Metadata of the chapter that will be visualized in Online

Series Title		
Chapter Title	A Husserlian, Neurophenomenologic Approach to Embodiment	
Chapter SubTitle		
Copyright Year	2010	
Copyright Holder	Springer Netherlands	

Corresponding Author	Family Name	**Petit**
	Particle	
	Given Name	**Jean-Luff**
	Suffix	
	Division	Université de Strasbourg ~~and~~ Laboratoire de Physiologie de la Perception et de l'Action
	Organization	Collège de France
	Address	Strasbourg, Paris
	Email	jean-luc.petit@college-de-france.fr

Abstract	Normally, we perfectly know where we are: we know that we are viewing the world from a particular and unique point of view. We know that we inhabit the physical body that is situated precisely at this same point of space. We localize ourselves in an absolute manner: definitely, we are 'here'! We know where our hand is without having to watch it constantly, and we move our body without having to look around to know where it went. We can reach out for an object close at hand without having to fix it attentively in advance in order not to miss it. Such 'knowledge' (a misnomer) is indispensable in order for us to deal in a rapid, silent, adaptive and efficacious way with our customary occupations and duties. It is only when anomalies occur linked to cerebral lesions which make unreliable this implicit 'knowledge' and distort our experience that we become aware of the fact that this experience is contingent upon unknown conditions.

A Husserlian, Neurophenomenologic Approach to Embodiment[1]

Jean-Luff Petit

A Description of Lived Experience

Normally, we perfectly know where we are: we know that we are viewing the world from a particular and unique point of view. We know that we inhabit the physical body that is situated precisely at this same point of space. We localize ourselves in an absolute manner: definitely, we are 'here'! We know where our hand is without having to watch it constantly, and we move our body without having to look around to know where it went. We can reach out for an object close at hand without having to fix it attentively in advance in order not to miss it. Such 'knowledge' (a misnomer) is indispensable in order for us to deal in a rapid, silent, adaptive and efficacious way with our customary occupations and duties. It is only when anomalies occur linked to cerebral lesions which make unreliable this implicit 'knowledge' and distort our experience that we become aware of the fact that this experience is contingent upon unknown conditions. Conditions that neuroscience help us understand by linking them to dysfunctions of the mechanisms underlying our sense of the moving body: 'kinaesthesia'.[2]

Let's first get straight about the etymology of 'kinaesthesia': *kinêsis* (movement) derived from *kineô* (to move) + *aisthêsis* (sensation, perception) derived from *aiô* (to hear, perceive). Apparently, neither more nor less than a sensation of movement. In the Husserlian theory of kinaesthetic constitution that interests us here, the term 'kinaesthesia' is only employed, for want of anything better, to designate both the lived experience of posture, the orientation of the motor organs of perception

J.-L. Petit
Université de Strasbourg and Laboratoire de Physiologie de la Perception et de l'Action, Collège de France, Paris

[1] I express my gratitude for the translation to Dr Christopher Macann.

[2] Lately in neuroscience there is a growing interest in an extreme disturbance of embodiment: 'out-of-body' epileptic experience, 'the intriguing experience of seeing one's body in a position that does not coincide with the felt position of one's body' (Blanke et al.2004; see Blanke et al. 2005; Blanke and Mohr 2005; Arzy et al 2006).

D. Schmicking and S. Gallagher (eds.), *Handbook of Phenomenology and Cognitive Sciences*, DOI 10.1007/978-90-481-2646-0_11, © Springer Science+Business Media B.V. 2010

and movement, even the acts used to simulate these movements from within. The kinaesthetic sense does not limit itself to a proprioceptive, muscular or sinews sense of displacement of the limbs or of locomotion of the whole body contingent upon peripheral stretch captors in the muscles. Above all it implies our more mysterious[3] vestibular sense of inner and outer egocentric space, with its coordinate axes rooted in the body: our sense of our massive limbs and body going forward or backward, up and down, right or left or turning round; our sense of a changing velocity in this movement, our sense of effort, of impulse or resistance against an alien force; not of perspective, but of perspective taking and changing, in the body or mentally only, etc.[4]

This is all part of our blind, preverbal, implicit and immanent knowledge we all exercise in daily life. In going over these aspects of daily life we are not really going beyond a phenomenological description of experience in its constant, structured character. It is interesting to try and bring together what belongs to such description of the lived experience of everyday life and what belongs to the objects of research of the neuro-physiologist. The true foundation of the work of the physiologist is the description and explanation of a repertory of behaviour covering the field of our interaction with the world. The familiar availability of this repertory of behaviour might give us the impression that we benefit from knowledge of the external world that guides our acts, making it possible to accomplish them even when there is no sensorial inputs.

The step that needs to be taken is the one that leads from a phenomenology of everyday life, just as it is lived out, to the theory of the subjective and objective constitution of the experienced world. If we manage to draw up a repertory of those structuring features which confer upon our lived experience its form, if we succeed in tracking these structuring features of experience back to the neural mechanisms underlying them, then we will be in a position to radically elucidate the sense of being of everything that inhabits the world of an agent – including the thing that this agent himself is. Thanks to this theory of constitution all these things would emerge endowed with sense from the fact that we would have identified and distinguished up to their central underpinnings their organizing principles. Evidently, in saying that, we are only making a tentative gesture in a direction that we would be happy to point to as the right one for the neuro-phenomenologist to go.

Only that, what might leave us unsatisfied from a phenomenological point of view is that one keeps falling back on mechanisms whose objectivated functioning can never really be properly 'internal', that is to say lived from within, because it is only observed from without. Representing processes of the living being through

[3]Its brain correlates are still being discussed: parietal, temporal, insular cortex or temporal-parietal junction? (see Lobel et al. 1998).

[4]In the following list of publications, certain aspects of the role of the vestibular system will be found: Berthoz 1973, 1978, 1991, 1994, 1996, 113–125; Berthoz, Graf and Vidal 1991; Berthoz and Jones 1995; Berthoz, Pavard and Young 1974; Buizza et al. 1979; Israël and Berthoz 1989; Ivanenko et al. 1997.

objective mechanisms whose functioning can not fail to miss the specificity of interior experience remains a permanent danger to which even phenomenology is exposed. In a manuscript from 1931, Husserl undertakes a scrupulous description of the dynamics of kinaesthesia, tracing this dynamic right back to instinctual impulses, in the phenomenon of the orientation of vision and the projection of the hands in the direction of an object of interest: specifically for the new-born baby, the mother's breast, as soon as it distinguishes itself from the indifferent background of experience. After a few pages, haunted by a doubt, Husserl asks himself the question: 'can one adopt this description? For all of this can *take place* without my being attracted to it or turning away from it in aversion.[5]' To avoid this outcome, a theory of constitution has to be developed that makes the agent alone, reduced to the sole resources of its internally felt bodily capabilities, responsible for the act of constituting (giving sense to) the action he is about to perform. 'The act' Husserl insists, 'is in the: I am doing,' I am still active throughout the entire time period in which the act is carried out, and it is I who make this act happen.'[6]

[AU2]

One's Own Body

> This is what distinguishes the body from all external things. On the one hand, the body of flesh and blood is also a thing, a physical thing like any other […]. It is a thing among other things, having its changeable location amidst them […]. On the other hand, this thing is precisely 'my own body' (*Leib*), what upholds my 'I'; the 'I' has sensations and these sensations are localized in the body, in part through thought, in part in a more immediately apparent way' (Husserl 1997, §47)

The body I am in is the body in which feeling, perceiving, knowing, prevails. 'Prevails' translates the German verb '*waltet*' which means: to be active in one's body, act in and through it or occupy it effectively. In any case, prevails in the sense of being there. If one wants to create a place for one's own body in phenomenology, it has to be thought of as having the meaning of being precisely that body where I prevail. This is the body in which I experience my states, my sensations, just as much those that are traditionally known as 'external' – despite the fact that they are, and can only be, internal, as kinaesthetic sensations. In a word, this body possesses a sense, and this sense has to be understood in a dynamic manner, by trying to recover the operations to which it owes this sense.

Here we find ourselves in an extremely tense situation whose description takes on the troublesome form of a tautology, that of having to designate, in the perceiving subject who has the experience of being a body, the constituting operations which have made it possible for this body to acquire the sense of being precisely what it is, an own body. The paradox consists in the fact that the body, as the unity of its

[5] E. Husserl, *MS* C 16 I (end 1931), 18.

[6] E. Husserl, *MC* B III 9 (October–December 1931), The Problem of the Act, 19.

organs, does not precede but rather follows upon the constitution of the organs of which it is composed. Clearly, I must first have hands, feet, eyes, etc., and use them practically in my relations with things in order to be able to acquire the sense of being that body whose organs are its parts[7]. As a descriptive problematic, the situation is much tighter than in the case of the perception of an external object, of something that is not me, and on which I only take up a point of view. We will have to come to terms with acts which are: (1) meaning giving, (2) the acts of the perceiving subject itself, (3) the very same acts as those brought into play in order to confer a sense upon surrounding objects.

However, if I want to constitute the body, that is, give the body a sense in the same way that I confer a sense upon surrounding objects when I perceive them, I bump up against an obstacle. For in order to confer a sense upon my own body I have to rigorously apply the same operators that I applied in the case of objects, if only for want of others. In advance, I have to suppose that the object remains the same through the different aspects of it that I catch when I go around it, when I pick it up, a variety of aspects that I have to pull together as a whole, etc., all of which I do as a matter of course. So I have to be able to deploy in perspective a series of adumbrations of this own body, reunite the relevant series of adumbrations, thread them all together as one unitary series through which the thing gets posed as being itself single and identical.

Can't this be done for one's own body? No, because none of these attempts at a description, at meaning giving, succeeds in the case of my own body, on account of the fact that, in this case precisely, '*I am inside it*'. What is it then that distinguishes the body in so special a way? First of all, the body is 'always here'. By contrast, external things are there, or rather can only become things for me to the extent that those that are here can be placed over there. And that their different appearances when they are here and when they are there do not stand in the way of my recognizing them to be the 'same things'. The immanental relation in which I stand with respect to my own body makes it impossible for me to take up such a point of view upon it. Indeed, this is what is meant by immanence: the fact of being one with my body entails the impossibility of taking up with respect to me an other point of view, with a view to developing adumbrations of me. But in the absence of this power of adumbrating, of forming pre-objective varieties that can both be differentiated and integrated in the course of experience in the way that is typical for things, things could not exist for the perceiving subject that I am, and so not with respect to my own self, thing that I also am.

This difficulty can be taken up another way: it has been noted that certain patients do not recognize their body as belonging to them, or attribute to someone

[7] E. Husserl, *MS* D 10 III (June 1932), 36: 'Genetically, and in and of itself, one's own body is not constituted ontically prior to the constitution of its moving and changing parts, nor to the practical mastery, by the Ego, of the course of their changes. The constitution of the members of one' own body, as physical contents appearing in the visual field precedes that of the unity of the body; in their reciprocal constitution they get unified as 'organs' of one and the same body.'

else the possession of their arm, for example. Somato-agnosies vary widely, and somato-paraphrenia is one of the examples of this inability to recognize a part of the body as one's own. Schizophrenic patients have difficulty in attributing movements of parts of their body to themselves, a disturbance involving 'agentivity' a deficit probably ~~liked~~ to the lack of linkage between areas of the brain producing the movement and those perceiving it (see Frith 1992; Frith et al. 1991; Daprati et al. 1997; Jeannerod 2002, 169–185). Identifying one's body as one's own is an actively cerebral, and therefore eminently vulnerable, process.

Perhaps this obstacle is not insurmountable. One way of understanding this contrast between the manner in which we confer a sense upon our body and the manner in which we confer a sense upon other objects is to draw attention to the fact that objects of perception are all of a certain type, always the same. *Grosso modo*, an object of perception can be manipulated, detached from its context as an object upon which I can focus at will while ignoring the surrounding world. This is evidently not the case with one's own body.

One's own body does not emerge out of a constitution of this kind because it can only be present as the environment of each perceived thing, never as a thing which would in turn have to be situated in an environment providing it with a background. A radical impossibility: the fact of my own immanence vis-à-vis my body excludes the very possibility of taking up perspectival views on it, views which I would only be able to assume if I could get away from it. And this in turn would immediately exclude the possibility of giving a meaning to my body as the intentional pole of unity: the only possible way in which meaning-giving can arise.

But can we stop there and simply refuse to accord any one meaning of being to one's own body? Alternatively and all things considered, do we really need a sense of its unity?

Precisely, Francisco Varela (Varela et al. 1993) steeped in an intellectualist reading of Husserl that I reject, criticized Husserl as a thinker who failed to recognize what seemed to him to be 'a fundamental fact': that the ego, the perceiving I, does not exist as a unity. For his part, Varela gave great weight to a contradiction between the shattering and fragmentation of the perceiving I, going as far as the absence (according to his Buddhist belief) of a unique ego, on the one hand, and, on the other, the intimate feeling we have regarding the unity of our existence as agent, the intimate feeling of the permanence of our identity as body-object, etc.

Delving into Husserl's unpublished manuscripts has given us the right to refute this allegation in what concerns Husserl by affirming the following: whatever may be the case regarding 'the identity of the I and the World', the kind of Buddhist belief that no one could possibly expect to find in this representative of the transcendental philosophical tradition, the tension (if not the contradiction) between a shattered I and a unified I was so little overlooked by Husserl that it doubtless became an existential drama haunting his later thinking.

> What are the kinaesthesiae themselves and what relation do they have with the acts of the I that accompanies them; the I which is directed through them and across them to …? Perhaps this very attempt to talk about acts directing kinaesthesia is already misguided? […] Are kinaesthesiae really something I-like? But then, what does the subjectivity in

question here mean?[8] […] What is the particular affinity between this kinaesthetic process and the I in its activity? […] Is the I itself anything at all outside of its concrete acts in the concretion of actual life[9]? […] But then what are we to make of pure subjectivity, the identical I of affection, of real acts, of feelings? […] The same world for me – the same I. What kind of identity are we talking about? *Perhaps constitution is multifarious*?[10]

Multi-sensorial Integration Through the Act

In this feeling of certainty we have regarding our ability to act we find implied, all the same, a 'certain sense' of the unity of our body. We could not act if we were multiple and if, what is more, persuaded of the fact of being so. Alain Berthoz (2000, 93–96) suggested that autistic children suffer from a deficit in the constitution of the unity of the own body and that it is this shattered perception of themselves that prevents them from establishing a relation with others. Without an own body – Husserl reminds those who get excessively enthusiastic about the empathic fusion of consciousnesses of precisely this – no social communication[11]. Pathological deficiencies in the sense of what it means to be an *I can* may even lead to the commission of criminal acts; to take an example offered by Hegel (1949), when an arsonist says that it wasn't he who set alight the house and eventually the entire town, but his hand, one should not rule out the possibility that he might be sincere (in the case of dissociated identity disorder or anarchic hand) – contrary to what is suggested by the purely institutional and legal (not existential) conception of the origin of responsibility defended by Hegel himself.

[8] E. Husserl, *MS* D 10 IV (June 1932), Difficulties with kinaesthesia, 9, 11.

[9] Here is the full quotation: 'What is the specific affinity between this kinaesthetic process and the I in its activity? […] But is the I something over and above its concrete acts enacted in the concreteness of life, and is a concrete act thinkable otherwise than as a process through which something runs off, something that could just as well run off from the self itself, inactively, or again, as a nodal point which runs off in an immediately active way and which is even immediately activable. But this is an originary property, therefore not one which can be immediately activated on one occasion and not on another. In the same way that the I is awake, therefore active as awake, it is always already in its activations. Before all else, it is active in its immediately active processes.' *Ibid*., 13–14.

[10] *Ibid.,* 18, emphasis added.

[11] E. Husserl 1973, I, 70: 'The aesthesiological-kinaesthetic layer of constitution makes of the body (*Leibkörper*) an own body (*Leib)*, a sensorial field and an organ of the Ego. And in such a way that the subject can express itself through this body, have corporeal expressions that serve to express its states of mind. […] If it is true that one can separate the bodily (aesthesiological) and the mental (spiritual), the first is primordial (*das Primäre*) for empathy (*Einfühlung*). It is absurd to connect the whole problem of empathy with purely expressive movements, corporeal expression of the mind, as one ordinarily does, and as Lipps himself also did in his research, however valuable that research might have been. Grasping the 'expressivity' of acts and mental states depends on a prior grasp of the body (*Leib*) as own body (*Leib*).'

That there might be a unity of one's own body despite the multiplicity of referential frameworks, of selections between captors, internal simulations of different parts of our body, remains a central problem that has to be tackled in the contemporary physiology of action. Whether one is talking about *coherence* (Berthoz 2000, Chapter 3) or *binding* (Singer 1990), what has to be understood is effectively the linkage between the incomplete perspectives we have of our body, and which are sequentially ordered in time. How do we come by the idea of the permanence of the body?

This question is not perhaps as overtly thematized in Husserl's unpublished manuscripts, but it is to be found there all the same. And in this sense, that, in order to understand the specific constitution of one's own body across its kinaesthetic adumbrations, a change of category proves necessary. That is, by no longer considering one's own body solely as the result of what is called today 'a multi-sensorial integration' and by the way sticking to sensation, but by crossing over to the category of action, in order the better to understand its sense. Because one's own body as a thing having its own meaning of being is after all something practical, caught up at each instant in an intentional act.

Later on, it might turn out that the body also proves to be an aesthetic thing, an object of theoretical enquiry, or whatever you want. But in the first instance it has to be taken as something practical. What confers a sense upon the body for us, is the fact that it is the original location of our intervention in the surrounding world through our actions – in a word, it is itself made up of our actions. To act is to grasp things and to appropriate these things by making use of them as a function of our intentions. To act therefore presupposes that there is a world already constituted for us, a world of things which already enjoy certain stability, certain permanence insofar as they are arrayed around 'me', which in turn presupposes the prior constitution of these things.

A fruitful way of approaching the problem is through certain later attempts made by Husserl at a phenomenology of the instrument, stemming from the 1930s.[12] The ability to act also includes the possibility of extracting one thing from that system through which it is given, the system of orientations. Something is presented as being close at hand or far off, to the right or to the left, etc. We can tear things away from this system through which they spontaneously present themselves to us and divest them of their external properties, with a view to tying them in to the own body. This moment of linkage with external things which, in the first instance, seemed to be things whose disclosure remained independent of the own body, is the decisive moment for action.

In this way we can selectively associate a thing with the source point, that is, the place where the perceiving subject is situated. We find here two aspects, two presuppositions of action which are also two factors in the constitution of the own body:

1. The fact that there are things whose mode of presentation depends both upon my own accompanying movements and upon my compensating for their own movements in order to keep their unity: visual constitution.

[12] E. Husserl, MS C16 V (September 1931); MS D10 I (1932) à III (June 1932).

2. A fact that no longer depends upon the above mentioned visual constitution, that is, upon the eyes and the organs supporting the eyes, but rather upon my ability to grasp with the hands, a new, *haptic* power.

How does this haptic constitution of my own body proceed? It proceeds by taking hold, a taking hold through which we appropriate a thing as the extension of a motor organ. And this taking hold manifests itself, literally, whenever we manipulate a tool. In an analogical manner, it is operative whenever we put on our clothing and wear it, whenever we make use of a piece of furniture (the artisan at his bench), whenever we get into a car and transform it into a vehicle.[13] In every such instance it is a matter of a linkage that gets set up with the own body and which depends upon a handling operation. This is what can be extracted from the notion of action by going back to its corporeal roots.

Husserl supposes that the own body is the result of a double constitution: (1) The constitution of things that are principally visual; (2) a new constitution which is typically haptic, that is, tied to the ability we enjoy to take hold of, grasp. Showing a notable premonition of the scientific knowledge which would have made it possible for him to recognize the existence of muscular and articulatory proprioceptors, Husserl insisted upon the tactile aspect of the haptic sense. But it is evident that he had in view this richer haptic sense, whose power is precisely to combine the various perceptions, of forces, of cutaneous pressures, of limb displacements, etc. For example, we pick up a tool. We wear a piece of clothing. For even wearing is a kind of taking hold of. We make use of tables and chairs in our daily environment, beginning with our bedroom. We 'run around in a car'. We 'make use of a vehicle'. We travel 'by plane'. All of this results in a description of the totality of things taken from the point of view of the use we are able to make of them. What is needed is to re-define the very reality of objects as a function of their possibility of being linked to one's own body, and in this way, as a function of their being granted a sense by an agent acting on the basis of his body and exerting his haptic power, his "hold over …": a sense giving operation which contributes essentially to this agent making sense of his own body.

Transforming the Subjective into the Objective

For Husserl, we have first of all the system of orientations in the first person perspective. One's own body is the zero point on the basis of which directional perspectives are unfolded. But in addition to this original role of directed activity it also captures in a certain way the objects it manipulates and assimilates them to parts of it. It can therefore also be seen as a sort of compass tracing out the sphere

[13] One finds fragments of a phenomenology of changing appearances (points of view, if you prefer) through the very fact of participating in the movement of a car in Husserl (1997) and of a plane (or a space ship) in: *Earth does not move,* ms D 17 (in Farber 1940).

of belonging of the ego, and thanks to which I can say of all the things to which I have direct access that they are 'ready to hand'. Among the directly accessible things we find, of course, my body, but also all those objects I make use of regularly, which are more or less directly associated to me.

What then is the relation between these two sets of things? A direct link, as powerful as it is contingent, is created whenever I take hold of an object and displace it, and this by virtue of the fact that it now becomes a part of my body, in a certain sense, and at least as long as I keep hold of it. The constitution of one's own body has a fundamental property: that although it remains invariant it can be modified as a function of the action in progress. An example is given by the temporary extensions of the body implied by the use of tools of all kinds, and in all sorts of circumstance. In his later manuscripts, Husserl insists upon the special status of the act of taking hold of an object in the external world and so making of it a prolongation of the own body. One's own body functions as a transformer of the subjective into the objective and reciprocally. I get into my car. The car becomes an extension of me. I get out, and the car becomes an external object once again. The own body, this curious object, can, at any moment, take advantage of its special status to assimilate to itself an object in the external world, and thus confer upon this relation between the subject and the world the quasi-epistemological status of knowledge through action, knowledge through praxis.

Physiology has to account for a change in the status of the object starting from the moment when it is linked to the body. 'Linked': that could be taken to refer to the desk where I work, to the clothes I wear or, in general, to any extension of the body in the context of a practical activity in which the body is involved. For the latter is caught up in the agent's sphere of belonging. In this frame of reference, what is it then that confers a sense upon the tool? It is the fact that it has become a 'non-kinaesthetic extension of the own-body'[14] as Husserl puts it. Obviously, the tool is not invested with kinaesthetic sensations like an organ of the body, but it participates in the system of the body which is itself constituted kinaesthetically. And this to the extent that the tool is integrated in a transaction at the interface of two systems: the system of the *objectifying perspectives of perception* and that of

[14] E. Husserl, MS D10 I (May 1932): 'Non-corporeal things picked out by the place zero do not yield kinaesthetic sensations like limbs, but they participate in such sensations when they are linked to a member (p. 20)'; 'The object grasped in the hand immediately loses its ability to appear at rest or in motion like an external object; it becomes, so to speak, a part of the own body, with the exception of kinaesthesia, which are missing […]. It is precisely this inversion that obviously lies at the root of the possibility of any aperception of the body as own body (p. 58)'. MS D12 I (5 September 1931): 'Even if haptic touching is not yet practical, like pure vision, it has the property of being able to change into pressing, striking, sliding, etc., to the extent that the appropriate pressure is applied. By an appropriate coordination of the fingers employed to touch something from several sides, this touching can also change into handling, carrying, etc. From pure touching in which the image of the *res extensa* is constituted haptically […] a world emerges in which we can intervene by acting, by moving what is at rest, by carrying through changes which were going to happen anyway and, in this way, subjectivizing what, in a certain sense, is simply there, in itself, in external things by including such things within the frame of our own body (p. 34).'

the *ownness sphere of the body*. The tool is in truth only one of the aspects of a more general phenomenological structure of experience referring back to a functional structure of the brain.

In fact this phenomenology of the body, prolonged through the tool, has been quite recently put on the track of its neural correlates thanks to the work of Atsushi Iriki et al. (1996) and his team at Tokyo University of Medicine. They studied the [AU3] visuo-tactile neurons corresponding to the region of the hand. A monkey carrying implanted electrodes was trained to recuperate food pellets with a rake. The size of the visuo-tactile receptor field for the recorded neurons was measured at three stages of the experiment: before the use of the rake, during, and after. To obtain an evaluation of the visual receptor field of these neurons, a map was drawn up of the activations obtained when, in the immediate environment of the monkey; a food pellet was dragged within his reach.

What was discovered was an extension, in the axis of the rake, of the visual receptor field of the visuo-tactile neurons whenever the monkey used the rake or, in the words of the authors, 'whenever he intended to make use of it'. This receptor field returns to its previous configuration just as soon as the monkey stops using the rake, even if he is still holding it in his hand. Note that this extension does not coincide with eye movements. To prove it, the eye movements were also recorded and the action potentials released by the presentation of food were superimposed upon eye movements recorded while looking. And here we see clearly the disjunction of the two. It now becomes clear that we have here a modification in the inner sense of the own body in action, whose obvious 'cause' is the intentional use made of the rake. The phenomenologist would say that the probable substrate of the kinaesthesia of the hand gets transformed in such a way as to incorporate the instrument employed in the action in progress. The authors were not unaware of what appears to us to be a direct validation of phenomenological description, since they made an explicit reference to Merleau-Ponty.

The Hand Touching and Touched

Everyone is familiar with the peculiar experience that arises when one touches one hand with the other. What happens is this curious ambiguity consisting in one of the hands being perceived as actively touching while the other is perceived as passively touched. A situation that can be inverted at will. We just said that whenever I grab hold of a tool and make of it the prolongation of my body, the mechanism I bring into play contributes essentially to my sense of having a body. But at the same time, let's remember that it also contributes to my body keeping its status as an object. The objectifying dimension of perception – too easily forgotten in the present day fashion of 'embodiment' of perception in cognitive science literature – depends upon this double contribution. A dimension as essential as that which shoves the object away from me, because this object will not be indefinitely associated with my own body. I can always get rid of it. In the same way, the touched hand

remains 'external', becomes an object for me. When it's a matter of the two hands of the same body, the situation turns to be paradoxical: alternatively objectified and subjectively animated, the hands and the entire body are eventually endowed with the sense of a thing, – but a thing that is lived from within!

The attribution of such a sense of being to our own body depends essentially upon kinaesthesia. Husserl distinguishes two categories of kinaesthesia. First, *objectifying kinaesthesia* (KO) functions in the perceptual mode so as to objectify the thing that the touched hand is. This is not, as Husserl reminds us, 'the kind of kinaesthesia that bring our two hands together in accordance with one's desire[15]'. For there is another contribution made by kinaesthesia, a contribution which, this time, goes back up to the source of our motor intentions and which Husserl calls '*motor kinaesthesia*' (KM), and this with a view to distinguishing them from the 'objectifying kinaesthesia'. However we do also *feel* the motor kinaesthesia that invade the touching hand. So, in addition to the feeling of being acted upon, we have to recognize *a feeling underlying action*. In this way, a double kinaesthetic contribution is brought to the theory of constitution. In order to account for the way in which our feeling of being a body arises, we have to bring into play both groups of kinaesthesiae, KO and KM. And if we can play with our different organs in such a way as to evoke this reciprocal touching-touched relation, it is simply because of the contingent, dual way in which the sensori-motor functions of our body have been set up: the touched hand can arbitrarily turn into the touching hand, the touching hand, into the touched hand. Each in turn can be animated by motor kinaesthesia or uphold objectifying kinaesthesia.

We now need to examine the relation between this dichotomy and experiments done on monkeys which show a difference in the activation of the neurons of the superior temporal sulcus, depending on whether its arm is touched by a stick or whether it touches its own arm (Perrett and Mistlin 1990). The neurons of the somato-sensory cortex also exhibit different activities under these two conditions (Nicolelis 1996, 2005; Ghazanfar and Nicolelis 1997). When an object is touched what is made use of is sensorial information to characterize the object, and that has nothing to do with the structures responsible for constituting the own body. On the other hand, when one is passively caressed, then the cerebral activity is principally devoted to the constitution of the own body. With humans this fundamental difference between touching oneself and being touched is brought to light through the tickling experience. We can't tickle ourselves for different regions of the brain are activated when we touch ourselves (which fails to produce the tickling impression) and when we are tickled by others, which does indeed produce the laughing reaction (Blakemore 2003; Blakemore et al. 2000).

How is it then that we come by this feeling that there is a body we inhabit? We come by it because, with our two hands, which are organs of action, we are able to operate haptic links with objects – e.g., a hammer – which thereby become extensions of one's own body and which are arbitrarily substitutable each for the other

[15]E. Husserl, ms D 10 III (June 1932), 41.

by virtue of the fact that they have been taken from my environment. Constitution, the attribution of the meaning of being to our own body when we are an agent is linked to the fact that there are motor orders, and also to the fact that there is objectifying kinaesthesia (visual, tactile, proprioceptive afferences). But that is not all. The most important thing is that there is in addition *an interaction and a continual co-evolution between the somato-motor and somato-sensory topographical maps* which make up together a system of re-afferences (a constant returning upon themselves of these afferences) to which we referred under the name 'motor kinaesthesia'. So what has just been said about the hands could be taken up again with respect to other parts of the body.

Of course, the notion of 'maps' has to be taken with a grain of salt, however commonplace its use might have become with the specialists of cortical cartography (Xerri 2003; Xerri et al. 1999). Taken just as it arises through the topographical readings obtained in the anatomical or physiological study of the monkey, this notion certainly does not include what features, in our view, as the neural substrate of the constitution of one's own body: the possibility of *simulating action without moving the body*. This is why the notion of maps has to be understood in an extended sense, following the example of Gerald Edelman (Edelman and Tononi 2000), who conceives them as emerging out of dynamic processes implying entire networks of brain. In the course of ontogenesis and indeed throughout the entire length of individual experience, one process (re-entrance) ensures the selection and the correlating of groupings of cells functionally associated through perceptual activities, even though these groupings are situated in distinct and distant anatomical cerebral regions. This process creates solidarity of mutual linkage between the maps at the root of the perceptual categorization of the environment[16].

This would mean that there would have to be an integrated system of somato-sensory and somato-motor maps which constantly modify each other, a system brought into play whenever I take hold of an object independent of me, thereby making of it a prolongation of my body, and that it is across this transitory prolongation and shortening again that I acquire the sense of being my own body. Michael Merzenich, to whom we owe the discovery of the plasticity of the sensory and motor cortical maps, writes as follows:

> To a large extent we choose what we will experience, then we choose the details that we will pay attention to, then we choose how we will react based on our expectations, plans and feelings, and then we choose what we will do as a result. This element of choice and the relational nature of awareness in general have almost never been considered in neurophysiological experiments. We realize now that experience coupled with attention leads to physical change in the structure and future functioning of the nervous system. This leaves us with a clear physiological fact, a fact that is really just a mechanistic confirmation of what we already know experimentally: moment by moment we choose and sculpt how our ever-changing minds will work, we choose who we will be the next moment in a very real sense, and these choices are left embossed in physical form on our material selves. (Merzenich and deCharms 1995, 76).

[16] Edelman 1989, Fig. 3.1, 45. Other mechanisms have also be taken into account, like those which Rodolfo Llinas (2001) stressed, and which emphasize a continuous oscillatory flux in the loops linking the thalamus to the cortex across the basal ganglia.

Summary

The operations involved in the constitution of the sense of being a body would indeed prove to be a piece of vainglorious conjuring if they were not rooted in our corporeal organization and if they did not bring this organization into play, perhaps in a more eminent manner than ordinary activities. This rootedness in the body is required of any theory of the incarnation of meaning that wants to take up its stand in the wake of lived experience. The act of conferring a meaning upon its body is grounded in the fact that it prolongs, and so makes explicit, the sketch of a corporeal movement founded in the kinaesthetic system.

The neuro-physiological work subtending the constitution of the body could very well not be due entirely to mechanisms of the touching-touched type, that is, the exploration of the own body by itself. Even if the bringing to light of the singularity of one's own body owes a great deal to the philosophically happy choice of this paradigmatic example. In fact, phenomenological description grasps the own body as an acting body, a continually busy body, continually at work at some task. And this is what is meant by the German verb '*hantieren*', which French phenomenologists, following Merleau-Ponty, have rather poetically (and misguidedly) translated as: 'our body haunts the world.' From the physiological point of view, the constitution of one's own body as acting body also, and necessarily, brings into play mechanisms set up to explore the external world.

The fact that one's own body draws its sense of being a body for us from the actions that we are only able to accomplish by bringing into play its practical powers implies that the own body is not enclosed within itself as by a frontier, as is the physical body in the way we ordinarily think of it. It's a lived and not simply a perceived (in the sense of passively represented) body. Accordingly, the diversity of the temporal flux of our intentions, as we project ourselves in all directions foreseeable, is such that there is a constant renewal of the sense of our own body, including the one we have of its geometry. And as long as we are active, the work will not be finished! However, all of this requires – and circularly enforces – an integrated articulation of one's own body, a harmonious synergy as between the different organs, beginning with the two hands.

In the same way, Husserl's robust idea of 'harmony' (his expression for today's physiology 'coherence') was that harmony is always aimed at and that, although it is never wholly achieved, it is constantly sought as a response to a variety of looming dissonances.[17] The vital issue being that of not stumbling over a catastrophic dissonance: Discongruity in the sensorial information available to the perceiving

[17] Husserl (1997): 'It belongs to the general essence of conflict, of being otherwise, that it should presuppose a foundation of agreement.' This foundation becomes the horizon of an infinite quest in the later manuscripts where constitution, after being static, becomes dynamic: *MS* B III 9 (October–December 1931) The problem of the act: 'each "creative" real doing serves a universal goal of life centred on the Ego: will to unity, to harmony of being as something that has constantly to be re-established by correction.'

subject – and in the practical intentions of the agent – which might bring with it the destruction of one's own body and its environment, not to say the collapse of the life-world. Something of this kind often does transpire in disturbances like depression, spatial anxiety, agoraphobia (without forgetting out-of-body paroxysmal episodes in epilepsy), but also in such psychiatric afflictions as anorexia, autism, schizophrenia, etc. We are told that the flexibility of the perception of the lived body is such that, in illnesses such as anorexia, certain persons can have the impression that their body is enormous even when they are quite slim and, on the other hand, persons afflicted with elephantiasis can have the impression that the size of their body is normal (see Viaud-Delmon et al. 1999; Viaud-Delmon et al., 2002); [AU4] Viaud-Delmon et al. 2000). In this regard, physiology and phenomenology both share a commitment in favour of recognizing significance to the anomalies as contributory factors in constituting the world of living that sets them apart from physics. At least to the extent that the (classical) physicist, who works on the principle that he is fully enabled in considering things independently of his access to them, dreams of an exclusively normal system of experience: Never having had any reason to relate sensorial qualities to the corporeal conditions (normal or abnormal) of the subject of experience, this physicist, Husserl observes, 'has nothing to offer the physiologist.[18]

References [AU5]

Arzy S, Thut G, Mohr C, Michel CM, Blanke O (2004) Neural basis of embodiment: distinct contributions of temporoparietal junction and extrastriate body area. J. Neurosci 2006 26(31):8074–8081

Berthoz A (1973) Contrôle vestibulaire des mouvements oculaires et des réactions d'équilibration. Thèse, Faculté des Sciences

Berthoz A (1978) Vision et système vestibulaire. Encyclopaedia Universalis, Paris, 441–444

Berthoz A (1991) Reference frames for the perception and control of movement. In: Paillard J (ed) Brain and space, Oxford University Press, Oxford

Berthoz A (1994) La Géométrie Euclidienne a-t-elle des fondements dans l'organisation des systèmes sensoriels et moteurs? [AU6]

Berthoz A (1996) How does the cerebral cortex process and utilize vestibular Signals. In: Baloh RW, Halmagyi GM (eds) Disorders of the vestibular system. Oxford University Press, Oxford

Berthoz A (2000) The brain's sense of movement. Harvard University Press, Cambrigde MA

Berthoz A Melvill Jones G (1985) Adaptive mechanisms in gaze control. Reviews in oculomotor research. Elsevier, Amsterdam

Berthoz A, Petit J-L (2008) The physiology and phenomenology of action. Oxford University Press, Oxford

Berthoz A, Pavard B, Young L (1974) Rôle de la vision périphérique et interactions visuo-vestibulaire dans la perception exocentrique du mouvement linéaire chez l'homme. C.R. de l'Académie des Sciences T.278, D (1974), 1605–1608

[18] E. Husserl, ms D 13 XV (1910–1918), 33. On the importance of anomalies for the constitution of the world of normality. Also see Petit, (1996) *Solipsisme et Intersubjectivité*. Section 2–4, 23–72.

Berthoz A, Graf W, Vidal PP (1991) The head–neck sensorymotor system. Oxford University Press, Oxford/New York
Blakemore SJ (2003) Deluding the motor system. Conscious Cogn 12(2003):647–655
Blakemore SJ, Smith J, Steel R, Johnstone CE, Frith CD (2000) The perception of self-produced stimuli in patients with auditory hallucinations and passivity experiences: evidence for a breakdown in self-monitoring. Psychol Med 30(5):1131–1139
Blanke O, Mohr C (2005) Out-of-body experience, heautoscopy, and autoscopic hallucination of neurological origin: Implications for neurocognitive mechanisms of corporeal awareness and self consciousness. Brain Res Rev 50:184–199
Blanke O, Landis T, Spinelli L, Seeck M (2004) Out-of-body experience and autoscopy of neurological origin. Brain 2004(127):243–258
Blanke O, Mohr C, Michel CM, Pascual-Leone A, Brugger P, Seeck M, Landis T, Thut G (2005) Linking out-of-body experience and self processing to mental own-body imagery at the temporoparietal junction. J Neurosci. 25(3):550–557
Buizza A et al (1979) Otolothic acoustic interactions in the control of eye movement. Exp Brain Res 36:509–522
Daprati E et al (1997) Looking for the agent. An investigation into consciousness of action and self consciousness in schizophrenic patients. Cognition 65:71–86
Edelman GM (1989) The remembered present. A biological theory of consciousness. Basic Books, New York, Fig. 3.1, 45
Edelman GM, Tononi G (2000) Comment la matière devient conscience. Odile Jacob, Paris
[AU6] Farber M (1940) Philosophical Essays in Memory of E. Husserl
Frith CD (1992) The cognitive neuropsychology of schizophrenia. Lawrence Erlbaum, Hove
Frith CD et al (1991) Willed action and the prefrontal cortex in man: a study with PET. Proc R Soc Lond 244:241–501
Ghazanfar AA, Nicolelis MA (1997) Non linear processing of tactile information in the thalamocortical loop. J Neurophysiol 78(1):506–510
Hegel GWF (1949) Philosophy of right (trans: Knox TM). Clarendon, Oxford
Husserl E (1973) Zur Phänomenologie der Intersubjektivität. Texte aus dem Nachlass. I, Husserliana XIII. Martinus Nijhoff, Den Haag
Husserl E (1997) Thing and space. Lectures from 1907 (trans. & ed Rojcewirz R) Kluwer, Boston, MA
Iriki A et al. (1996) Coding of modified body schema during tool use by macaque postcentral neurones. NeuroReport 7:2325–2330
Israël I, Berthoz A (1989) Contribution of the otoliths to the calculation of linear displacement. J Neurophysiol 62:247–263
Ivanenko YP et al (1997) The contribution of otoliths and semicircular canals to the perception of two-dimensional passive whole-body motion in humans. J Physiol (London) 502:223–233
Jeannerod M (2002) La nature de l'esprit. Odile Jacob, Paris
Llinas R (2001) I of the Vortex. MIT Press, Cambridge, MA
Lobel E, Kleine J-F, LeBihan D,Leroy-Willig A, Berthoz A (1998) Functional MRI of galvanic vestibular stimulation. J Neurophysiol 80:2699–2709
Merzenich M, deCharms RC (1995) Neural representations, experience, and change. In: Llinas R, Churchland P (eds) Mind and brain. MIT Press, Cambridge, MA
Nicolelis MA (1996) Beyond maps: a dynamic view of the somatosensory system. Braz J Med Biol Res 29(4):401–412
Nicolelis MA (2005) Computing with thalamocortical ensembles during different behavioral states. J Physiol 566(Pt 1):37–47
Perrett DI, Mistlin AJ (1990) Visual and somatosensory processing in the macaque temporal cortex: the role of 'expectation'. Exp Brain Res 82:437–450
[AU6] Petit J-L (1996). Solipsisme et Intersubjectivité. Quinze Leçons sur Husserl et Wittgenstein, Cerf
Singer W (1990) Search for coherence: a basic principle of cortical selforganization. Concepts Neurosci 1:1–26

568 Varela F, Thompson E, Rosch E (1993) L'Inscription corporelle de l'esprit. Sciences cognitives et
569 expérience humaine. Seuil, Paris
570 Viaud-Delmon I et al. (1999) Anxiety and integration of visual vestibular information studied with
571 virtual reality, Biol Psychiatry 47:112–118
572 Viaud-Delmon I et al. (2000) Adaptation as a sensorial profile in trait anxiety: a study with virtual
573 reality. J Anxiety Disord 14.6:583–601
574 Viaud-Delmon I, Berthoz A, Jouvent R (2002) Multisensory integration for spatial orientation in
575 trait anxiety subjects: absence of visual dependence. Eur J Psychiatry 17.4:194–199
576 Xerri C (2003) Plasticité des représentations somesthésiques et illusions perceptives: le paradoxe
577 du membre fantôme. In: Petit J-L (ed) Repenser le corps, l'action et la cognition avec les
578 neurosciences. Intellectica 1–2(36–37):67–87
579 Xerri C et al (1999) Representational plasticity in cortical area 3b paralleling tactual-motor skill
580 acquisition in adult monkeys. Cerebral Cortex 1999(9):264–276

Author Queries

Chapter No.: 11 0001090484

Queries	Details Required	Author's Response
AU1	Please check if footnote 1 can be changed to acknowledgement.	
AU2	Please check if the deletion of 'p.' in the reference cross citation is correct.	
AU3	The citation 'Iriki (1996)' (original) has been changed to 'Iriki et al. (1996)'. Please check if appropriate.	
AU4	The citation 'Viaud-Delmon, Berthoz and Jouvent 2002' (original) has been changed to 'Viaud-Delmon et al., 2002'. Please check if appropriate.	
AU5	Following references are not cited in text: Arzy 2006; Berthoz et al. 1974, 1991; Berthoz and Melvill Jones 1985; Berthoz and Petit 2008; Blanke et al. 2004; Petit 1996	
AU6	Please update.	