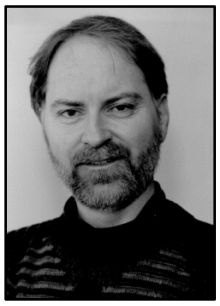
A conference was held in Prague, Czech Republic, in November 2002 that was entitled "Issues Confronting the Post-European World" and that was dedicated to Jan Patočka (1907-1977). ***The Organization of Phenomenological Organizations*** *was founded on that occasion. The following essay is published in celebration of that event.*

Essay 41

Neurophenomenological Research on Embodied Experience[1]



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Abstract

This paper combines phenomenological and empirical research on questions that pertain to human embodiment. Starting with the conceptual distinction between 'body image' and 'body schema', it explores the possibilities and limitations of using these concepts to explain a variety of embodied experiences, including neonate imitation, primary self-consciousness, and pathologies such as unilateral neglect, deafferentation, and aplasic phantom limbs.

Recently, the neuroscientist Jean-Pierre Changeux gave expression to a spirit of détente in interdisciplinary affairs. He suggests that cognitive neuroscientists should "not to go to war against phenomenology; to the contrary, [he wants] to see what constructive contribution it can make to our knowledge of

[1]This text can be considered an Abrégé or précis of my forthcoming book, How the Body Shapes the Mind (Oxford: Oxford University Press, 1994). A conference version of this paper, "Phenomenological and experimental research on embodied experience," was first presented at Atelier phénoménologie et cognition, organized by the Phénoménologie et Cognition Research Group, CREA. Paris (December 2000). A Danish translation of that version was published as "Født med en krop [Born with a body]: Fænomenologisk og eksperimentel forskning om oplevelse af kroppen," trans. Ejgil Jespersen. Tidsskrift for Dansk Idraetspsykologisk Forum (Danish Yearbook for Sport Psychology) 29: 11-51. I dedicate this paper to the late Francisco Varela, a good friend and continuing inspiration.

the psyche, acting in concert with the neurosciences" (Changeux and Ricoeur, 2000, p. 85). I have called this an "uneasy détente" (Gallagher, 1997) because of the lack of comfort found on both sides of the disciplinary lines. It is not unusual to find dismissive gestures made toward phenomenology by philosophers of mind like Daniel Dennett (1991), who confuses phenomenological method with the worst forms of introspection. For very different reasons, resistance is frequently found on the phenomenological side of this issue. Thinkers well versed in the transcendental tradition of Husserl, for example, often exhibit a form of philosophical neurophobia and immediately think that any mention of the central nervous system is reductionistic. There are, of course, traditional approaches to the cognitive sciences that are simply too computational or too reductionistic to be seriously considered as capable of explaining experience or consciousness. Part of the motivation for drawing on the phenomenological tradition in this context, however, is to move forward on a new and expanded conception of the cognitive sciences (see Gallagher and Varela, 2002). This project also entails rethinking the concept of phenomenology and its relation to the empirical sciences.

For phenomenologists, however, there is precedent to be found in the works of Maurice Merleau-Ponty and Aron Gurwitsch, and others informed and inspired by phenomenonlogy, like Hans Jonas and Erwin Strauss. These thinkers integrated phenomenological analyses with considerations drawn from the empirical sciences of psychology and neurology long before cognitive science was constructed as a working framework for understanding the mind. More recently a small but growing number of phenomenologists and scientists have renewed and explored the idea that phenomenology may be directly relevant for a scientific understanding of cognition. Sometimes the empirical scientists themselves have arrived at this conclusion even before, and in spite of the philosophers. Francisco Varela's work on neurophenomenology provides an important example (Varela, 1996).

It is in the spirit of these earlier phenomenologists, especially Merleau-Ponty, and Varela's concept of neurophenomenology, that I offer the following analysis. My thought is that rather than developing here a theoretical justification of what Varela has called the "mutual constraint," and what I like to call the "mutual enlightenment," that is possible between phenomenology and the cognitive neurosciences, it may be more productive to provide an example of this kind of analysis.

I. Phenomenological Distinctions in the Lived Body

> It is not enough to say that the mind
> is embodied; one must say how.
> (Edelman, 1992)

It is a long-established principle in phenomenology that a strictly physical (neuroscientific) analysis of the objective body not sufficient to reveal its contribution to cognition. Phenomenology proposes an analysis of the body as we live it. In the context of the cognitive sciences, however, we cannot stop with a pure phenomenology of lived experience. We need to appeal to empirical verifications and clarifications that will correlate with phenomenological insight, and then use that insight to interpret the empirical data – a hermeneutical circle, but not a methodologically vicious one.

The following considerations about embodiment start with two preliminary questions. (1) To what extent and in what way is one's body part of one's perceptual field? This question is clearly open to phenomenological analysis. (2) How does the body shape cognition? In this case, phenomenology can point in the direction of certain "prenoetic" performances of the body; but empirical science is required to clarify such performances.

Psychologists already have a relatively developed way of addressing the first question about the appearance of the human body in the perceptual field, or more generally, about the image that a person has of her own body. In most instances, this is referred to as a body image. The extensive literature on body images, however, is problematic. First, it is too wide-ranging. The concept is employed and applied in a great variety of fields, from neuroscience to philosophy, from the medical sciences to the athletic sciences, from psychoanalysis to aeronautical psychology and robotics. As often happens in such cases, a term can change meaning across fields and disciplines. Even within a particular discipline one can find subtle shifts in the meaning of the term body image. Perhaps even more surprising is the fact that the term often shifts meaning within the works of a single author.

Problems about the meaning of the term body image are also bound up with the use of another term, body schema. This is not just a terminological problem. The terminological confusion tells of a more deep-seated conceptual confusion. Precisely such confusions, which can lead to problems involving experimental design and the interpretation of experimental results, motivate some authors to suggest that we ought to give these terms up, abandon them to

history, and formulate alternative descriptions of embodiment (e.g., Poeck and Orgass, 1971). I argue here that it is important to retain these terms and to formulate a clear conceptual distinction between them. It will be apparent in the following discussion that the distinction between body image and body schema cuts across a number of other distinctions, such as conscious/nonconscious, personal/subpersonal, explicit/tacit, and willed/automatic. The body image/body schema distinction, however, is not reducible to any one of these, and no other distinction seems to carve up the conceptual space in quite the right way.

With respect to our two questions, I want to show that the distinction between body image and body schema can do some useful work despite the ambiguity involved in the historical use of these concepts. Each concept addresses a different sort of question. The concept of body image helps to answer the first question about the appearance of the body in the perceptual field; in contrast, the concept of body schema helps to answer the question about how the body shapes the perceptual field. So these terms and concepts, if properly clarified, provide a way to explicate the role embodiment plays in the structuring of consciousness.

Rather than rehearse the long history of conceptual confusion regarding these terms (see Gallagher, 1986 and 1995), let me go directly to the conceptual distinction that I propose, based on a phenomenological analysis, and then verified and clarified by empirical studies. Specifically the phenomenological results are verified empirically in studies of neonate imitation and primitive self-consciousness, as well as the pathologies involved in unilateral neglect, deafferentation, and phantom limb.

Phenomenological reflection tells us that there is a difference between taking an intentional attitude towards one's own body (having a perception of, or belief about, or emotional attitude towards one's body) and having a capacity to move or to exist in the action of one's own body. The concepts of body image and body schema correspond to this phenomenological difference, as the following definitions make clear.

> Body image is a (sometimes conscious) system of perceptions, attitudes, and beliefs pertaining to one's own body.
>
> Body schema is a system of processes that constantly regulate posture and movement – sensory-motor processes that function without reflective awareness or the necessity of perceptual monitoring.

Body schemas (the plural) refer to a collection of sensory-motor interactions that individually may be defined by a specific movement or posture, for example, the movement of hand to mouth.

The distinction between body image and body schema is not an easy one to make because behaviorally the two systems interact and are highly coordinated in the context of intentional action, and in pragmatic and socially contextualized situations. A phenomenologically-based conceptual distinction is nonetheless useful precisely in order to understand the complex dynamics of bodily movement and experience.

The body image, consisting of a complex set of intentional states – perceptions, beliefs, and attitudes – in which the intentional object of such states is one's own body, involves a form of reflexive or self-referential intentionality. Studies involving body image (e.g., Cash and Brown 1987; Gardner and Moncrieff 1988; Powers et al. 1987) frequently distinguish among three of these intentional elements:

(a) the subject's perceptual experience of her own body;
(b) the subject's conceptual understanding (including folk and/or scientific knowledge) of the body in general; and
(c) the subject's emotional attitude toward his own body.

Although (b) and (c) do not necessarily involve an occurrent conscious awareness, they are maintained as sets of beliefs, attitudes, or dispositions, and in that sense form part of an intentional system. Conceptual and emotional aspects of body image are no doubt affected by various cultural and interpersonal factors. It is also the case, as I will suggest below, that the noematic content associated with the body image originates in intersubjective perceptual experience.

In contrast to the body image, a body schema is not a perception, a belief, or an attitude. Rather it is a system of motor functions or motor programs that operate below the level of self-referential intentionality. It involves a set of tacit performances – preconscious, subpersonal processes that play a dynamic role in governing posture and movement. In most instances, movement and the maintenance of posture are accomplished by the close to automatic performances of a body schema, and for this very reason the normal adult subject, in order to move around the world, neither needs nor has a constant body percept. In this sense the body tends to efface itself in most normal activities that are geared into external goals. To the extent that one does become

aware of one's own body in terms of monitoring or directing perceptual attention to limb position, movement, or posture, then such awareness helps to constitute the perceptual aspect of a body image. Such awareness may then interact with a body schema in complex ways, but it is not equivalent to a body schema itself.

That the body schema operates in a close to automatic way does not mean that its operations are a matter of reflex. Movements controlled by a body schema can be precisely shaped by the intentional experience or goal-directed behavior of the subject. If I reach for a glass of water with the intention of drinking from it, my hand, completely outside of my awareness, shapes itself in a precise way for picking up the glass. It takes on a certain form in conformity with my intention. Thus it is important to note that although a body schema is not itself a form of consciousness, or in any way a cognitive operation, it can enter into and support (or in some cases, undermine) intentional activity, including cognition. Motor action is not completely automatic; it is often part of a voluntary, intentional project. When I jump to catch a ball in the context of a game, or when I walk across the room to greet someone, my actions may be explicitly willed, and governed by my perception of objects or persons in the environment. My attention, however, is centered on the ball or on the other person, and not on the precise accomplishment of locomotion. In such cases the body moves smoothly and in a coordinated fashion not because I have an image (a perception) of my bodily movement, but because of the coordinated functioning of a body schema. In such movements, a body schema contributes to and supports intentional action.

It is also the case, as I mentioned, that in some situations a body image or percept contributes to the control of movement. The visual, tactile, and proprioceptive attentiveness that I have of my body may help me to learn a new dance step, improve my tennis game, or imitate the novel movements of others. In learning a new dance step, for example, I may consciously monitor and correct my movement. In another case, my movement along a narrow ledge above a deep precipice may involve a large amount of willed conscious control based on the perception of my limbs. Even in such cases the contribution made to the control of movement by my perceptual awareness of my body will always find its complement in capacities that are defined by the operations of a body schema that continues to function to maintain balance and enable movement. Such operations are always in excess of what I can be aware of. Thus, a body schema is not reducible to a perception of the body; it is never equivalent to a body image.

Let us consider a little more closely the conscious awareness of one's own body. Is my body always intentionally present, that is, am I always conscious of my own body as an intentional object, or as part of an intentional state of affairs? The distinction between consciously attending to the body and being marginally aware of the body is important. It appears that sometimes we do attend specifically to some aspect or part of the body. In much of our everyday experience, and most of the time, however, our attention is directed away from the body, toward the environment or toward some project we are undertaking. In cases where our attention is not directed toward the body, do we remain consciously aware of some aspect or part of the body? Such awareness may vary by degree among individuals – some more aware, others, at times, not at all aware of their body. If I am solving a difficult mathematical problem, am I also and at the same time aware of the position of my legs or even of my grip on the pencil, or are these things so much on "automatic pilot" that I do not need to be aware of them?

To define a difference between body image and body schema it is not necessary to determine to what extent we are conscious of our bodies. It suffices to say that sometimes we are attentive to or aware of our bodies; other times we are not. A body image is inconstant in this sense at least. Conscious perception of my own body can be used to monitor and control my posture and movements. Ordinarily, however, in walking I do not have to attend to putting one foot in front of another; I do not have to think through the action of reaching for something. I may be marginally aware that I am moving in certain ways, but it is not usually the center of my attention. And marginal awareness may not capture the whole movement. If I am marginally aware that I am reaching for something, I may not be aware at all of the fact that for the sake of balance my left leg has stretched in a certain way, or that my toes have curled against the floor. Posture and the majority of bodily movements operate in most cases without the help of a body image.

Some of the operations performed by the body that remain outside of conscious attention, and even outside of perceptual awareness, belong to a system of processes that we are designating as the body schema. As I have indicated, a body schema is neither a perception, nor a conceptual understanding, nor an emotional apprehension of the body. As distinct from body image it involves a prenoetic performance of the body, that is, a performance that helps to structure consciousness, but does not explicitly show itself in the contents of consciousness. Through this performance the body acquires a certain organization or style in its relations with its environment. For example, it

appropriates certain habitual postures and movements; it incorporates various significant parts of its environment into its own schema. The carpenter's hammer becomes an operative extension of the carpenter's hand, or, as Head (1920) noted in commenting on the fashions of his day, a body schema can extend to the feather in a woman's hat. The system that is the body schema allows the body to actively integrate its own positions and responses and to deal with its environment without the requirement of a reflexive conscious monitoring directed at the body. It is a dynamic, operative performance of the body, rather than a copy, image, or conceptual model of it.

The body-schema system, as the result of a variety of perceptual and non-perceptual inputs, prenoetically governs the postures that are taken up by the body in its environment. That a body schema operates in a prenoetic way means that it does not depend on a consciousness that targets or monitors bodily movement. This is not to say that it does not depend on consciousness at all. For certain motor programs to work properly, I need information about the environment, and this is most easily received by means of perception. If, in the middle of our conversation, for example, I decide to retrieve a book from across the room to show you something, I may be marginally conscious of some of the various movements I am making: rising from the chair, walking across the room and reaching for the book. But my attention is not directed at the specific details of my motor behavior, nor am I even aware of all relevant aspects of my movement. Rather, I am thinking about the passage I want to show you; I am trying to spot the book; I am marginally aware of a piece of furniture I should try to avoid, and so forth. My consciousness of this environment and the location of things that I need to reach will guide my movement, and will help my body gear into that environment in the right way. In that sense, consciousness is essential for the proper operation of a body schema. But the fact that my posture undergoes a complete transformation, the fact that I put one foot in front of another in a specific way, the fact that my body maneuvers in a certain way around the furniture, the motor facts of my reaching and grasping, and so forth, are not the subject-matter of my consciousness.

In so far as I am conscious of my bodily movement, the content of my consciousness is specified in its most pragmatic meaning. That is, if I were to formulate the content of my consciousness in this regard, it would not be in terms of operating or stretching muscles, bending or unbending limbs, turning or maintaining balance; it would not even be in terms of walking, reaching, standing or sitting. Rather, in the context of an intentional project, if I were stopped and asked what I was doing, I would say something like "I'm getting a

book." All of the bodily movement entailed in that action remains phenomenologically hidden behind that description. I am aware of my bodily action not as bodily action per se, but as action at the level of my intentional project. Thus, prenoetic functions underpin and affect explicitly intentional experience, and are subsumed into larger intentional activities. In this sense, detailed aspects of movement (such as the contraction of certain muscles), even if we are not aware of them (even if they are not explicitly intentional), are intentional insofar as they are part of a larger intentional action.

The body-schema system takes measure of its environment in a pragmatic rather than objective fashion. It allows a subject who is immersed in conversation, for instance, to walk beneath a low-hanging tree branch without bumping her head; it enables her to maneuver around objects in her path without having to think about what she is doing or calculate the distance between her and the objects. In contrast to results obtained in body-image studies of estimation of body size, the issue of calculated objective measurement does not pertain to the body schema. For example, in studies of size estimation of one's own body, size is consistently overestimated relative to other objects (Shontz, 1969; Gardner, et al. 1989). If we depended solely on body image to get around – something that does occur in rare instances – our movements would be inexact and awkward. Just consider, for example, the prospect of having to think through every step of walking across a room. In this sense, neither an account of body image, nor an objective, third-person account of bodily movement, is equivalent to an account of body schema and does not fully represent the way in which the body functions in human experience.

Establishing a phenomenologically-informed conceptual distinction between body image and body schema is only the beginning of an explication of the role played by the body in action and cognition. There are reciprocal interactions between prenoetic body schemas and cognitive experiences, including normal and abnormal consciousness of the body. Such behavioral relations between body image and body schema can be worked out in detail, however, only if the conceptual distinctions between them are first understood.

I have suggested through a phenomenological analysis that the two concepts can be kept distinct, that the terminology does not have to be confused, and that such distinctions are clarifying rather than confusing. The conceptual distinctions that I have outlined are based more on phenomenology than on a study of empirical function, and they do not tell us in precise terms what the body schema is or how it functions. To take the analysis further along that line I turn now to empirical studies.

II. Verifications and Clarifications from the Empirical Literature

A. Unilateral Neglect and Deafferentation

Importantly, it is possible to find cases in which a subject has an intact body image but a dysfunctional body schema, and vice versa. This kind of situation is referred to in psychology as a double dissociation, and such dissociations constitute good evidence for the real basis of a distinction. For example, one finds evidence of an intact body schema in the absence of a completely intact body image in some cases of unilateral neglect. Denny-Brown and his colleagues report that a patient suffering from a neurologically caused persistent defect in perception related to the left side, fails to notice the left side of her body; excludes it from her body percept. She fails to dress her left side or comb the hair on the left side of her head. Yet there is no motor weakness on that side. Her gait is normal, although if her slipper comes off while walking she fails to notice. Her left hand is held in a natural posture most of the time, and is used quite normally in movements that require the use of both hands, for example, buttoning a garment or tying a knot. She uses her left hand and thus the motor ability of the neglected side, to dress the right side of her body (Denny-Brown, Meyer, and Horenstein, 1952). Thus her body schema system is intact despite her problems with body image on the neglected side.

Similar patients are described by Ogden (1996) and Pribram (1999). Ogden describes a neglect patient, Janet, as "reluctant to dress the left side of her body," and as letting her left leg hang over the edge of the bed (p. 109). Janet has been diagnosed with motor neglect or akinesia, which involves deficits that seem to be associated with the body schema. Patients with this condition show an inability to initiate an action on the neglected side (Heilman et al., 1987). Despite appearances, however, Janet is not hemiplegic. In fact, she suffers from an attention problem, and it is her body image that is deficient for the neglected side. Although she will not spontaneously move her neglected left arm at all, she is still able to use that arm if its movement is directed to the right side, ipsilateral to the brain lesion. Patients such as this may unconsciously use their left arm to brush a fly from their face, or be able to use it with concentrated effort. Janet, for example, sometimes uses both legs to walk. Other times, she hops on one leg (Ogden 1996). In the case described by Pribram, the subject uses her neglected

arm but is unaware of it. She reports that she takes classical guitar lessons, but does not feel the strings or frets. "I don't know where my fingers are nor what they are doing, but still I play" (Pribram, 1999, p. 23). In such cases, awareness of the arm is seriously impaired, but purposive movement is still possible.

Dissociation of the opposite kind can be found in rare cases of deafferentation. A subject (IW) who has lost tactile and proprioceptive input from the neck down can control his movement only by cognitive intervention and visual guidance of his limbs. In effect he employs his body image (primarily a visual perception of his body) in a unique way to make up for the impairment of his body schema (see Cole, 1995, Gallagher and Cole, 1996).

IW suffers from an acute sensory neuropathy in which large fibers below the neck have been damaged due to illness. As a result he has no sense of touch and no proprioception below the neck. IW is still capable of movement and he experiences hot, cold, pain, and muscle fatigue, but he has no proprioceptive sense of posture or limb location. Proprioception is that bodily sense which allows us to know how our body and limbs are positioned. If I ask a person with normal proprioception to sit, close their eyes, and point to their knee, it is proprioception that allows them to successfully guide their hand and find their knee. If I ask IW to sit, close his eyes, and point to his knee, he has some difficulty. If, in this situation, I moved either his knee or his arm, he would be unable to point to his knee since, without vision or proprioception, he would not know where either his knee or his hand were located. He would assume that they were in exactly the same location as when he last saw them and he would move his hand so as to point to where he remembers his knee to have been.

Prior to the neuropathy IW had normal posture and was capable of normal movement. At the onset of his illness IW's initial experience was the complete loss of control of posture and movement. He could not sit up or stand or move his limbs in any controllable way. For the first three months, even with a visual perception of the location of his limbs, he could not control his movement. In the course of the following two years, while in a rehabilitation hospital, he gained enough motor control so that he could feed himself, write, and walk. He went on to master everyday motor tasks involved in personal care, housekeeping, and those movements required to work in an office setting.

Because of the loss of proprioception and tactile sense IW does not know, without visual perception, where his limbs are or what posture he maintains. In order to maintain motor control he must conceptualize his movements and keep certain parts of his body in his visual field. His movement requires constant visual and mental concentration. In darkness he is unable to

control movement; when he walks he cannot daydream but must concentrate on his movement constantly. When he writes he needs to concentrate on both his body posture and on holding the pen. Maintaining posture is, for him, a task rather than an automatic process. IW learned through trial and error the amount of force needed to pick up and hold an egg without breaking it. If his attention is directed toward a different activity while holding an egg, his hand either crushes the egg or drops it.

In terms of the distinction between body image and schema, IW has lost major aspects of his body schema, and thereby the possibility of normally unattended movement. He is forced to compensate for that loss by depending on his body image in a way that normal subjects do not. For him, control over posture and movement are achieved by a partial and imperfect functional substitution of body image for body schema.[2]

That proprioception is a major source of information for the maintenance of posture and the governance of movement – that is, for the normal functioning of the body schema – is clear from IW's experience. But proprioception is not the only possible source for the required information. IW, as a result of extreme effort and hard work, recovered control over his movement and regained a close to normal life. It is important to understand that he did not do this by recovering proprioceptive sense. In strict physiological terms, he has never recovered from the original problem. His neuropathy has not been repaired. He has been able to address the motor problem on a behavioral level, however, by rebuilding a partial body schema and by using body image to help control movement. This case, in terms of the body image-body schema distinction, is just the opposite to neglect. If the neglect patient is capable of controlled movement even on the neglected side because of an intact body schema, IW, who is unable to depend on a body schema, must employ his body image to guide his movement. In complete contrast to neglect, IW is required to pay an inordinately high degree of attention to his body.

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[2] This conclusion is supported by studies using transcranial magnetic stimulation (Cole and Katifi, 1991; Cole et al., 1995) and recent PET studies (Cole, Athwal, Wolpert, Frith & Frackowiak, 2001). In the PET studies IW and 6 controls performed a simple sequential left side finger thumb apposition task movement with on-line visual feedback via a video display movement with vision of the still hand (no visual feedback of movement). In the case of moving with visual feedback a wide number of brain areas (not activated by controls) were activated in IW: right pre-visual and bilateral cerebellar areas – indicating greater dependence (relative to controls) on visual feedback for supervision of movement. In the case of movement with no visual feedback there was activation in IW of right prefrontal, right inferior parietal cortex and bilateral cerebellum, (both visual and motor areas) – indicating a top-down, cognitively planned control of movement.

Cases of unilateral neglect and deafferentation, and the double dissociation implied, complement the phenomenological description, and provide the logical and empirical reasons for thinking that there is a useful distinction to be made between body schema and body image.

B. Neonate Imitation

I turn now to questions about development. In sorting out the relations between consciousness and embodiment, one may be inclined to see a certain complication arising with respect to developmental issues. Even if we say that embodiment constrains consciousness in certain ways which involve concepts like body image and body schema, one may think that at some point in ontogenesis this is not true. Prior to the development of a body image or a body schema in a small child, for example, perhaps something like a less embodied consciousness exists. Less embodied may even mean less structured, along the lines of William James's famous phrase about the "blooming, buzzing confusion" of the infant's experience. It is not unusual to find proponents of the view that conscious experience is in some way the developmental source for both the body image and the body schema. Indeed, as we will see, this is the traditional view in both psychology and philosophy.

An empiricist, for example, might hold that a body image is generated only on the basis of the prolonged perceptual experience that one has of one's own body. Conceptual and emotional aspects of the body image, and the structural aspects that the body image brings with it, are obviously traceable to certain early and originary experiences that the child may have in tactile, visual and other sensations of the body. It might also be thought that a body schema originates only through the conscious experience of movement. Much as we learn habits through practice, we learn to control our movements through the practiced experience of movement. This seems to be the case in examples we referred to before, such as in the learning of a new dance movement. It seems more obviously true of learning to crawl and to walk. On this view, then, conscious experience is at the origin of such things as body image and body schema. Thus, a certain kind of consciousness, primitive and perhaps disorganized, would predate the consciousness that is shaped and structured by embodiment.

This traditional view assumes that the newborn infant has no body image or body schema, and that such mechanisms are acquired through prolonged experience in infancy and early childhood. This view has been worked out in a

number of ways and in a variety of contexts in scientific and philosophical discussions. Up until about thirty years ago this position was the almost unanimous consensus among developmental theorists. At that time, however, on several fronts, new evidence was developed in support of a more nativist position. The idea that body schemas may in fact be innate was put forward, for example, in studies of phantom limb in cases of congenital absence of limb (Weinstein and Sersen, 1961). In the 1970s, in studies of neonate imitation (Meltzoff and Moore, 1977), further evidence was provided to show that certain elements of what previously were understood to be learned motor behaviors were in fact already present in the newborn. I will first consider the controversy over neonate imitation, and then return to the issue of aplasic phantoms.

The traditional view is that the body schema is an acquired phenomenon, built up in experience, the product of development. This traditional view is well-represented by the developmental psychologist Marianne Simmel (1958, 1962, 1968), one of the few psychologists who makes a clear distinction between body schema and body image. The body schema, Simmel claims, is

> built up as a function of the individual's experience, i.e., it owes its existence to the individual's capacity and opportunity to learn. This means that at some early time in the development of the human organism the schema has not yet been formed, while later … it is present and is characterized by considerable differentiation and stability. (1958, p. 499).

We can see this position expressed in Merleau-Ponty (1962), who was greatly influenced by his study of developmental psychology and by the psychologists and psychological research he cited, including the work of Piaget, Wallon, Guillaume, and Lhermitte. Although Merleau-Ponty rightly conceives of the body schema as an anterior condition of possibility, a dynamic force of integration that cannot be reduced to the sum "of associations established during experience," still, in terms of development, the operations of the body schema are "'learnt' from the time of global reactions of the whole body to tactile stimuli in the baby …" (1962, pp. 101, 122n). The body schema functions as if it were an "innate complex" (p. 84), that is, as strongly and pervasively as if it were innate, but, as an acquired habit with a developmental history, it is not actually innate.

Merleau-Ponty, following Wallon, believed that experience begins by being interoceptive, and that the newborn is without external perceptual ability

(1964, p. 121). James's "blooming, buzzing confusion" does not begin to be straightened out until between the third and sixth month of life when a collaboration takes place between the interoceptive and exteroceptive domains – a collaboration that simply does not exist at the beginning of life (1962, p. 121). On this view, one reason for the lack of any organized exteroceptive perception is precisely the absence of a "minimal bodily equilibrium," an equilibrium that must be sorted out between a developing body schema and the initial and still very primitive stages of a body image. For Merleau-Ponty, motor experience and perceptual experience are dialectically or reciprocally linked. The mature operation of a body schema depends on a developed perceptual knowledge of one's own body; and the organized perception of one's own body, and then of the external world, depends on a proper functioning of the body schema.

> Up to that moment [exteroceptive] perception is impossible …. The operation of a postural schema – that is, a global consciousness of my body's position in space, with the corrective reflexes that impose themselves at each moment, the global consciousness of the spatiality of my body – all this is necessary for [exteroceptive] perception (Wallon). (Merleau-Ponty, 1964, p. 122).

The infant does not yet have a body schema, according to Merleau-Ponty, because of a certain lack of neurological development. The myelination of nerve fibers responsible for proprioception, which is said to occur between the third and sixth months and is later in some limbs than in others, was thought to be required for the full and proper functioning of relevant parts of the nervous system. The development of the body schema can happen only after these physical conditions are met and thus, only in a fragmentary way at first. Motor schemas are then gradually integrated, and in a reciprocal system with external perception and sensory inputs, become "precise, restructured, and mature little by little" (1964, pp. 123).

Simmel and Merleau-Ponty are good representatives of the traditional view that both body schema and body image are acquired through experience. This view then defines what is possible and what is not possible in a number of different instances. We have seen in brief outline what it implies about the conscious experience of the infant: conscious experience is disorganized; exteroceptive perception is impossible. It also implies certain other limitations about what is possible for the infant. Consider, for example, the capacity for

imitation – an important capacity directly related to questions about perception, social recognition, the ability to understand another person, and the origins of a sense of self.

On this issue Piaget is another good representative of the traditional view. The question is about a certain kind of imitation called "invisible imitation." Piaget defines invisible imitation as the child's imitation of another person's movements using parts of the child's body that are invisible to the child. For example, if a child does not see its own face, is it possible for the child to imitate the gesture that appears on another person's face? Piaget's answer is that at a certain point in development it is possible; but in early infancy it is not. The reason is that invisible imitation requires the operation of a relatively mature body schema. Thus, according to Piaget (and Guillaume [1943], as well as most other classical theorists of development), invisible imitation is not possible prior to 8 to 12 months of age.

> The intellectual mechanisms of the [child under 8 months] will not allow him to imitate movements he sees made by others when the corresponding movements of his own body are known to him only tactually or kinesthetically, and not visually (as, for instance, putting out his tongue) .... Thus since the child cannot see his own face, there will be no imitation of movements of the face at this stage.... For imitation of such movements to be possible, there must be co-ordination of visual schemas with tactilo-kinesthetic schemas..." (Piaget 1962, pp. 19, 45)

Piaget's traditional view on invisible imitation is completely consistent with the idea that body schemas are not sufficiently developed in early infancy, from which it follows that imitation dependent on such schemas would not be possible until their acquisition at 8 to 12 months of age. Thus invisible imitation is absolutely out of the question for a neonate. Furthermore, there must be some mechanism that allows for the translation between what the infant sees and what movements the infant is capable of. The traditional view on this issue, going back as far as John Locke's original statements on sense perception, is that different sense modalities (vision, touch, and proprioception, for instance) are not naturally intermodal, and that prolonged experience is required to be able to translate between vision and tactilo-kinesthetic sensation. Piaget's claim that the child's intellectual mechanisms are not sufficiently developed to perform the

imitation suggests that the child needs to be able to relate sense experiences (vision and proprioception) that are not naturally related.

Merleau-Ponty follows Guillaume and Piaget in regard to these issues. To imitate;

> it would be necessary for me to translate my visual image of the other's [gesture] into a motor language. The child would have to set his facial muscles in motion in such a way as to reproduce [the visible gesture of the other] …. If my body is to appropriate the conducts given to me visually and make them its own, it must itself be given to me not as a mass of utterly private sensations but instead by what has been called a "postural" or "corporeal schema" (1964, pp. 116-117).

Since Merleau-Ponty also holds that exteroceptive perception is unorganized in early infancy, precisely because the body schema has not organized interoceptive perception sufficiently, the infant under three months of age would seemingly have a difficult time even seeing the face of the other person. Even beyond three months, when the infant could distinguish facial features of the other person, it has little or no familiarity with its own face, and has little or no control over moving that face, since motor schema are not yet in place. As a result, the young infant could not even begin to imitate the facial gesture of the other person, although, as Merleau-Ponty observes, by 15 months, this kind of imitation is possible (1962, p. 352).

This traditional view turns out to be wrong. In complete contrast to the established view, studies on imitation in infants conducted by Meltzoff and Moore (1977, 1983) show that invisible imitation does occur in newborns. Their experiments, and others that replicate and extend their results (see Meltzoff and Moore, 1994 for summary), show that newborn infants less than an hour old can indeed imitate facial gestures. A brief review of several of their experiments will help to clarify the results and their relevance to the issues of body schema, body image, and intermodal perception.

> Meltzoff and Moore (1983): 40 normal and alert newborn infants ranging in age from less than 1 hour to 71 hours were tested. The experimenter presented each infant with a mouth-opening gesture over a period of 4 minutes, alternating in 20-second intervals between the mouth opening and a passive facial appearance. The

> same procedure was then followed using tongue protrusion as the target gesture. The study showed a clear and statistically significant result in terms of both the frequency and duration of the infants' response gestures, demonstrating that normal and alert newborn infants systematically imitate adult gestures of mouth opening and tongue protrusion. Notably, even the youngest infant in the study, 42 minutes old at the time of the test, showed a strong imitation effect. Other experiments have extended the range of gestures that young infants imitate to a wider set, including lip protrusion, sequential finger movement, head movements, smiling, frowning, and surprised expressions.
>
> Meltzoff and Moore (1977): showed some form of memory to be involved in early imitation. Infants between the ages of 16-21 days imitated facial gestures after a delay. This involved putting a pacifier in the infant's mouth as it was shown a facial gesture. After the presentation of the facial gesture was complete, the pacifier was removed and the infant imitated the gesture. Thus, imitative responses were delayed and only allowed when the gesture had vanished from the perceptual field.
>
> Meltzoff and Moore (1994): showed that infants imitate after a delay of up to 24 hours. Infants also improve their gestural performance over time. Their first attempts at imitation do not necessarily replicate the seen gesture with a high degree of accuracy. When tongue protrusion is displayed, infants quickly activate the tongue; but they improve their motor accuracy over successive efforts.

The findings of imitation under these experimental conditions rule out "reflexes" or release mechanisms as potential mediators of this activity. Reflexes and release mechanisms are highly specific – that is, narrowly circumscribed to limited stimuli. One cannot have a reflex or release mechanism for imitation in general. As a result, the range of behaviors displayed by infants would require the unlikely postulate of distinct reflexes or release mechanisms for each kind of imitative behavior: tongue protrusion, tongue protrusion to one side, mouth openings, smile, frown, etc. While it may not be difficult to imagine how evolution might provide for a reflex smile, it is difficult to understand why it

would furnish a reflex for angular tongue protrusion. Furthermore, the data from the third and fourth experiments indicate that neonate imitative behavior involves memory and representation, since imitation can happen even after a delay. The fourth experiment also shows that infants improve or correct their imitative response over time. Neither delayed response nor improvement in response is compatible with a simple reflex or release mechanism.

What mechanisms allow for these possibilities in the neonate? At least two things need to be considered. First, a body schema; second, an intermodal capacity for sensory integration. In regard to the first, if we follow the logic expressed by the proponents of the traditional view, namely, that imitation requires a developed body schema, then the studies on newborn imitation suggest that there is at least a primitive body schema from the very beginning. This is a schema sufficiently developed at birth to account for the ability to move one's body in appropriate ways in response to environmental stimuli, and specifically for the possibility of invisible imitation. Here I use the word "innate" to mean, literally, "something existing prior to birth" – something that most probably comes into existence through processes involved in fetal development.

Second, an intermodal sensory system is required to enable the infant to recognize a structural equivalence between itself and the other person. In support of this idea experiments show that there is an early relation between vision and touch and between the sound of speech and the particular lip movements that cause them (see Meltzoff, 1993). Meltzoff and Moore (1997) propose a psychological-cognitive model, a set of theoretical black boxes representing "comparison function," "act equivalence," "recognition of my own capability," etc. Here I want to suggest some neurophysiological structures that might help to fill in the black boxes in this cognitive model. For the infant to be able to imitate a displayed facial gesture, it must be able to translate a visual display into its own motor behavior.

In an intermodal system, proprioception and vision are already in communication with each other. In certain cases, what I see automatically gets translated into a proprioceptive sense of how to move. Proprioception and vision are intermodally linked in several ways, and these linkages are part of a more general link between sensory and motor activities. For example, and quite relevant to the possibility of neonate imitation, both proprioception and vision are integrated with vestibular information about head motion and orientation. The vestibular nucleus, a relatively large midbrain structure, serves as a complicated integrative site where first-order information about head position is

integrated with whole-body proprioceptive information from joint receptors and oculo-motor information about eye movement. This integrated, multimodal information projects to the thalamus, informing connections that project to cortical areas responsible for control of head movement. Vestibular neurons in the parietal lobe respond to vestibular stimulation, but also to somatosensory and optokinetic stimuli, and more generally there is cortical integration of information concerning self-motion, spatial orientation, and visuo-motor functions (Guldin, Akbarian, and Grüsser, 1992; Jouen and Gapenne, 1995). Importantly, these structures, involving self-awareness, are mature at birth. Thus in the case of neonate imitation, the imitating subject depends on a complex background of embodied processes, a body-schema system involving visual, proprioceptive and vestibular information. In the foreground, what the infant sees gets translated into a proprioceptive awareness of her own relevant body parts; and proprioceptive information allows her to move those parts so that her proprioceptive awareness matches up to what she sees. This intermodal intra-corporeal communication, then, is the basis for an inter-corporeal communication. Just here we can postulate the beginnings of a body image-based on the infant's sense that the face of the other person is like its own face, defined pragmatically, as something it can move in the same way. This has profound implications for the child's relations with others.

Recent studies in neuroscience suggest that there are specific neurophysiological mechanisms that can account for the intermodal connections between visual perception and motor behavior. These are mechanisms that operate prenoetically as general conditions of possibility for motor stability and control. They are also directly related to the possibility of imitation. Indeed, these studies suggest that what theorists refer to as the mirror stage in later childhood, and consider to be important for the development of a mature body image and the onset of self-recognition, may in fact be prefigured in what one might call an earlier and interior mirror process. I refer here to what neuroscientists now describe as processes that involve mirror neurons (Gallese, 1998; Gallese et al., 1996; Rizzolatti et al., 1996). Mirror neurons link up motor processes with visual ones in ways that are directly relevant to the possibility of imitation.

C. Aplasic Phantoms

The logic regarding phantom limb in cases of congenital absence of limb (aplasia) is the same as that debated in the context of the question about the

possibility of neonate imitation. On the one hand, according to the traditional view, if a body schema is something that is acquired only over the course of experience (in the first 8-12 months of life) then an aplasic phantom is just as impossible as neonate imitation. On the other hand, if a body schema is innate in the right way, then it should be quite possible to find cases of aplasic phantoms. Now despite the fact that there is good evidence for an innate body schema to be found in the examination of neonate imitation, much of the evidence cited for an innate body schema in discussions of aplasic phantoms is problematic. Indeed, the evidence that is cited to support the idea of an innate body schema in this context misses the mark because it actually pertains to the notion of body image.

Two issues, therefore, are in need of clarification. First, if there is an innate body-schema system, as studies of neonate imitation indicate, what role does it play in explaining the aplasic phantom? Second, what precisely does it mean for the body schema to be "innate"? In other words, what are the precise developmental details that lead to the existence of a body schema at birth? The issue of a prenatal development of body schemas is of interest because it helps to explain the earliest relation between movement and consciousness.

On the question of aplasic phantoms, Simmel, again, reaffirms the traditional view which can be summarized in two propositions:

1. A body schema is acquired through experience and practice which organizes proprioceptive, kinesthetic, and tactile sensations (3-6 months of age).
2. Interoceptive organization of embodied experience is gradually coordinated with visual experience (8-12 months of age), and only in this process does one acquire a body image.

On the assumption that a body schema is simply not present at birth, then a person who lacks an extremity at birth and has therefore received no sensations from the missing limb, should not have a phantom. This long established view is precisely enunciated by Simmel (1958): "if a person lacks an extremity since birth, he has never received such sensations from the missing limb, and he should therefore not have a phantom." The studies conducted by Simmel confirmed this view. There is no phantom in aplasia because the limb in question is never experienced, and thus is never incorporated into a body schema or body image.

This view of the phantom was also expressed by Merleau-Ponty in connection with his acceptance of the received doctrine that the body schema is

a product of development. For the very same reasons that the traditional view implied the impossibility of neonate imitation, it also implied the impossibility of aplasic phantoms. On this view, the existence of a phantom limb in the case of amputation is based on a history of sensory inputs to the now missing limb, and the continuation of sensory inputs at the stump. Sensory impulses, which are organized in a coherent fashion by a developed body schema, "establish and maintain [the phantom's] place, prevent it from being abolished, and cause it still to count in the organism." Sense experience organized by a body schema is the sine qua non by which we "build up the phantom" (Merleau-Ponty, 1962, p. 86). Since, in the case of aplasia, the missing limb is never the subject of sensory impulses, there can be no aplasic phantom, that is, the missing limb is not incorporated into a body schema or body image.

A challenge to the traditional consensus about the development of a body schema and the impossibility of aplasic phantom limbs started to take shape in 1961. Weinstein and Sersen (1961) cited evidence that directly challenged the received doctrine. They found, in a study of 30 cases of aplasia, that 17% experienced a phantom limb. Even this small percentage, they reasoned, would be enough to indicate that phantoms do not require prior stimulation of the missing part. "The fact that phantoms can exist for limbs which themselves never existed indicates that some native factor must be responsible, at least in part, for the existence of the phantoms" (Weinstein & Sersen, 1961, p. 910). In more precise terms, similar to the evidence concerning neonate imitation, the evidence for aplasic phantoms raises the possibility that the basic framework of a body schema is innate. Subsequent studies (Brugger, et al., 2000; Gallagher, et al., 1998; Melzack 1989; Poeck 1963, 1964; Scatena 1990; Vetter & Weinstein 1967; Weinstein, Sersen & Vetter 1964) supported the thesis of an innate body schema based on a built-in neural substrate. This implies a body-schema system from the very beginning, but one that is also open to modification by multimodal sensory experiences throughout the lifetime of the organism.

The theorists and experimenters representing both sides of the debate, that is, those who proposed this new view, or those who defended the traditional one, failed to use the concepts of body image and body schema with precision and this failure qualifies their conclusions in an essential way. Simmel (1958), for example, claims that the aplasic phantom is not part of a body schema although the non-aplasic (post-amputation) phantom is. The body schema's relative resistance to alteration accounts for the non-aplasic phantom. Yet, the evidence cited in her study actually suggests that the phantom is ordinarily part of a body image. Simmel's data were based on interviews in which subjects were

explicitly asked to describe their perceived phantom, indicating that the phantom is an "experiential representation" that patients consciously "feel" (as itchy or painful, for example), and that it has a cognitive status, dependent on intellectual maturity. Although Simmel defines the phantom as part of a body schema, she describes it as part of a body image.

Perhaps even more surprising, on the other side of the controversy, in studies that claim to show evidence for an innate body schema, the evidence cited actually points to the existence of a body image developing sometime after birth. The procedures used by Weinstein and Sersen (1961) involve, for example, asking the child to indicate kinaesthetic sensations associated with the phantom limb, or to estimate the length of the phantom. Such questions require the child to focus perceptual attention on the phantom. In effect, they test for a phantom limb percept. Similar procedures have been used by the other researchers.

We need to sort things out a little better than this. Following our distinction between body image and body schema, it should be possible to make more precise sense out of the aplasic phantom. Even if the evidence provided in the studies since 1961 indicates that the aplasic phantom is part of a body image (and more generally it can be noted that most analyses of post-amputation phantoms treat the phantoms as perceptual phenomena), the question is still open: is it is also part of a body schema?

One clear kind of evidence that a non-aplasic (post-amputation) phantom is an aspect of a body-schema system (and not solely part of the body image) is described in numerous studies and is sometimes referred to as a form of "forgetting" (Simmel 1966; Poeck 1964; Melzack 1990; Merleau-Ponty 1962). In some cases of phantom limb after amputation, although the subject clearly knows about and acknowledges the loss, in certain instances of motor behavior he seems to be unaware of the loss and relies on the phantom as one would on the real limb. For example, an amputee who attempts to walk with his phantom leg is surprised when he falls. Poeck (1964) reports this type of incident in a fifty-year old woman who lost her right thumb when she was five years old. "Every time she handles an object with her right hand, she tries to grasp it as if the missing member were still present. Even today, it is only when her grip fails that she becomes consciously aware of her defect" (p. 272). The phenomenon of forgetting suggests that the missing limb continues to function schematically in motor behavior for an indefinite time. It continues to play a part in the organization of instrumental or locomotive actions. Its absence is not taken into account.

Does this continued functioning depend on a vivid representation or percept of the missing limb? This is a view expressed by numerous theorists (e.g., Melzack, 1990; Aglioti, Bonazzi & Cortese, 1994); they suggest that the vividness of the phantom (in effect, an aspect of the body image) accounts for such incidents of forgetting. This would need to be an unusually complex combination of awareness and forgetting, however. Against a background of conscious acknowledgement concerning the missing limb, the subject would have to have a vivid awareness of the phantom, not as a phantom, but as a present and workable member. The forgetting in this case would be a forgetting that this vividly present limb is nothing more than a phantom. It would involve a basic contradiction in the body image: a perceptual presence alongside a conceptual acknowledgment of absence.

A more parsimonious explanation is possible, however. The phenomenon of forgetting is actually a normal part of normal motor action. Movement in general, and specifically the continued functioning of a phantom part in movement, does not depend on a vivid representation or percept of the body, or specifically of the missing limb. Rather, forgetting is normal and it is possible precisely because motor behavior does not ordinarily require that my limbs be included in my perceptual awareness. I step out to walk, or I reach out to grasp something, not by making my limbs vividly present; nothing in such cases depends on their vivid presence. Smooth movement, successful walking, reaching, and grasping depend on a certain experiential transparency of the body. This transparency is possible because, thanks to the work of body schemas, movement usually takes care of itself. If I am aware of my body in the motor act, my awareness is a non-perceptual, performative awareness rather than a vivid presence. On this account, forgetting is explained in the normal workings of body schemas, and the inference is that the phantom, precisely in this regard, is an element of the body schema. Here, I note, phenomenology makes a very clarifying contribution to interpreting the scientific data.

In regard to the aplasic phantom, there are a number of complex issues that I will not go into here (but see Gallagher et al., 1998). I will indicate only one inconclusive proposal that suggests there may be some “forgetting” involved in cases of the aplasic phantom, thereby qualifying it as part of an innate body schema. Although an important part of brain development involves a genetic blueprint that predetermines the pattern of growth, self-organizing movement plays an important role in stimulating and promoting normal growth. Reflex movement in the embryo begins around week seven gestational age and grows in complexity in the eighth week. The actual development of embryonic neural

tissue depends, in part, on fetal movement, and on components that are important for the attainment of postural balance. Proprioceptors in the muscles (muscle spindles), which will ultimately be responsible for a sense of position and movement, first appear at 9 weeks gestational age; spontaneous and repetitious movements follow shortly.

Consider a certain kind of movement that emerges in early fetal development. Ultra-sonic scanning of fetuses shows that movement of the hand to the mouth occurs between 50 to 100 times an hour from 12 to 15 weeks gestational age (DeVries, Visser & Prechtl, 1984). This suggests that hand-to-mouth movement may be an aspect of an early, centrally organized coordination that eventually comes to be controlled proprioceptively. This kind of prenatal movement may in fact be precisely the movement that helps to generate or facilitate the development of body schemas. That is, quite consistent with the traditional hypothesis, it may be the movement (the motor experience) that one requires for the formation of a body schema. The only difference is that this movement occurs much earlier, and by implication, body schemas develop much earlier than the traditional account permits, that is, in the fetus rather than in the 6-8 month old infant.

It turns out that there is some continuity between this very early movement and postnatal movement. Spontaneous movements such as whole-body flexions or more localized limb movements occur in human neonates until approximately the third month of life. These movements are very similar to fetal spontaneous movements and are generally thought to reflect the relative motor immaturity of humans at birth compared to other. Butterworth and his colleagues, however, have discovered relatively organized movements of hand to mouth (similar to the fetal movement mentioned above) embedded within these spontaneous movements. They suggest this as evidence for an innate coordination between the hand and the perioral region (Butterworth and Hopkins, 1988; Lew and Butterworth, 1995).

A significant percentage of the arm movements that result in contact with the mouth are associated with an open or opening mouth posture, compared with those landing on other parts of the face. Important here is the fact that in such movements the mouth “anticipates” arrival of the hand. Since the eyes are no more likely to be open than closed when the hand finds the mouth directly, there is no evidence that this motor behavior is guided by sight. Butterworth has also tested to rule out the possibility that these movements are the result of reflex responses such as the Babkin reflex where the infant’s mouth opens when the

palm is pressed. Nor is any instance of the rooting reflex observed in relation to these movements.

The notion of an innate motor schema in connection with hand-mouth coordination is consistent with the following hypothesis, which can help to explain the aplasic phantom as a product of innate mechanisms.

> Hypothesis: where a functional system is disrupted by failure of limb formation, the missing limb may nevertheless manifest itself as a phantom because a specific movement coordination is represented within a neural matrix which includes both cortical and subcortical structures.

One needs to think of the hand-mouth coordination as having two related elements: the hand movement and the mouth movement. Remember that the mouth moves to anticipate the arrival of the hand. In the case of a missing limb, it is not just that the intact body part involved in the coordination, for example, the mouth and perioral region in the hand-mouth coordination, is neurally represented. Insofar as the motor coordination or schema itself is represented, there must be some implicit representation of the "other end" of the coordination. Even if the arm and hand are not there, a circuit or a defined schema (involving some definite tendency of arm movement) would require that both sides of the circuit be neurally defined.

If this is the case, then, under certain conditions, a stimulation of the mouth would be sufficient to activate the joint mouth-limb neural system. The virtual limb (the phantom) thus comes into existence when the coordination is activated. A singular representation of the coordinated schema or action pattern incorporates both ends of the movement, the mouth and the hand, even when there is no hand. One might say that the mouth "forgets" that the hand is not there. This account depends on an innate body schema, in this case a specific coordination or motor capacity. The hypothesis does not require that the 12-15 week-old fetus be conscious of the movement. The coordination, even in the neonate, can function without the necessity of perceptual monitoring. Still, it is likely that at some point in development a proprioceptive accompaniment develops along with it. The enactment of the motor schema would, at some ontogenetic point, motivate/cause a proprioceptive sense of movement. In this case, one might say, the movement precedes the awareness of movement but motivates that awareness (in the form of proprioception) when the system is sufficiently developed to allow that. This specific proprioceptive sense of hand-

mouth coordinated movement would then form the initial aspect of an experienced phantom.

D. Primary Self-Consciousness

Does the embodied (proprioceptive) experience evident in neonate imitation and the neonate's organized perception involve self-consciousness? The traditional answer to this question is "No." Self-consciousness is typically thought to be conceptual and linguistic in nature. Thus, for example, Kathleen Wilkes (1988) suggests that there is little reason to believe that infants are self-conscious. Dennett (1976), proposing a complex notion of self-consciousness, suggests that "One's stance toward oneself and access to oneself in [the case of self-consciousness] is essentially the same as one's stance toward and access to another." This involves a second-order intentionality of which infants would not be capable. Thus Dennett, following Frankfurt, denies that "small children" are capable of self-consciousness (Dennett, 1976).

It is possible, however, to conceive of self-consciousness as a more primitive, embodied, non-conceptual phenomenon. Bermúdez (1998), for example, argues that there is a first-person content that is non-conceptual. He also suggests, on the basis of the neonate imitation studies, that a primitive self-consciousness includes three elements (Bermúdez, 1996). Here is a slightly revised list.

(1) Body schematic control of movement
(2) Pragmatic differentiation between self and non-self
(3) Recognition that the other person is of the same sort as oneself

I will call the first two aspects "primary self-consciousness." I want to argue that the first element is itself complex. That is, body-schematic control of movement involves at least two mechanisms. First, a sensory-feedback mechanism responsible for a sense of ownership for one's movement – the sense that I am the one moving, regardless of whether the movement is voluntary or involuntary. Second, a forward mechanism responsible for a sense of agency for one's actions – the sense that I am the one causing the movement (a sense that is absent in the case of involuntary movement) (see Gallagher, 2000 for a development of these themes). Phenomenologically, senses of agency and ownership are first-person, non-conceptual contents built into body schematic

control of movement. These senses of agency and ownership (including proprioceptive self-awareness) help to constitute the second element of primary self-consciousness: the pragmatic differentiation between self and non-self – a sense of differentiation that arises in movement and action.

All three elements of self-consciousness are apparent in the case of neonate imitation, and thus characterize the experience of the newborn human. Furthermore, there is evidence to suggest that the first two aspects, the (1) senses of agency and ownership generated in body-schematically controlled movement, and (2) self/non-self differentiation, are present in the late-term fetus (Gallagher, 1996).

For example, besides neurological evidence that shows early development of a proprioceptive system, and significant cortical development by 25 weeks, there is some behavioral evidence indicating that a differentiation between self and non-self, and therefore a primary self-consciousness, are possible for the close-to-term fetus. Consider the following data.

- At 24 weeks gestational age, in response to auditory stimuli the fetal heart rate changes. After 25 weeks the fetus responds by blinking its eyes or moving its limbs. Between 24-29 weeks gestational age, cortical response to such stimuli has been demonstrated. The fetus is also capable of differential responsiveness, showing preference for some sounds (such as the mother's voice) rather than others (Fifer & Moon, 1988).

- DeCasper and Spence (1986) have shown that listening skills develop prior to birth. In their study, mothers read stories to their fetus during the last two months of pregnancy. It was shown that 1-2 day old newborns preferred to hear the same stories that were read to them during pregnancy.

- Responsive facial movements are often cited as evidence that infants are differentially aware of what is going on in their surroundings (for example, Trevarthen, 1983). Fetal facial movements are sometimes prompted by music or voice and this may be indicative of a similar differential awareness.

- Bright light directed on the lower abdomen of the mother in the third trimester can elicit fetal eye blinks (Bimholz, 1988).

- Emory and Toomey (1988) suggest that "rudimentary forms of learning, memory and cognition" can be found in the prenatal period.

Thus, on a variety of data, across auditory, tactile, and even visual perceptual modalities, there seems to be continuity between fetus and infant. Is this enough, however, to establish a sense of differentiation between self and non-self? In this regard, we can say that the fetus definitely reacts to sound and other stimuli, but it is not completely clear that such reactions attest to a fetal experience of stimuli as being something other than the fetus. Although such self/non-self differentiation is implied by basic ecological perception, fetal phenomenology remains inaccessible, and our conclusions must remain less than certain.

Consider, however, one further piece of evidence, which is also less than certain.

- Field et al. (1983) report the capacity for imitation in premature neonates (of 35.6 weeks instead of full-term, 40 weeks). Infants who are more premature would not see well enough or have enough motor control to be able to test imitation (Meltzoff, private correspondence).

If the results reported in the study by Field et al. are right (it is important to note that there has been no replication of this data, however), it would certainly help to establish the capacity for imitation, and thus for primary self-consciousness, in premature neonates and the 35 week old fetus. The actualization of imitative behavior still would depend on a postnatal social environment, but this does not mean that primary self-consciousness does also. All of this data brings us close to the conclusion that there is a capacity for primary self-consciousness existing prior to birth. If this capacity is actualized or exercised in the particular form of imitation when in the right environment, it might also be actualized in prenatal behavior, for example, in differential reactions to sound and other stimuli.

My claim is simply this: the primitive senses of agency and ownership that accompany body-schematically controlled movement, and the self/non-self differentiation are sufficient to constitute a primary, embodied form self consciousness in the neonate, and likely in late-term fetus.

Conclusion

My primary concern has been to show in a partial way, but in sufficient detail to meet Edelman's requirement ("It is not enough to say that the mind is embodied; one must say how"), how embodiment provides certain innate capacities that enable and condition our experience of ourselves and others. There is much more to say in regard to all of these issues (see Gallagher, 2004), but I hope that I have given sufficient indication of how the distinction between body image and body schema can be used in a productive way. More specifically, I think the use of these concepts entails a multi-disciplinary approach that starts with phenomenology and that gets tested out by empirical studies. This is a two-way process, however. Not only does the phenomenological distinction between body image and body schema receive verification and clarification by appealing to the empirical evidence, but the distinction itself goes some distance towards clarification of a variety of confusions in the empirical literature. At times those clarifications are simply logical ones; but at other times they are phenomenological. Logical, for example, in the case of distinguishing claims about aplasic phantoms being part of the body schema, when the evidence cited by most studies indicates they are part of the body image. More clearly phenomenological when, for example, phenomenology makes a contribution to interpreting the scientific data concerning the phenomenon of forgetting in the case of phantom limbs. Only through this combination of disciplines which constitute neurophenomenology can we begin to map out the details of how the body shapes the mind.

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