, or even earlier with the emergence of functional pathways necessarily involved in conscious pain perception (Lee *et al.*, 2005). If there is a renewed effort in mapping pre- and postnatal brain growth, using neural markers that would correlate with levels of consciousness achieved by children in development, we are still far from explaining the actual mechanisms that

would drive such development. If there is a positive correlation between brain growth and levels of consciousness, including levels of embodied self-consciousness achieved by the child (see Zelazo *et al.*, 2007), we are still far from a causal explanation.

Language and its progressive mastery do certainly play a causal role in the development of new explicit levels of consciousness. We don't have to assume that language shapes the mind, to recognize that language use by the child in interaction with scaffolding others and its progressive mastery does unquestionably contribute to new levels of abstraction and representational re-description. But to a large extent we are still very much agnostic as to what might trigger such re-description prior to language and what might lead infants in particular to re-describe their innate unity and sense of selfhood to eventually become explicit and conceptual about it. We can assume, however, that from the outset, social interactions with more advanced and linguistically competent others play a central role in infants' advances toward more abstract levels of embodied self-awareness (Vygotzky, 1978; Tomasello, 2008).

These developmental issues form a challenge that is worth embracing because the way children develop and what develops in their experience of the world, including their own body experience, can reveal the building blocks and layers of what we construe as adult forms of consciousness and embodied self-consciousness.

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## 2 The development of body representations: the integration of visual-proprioceptive information

*Stephanie Zwicker, Chris Moore and Daniel Povinelli*

Body representations may be considered in terms of both their first- and third-person characteristics. By first-person, we mean those aspects of body awareness and knowledge that are typically exclusively available to the “owner” of the body – the self. By third-person, we mean those aspects of body awareness and knowledge that are at least potentially available to any observer. Although there is overlap between first- and third-person characteristics – I can observe my own hand movements as I type just as anyone who happens to be watching me type can also observe these movements – there are also some qualitatively distinct characteristics. Most importantly, the owner of the body gets various kinds of information in a qualitatively different form and in some sense “privately.” For example, the proprioceptive sense yields a type of first-person information that allows for awareness of one’s movement and the relative position of various parts of one’s body. Thus, even without visual information, it is possible to determine fairly accurately both dynamic and spatial aspects of one’s body parts through proprioception. And so, in the dark, I know a lot more about my body than you do.

At least in humans, however, bodies are represented simultaneously in terms of both first- and third-person characteristics. Bodies have both externally observable properties and internal conditions. As adults, our experience and representation of our own bodies, for the most part, consist of integrated multi-sensory input. That is, when we perform an arm movement, we do not perceive the visual and proprioceptive information as separate yet correlated, but instead as unified and integrated. Similarly, the observed movement of our faces when we look in a mirror is perceived in integration with felt movement of our face. This integration depends upon the perfect temporal coincidence of the relevant information. In illustration, we know that adults will misperceive a fake rubber hand as their own under conditions where they are presented with a tight temporal correlation between first person information (either tactile or proprioceptive) from their own real hand and “third person” visual information from the rubber hand (e.g. Botvinick and Cohen, 1998; Dummer *et al.*, 2009).

It is worth noting here that such integrated multimodal body representations are applied equivalently to both self and other (Barresi and Moore, 1996;