

In : V.Knockaert & H. De Preester (eds) (2005) *Body Image and Body Schema: Interdisciplinary perspectives*. (pp. 89-109). John Benjamin, Amsterdam

Running heads: Dual framing of body space

Vectorial versus configural encoding of Body Space

A neural basis for a distinction between

Body schema and Body image.

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The way in which space relationships are represented in the brain and intervene to organize our vision of a stable world in which we move our private body space has been the topic of lasting philosophical and scientific debates. In interdisciplinary workshop like this, each of us, depending on his own background and experiences, is necessarily coming with his biased point of view. Let me first briefly outline how my own itinerary, as an early trained neurobiologist (having to teach psychobiology in the faculty of sciences) lead me, as early as 1972, to confidently consider a functional segregation between body schema and body image as biologically and evolutionary founded .

One of the most impressive features of our brain is its ability to process a continuous flow of multimodal information from internal and external sources thus producing an integrated and coherent central representation of our perceptible outside world and of both our perceived and unconsciously registered own body space.

Motor action is assumed to play a crucial role in accounting for the astonishing capacity of the nervous system to extract regularity and covariant features from changing surroundings and body state, storing them in some central representation of both a predictable outside world and the private domestic body space which we inhabit.

Additionally, inherited sensori-motor mechanisms intervene both for regulating the large spectrum of autonomic functions underlying body metabolic functions and for automatically framing the basic postural mechanisms underlying body's orientation in the field of gravity, and those anchoring oriented sense organs to targets located in a coherent, stable, and unified perceived world. ('Paillard, 1999b)

We initially proposed (Paillard, 1971) to attribute a distinctive role to two types of motor activities: those involved in 1) *transporting* body segments or the body as a whole from one place to the other, toward definite targets in their action space and 2) those exploring unvisited local spaces for instance in tactually or visually palpating objects for their identification. *Transport* toward stable targets (regardless sensory modality) are critically important in mapping an "*espace des lieux*" i.e. an action space where targets are vectorially located in a *body-centric space coordinate system*. Contrastingly, *exploration* contributes to uncover an "*espace des formes*" where local spaces are shaped by the outlines of their boundaries and internally characterized by the stable configuration of their components parts whose relative positions are referred in *word-or object-centric space coordinate systems*.

Self-generated transports have been shown to play a prominent (although not exclusive) role in the inter-calibration of the various sensorimotor action fields (Paillard, 1971, 1991a) thus grounding the building up of a general amodal action space. In contrast exploratory investigations operate within a circumscribed local space for identifying its shape characteristics and internal features thus contributing toward the central registering of configural invariants that would allow its categorisation and later recognition.

Our basic assumption is that a sensorimotor body schema and a configurally coded body image derive from such a dual processing mode of spatial relationships. The neurological relevance and functional consequences of such a distinction will now be examined under the following headings: a) Sensorimotor versus representational levels of neural processing. b) The what and where dichotomy. . c) The neural basis of vectorial or configural encoding of body space d) Evidence from deafferented patients of a dual body mapping; we will conclude by some comments on the biological roots of identity.

A) Sensorimotor versus representational levels of processing

Right from the beginning of my university career, around the fifties, I was facing the hopeless challenge to try to feel the gap between the data gathered by a still immature neurophysiology (recently endowed with the new promising technological resources from the computer revolution) and, the psychological approaches of mental functions (yet still largely influenced by philosophical and psycho-analytical theories). To meet this ambition, and following the Piagetian assumption (Piaget, 1937; 1971) that higher cognitive functions have their roots in basic sensorimotor mechanisms that primarily ensure the organism survival. I

found pedagogically useful to frame the problems in introducing the simplified model depicted in figure 1 (with its improvement over the time) which highlights the main questions we have to cope with?

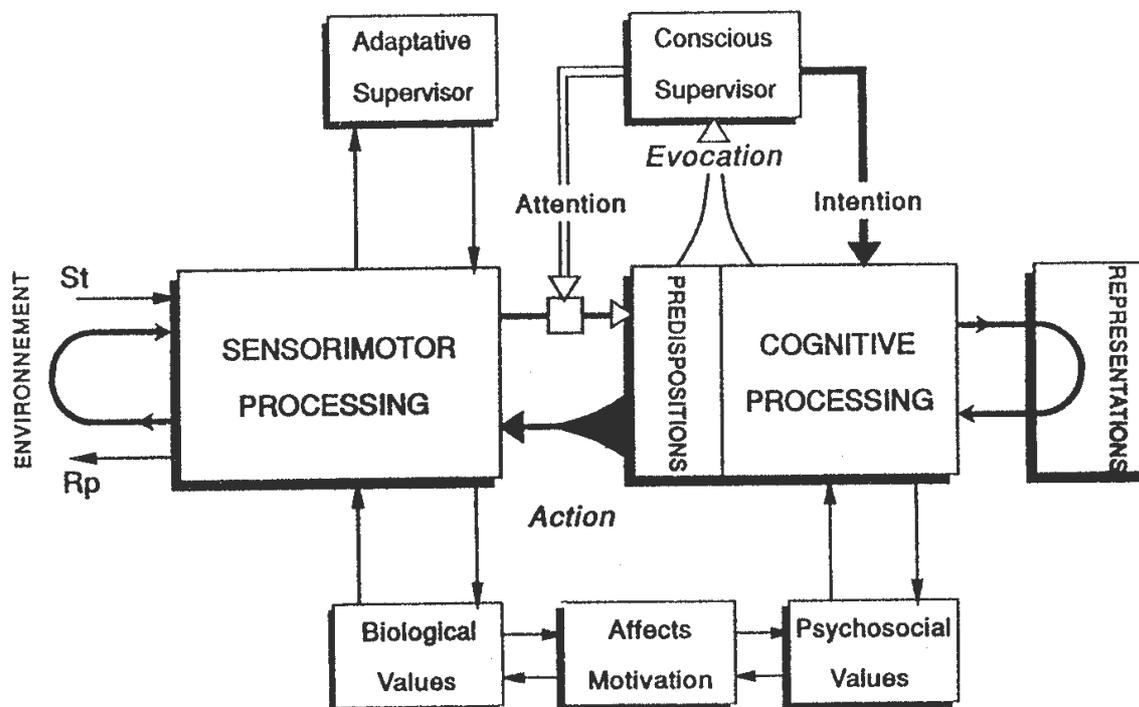


Figure 1: Two levels of information processing in the nervous system: see comments in the text (modified from Paillard 1980)

This model attempted in an oversimplified form to schematize the two fields that characterize the neurophysiological and psychological approaches of behavioral and mental outcomes. A first compartment involves a *sensorimotor* machinery directly dialoguing with its physical environment mainly through its genetically prewired circuitry selectively tuned to supply vital functions whereas the second concerns a *cognitive* apparatus endowed with the whole resources of neocortical structures (with their stored abstracts representations of internal or external world) able to process the variety of mental states that characterizes higher brain functions. The question arises as to whether the two processing modes operate in parallel, each using its own neural circuitry and generating its own mapping of space in two fundamentally different ways. Thus the central problem of the interaction between both levels stand before us. The sensorimotor level clearly stands as an interface between a cognitive brain and its outside world. It imposes its own constraints to the collecting of information gathered by sense organs and in their distribution for further processing to higher

structures through the control of attentional processes and conscious awareness. In the same way, descending commands for self-generated action can not ignore the requirement of the sensorimotor interface. They have to anticipate the inverse dynamic of the sensorimotor machinery to meet their desired target in the physical space. Thus both levels are functionally tightly coupled. Since, we have to envisage how far sensorimotor schemas of Piaget's model (1937) providing the various "savoirs faire" of the basic biological machinery, may contribute to mediate the neural implementation of the diverse "savoirs" categories in the cognitive brain. To use the more commonly quoted distinction later introduced by Ryle (1949) we may conclude that a '*knowing what*' can not be build without the assistance of a '*knowing how*' (which, in a sense, is no more that a reformulation of motor theories of mind). Thought are we legitimated in the body space to consider that a "body image" (a '*what*' problem) could not be shaped without the presence of a "body schema" (a '*How*' problem)? Let us now come back to the historical background of this "*What and Where*" dichotomy.

B) The what and where dichotomy

The early distinction we introduced (Paillard 1971) between an "espace des lieux" (target space) and an "espace des formes" (shape space) was consonant with the then emerging segregation in neuro-behavioral studies between 'two visual systems' respectively processing 'identification' and 'location' cues (Ingle, 1973; Schneider, 1969; Trevarthen, 1970; Held, 1970). The model derived from a seminal study by Ingle (1967) on the frog's visuomotor behaviour, then extended to the hamster by Schneider (1969). Both suggested a dissociation between the role of cortical visual areas in the perceptual *discrimination and recognition* of visual forms and that of collicular structures in *body orientation and target localization* in the action space. (see figure 2)

Having been committed at that time as discussant in a symposium on "Psychologie de la conscience de soi" (1972), I found confronted to a violent attack of the Schilder book (on Body Schema) by René Angelergues (a french neurologist from the Haecan's group) emphasizing "l'assumption triomphante de l'image" in the human brain and concluding sharply : « *The Body Schema as to be considered as a useless concept, unnecessary, even deleterious and becoming an obstacle to biological and psychological thinking...* »

In my vigorous plea for an attempt to preserve this concept as one of the rare bridge we still had between neurophysiologically graspable data and psychological theories, I explicitly

questioned, (see in foot note its original french formulation), the enduring conceptual confusion entertained by neurological and neuropsychiatrical studies between body schema

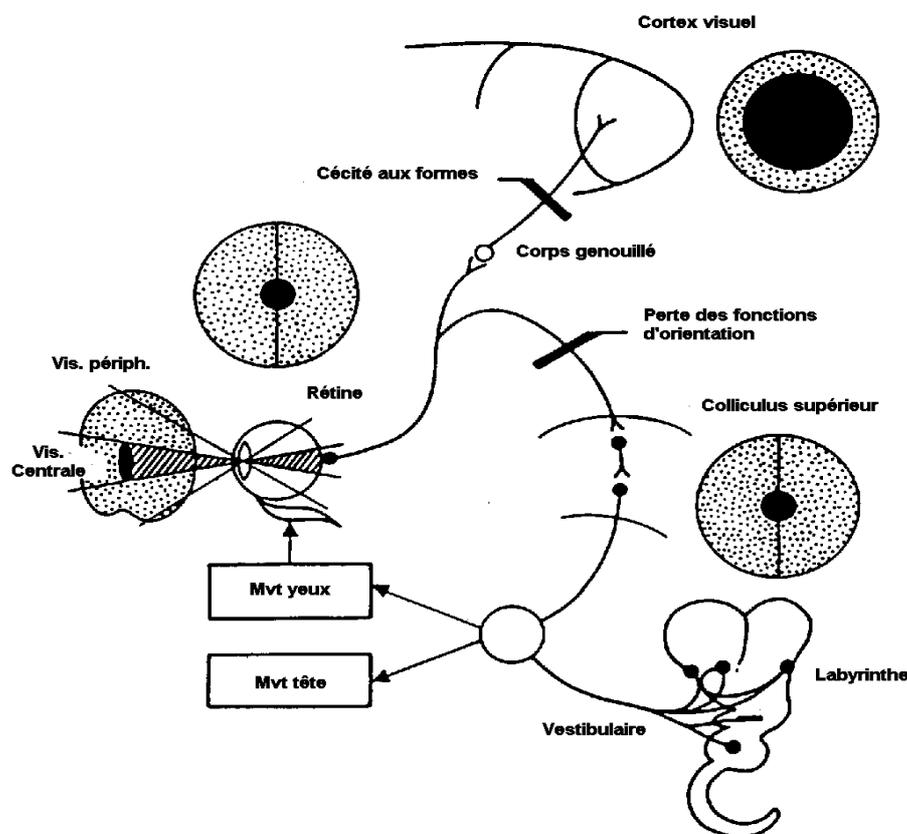


Figure 2. Two visual Systems : one conveying visual information through the geniculate body to the visual cortex (with a dominance of central vision) allowing the perception of form; the other afferented collicular structures of the optic tectum ensuring orientation and localisation in the visual space. (modified from Schneider 1969 in Paillard 1980)

and body image as the main obstacle to overcome, if we really aim at promoting a productive dialogue between biological and psychological thinking. (Paillard 1973).

Afterwards, I took the opportunity for further enlarging the distinction between a body “localized in an *“espace des lieux”* and a body shape identifiable in an *“espace des formes”* .In the same line, I similarly emphasized the necessary distinctive status of the body as the egocentric origin of a space coordinate system and a body referred as an object by its relative position with respects to other objects or other landmarks in a configural world-centric frame of reference (Paillard 1980,1982, 1991a, 1991b). Additionally, I was also specially interested by the specific properties of self-induced movements when compared to passive body displacements (Paillard & Brouchon 1968) and eager to look at the inherent properties of the self-acting body . A problem re-actualised to day with the new approaches

of the sense of ownership as dissociable from that of agency (Gallagher 1986, Richemond, in preparation)

Coming back to our historical survey, I would like to mention that the Trevarthen proposal in its first monkey study (1970) to distinguish a “focal vision” entailing foveal retina for identification and an “ambient vision” involving the peripheral retina for localisation, obviously prefigured the now influential “*What*” and “*Where*” dichotomy. The later proposed 10 years later by Ungerleider and Mishkin (1982) was also derived from works in monkey and established that visual information, conveyed to primary cortical visual areas through geniculo-striate pathways was distributed to associative cortex along two main streams: one travelling through the posterior parietal association cortex and subserving the knowing ‘*where*’; the other, mainly projecting into the temporal association areas (where object features are analysed) and constituting the neural substrate of the knowing ‘*what*’. The dominant contribution of peripheral and central vision in each of these processes has recently been confirmed by Morel & Bullier (1990). Such a functional segregation between parietal and temporal associative cortex is now largely recognised and supported by neuroanatomical, neurophysiological, and neuropsychological studies (Jeannerod and Rossetti 1993) (see figure 3)

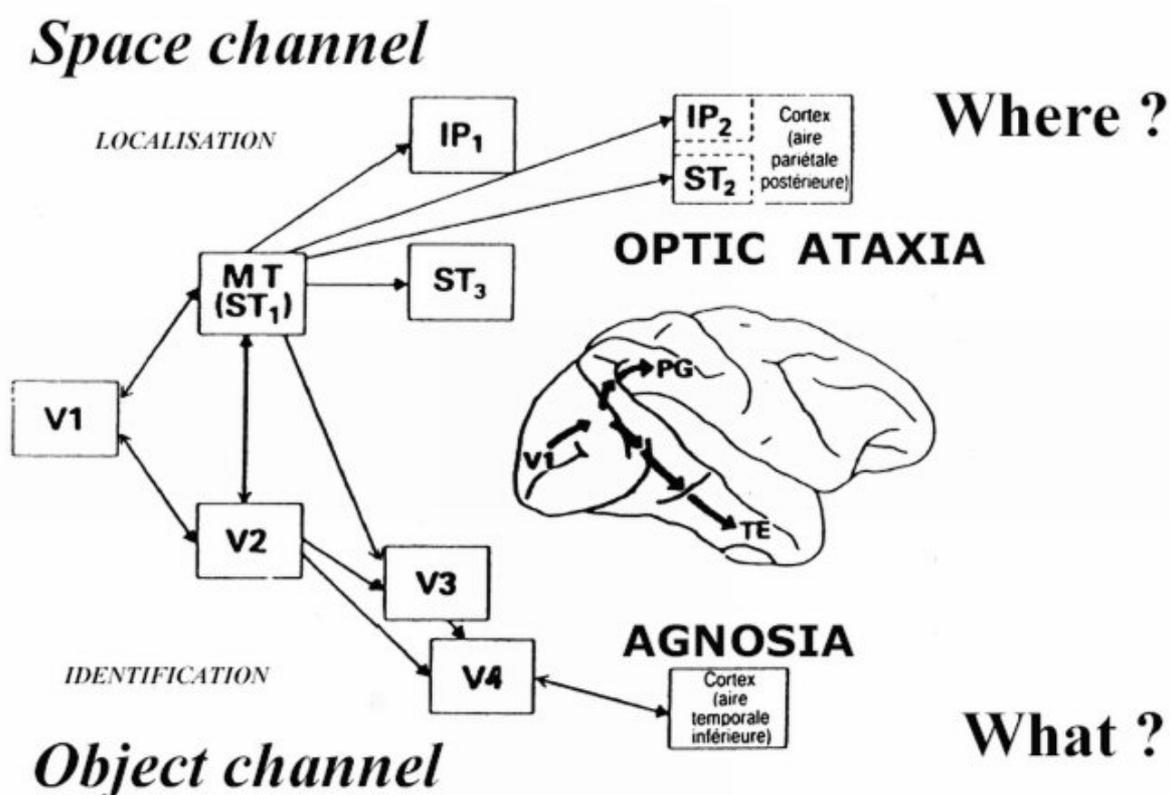


Figure 3: Double distribution of visual information to the parietal and temporal cortex. See comments in the text (modified from Ungerleider & Mishkin, 1982)

Moreover, different mechanisms of processing spatial information have been assumed to be represented in the human inferior and superior parietal lobule. Perenin (1997) argued that the superior part of parietal cortex whose lesion lead to disturbances of visuomotor control such as optic ataxia is mainly involved in 'direct coding of space for action by means of several effector-specific representations' while the inferior part is responsible for 'more enduring and conscious representations underlying spatial cognition and awareness'. Milner and Goodale (1995) suggested that the superior parietal lobe as part of the dorsal stream of visual processing mediate 'the control of goal-directed actions in an ego-centric reference system, whereas the inferior part of parietal lobe with the parietotemporal region deal with abstract spatial processing based on input from the ventral stream and thus associated with the formation of perceptual and cognitive representations which embody the enduring characteristics of objects and their significance'. Obviously these observations fit remarkably well with the hypothesis of a dual mapping of a body schema and a body image pointing moreover to a presumptive regionalization of two separated underlying cortical networks. In fact, it gives evidence that a corticalization of the primitive motor functions of the tectum optic in spatial, orientation may have contribute to bestow the parietal cortex with the leading role it has taken in primates and man in the organisation of spatial function

Surprisingly however, we have still to wait a more decade to see taken into due consideration the contribution of collicular efferent projection to these cortical areas (through the pulvinar thalamic nuclei) which contributed to confer to this regions their newly discovered spatial functions.

The interesting observations by Goodale (1991) of their implication in the automatic monitoring of spatially oriented action at a subconscious level clearly disclose their relationship with collicular primitive functions. Subsequently it offers a convincing neural explanation for the perplexing phenomena of “*blind sight*” (Weiskrantz 1989) and “*blind touch*” (Paillard et al. 1983b). The emphasis being put on the motor oriented role of these regions (Goodale & Milner (1992), the proposal by Jeannerod and Rossetti (1993) to distinguish a *semantic* from a *pragmatic* processing mode in the brain is especially welcome, distinction which, in a sense, is consonant with the piagetian one between “*savoirs*” and “*savoir faire*”.

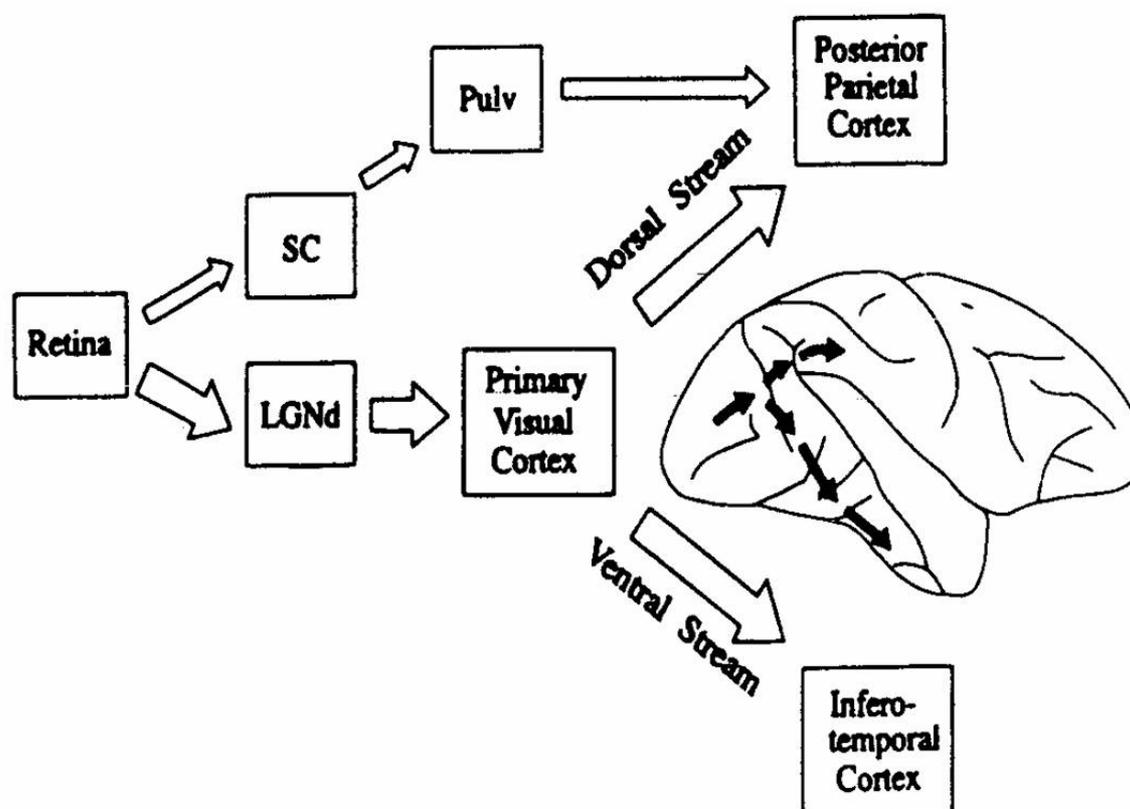


Figure 4 : Double distribution of the visual streams in primates through temporal and parietal cortex. The *dorsal stream* jointly participate in the posterior parietal areas with information from collicular origin (superior colliculus **SC**; Thalamic pulvinar nuclei: **Pulv**; Lateral geniculate nuclei: **LMGd**). The *ventral stream* contributes , in the infero-temporal cortex, to objects identification according to their shape and internal features (adapted from Goodale & Milner, 1992)

This new forward developments greatly contributes to further splitting of the original What and Where dichotomy into various subclasses distinguishing for instance the *Where* from the *How to get there* and the *What* from the *How to use it* (see Paillard 1991b). It also has stimulated behavioural neurosciences to re-actualise rather neglected topic of the old neurology, as for instance the automatic:/voluntary control of movement,. Hence new models have been proposed to identify separate neural nets for the predictive or reactive driving of action (Goldberg, 1985a, 1085b). More generally the emphasis put on the complementary role of implicit and explicit brain process (i.e. consciously or subconsciously controlled), has open promising new lines of research (Shachter, et al. 1988; Pisella and Rossetti, 2.000). More generally this new trend join the contemporary growing interest of neurosciences, endowed with the new technologies of neuro-imagery (opening the non-invasive exploration

of the waking brain in man,) to invest the long prohibited territory of consciousness, still almost exclusively reserved, until recently, to phenomenological and philosophical survey (Paillard, 1999c). The topic of this interdisciplinary meeting asserts precisely the reality and promises of such converging endeavours but it obliges us to evaluate how far our own contribution is providing compelling evidence for the reality of known neural mechanisms able to fully establish the Schema-Image distinction as physiologically justifiable. To that aim we have to turn out to the encoding problem.

C) The vectorial versus configural encoding of body space.

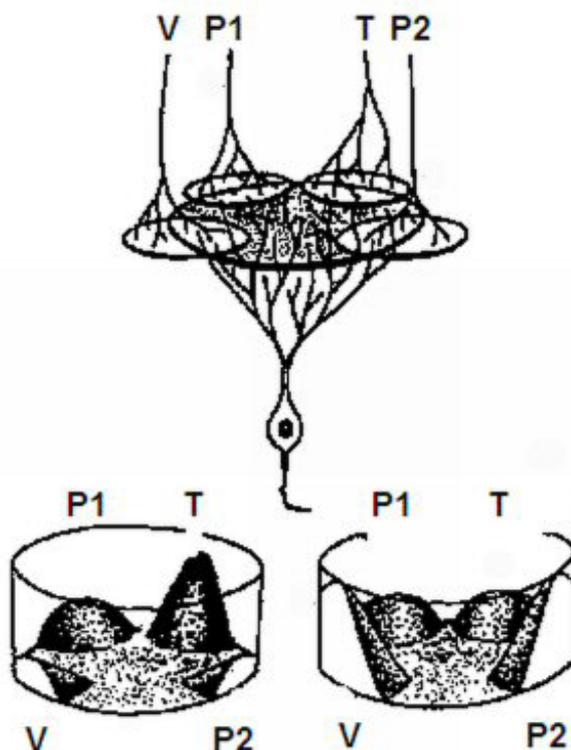
Looking at the identification of the neural mechanisms underlying the encoding modes presumably involved in a dual mapping of body space we may summarize the main arguments as follows:

Two main codes, temporal and structural, are recognized to be used in the processing of neural information. (see Paillard, 1983a) In *temporal* coding, the frequency of propagated train of repetitive impulses (for coding intensity for instance) or the configuration of a sequence of pulse train have been identified as the most commonly used. The *structural* code still designated as the “labeled line” code concerns the signification acquired by a neural message depending of the target zone of its destination (for instance an optic fibre which should be grafted so as to direct its message to an auditory area zone should raise a sound sensation).

Moreover considering the multimodal neurones of the cortical associative areas which received a great amount of converging sensory fibres of various origins on its membranes, each singular neurone is presumed to get around ten thousand synaptic contacts distributed on its membranes. One simple law attributed to Hebb tells that synapses repetitively co-activated (within a critical time delay) see their transmission power reinforced whereas it diminishes in the others. Consequently, if a given configuration of afferent information is invariantly present in impinging messages the neurone behaves progressively like a filter recognising specifically the selected configuration. In other words, it becomes the neural representation of some invariant feature of the incoming information. See figure 5

We speak here of configural encoding. It is most pervasively used in the structuration of neural network activities. It may account for the astonishing capacity of biological systems endowed with neural networks to extract covariant signals from the flow of multimodal

sensory inputs that impinges on their sense organs, and to stabilize in the neural circuitry selective configurations of synapses that are co-variantly activated (Phillips *et al.* 1984) thus imprinting in the hard core of the neural system a kind of internal representation of the invariant feature of collected information..



Figures 5 : Schematic illustration of how a configuration of polymodal information converging to membrane of a single neuron arouses a configuration of co-activated synapses. Synapses repetitively and synchronously activated see their transmission power reinforced whereas it decreases in others. The figure shows the convergence of 4 fibres carrying polymodal afferent information (visual V; tactile T; proprioceptive P1 and P2). To the left: initial state of the configuration of synaptic activation at different sites. To the right :state of the configuration after repetitive coactivation of visual V and proprioceptive P2 afferent with the corresponding reinforcement of the synapses involved whereas other connections not synchronously solicited (P1, T) are weakened . (from Paillard 199b)

In analogy with the distinctive “labeled line” and “configural” code identified in the neural network (the first being defined through the destination locus of the fibers, and the second by a configuration of co-activated synapses) and considering now the neural encoding of the body space, we are also clearly facing two modes:

-one, considering a *target space* (our “espace des lieux”) where target goal for a directed movement has to be **vectorially** defined by its location (direction and distance) in a stable reference system,

-the other, a shape *space* (our ”espace des formes”) in which a spatial **configuration** has to be registered as an invariant feature. .

. We have described elsewhere (Paillard, 1991a) how certain metric rules (corresponding to the “geometry of space“described by mathematicians as “path structures”) encode, in direction and distance, the trajectory to follow in order to move from one point to another. A 'path structure', superimposed on a collection of separate points, defines the *locality* of each of these points in a **vectorial map**. This kind of geometry is particularly suitable for a description of a sensorimotor space. Motor commands that displace a given sensory receptive surface from one point to another in physical space are generally prescribed in terms of direction and distance. They therefore fit the requirements for the definition of a vectorially coded path structure (Paillard, 1991a). It has been shown that the plurality of sensorimotor action spaces depending of the acting body segments and from the involved sensory modality have to be coordinated in a unified amodal dynamic structure of space, anchored on a geotopically oriented postural frame, which constitutes the ***Body Schema***.

On the other hand,, there are many co-variant changes in the retinal image of the outside world when the body moves, and these signals might well serve to generate an internal **configural representation** of a stable visual environmental frame (Gibson 1950, Paillard, 1991a)) where distributed local spaces are identified as singular object categorisable in term of their specific features (including their shape). Similarly, reafferent visual and somesthetic proprioceptive information (Lee, 1974) issued from our moving body may tune the layered net of configurated neural filters leading to composite and dynamic configural maps of the body's state consciously experienced as our ***Body Image*** . (see heading D below)

It is however a matter of debate whether our transport's movements are directed in space in terms of a *vectorial coding* of the required displacement (direction and distance) or in terms of a *place calibration* within a configural space map. These modes, however, are not mutually exclusive and may depend on the requirement of the motor task and of the action system involved. There is a substantial body of experimental data from ethological and psychological research which suggests that spatial orientation in animals and man relies heavily on their internal mapping of the environment. Most investigators of the locomotor's space of rodents, for instance, accept Tolman's notion of '*cognitive spatial maps*' and now offer convincing evidence of its neural counterpart. However, in this field, the distinction between 'maps' and 'taxon' systems (O'Keefe and Nadel 1978) or between “bearing” and “sketch maps“ (Jacobs and Schenk 2003) assert the coexistence of various neural processing modes of space relationships.

Our last remarks point to the advantage to look at some other pathology, especially patients suffering partial or acute loss of proprioception and touch, as observed in

the sensory neuropathy syndrome. They offer unique opportunities to evaluate the role of somesthetic reafferent information in the structuration of their space maps. In one of them (patient GL described below) presumably deprived of her body schema then unable, without visual control of his body position, to correctly reach a point located in her body-centric target space, exhibits nonetheless with vision, a correct pointing to that place in the configural mapping of her configural visual space.

D) Evidence for a dual mapping in deafferented patients

Herewith we wish to present two clinical observations that seem relevant to us in corroborating the existence of such a dual mapping of the body space in localizing stimulation on her body skin. They concern two clinical cases which offer a contrasting view of the consequences of deafferentation, whether of central or of peripheral origin, in their ability to perceive and to locate a tactile stimulus on the skin surface of their body. (For a detailed presentation of these cases see Paillard, 1999a) The first concerns a patient suffering from an extensive peripheral neuropathy who shows a capacity to detect and verbalise the perceived location of a stimulus delivered on her body but failing to reach the stimulated site when her vision is blocked (Paillard, 1997). The second, a centrally deafferented stroke patient shows the converse dissociation i.e. offering the first clinical observation of an equivalent of «blind sight " in the tactile modality, i.e. a location without perception (Paillard, *et al.*, 1983).

Perception without location: The peripherally deafferented patient GL, chronically suffered from a selective loss of large myelinated sensory fibres extended to the whole body below the nose, as a consequence of a polyneuropathy (see figure 6). The contingent of motor fibres was preserved integrally and a residual thermal and algic sensation was still present. When vision was prevented, although unable to point with her right finger the location of a thermal or pricking stimulation delivered on her passively displaced left arm, she proves very accurate in localising the stimulated site, either verbally or on a body picture. Hence, she seemed able to localise the stimulus in her **configural visual body image** while unable, in blind folding condition, to move her finger toward the stimulated area within a **vectorial proprioceptive sensori-motor body space**.

Patiente G L Peripheral deafferentation

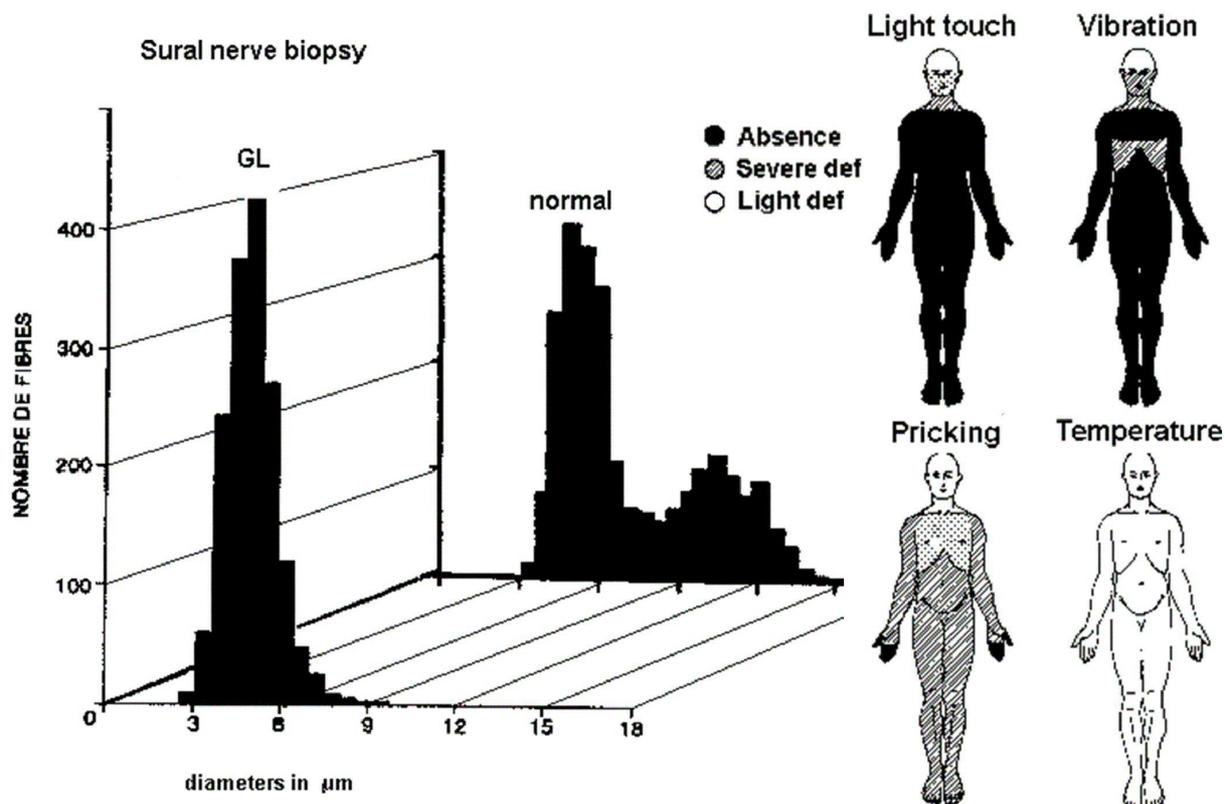


Figure 6. As seen on the right side GL presents clinically a total loss of touch, vibration, pressure and kinæsthetic senses below the nose. Pain and temperature sensations are present suggesting a selective impairment of the large diameter peripheral sensory myelinated fibres with an intact motor system.

Histograms on left compare the distribution of the diameters of sensory myelinated fibers observed in GL with that normally present. A sural nerve biopsy revealed that nervous fibres larger than 6.5 microns (subserving kinesthesia and somesthesia) represented in GL only 1.6 % of the total number of myelinated fibres (N= 1,600) (Cooke *et al.*, 1985).

Location without perception: We already had the opportunity to study another patient (RS) showing a partial deafferentation of her right arm (below the elbow) with complete preservation of her motor control as a consequence of an occlusion of the left posterior cerebral artery. In contrast to the preceding deafferentation was purely cortical in this case, thus preserving potential implication of somesthetic information at lower processing stages. Unable to detect and to perceive any tactile stimulation delivered at various sites on her right hand when vision was prevented, this patient showed, to her own surprise, a spontaneous ability to point her left finger toward stimulated places on her deafferented right hand. Following the early description of this phenomenon as a tactile equivalent of *blind sight* by Paillard, *et al.* (1983) three similar observations have since been reported (Brochier *et al.* 1994; Rossetti *et al.* 1995; Halligan *et al.* 1995). They all mirrored remarkably the above

described behaviour of our peripherally deafferented patient. Conversely, the centrally deafferented patient is obviously unable to perceive the stimulus delivered on her insentient hand and hence to localise it in her **visually configured body image**, although proving able to drive automatically her left hand toward the right stimulated place in her **proprioceptively framed body schema**.

Patient R S Central deafferentation

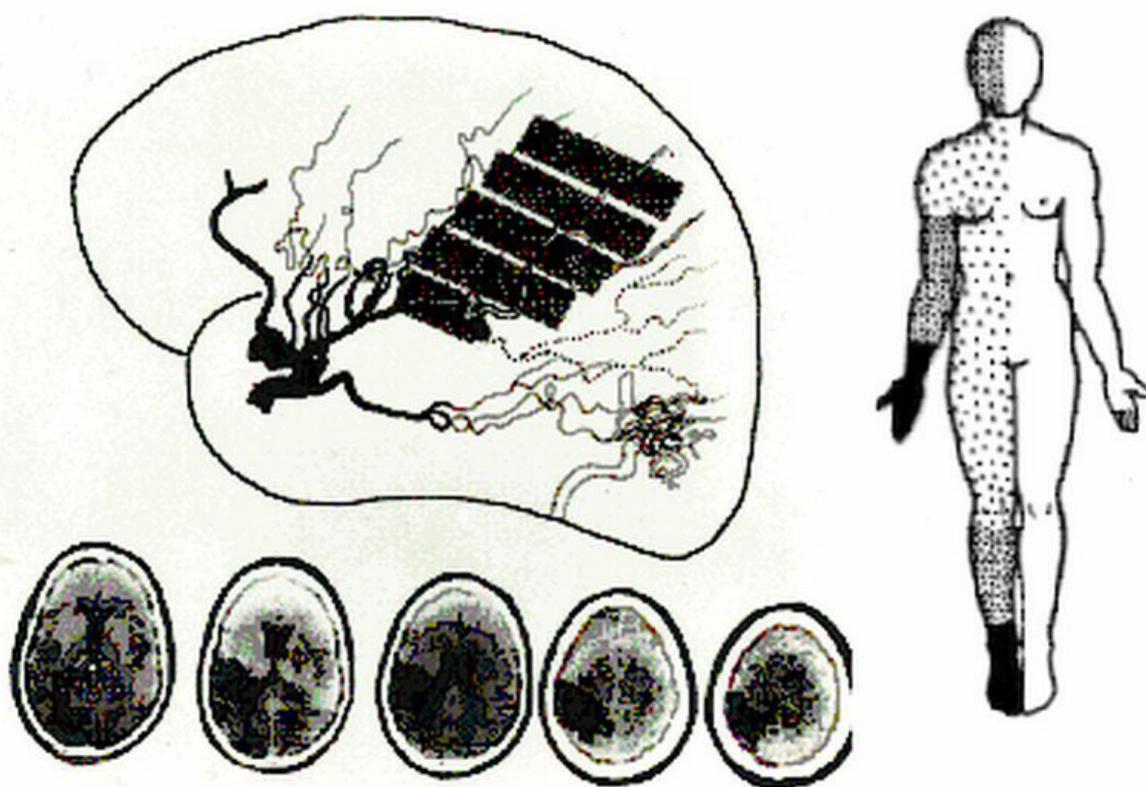


Figure 7. On the right Reconstruction of the parietal lesion observed in RS according to five *computed tomographic scan* slices at bottom On the left. RS presented, among other neurological syndromes (described in Paillard et al '1983) a clinically right side hemianesthesia, persistent after several years, With the most severe sensory deficit (complete anesthesia) in the distal part of left arm below and left foot.

This double dissociation obviously request, as already emphasized in my 1973 paper (see above and also Paillard 1999), for a reappraisal of the clear distinction first proposed by Head and Holmes (1912). Indeed these authors suggested the distinction between a **Postural Schema** considered as *“a combined standard against which all subsequent changes of*

posture are measured ...before the change of posture enter consciousness...” and a **Body Image** as an “*internal representation in the conscious experience of visual, tactile and motor information of corporal origin*”. Interestingly, Head and Holmes added the somatotopic mapping of tactile information as a “*superficial schema*” endowed with an independent status as the borderline interfacing internal and extra-corporal body space. How far could this superficial somatotopic map be independently framed either in the postural body schema (for targeting body-centred action) or within the body image (for localizing position within its configural representation) could provide a productive issue to reappraise clinical data and to identify neural structures potentially involved in body space information processing. (Paillard, 2003; Poncet, 19xx).

Additionally we have also to mention two recent publications done on this patients in collaboration with the Jeannerod’s group in Lyon (Fournier et al., 2002; Farrer et al., 2003) dealing with the role of proprioception in action recognition touching the still debated problem of self consciousness which will be the matter of our last comment .

In conclusion: The biological roots of identity

One major trend in contemporary phenomenological approaches concerns the reactualisation (probably stimulated by recent progress in neurosciences), of old philosophical questions related to self-awareness (A recent bibliography can be found in Legrand 2004)

When questioning the biologist on how do we recognize our body as our own, it seems to me that he would be first inclined to try to understand where this particular human ability is coming from. When asking what characterizes the organisational singularity of biological machines, we become readily facing the rather conceptual haze in which Biology has left the term of *organisation*, though recognizing its central role in the transformation of a natural history descriptive of the morphology of living beings into an Biology explicative of their functional mechanisms .As pointed by François Jacob in his “Logique du vivant” (1970) “*It’s no more possible, to day, to dissociate the structure from its functional significance, not only within the organism but in the succession of events which steer the organism to become what it is now. Every living system results from a given equilibrium between elements of an organisation*“. Indeed organism may be defined as “living entity with interrelated parts, dependant of each other and which work together to preserve and maintain their coexistence”. The key problem therefore bear on the identification of the determinants of

this purposive internal cohesion which bind them. In fact the biologist has long eluded this “Why” question, long considered in his community as out of reach of clean scientific investigations and let to the sagacity of the philosopher. Yet, he may well accept that a living cell or even a football team exhibit similar systemic properties linking collective efforts of component parts toward the realization of collective goals as an active unitary whole. The biologist, however, certainly don't worry speaking of the “irritability” of a cell preserving its (‘or even her ?) frontiers integrity. He also has no problem to accept the idea of a “team spirit” conditioning the purposive cohesion of a social group. Ethology is replete with examples of instinctual sense of ownership in territories marking and defence or in maternal instinct in whole animal kingdom. The *emergence* of self-consciousness in human organism seems obviously derived from related processes. Whether cellular, organic or social, autonomic organisational units are bestowed with emergent integrative properties grounded in identifiable conjunctive solidarities at their structural, operational and functional levels (see Paillard, 1986). At the *structural level* mechanical solidarities derive from the rigidity of the skeletal frame and from the ubiquitous binding role of the fittingly-name *conjunctive* tissue, as agent of individuation of a body space genetically structured with its internal frame of organic substructures. At the *operational level*, distributive and connective substructures allow each member of the cellular community to receive its foods and energetic needs through a stabilized internal medium with its expanding net of lymphatic and blood channels of distribution, equally used for remote hormonal command signals. But it is the increasing development of an elaborate neural system of long-distance, high speed and private system of intercommunication, which will provides living organisms with an exceptional tool of functional integration. At the *functional level*, however, we right away meet *teleonomic* questions and the stipulation of identifying the unifying common incentive which orients the coordination of the many specialized operations at work within the organic community. Simply survive would be the obvious answer of the biologist. Survive means first preserving the body structure permanently compromised in its flesh by the thermodynamic eroding forces; it means also defending the integrity of the borderline of his private territory by identifying and driving back the foreigners and neutralising pathological intruder,. The immunologic system clearly meet this criterion with its astonishing ability to discriminate the organic oneself from the non-self. As already stress by many authors, and most compellingly by Varela (1979; Varela et al., 1993) it occurs that the nervous system, as the chief manager of the relation of the body space with its environment, and as the supervisor of its metabolic functions tends to cerebralize functions isomorphic to that of the immunologic system in its

ability to recognize the organic self from the non-self. As we have seen , the neural representation of a configural space structures results from the genuine ability of central neural networks to spontaneously extract invariant features from the flow of its incoming information . Once experienced at the perceptive level these neural representations allow the recognition of such local spaces as external object *located* in a stable outside work and *identifiable* as singular things categorisable according to biological or social systems values derived from species characteristics; or from cultural imprints and individual history. Hence our body space may be recognised as an object located in the outside work or as an experienced internal image, and subsequently, like every perceptual experience, amendable to illusion, distortion, completion, and affective investment.

Hence all ingredients seem to be tided for grounding a mental self with his private experienced motivations and emotions , As well as we may consider the body image as knowledge derived from the "*savoirs faire*" of a body schema interfacing the cognitive brain with its external world, we may similarly consider the basic organic self, which *knows how* to perpetuate the continuity of his private body life, as funding a *mental self* intimately aware of being the self-owner of his body space and accountable of his own purposive action in the world..

Foot note : Quotation from Paillard (1973) pages 245-246.

“ *Schilder, en effet, entretient fâcheusement une ambiguïté sur la nature du schéma corporel. Celui-ci se confond d'une part avec l'image que nous formons dans notre esprit de notre propre corps et d'autre part avec le modèle postural qui en constituerait le substrat.*

Tout en se référant principalement à Head pour cette dernière notion, c'est en fait les vues de Pick que Schilder adopte en valorisant le rôle de l'image visuelle des diverses parties du corps pour l'édification du schéma corporel.

Or, il me semble que les vues de Head et Holmes (1911-1912) apportaient une distinction essentielle, totalement éclipsée par ses successeurs, entre la notion de schéma et celle d'image.

Ayant distingué un schéma postural comme « a combined standard against which all subsequent changes of posture are measured... » et un schéma superficiel qui permet au sujet de localiser correctement les points stimulés sur la surface de son corps, ces auteurs étaient conduits à considérer le schéma du corps comme responsable d'opérations de référence « before the changes of posture enter consciousness » et l'image, qu'elle soit visuelle, tactile ou motrice, comme reflétant le contenu de ces informations relatives au corps dans l'expérience consciente.

Cette subtile différence entre schéma et image semble avoir été complètement négligée par la suite dans la littérature neurologique ; ce qui n'a pas contribué à clarifier les débats.

Or, il se trouve que les données neurobiologiques récentes amènent à distinguer nettement deux modes de distribution et de traitement des informations sensorielles dans le système nerveux : le premier concerne l'identification de la forme et des propriétés des objets et met en jeu les structures d'analyse sensorielle corticale, le second aboutit à l'indexation spatiale des sources d'informations visuelles, sonores ou tactiles en les référant aux schémas posturaux. Ces problèmes ont été discutés en détail lors de notre précédent symposium de l'Association à Bruxelles, l'an passé (APSFL: De l'espace corporel à l'espace écologique, Bruxelles, 1972; Paris, P.U.F., 1974).

References

- Brochier, T., Habib, M., & Brouchon, M. (1994) Covert processing of information in hemianesthesia: a case report. *Cortex*, 30, 135-144
- Cooke, J. D. Brown, S. Forget, R., & Lamarre Y. (1985). Initial agonist burst duration changes with movement amplitude in a deafferented patient *Exp Brain Res*, 60, 184-187.
- Craigh, A. D. (1994). Pain, temperature and the sense of the body. In: O.Franzen, R.Johansson & L. Terenius (Eds). *Wenner-Gren Symposium on Somatosensation*. J. Birkhäuser, Basel.
- Farrer C., Franck N., Paillard J. , Jeannerod M. (2003). **The role of proprioception in action recognition**. *Consciousness and Cognition*, 12 609-619
- Fourneret, P., Paillard, J., Lamarre, Y., Cole, J., Jeannerod, M. (2002). **Lack of conscious recognition of one's own actions in a haptically deafferented patient**. *Neuroreport*. 25;13(4):541-547
- Gibson, K. R. (1981). Comparative neuro-ontogeny. Its implication for the development of human intelligence. In G. E. Butterworth (Ed.), *Infancy and epistemology: An evaluation of Piaget's theory* (pp. 52-81). Brighton: Harvester Press.
- Gallagher, S. (1986) Body image and body schema: A Conceptual clarification. *J. Mind and Behav*, 7, 541-554
- Gallagher, S. (1995), 'Body schema and intentionality', in *The Body and the Self*, ed. by J.L. Bermudez, A. Marcel and N. Eilan (Cambridge, MA: MIT Press).
- Goldberg, G. (1985a). Supplementary motor area structure and function. Review and hypothesis. *Behavioral Brain Science*, 8, 507-616.
- Goldberg, G. (1985b). Response and projection. A reinterpretation of the premotor concept. In E. A. Roy (ed). *Neuropsychological. studies of apraxia and related disorders*. pp. 251-66. Elsevier, Amsterdam.
- Goodale , M.A. & A.D. Milner (1992). Separate visual pathways for perception and action. *Trends in Neurosciences*, 15(1), 20-25.
- Gurfinkel, V.S., & Levick, Y.S. (1991) Perceptual and automatic aspects of the postural body

- schema. In: J. Paillard (ed.), *Brain and Space*, chap. 10, Oxford University Press. Oxford, 147-162
- Halligan, P. W., Hunt, M., Marshall, J.C. & Wade, D.T. (1995). Sensory detection without localisation. *Neurocase*, 1, 259-266
- Head, H., & Holmes, G. (1911) Sensory disturbances from cerebral lesions. *Brain*, 34, 102-254.
- Held, R. (1970). Two modes of processing spatially distributed visual stimulation. In F. O. Schmitt (ed.), *The neurosciences second study program*, pp.317-24. MIT Press. Cambridge, MA.
- Ingle, D. J. 1967). Two visual mechanisms underlying the behaviour of fish. *Psychologische Forschung*, 31, 44-51.
- Ingle, D. (1973). Two visual systems in the frog. *Science*, 181, 1053-1055
- Jacob, F. (1970). *La logique du vivant : une histoire de l'hérédité*; Gallimard. Paris
- Jacobs, L.F. & Schenk, F. (2003). Unpacking the Cognitive Map: The Parallel Map Theory of Hippocampal Function *Psychological Review*, 110 n°2, 285-315
- Karnath H-O. (1997). Spatial orientation and the representation of space with parietal lobe lesion . *Phil. Trans. R. Soc. Lond. B.* 352, 1411-1419
- Morel, A.& J. Bullier (1990). Anatomical segregation of two cortical visual pathways in the macaque monkey. *Visual Neuroscience*, 4, 555-578.
- O'Keefe, J. and Nadel, L.(1978). *The hippocampus as a cognitive map*. Oxford University Press, Oxford
- Paillard, J. (1971). Les déterminants moteurs de l'organisation de l'espace. *Cahiers de Psychologie*, 14, 261-316.
- Paillard, J. (1975). Discussion du rapport de R. Angelergue sur "Réflexions sur la notion de schéma corporel" In: Symposium de l'APSLF (Paris, 1973). *Psychologie de la conscience de soi*, pp.143-148. Presses Universitaires de France. Paris.
- Paillard, J. (1980). Le corps situé et le corps identifié. Une approche psychophysiologique de la notion de schéma corporel. *Revue Médicale de la Suisse Romande*, 100, 129-141.
- Paillard, J. 1982). Le corps et ses langages d'espace: Nouvelles contributions psychophysiologiques à l'étude du schéma corporel. In: E. Jeddi (ed.), *Le corps en Psychiatrie*, pp. 53-69. Masson, Paris.
- Paillard, J. (1983a). The functional labelling of neural codes. In J. Massion, J. Paillard, M. Schultz, M. Wiesendanger (eds), *Neural coding and motor performance*. *Exp. Brain Res.*, suppl. 7, 1-19.
- Paillard, J., Michel, F. and, Stelmach, G. (1983b). Localisation without content: a tactile analogue of "blind sight". *Arch. Neurol.*, 40, 548-551.

Paillard J.(1986), Système nerveux et fonction d'organisation, In: J. Piaget, P. Mounoud et J.P. Bronckart (eds), *Psychologie*, pp. 1378-1441. Paris, Gallimard, La Pléiade.

Paillard, J. (1991a). Motor and representational framing of space. In: J.Paillard (ed). *Brain and Space*, chap. 10. pp: 163-182. Oxford University Press. Oxford,.

Paillard, J. (1991b). Knowing where and knowing how to get there. In: J.Paillard (ed). *Brain and Space*, chap. 24. pp: 461-481. Oxford University Press. Oxford.

Paillard,J.(1999a), Body schema and body image. A double dissociation in deafferented patients', in,. G.N. Gantchev, S. Mori and J. Massion (eds), *Motor control, Today and Tomorrow* ,pp: 197-214. Academic publishing House. Sophia .

Paillard , J. (1999b). Motor Determinants of a Unified World Perception. In: G.Ascherleben, T. Bachman, and J.Müsseler (Eds). *Cognitive Contributions to the Perception of Spatial and Temporal Events*, pp. 95-111. Elsevier Science B.V.

Paillard, J.(1999c). L'approche neurobiologique des faits de conscience: vers une science de l'esprit. *Psychologie Française*, 44(3), 245-256

Paillard, J. & Brouchon, M. (1968). Active and passive movement in the calibration of position sense. In: S.J. Freedman (ed), *The neuropsychology of spatially oriented behavior*, , chap. 3, 37-55.Dorsey Press, Homewood Ill.

Phillips, C.G., Zeki, S. & Barlow, H.B. (1984). Localization of function in the cerebral cortex. *Brain*, 107, 328-361.

Piaget, J. (1937). *La construction du réel chez l'enfant*. Delachaux et Niestle, Neufchatel.

Piaget, J. (1971). *Biology and knowledge*. University of Chicago Press. Chicago

Perenin,, M-T. (1997). Optic ataxia and unilateral neglect: clinical evidence for dissociable spatrial function in posterior parietal cortex. In: P.Thier & H-O. Karnath (eds). *Parietal lobe contribution to orientation in 3D space*.pp. 289-308. Springer. Heidelberg.

Rossetti, Y., Rode, G., & Boisson, D. (1995) Implicit processing of somaesthetic information: a dissociation between where and how? *Neuroreport*, 6, 506-510.

Rossetti, Y and A.Revonsuo (2000). *Beyond dissociation :Interaction between dissociated implicit and explicit processing*. Benjamin. Amsterdam.

Rossetti,Y & L.Pisella (2001) Several vision for action'systems' ; A guide for dissociating and integrating dorsal and ventral functions. in *Attention and Performance* . Oxford University Press. Oxford

Rushworth, M. F.S., Nixon, P.D. & Passingham, R.E. (1997). *Exp. Brain Res.* 117, 292-310.

Ryle, G. (1949). *The concept of mind*. Barnes and Noble. New York.

Schacter, D. L, McAndrews, M. P., & Moscovitch, M. (1988) Access to consciousness: dissociation between implicit and explicit knowledge in neuropsychological syndromes. In: L. Weiskrantz (Ed.). *Thought without Language*. A Fyssen Foundation Symposium. Clarendon

Press. Oxford

Schneider, G.E. (1969). Two visual systems: brain mechanisms for localization and discrimination area dissociated by tectal and cortical lesions. *Science*, 163, 895-902.

Trevarthen, C. B. (1968). Two mechanisms of vision in primates. *Psychologische Forschung*, 31, 299-337.

Varela F.J.(1979). *Principles of biological autonomy*, North Holland, New York, 303p

Varela, F.J., Thomson, E. & Rosh, E. (1993). *L'inscription corporelle de l'esprit*. Paris. Seuil

Weiskrantz, L (1989) Blindsight. In: F. Boller & J. Grafman (Eds). *Handbook of Neuropsychology*. Elsevier Science Pub. Amsterdam.

Consciousness Research / Psychology

Body Image and Body Schema

Interdisciplinary perspectives on the body

Edited by **Helena De Preester and Veroniek Knockaert**

Ghent University

The body, as the common ground for objectivity and (inter)subjectivity, is a phenomenon with a perplexing plurality of registers. Therefore, this innovative volume offers an interdisciplinary approach from the fields of neuroscience, phenomenology and psychoanalysis. The concepts of body image and body schema have a firm tradition in each of these disciplines and make up the conceptual anchors of this volume.

Challenged by neuropathological phenomena, neuroscience has dealt with body image and body schema since the beginning of the twentieth century. Halfway through the twentieth century, phenomenology was inspired by child development and elaborated a specifically phenomenological account of body image and schema. Starting from the mirror stage, this source of inspiration is shared with psychoanalysis which develops the concept of body image in interaction with the clinic of the singular subject. In this volume, the creative encounter of these three perspectives on the body opens up present-day paths for conceptualisation, research and (clinical) practice. (Series B)

[*Advances in Consciousness Research*, 62] 2005. x, 346 pp.

Hb 90 272 5198 3 EUR 115.00 / 1 58811 639 5 USD 138.00

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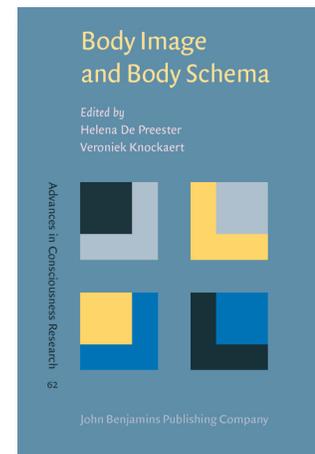
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