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On the relation between recent neurobiological data on perception (and action) and the Husserlian theory of constitution[1]

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Abstract. The phenomenological theory of constitution promises a solution for "the problem of consciousness" insofar as it changes the traditional terms of this problem by systematically correlating "subject" and "object" in the unifying context of intentional acts. I argue that embodied constitution must depend upon the role of kinesthesia as a constitutive operator. In pursuing the path of intentionality in its descent from an idealistic level of "pure" constitution to this fully embodied kinesthetic constitution, we are able to gain access to different ontological regions such as physical thing, owned body and shared world. Neuroscience brings to light the somatological correlates of noemata. Bridging the gap between incarnation and naturalisation represents the best way of realizing the foundational program of transcendental phenomenology.

Key words: action, constitution, kinesthesia, mirror neurons, plasticity

Introduction

Progress in the contemporary sciences of the brain still remains quite ambiguous. To be sure, a good many prejudices concerning the functioning of the brain have been dismantled. No one now believes in the brain as an organ genetically fixed in its anatomical structure, its homuncular or retinotopical topography, nor in its functioning, as an organ which is essentially receptive and reactive and which functions as a link between environmental stimuli and physical movements, strictly compartmentalised and ordered in a hierarchy reaching from peripheral receptors to the associative centres and from there to motor activity, etc. These prejudices have not withstood the onslaught of evidence relating to the epigenetic variability of the cerebral network, to the

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flexibility, modified by usage, of the synaptic connections, nor that of the activational potential of the neuronal network, whether spontaneous or induced, whether preparatory, or anticipatory, whether concerned with the projection of hypotheses or decisions, or with the internal simulation of actions, events or external processes. These transformations have made it possible for the neurosciences to gain access to the higher activities of the human mind and in so doing have opened the way to the cognitive neurosciences.

Does this mean that the phenomenology of our conscious experience, until now solely accessible in its meaning (even in its *expressible* meaning) to the reflective approach of phenomenological (or analytical) philosophy can now be dealt with in parallel from the standpoint of the biological processes which underlie and run parallel to this level of meaning? A certain popular literature has sought to furnish a short and dogmatic response to this question: the biology of the brain has up till now disregarded the mind – from now on it will explain it! It is our contention that another reply is possible. Starting out from the Husserlian theory of the transcendental constitution of the meaning of the being of objects we are beginning to find in recent neuroscientific evidence, and in new fields of research, quite definite parallels which make it possible for us to propose an alternative solution to that of dogmatic reductionism. The rootedness of the possibility of meaning in a corporeal experience rests upon the presupposition of the existence of a particular somatological organisation which is, so to speak, the contingent apriori of the field of meaning. The mechanisms brought to light by the neurosciences seem to me to present valid candidates for this function. For the neurosciences can be integrated into the foundational programme of transcendental constitution. In response to the demand for an ultimate explanation, the philosopher today can, as never before, fall back upon those circuits and schemas of cerebral activation which stand in correlation to perception and action. The optimistic conclusion is the following: instead of abolishing the transcendental project, the naturalisation process can contribute to its fulfilment. The world of experience is endowed with meaning by us: the contingent organisation of our nature has made this possible. Can this hypothesis be justified? And are we entitled to push matters even further than this?

Let us be more definite about our ultimate ambitions. In fact, what we idealize is a functional neurodynamics for the constitution of one's own body, and more broadly, a functional neurodynamics for the transcendental constitution of a world of meaningful experience through constitutive operations such that the subject itself can perform them with its own body. Let me clarify matters further. A rapidly growing body of discoveries in the specialized domain of brain cartography has been transforming the traditional dispute be-

tween phenomenology and positive science regarding the adequate treatment of the body into an obsolete quarrel – even though most philosophers remain as yet ignorant of this development. Up to now, phenomenology has been used to call attention to the difference (not without dramatizing the conflict) between the fixity of the anatomical structure of the physical body (*Körper*) and the free fluidity of the meaning patterns of the subjective experience of one's own body (*Leib*). From now on, the critical question should be: whether or not such a contrast is on the point of disappearing altogether. In fact, neuroscience has resolutely shaken off its former belief in a rigidly somatotopic representation of the peripheral organs of the body within the frontiers of a definite somatosensory mapping of the territories of the centro-parietal cortex and thalamus. Accordingly, a new methodological approach is forcing its way through brain science labs, putting on their common agenda the setting up of a global online recording of constantly moving functional activation patterns. These constantly changing patterns distribute themselves over varying regions of cerebral tissue at a rate determined both by the performance of the behavioral tasks and the ability of the system to recruit the necessary cerebral resources. Such representational plasticity, far from being genetically predetermined in all its localizational specifics, proves itself to be induced, shaped and modulated to a considerable extent by the unique experience of the organism in its environment. Laying our bet on the chances of a new relationship between phenomenology and objective science, we want to take advantage of the opportunities created by these developments. And (assuming some speculative license) we want to coordinate the flow of functional activity of the brain with the flow of lived experience of the body in an attempt to bridge (or at least narrow down) the gap between activation patterns and meaning patterns, the assumption being that they are mutually indispensable correlates underlying the *auto-affection* of the acting person.

But such a phenomenological reinterpretation of the biological data only covers one half of our program, the second half of which consists in a reinterpretation of phenomenology itself. The traditional criticism of that brand of phenomenology known as transcendental constitution is directed at an alleged submission of all meaning formations in the life world to the sense giving power of a Cartesian *cogito*, a move that turns this *cogito* into a kind of creative god, and that makes an enigma of the rootedness of our meaningful experience in the body. Such criticism may have had some credibility thirty years ago. But, nowadays, after the transcription and publication of the bulk of Husserl's manuscripts in the *Husserliana* series, this position can no longer be sustained. We have enough evidence of the constant efforts made by Husserl in his later work, to affirm unhesitatingly that a transcendental (i.e. subject-

relative) constitution of the sense of being is not only compatible with, but also actually requires a corporeal embodiment of the constitutive operations through which the objects of experience are endowed with meaning. On the one hand, the constitutive operations have been transformed into real actions of which we can be fully conscious as we accomplish the relevant movements. On the other hand, the somewhat disembodied activity of the *cogito* has been integrated into the fully concrete somatosensory experience of kinesthetic systems through which we are aware of and control our movements. As a result, the promotion of kinesthesia to the status of the principal operator in the process of constitution has meant that the role of the body has been generalized to each and every dimension of our daily experience of a world uniquely peopled by the products of constitutive operations. So that the body, and not the *cogito*, traditionally conceived as an abstract reference lacking in any material substratum, has turned out to be the true pivotal center around which all our subjective experience of a meaningful world revolves. Returning to the neurosciences, the gap that we try to bridge is reducible to a semantic difference between two expressions: the "modulation by experience" that neuroscientists postulate as the contribution of the somatosensory system to perception, and the "constitution by experience" that transcendental phenomenology views as the contribution of kinesthesia to the perceived world.

Two conceptions of consciousness

Consciousness in act

When we are actively engaged with something, we are directed towards this thing which thereby becomes our object. The thing is there, right at the centre of our attention. We are directed toward it. We apply ourselves to it. We are absorbed in it. Even though we remain fully alert we are, so to speak, deflected, torn away from ourselves. In not being present to ourselves we are for this very reason both absent from ourselves and present to something which is not our self. This experience of being outside ourselves and of being integrated into something external to ourselves is experienced as both fascinating and upsetting, something obscurely felt as a threat to our intellectual comfort.

In the philosophical tradition, few authors (and rarely in all parts of their work) have succeeded in successfully overcoming the peculiar difficulty of grasping this consciousness in act, especially if one considers how important it is not to water it down and then replace it with something which has little to do with it. For in fact we are exposed to all kinds of pressures and to all kinds

of temptations which lead us to dogmatically reduce our approximate and indicative forms of expression to a pseudo rational norm and so to objectify and substantialise or hypostatize them, by arbitrarily imposing topical and demarcational distinctions: there is an outside and an inside, physical things outside and their mental representations inside, etc.

Consciousness as a place

The understandable determination to take up a stand on something solid and to enjoy the reassuring certainty of dealing with something real has led many philosophers to give up trying to grasp this consciousness in act. They preferred to delimit an area which they could arrange as they pleased by populating it with objects of a certain type, a rather peculiar type certainly, but which could be treated in accordance with a standard method. Locke launched this tradition by interpreting Descartes discovery of the *cogito* in his own way. Getting rid of the *act* as much too ephemeral he opened the way to any future psychology by transforming human mentality into an interior space: *tabula rasa,* a blank sheet of paper, the mirror of external objects . . .

> Consciousness is the perception of what passes in a man's own mind. . . Light and sound force an entrance into the mind. . . The ideas come into the mind. . . There are such ideas in men's minds . . .The furniture of the yet empty cabinet (Locke 1961, I, p. 19).

This problematic of *inside-outside*, which comes down to systematically rejecting the act character of consciousness and replacing it with a spatialised fantasy confirmed by an obsession with boundaries has resurfaced today via the representational theory of mind espoused by analytical philosophy and – under its influence – cognitive science. The only valid question now appears to be whether we have conscious access (awareness) to certain internal events (Fourneret and Jeannerod 1998; Libet et al. 1983).

The alternative solution: according priority to intentionality

One approach to consciousness as act is a strictly correlational approach, one which refuses to separate the subjective and the objective pole of the experiences under consideration (perception, action, memory, imagination). This is the only way to avoid playing Cartesian games, alternatively extroverted and introverted, extroverted in the forgetfulness that objects are there for someone and introverted in the failure to recognise the essential nature of repre-

sentations whose very existence is dependent upon their reference to external things. The real problem is not that of knowing when and how the threshold of consciousness is crossed as soon as otherwise more decisive events are produced outside of it (Locke's inner chamber). The true problem is to know how a world invested with meaning unfolds within the field of vision of an inhabitant of this world, how things emerge, become available for handling, how their alterations satisfy (or frustrate) his motor intentions, etc. We need a theory about the way in which a perceiving agent makes sense of what does not in itself make sense. Both access and non-access to things stem from the fact that things are so constituted in their very being that they can be meaningful for us.

Starting with intentionality, the paradox of an external thing already constituted prior to its being encountered is eliminated in principle. It ceases to be a purely contingent event in the experience of a subject, something which nevertheless (and despite the manifest contradiction) had to be able to gain access to the interior of this subject and be received there. No longer mutually indifferent, but just the reverse, mutually sustaining, subject and object are henceforward reduced to opposed poles, each referring to the other in a circular and dynamic relation without which neither could be maintained. The *cogito* is an act which posits the object as one and the same. Each object thereby becomes a meaningful objective, a unifying pole, the guarantee of our expectations.

The viability of this alternative approach depends upon the fact that one is able to suspend the mutual indifference of subject and object and to relativise their difference in the context of each conscious experience and within the continual flux out of which these experiences emerge. The substitution for the subject-object duality of a *noesis-noema* correlation (*Ideen I*) gives expression to this ambition (Husserl 1976). The *noesis* is the subjective activity which traverses, animates and unifies the one with the other by linking together the multiple configurations stemming from the sensorial field within which a possible something is outlined in the course of experience. The *noema* is neither consciousness itself nor the object. As the unifying pole of the noetic synthesis in the absence of which it would be dissipated in the pursuit of the multiple, it cuts across the indefinite multiplicity of the process by offering a determinate segment: the object just as it is in its mode of givenness.

Intentionality in the constitution of the thing

What is decisive is that the noema confers its constituting character upon the lived duration. The result is neither a sterile succession nor yet a compressed accumulation but a regular development of meaning. Tied down to the proc-

ess by which it is formed rather than being fixed in the in-itself of an Idea, the noema retains the virtual flexibility of alternative possibilities of development at each phase of experience. But if one goes so far as to reduce the nucleus of intentionality to its constituting noesis has one not subordinated objectivity to subjectivity, the *esse* to the *percipi*?

The incarnation of meaning in the concrete development of corporeal experience is secured by the promotion of the *kinesthetic function* to the status of the constitutional operator.[2] In this regard, however, a process is required in order that the *kinesthesia* be invested with intentionality. In the first place, a meaning which only floated on the horizon line of gaze has to be contextually integrated into the movements of the body. The arrow of intentional consciousness traverses and links up instantaneous cross sections of the visual field in accordance with the movements I make in exploring the visual scene. Not only does it connect the finite series consisting of what is actually visible in the form of ever changing images, this finite series gets extended into the infinite series of other changes made possible by the trajectory adopted by the same action. But if this consciousness is capable of grasping the thing itself across the adumbrations through which it is present, this is only because each adumbration refers to the next, and because the movements of the body brings the very adumbration which satisfies this intention of unity and identity (Husserl 1973b, IV, pp. 154–203). If the visual field at some later moment outlined a scene which could not have been foreshadowed at an earlier moment, the consciousness of unity would collapse. Visual images only acquire the status of adumbrations, are only capable of sustaining intentionality, in circumstances where the kinesthesia develop normally.

The contribution of kinesthetic sensations to the constitution of the visual thing is however limited to varying the visual scene and placing it in perspective, as though the scenario was under the direction of an act of apprehension projecting the thing across its adumbrations. The sensations which alert me to the movements of my perceptual organs do not in themselves secure this projective exposition of the thing. My freedom of movement, the effort required to move my body, the tiredness that comes from expending muscular energy, none of this makes it possible for kinesthetic sensations to endow parts of space with qualities or to bring these parts of space together into fields, all of which remains the task of visual and tactile sensations. From gesture to gesture, what could possibly be implied by kinesthesia if not a continuing alternation of tension and relaxation whose continuity does not even require that any one phase be intentionally referred to any other? Wholly engaged in the direction of visual attention, such intentionality emanates exclusively from the subject.

Intentionality in the constitution of one's own body

The concept of kinesthesia relies upon the duality from whence it springs, the "I move" considered either from the proprioceptive (sensorial) or from the practical (voluntary) standpoint. In the constitution of the physical thing, the proprioceptive path is privileged. Its role is to separate out the changes due to the movements of the thing from the changes attributable to the movements of the subject. Whether the latter are voluntary or passive, the variation produced in the visual field is always the same: a new series of lateral aspects of the object is unfolded in perspective. In the constitution of the body as one's own, on the other hand, the duality of the kinesthesia is brought into play. Kinesthetic sensations of movement and position are what make possible the localisation of tactile qualities and their unification in a continuous surface which enfolds the hand touched by a constant referral from place to place of the touching hand. An experience intrinsic to my motor intentions even before the sensorial impact, this is what they amount to at each reversal of the touching-touched relation in the course of which I appropriate my physical body constituted in this way as that body which I can move when I will. Here we find the co-ordination of the two hands, a coordination which I bring about at will but which can not be brought about by kinesthesia directed toward the placing in perspective of the visual thing. Not because these kinesthesia are devoid of intentionality but because the polarisation of visual perception means that one's own body, the nul point of any orientation, loses itself in the outward thrust toward the goal of action.

The radicality of the kinesthetic constitution of one's own body has much less to do with imprinting its natural anatomy upon a sensorial configuration than with what is brought about by the realisation of our motor intentions. Two kinesthetic systems have to be distinguished.[3] A first system is devoted to orientation in perspective; it contains all those objects whose aspects vary from the remote horizon to the immediate availability of things within reach. The other system seems at first to be concentrated upon an unextended point, the point of origin of the axes of co-ordination of the perceived world. The experience of the tool, as a "non-kinesthetic extension of one's own body," recommends its reinterpretation as a system functioning in equilibrium with the first system. In fact, any object I lay hold of, which I pick up and take with me or which I make use of (Heidegger's hammer) is immediately withdrawn by me from its primary condition of an object of visual constitution to be incorporated into my sphere of ownness as the vector of my intentions, woven into the kinesthetic system, whether explicitly or implicitly, by the practical handling of things encountered in the world. Nothing brings out more clearly

the variability of the corporeal horizon than the possibility of replacing the earth as the immobile point of reference of all perceived movements by a plane or space craft.

Intentionality in intersubjective constitution

The systematic exploitation of the resources of kinesthetic functions in constitutive operations does not lead to an indefinite stratification of the layers of meaning. On the contrary, a certain dialectical closure of the field of referential possibilities blocks this progression: constitution of the thing – constitution of one's own body – constitution of an intersubjective world. In fact, it makes perfectly good sense to say that, for us, the meaning of this world requires that it be populated with physical things and that we are not alone in living in the midst of such things. The different ontological regions of experience thereby evoked (things, the self, others) are, one by one, brought into play in a movement first of projection, then of introjection and finally of analogical transfer. The eidetic structure of intentionality closes this movement. Goal-oriented intentionality profers things, self-referential intentionality profers one's own body. What might be called transferential intentionality or empathy (*Einfühlung*) founds the openness to the other of one's own experience by supplementing one's own kinesthetic system with the possibility of its resonating with that of someone else, attested and confirmed through the perception of the physical movements (expressive of the other's active intentions) of another agent.

For Lipps, *Einfühlung* was a way of gaining direct access to the interior life of the other (Lipps 1903a, 1903b, II, pp. 97–223). Only later do we come to separate this life of the other from our own subjective life. For Husserl, what particularly distinguishes the perception of the other is the absence of any direct experience of his mentality (Husserl 1973a, T3, Bl. IX, X, XVI). With regard to the other, as with regard to any physical thing, only a part is directly given: his body from the front. But a more complete experience of the other would also have to comprise those parts which are not given, which are prefigured as accessible in the further course of experience: his back and sides. In addition, we see his body as his own body, the bearer of sensorial fields and kinesthetic systems but we do not perceive the red he sees nor do we feel his activity. When we see other human bodies, impressions of movement can be associated with this sight through empathy. But they refer us on to an experience of "I feel, I move my body" which is not itself given. We know that there is on that side a new sensorial field, another freedom which is not anchored

in our own self-apperception. As soon as we integrate, within the horizon of our perception of the other, the empathic quasi-givenness of his kinesthesia and his subjective life, both of which are always suggested without actually being given, then, instead of a cognitive deficiency in the perception of the other, we find ourselves equipped with an (super-sensible) historical and hermeneutical understanding of intersubjectivity.

The neurophysiological basis of the constitution of meaning

We should be careful not to confuse incarnation and naturalisation. Incarnation is a response to the demand that the flux of experience be relived concretely, that is, freed from the accretions of meaning that come from verbal expression or logical shaping. Naturalisation is a response to a completely different demand; that of procuring, for an eidetic description, the meaning structures belonging to the subjective experience correlated with objects located within the field of investigation of the cognitive sciences. Recognition of the role of kinesthesia in constitution amounts to a move in the direction of the incarnation of meaning or of the possibility of a world figuring within the corporeal experience of an agent. But it is still well worth asking whether anything has been accomplished thereby in the direction of naturalisation. To be sure, the experiences connected with the movement of the organs of perception, of one's own body or the body of the other, remain at a distance from the physical aspects of the corresponding movements. However, this distance is no longer a metaphysical abyss separating two substances, but a demarcation line which can be crossed by appealing to some postulate of normality. Normally, when we raise our arm, when we feel it moving, or rather, when we feel the *I move* of our arm, it rises. That this normality is a purely contingent consequence of the way our body is constructed and that things could have been otherwise (so that my left arm rose every time I tried to raise my right arm) does not endanger its constitutive function. Disconnected from the realm of Platonic Ideas, the apriori of meaning is rooted in a body of flesh and blood. The visual field belongs to lived experience not to the retina. For all that, the structure of the retina imposes its own constraints upon the visual field. It is this predetermination of the phenomenal field by an underlying organisation which sets the stage for the implementation of a neurobiological programme.

The theory of constitution makes perception responsible not just for the reception of the perceived thing, or for its representation, but also for its givenness. The absence of anything like an external instructor capable of let-

ting the brain know whether or not its cellular activity corresponds to a real external object only makes the problem of cognition for the brain that much more akin in its radicality to the one of constitution. Everything about the object, not just its figurative and qualitative properties but also its identity and individuation, depends upon cerebral activity. On the one hand, constitution is not to be construed as the solipsistic unfolding of internal representations but as a matter of a mutual and reciprocal formative interaction between an active agent and its environment. On the other hand, abandoning the myth of *the grandmother neuron,* cognitive neuroscience is moving in the direction of a more abstract and dynamic conception of the neural pathways responsible for the treatment of sensorial information by, for instance, identifying the schemas of activation making possible the identification of a face, schemas progressively modified with a retroactive feed-back of information upon the functioning of the primary sensory regions (Rolls and Deco 2002). The same primacy of central activity is to be found in the interaction between the cerebral circuits and the effectors and sensors at periphery on one side, and in the interaction between the intending act of the subject and the body as organ of its intentions on the other.

A neural correlate for the noema of a face

The regions of the cerebral cortex are, from the point of view of their respective contribution to the perceptual treatment of visual information, divided up into primary occipital regions and parietal and frontal regions of temporal association. The primary regions are organised retinotopically and in such a way that a stimulus appearing in the contiguous regions of the visual field will fall into the receptor field of contiguous neurones. The regions of association contain neurones possessing more extended receptor fields, reacting to more complex stimuli and contributing to the highest levels of the processing of visual information. In particular, in the case of the monkey, we have been able to register in the lateral fusiform gyrus, the superior temporal sulcus and the intraparietal sulcus, cells which are selectively activated by faces (Perrett, Rolls, and Caan 1982). These cells are not of the type *grandmother neuron,* that is, exclusively concerned with the face of one and the same individual, in abstraction from variations in its mode of presentation. But, unlike the cells of the primary regions, they are also not restricted to the encoding of an elementary feature of the visual image in a receptor field limited to a narrow sector of the retina (e.g., a small luminous band in movement). Their conditions of activation are associated to varying degrees with (1) a relative *invari-*

ance with regard to isomorphic transformations (rotation, colour, size, contrast, plane or volume, orientation with regard to the *ego*) and (2) a relative sensitivity to changing *points of view or aspects* (face or profile, eyes, mouth, hair, orientation of the gaze) (Baylis, Rolls, and Leonard 1985; Desimone et al. 1984; Hasselmo et al. 1989; Rolls and Baylis 1986).

This type of behaviour suggests the existence of a system of analysis and recognition of faces which proceeds by associative synthesis of any relevant information and a filtering out of irrelevant information, and not by means of any simple comparison between a stimulus and a preestablished concept stored in the memory (Booth and Rolls 1998; Tanaka 1996). In the (non-anatomical) functional configuration resulting from this process, a configuration which is sometimes described as the distributed representation of an identity equivalent to a list of distinctive characteristics, at other times, as a buffer process capable of absorbing changes in the retinal image of one and the same object, I would be prepared to see a correlate of the noema of a face. With regard to this noema, this functional configuration possesses in effect the dialectical polarity of both of two moments (1) the pure something = X which refers to the individuality of the transcendent thing in itself in relation to the experience, and (2) the perceived as such, the object in the how of its determinations and in-determinations, situated at the very heart of the experiences of perception and action directed towards this thing.

A neural correlate for the noema of one's own body

The constitution of one's own body rests upon the distinction and the articulation of two types of kinesthesia: objectifying tactile kinesthesia which present this body as a spatial thing, and subjectifying practical kinesthesia thanks to which these organs are experienced in their very movement as organs of the *ego*. As a possible correlate I will this time make use of the phenomenon of the plasticity of those body maps which are localised in the primary somato-sensorial and somato-motor regions of the cerebral cortex throughout the central sulcus as well as in the relay regions of the cortical and sub-cortical sensori-motor pathways activated by motor behaviour (Merzenich and deCharms 1995).[4] In support of this theory of constitution I can think of no better empirical argument than the cumulative evidence relating to the modifying effects (already noticeable in the learning process but also more directly) upon this plasticity of voluntary motor activity and of intentional behaviour. Corresponding to Husserl's intuition that the intentionality of action contributes to the meaning of one's own body we find the hypothesis that this func-

tional somatotopy is moulded by the intra-cortical signals whether efferent, reentrant or reafferent, thanks to which the somato-motor and somato-sensorial maps influence each other in the course of the entire experience of the subject. That the habitual localisation of subjective properties (qualia) in the body requires the integration of tactile fields and of practical kinesthesia could be due to the fact that the somatotopy of the cortical representation of the sensitive regions of the body is mediated by the use the subject makes of his body and from there by the motor somatotopy of his voluntary action and the imprinting of the latter into his memory as a motor schema. At the level of the cerebral metabolism the complete circuit of these mediations represents the basis for the spatialisation of the acting subject in its own body.

Whatever might be held to be true of the anatomical form of the body, the truly real body is both an acting body and a sensibly experienced body, the acting body constantly modifying the experienced body which, in its turn, anticipates its own modification. As a result, what we call "the body" emerges from its permanently internal reconfiguration and this at a variety of levels, the level of visual, tactile and proprioceptive perception, that of muscular control and, even earlier, of motor schemas, while further back still we find the intention. This reconfiguration accompanies an entire series of steps encompassing the mastery of tasks, the choice of strategies, the level of attention, the formation, maintenance and reactivation of the intention, the fixation in memory of the repertory of motor schemas – in a word all the micro-aspects of action.

A neural correlate for the instrumental noema

We employ a tool as a prolongation of our hand, a physical extension complemented by a perceptual assimilation of this tool to the corporeal schema of the hand. In a study bearing on the neural correlates of this phenomenology, monkeys were trained to make use of a rake to drag back towards them with one hand pellets of food to be grabbed with the other (Iriki, Tanaka, and Iwamura 1996). The identification of a group of visuo-tactile neurones in the parietal cortex has made it possible to locate at this point a map of the visual space centred on the body of the animal. Measurements of the visual receptor field (RF) of these neurones whose cutaneous RF is localised on the fingers and the palm of the hand being used has revealed its plasticity and the dependence of the latter upon usage. This visual RF which is at first superimposed upon the cutaneous RF gets extended along the axis of the rake at the end of five minutes of use as if the image of this tool had been incorporated into that

of the hand, then gets retracted just as soon as this usage ceases, thereby recovering its initial localisation, even if the monkey continues to hold onto the rake. Proof that this expansion is linked to its intention to make use of this tool, it legitimises our attempt to trace the origin of this modification (linked to usage) back to the animating intention.

This hypothesis concerning the neural substrate of the use of a tool has been confirmed at the clinical level with humans in the case of a patient whose right hemisphere had been lesioned and who showed a hemineglect restricted to the immediate vicinity (Berti and Frassinetti 2000). In a line-bisection test on a piece of paper (the left half of which she could not see) this patient deflected the centre of these lines towards the right. This deviation was more pronounced in the foreground where she could touch the lines with her finger than in the distant background where she used a luminous pointer. It has been noted that the perceptual distortion characteristic of the spatial foreground reappeared when she was given a stick rather than a pointer to carry out this test in the more remote reaches of the spatial field. If we assume that the utilisation of a stick induces an extension of the cerebral map of the body into a region of space inaccessible to direct handling and that this map subtends the close-far difference within our conscious experience of space, this phenomenon of functional plasticity can be seen as the correlate of the instrumental noema for whoever makes use of it as a non-kinesthetic extension of one's own body.

A neural correlate of the noema of the other

At the level of the individual neuron, biological support has been uncovered for the understanding of the intentional signification of the actions of an other agent (di Pellegrino et al. 1992; Gallese et al. 1996; Rizzolatti and Gallese 1997). To the extent that an organism is capable of understanding the intentional signification of its own actions, it acquires the possibility of immediately understanding the signification of the actions of others, that is, without the mediation of any perception of an initially non-interpreted bodily movement followed by a judgement which attributes meaning on the basis of a special interpretation. In the pre-motor cortex of the macaque monkey (frontal area 5) a class of "mirror neurons" was found, the characteristic of which is that they are activated *both* when the animal accomplishes certain goal-directed hand movements *and* when he observes the experimenter in the process of accomplishing what one is obliged to call *the same action.* Where the latter is defined as a series of articulated movements aimed at one and the same goal no matter what the limb, or muscles of the movements brought into play.

These neurons make up a vocabulary of all the actions necessary for the animal to bring its food to its mouth: "grasp with the hand," "grasp with the hand and the mouth," "reach," "catch with precision," or "with the full hand," etc.

When another monkey was placed in the presence of the recorded one, a synchronised firing of the neurons of area 5 was noted each time this other monkey grasped some food. Trying to establish the existence of mirror-neurons in humans, it has been discovered that observing the experimenter grasping an object induced in the human subject an increase in the motor potential evoked by magnetic stimulation of the cortex in the muscles which bring into play the execution of the same movement (Fadiga et al. 1995). In both cases, positron emission tomography shows an activation in Broca's area, the analog of monkey's frontal area 5 known for associating a somatotopic representation of the hand (predominant with the monkey) and a somatotopic representation of the mouth (predominant with the human).

What could be the functional role of these mirror-neurons in humans, neurons whose schema of activation seems capable of representing the identity between the meaning of one's own actions and those of the other, but not the emotional state nor the predisposition of the subject to action? The scientists speculate that this comprehension of the actions of others lies at the root of speech (Rizzolatti et al., 1996). We understand each other through language because, in advance, we have already understood each other's actions by visual observation, which is the most basic intersubjective precondition. Without pressing too far the question of an empirical confirmation of phenomenology, it must be admitted that these findings justify Husserl's upholding of the idea that our empathic experience of the other is an internal imitation of the movement accomplished by the other. This implies an actualisation of the *kinesthetic sensations* corresponding to the movement in question, and not its effective execution nor even (against Max Scheler) an affective fusion with the other. In addition, Husserl was also amply justified in holding that the constitution of the world is intersubjective and practical and not solipsistic and representational.

Notes

1. This paper was presented at *The Naturalistic Tension: An International Symposium on Phenomenology and Cognitive Science,* University of Tampere, May 16–17, 2002. I would like to express my appreciation to Dr. Christopher Macann for the English translation, and to Professor Leila Haaparanta, and the participants at this colloquium for their friendly reception and interesting comments.
2. Concerning the role of kinesthesia in (late) Husserlian constitution theory, we rely on Husserl's manuscripts of the thirties, series B and D, at Archives Husserl de Paris, ENS, 45, rue d'Ulm.

3. Husserl himself expresses his theory of constitution in terms of *System* (ms D13, 1921). To the system of appearances of spatial things in perspective whose sense of being we constitute by moving our eyes, our neck and our whole body there corresponds the system of postures and movements of our body parts, such as sense organs. This correspondence is no mere mapping, but a motivating running through of our motor and sensory organs by our kinesthetic sensations as we orient ourselves in relation to objects. An analogy in scientific physiology might be the motor or sensory systems, as the physiologist understand them. With the following reservation: that most neuroscientists, when they are not uniquely interested in the anatomical structures (receptors, effectors, conduction paths, cortical maps, etc.), have a piecemeal ("modular") approach to the functions sustained by these structures, one that is wholly opposed to the holistic and highly differentiated approach of Husserl.
4. On experience as a factor of cerebral plasticity cf. Elbert et al. (1995); Mogilner et al. (1993); Pascual-Leone and Torres (1993); Pascual-Leone, Grafman, and Hallett (1994); Sterr et al. (1998); Wall, Felleman, and Kaas (1983), and the papers by Merzenich and collaborators in the references.

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