Part VI Intention and Intentionality: Neuroscientific and Philosophical Perspectives

13 Intention in Phenomenology and Neuroscience: Intentionalizing Kinesthesia as an Operator of Constitution

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The advances in cognitive sciences over the last thirty years used to be so enthusiastically applauded by the practitioners of these same sciences that it did not occur to an outside observer to note a lack of clarity in the assumed representation of the relationship between conscious conduct and its hypothesized neural bases. An ever growing number of researchers are even trying to apply the tools of information theory to the encoding, translating, and decoding (presumably performed by specialized brain areas) of signals impinging on the body. Nevertheless, the brain cell (the so-called "grandmother cell" or "cardinal cell") responsible for coding a significant item of daily activities or an important concept of the mind has still not been found. And an ever growing wealth of substitutes for this cell are in the offing—"population coding," "temporal coding," "volume coding," and so forth—an excess of competitors that makes it even more difficult to determine what patterns in brain tissue can be held responsible for what behavioral patterns, warned the neuroscientist Horace Barlow.[1] Other researchers, more reluctant to launch out into neurocomputational constructions (or the same researchers in popularizing works), limit themselves to borrowing ordinary, personal conduct predicates and boldly reusing these predicates in reference to brain functioning. Mental verbs, besides expressing what a person might be doing on some occasion of experience, are thus employed to label the brain. This is a simple renaming procedure that, for want of agreement on an interpretative model in neurosciences, a default that Alain Berthoz recently deplored,[2] cannot but postpone a satisfactory explanation, given the dubious intelligibility of common speech mental vocabulary in this new context. In such a situation, the classic three-stage transition of the genesis of scientific knowledge—ordinary language metaphor, hypothetical model, theoretical concept—fails and leaves us stuck either in metaphors or in computational tricks with no bearing on mental life.

From the phenomenological viewpoint,[3] this epistemological blockage might be interpreted as a failure to understand the intentionality of the *sense-giving acts*,[4] or *constitutive operations*,[5] to which any component of a person's experience owes its *sense of being*.[6] At first sight, and at the very least, the main purpose of these acts is to orient the field of vision toward an object of interest and to grasp or maintain the object in question within arm's reach. A rather trite accomplishment apparently! However, by constantly repeating the process by which one directs one's gaze in ever changing directions and learns to handle things in a variety of different ways, these acts contribute to the emergence and constant updating of a certain *field of vivid actuality*[7] against a background or under *a horizon*[8] of indifferent inactuality—a field to which things have to have access in order that they acquire fully fledged being for the perceiving–acting person. Only in such a context do things really acquire significance for the agent. And as for the agent itself, its biography is composed of little else but such acts. Thus, the being, the reality or objectivity of absolutely anything whatsoever (for the subject interacting with the thing in question), is contingent upon acts that have to be accomplished for this *pretended value of being* to be sustained.[9]

To set the matter in a specifically philosophical light, Husserl's later writing investigates the possibility of making use in his theory of intentionality of consciousness of the psychophysiological notion of *kinesthesia*[10] by blending James's peripheral sensations of movement and Wundt's central *Innervationsgefühle*.[11] To remain constantly aware of the way in which we will the movements of our body, this is the task of the "kinesthesia of the I." To remain constantly aware of the sensory contact of the skin of our hands or other limbs with any external thing or other part of the body, this is the task of "organ kinesthesia." This doubly oriented kinesthesia was granted a major role in the constituting of that sense of being which gives us the things we perceive or act upon in daily life. However, in stressing this aspect of constitution, my proposal is not to stick to an interpretation of kinesthesia from a strict phenomenological perspective, that is, as pure interiorities of conscious experience. What I propose is to rethink kinesthesia as a possible link between the subjectivity of experience and the objectivity of functional activation patterns in the brain.

I base this proposal on the fact that kinesthesia happens to be one of the more primitive ways in which an embodied consciousness can manifest itself in space and time. This, to the extant that it "expands or retracts"

through its material inscription, locally, in *neural map*[12] shaping and, at a distance, in synchronizations or desynchronizations of *cortical oscillatory patterns*.[13] Such map changes and pattern shifting initiate a process of "spatialization and temporalization of the mind." Whatever its final destiny as a factor of structuring *the lived world*[14] at large, this process begins modestly. It begins in body–brain transactions that subtend motivations, emotions, intentions, or anticipations of inner, mental life emerging into bodily gestures without needing the mediation of verbal expression or reflective thinking. Kinesthesia is thus our best candidate for endowing with experiential value the patterns of activation of brain regions elicited by any behavioral conduct on the part of the subject. Sure enough, not each and every activation pattern of brain can be convincingly correlated in this manner with kinesthesia. We have to concede that most brain events stand in no provable correlation to kinesthetic experience. Nevertheless, it remains (1) that at least some of these patterns are already currently acknowledged as *neural signatures of intentions*[15] or similar acts, and these are indeed typical kinesthesia, and (2) that the same acts, by exerting some measure of feedback, *top–down*,[16] *frontoparietal*[17] control over the whole functional dynamics of brain machinery, recategorize it as kinesthetic. In fact, a few but well-authenticated neurobiological results (reviewed hereinafter) indicative of the modifying influence of intention and attention on the topologic organization not only of the motor but also the primary sensory areas, provide us with indispensable empirical proof of the well-foundedness of our suggestion.

In so funneling the dynamics of brain activation patterns through the kinesthetic channels of experience, we hope to find an embodiment of intentionality that goes farther than dodging the issue like current cognitive theory of mind by implementing mental representations (its fake substitutes) in the brain. In the staggering entanglement of *horizontal*,[18] *vertical*,[19] and *diagonal*[20] connecting loops that the present state of research has kept track of, kinesthetic constitution theory would be a welcome Ariadne's clue. It will be an Ariadne's clue, insofar as it would help us to organize data under the heading of kinesthesia in three fundamental ontological domains: things, body and others. To put the matter in a nutshell (not without paying tribute to Merleau-Ponty), our way out is to admit gesturing, effectively accomplished in bodily movements or kept inchoate in purely internal acts, as a schema for furthering an impending reconciliation between the objective "materialism" of the neurosciences and the subjective "idealism" of a phenomenology of consciousness.

A Sampling of Constitutive Analyses in Phenomenology

Now, let's get back to examples of intentionally constituted objects: a sound, a cube. A sound is not a simple "acoustic stimulus" in the physical environment captured by a passive receptor in the internal ear (cochlea) to give us automatically an auditory representation. A sound is a temporal objectivity which appears as endowed with the following sense of being: an objective entity temporally extended across the flux of my experience. This object owes its constitution to its being placed at the center of *positings,*[21] a system of subjective tensions and projections of the living subject.[22] As for the place that this object occupies in objective time, it results from a later abstraction of the axioms of physical time measurement from the experience to which this system owes its structure—an abstraction purchased at the cost of obliviousness to the original structure of that constituting time which lies at the root of habitual time. Adopting the Husserlian metaphor of the comet, one might say that when a sound sounds it is possible to distinguish a core made up of original sensorial experience and a tail of retentions consisting of its "just having been" and of the "just having been" of its "just having been," and so on. The latter is thereby prolonged in a continual series of overlapping temporal fields right up to that limit beyond which the sound trails away and a new act is needed in order for it to be recalled in memory. The present of the actual sound is not a fixed point but a generative origin from which there arises a constantly renewed sensorial material, each of whose newly engendered phases is subject to a process of *modification*[23] which stretches out into an ever increasing distance from the present "now." This point is not the limit of an approximation which once attained would provide a definitive term but an incessant source of novelty. This novelty is neither a simple diversity nor a pure successive dispersion. Rather, the series of present "nows" of the sound is embraced and firmly upheld in its unity of sense as being "the same sound" by an act of *apprehension of identity*[24] which is effected in the actual now. The circularity between an original self-identity maintained through distance and a distance which increases up to the point of nonretention is a pre-empirical (*transcendental*)[25] structure. The actualization of such structure in the acts of the subject perceiving a sound is the condition of the possibility of his or her experiencing "the sound."

In the same way, a cube (a gaming dice) is not simply "an optical stimulus" whose passive impression on our retina gives us automatically the corresponding spatial representation. A cube[26] is a spatiotemporal objectivity which is never given in any actual sensorial content because it only

presents its frontal aspect, while its lateral aspects run off into perspectives, if they are not completely closed off. As any and every object of spatial perception, it is the product of the constituting activities of the perceiving subject whose contribution is indispensable for the appearance of the thing in its full range of aspects.[27] At the outset, nothing like "the thing" is given; there are only *adumbrations*,[28] shadowy or phantom bearers of objective pretensions in the course of being confirmed (or the reverse) through the further course of experience. These series of adumbrations enter our instantaneous visual fields, go through them, and leave them up at the pace of the movements of our sensory and motor organs. They only get organized for the perceiving subject into a permanent configuration bearing the value of being "a thing" because the subject enfolds them all in a positing of identity. By means of this act, they are retained and connected in such a way as to form "a manifold." That is a series of a sensorially laden phases of experience which is no longer arbitrary and dispersed but "definite" under expectations of the subject. On the objective side of this experience its *noematic correlate*[29] is the identical and unique thing.

Once again this structure of multiplicity is a system emerging from the flux of sensations, principally visual but also kinesthetic. The realization of such a system requires a tight synchronization of the series of adumbrations with the *running off*[30] of kinesthetic sensations under the control of the objectifying posit. By contrast with the sound example, what produces the diversity of spatial perception can no longer be identified with the impressional sensation (the *hyletic material* of the sensory content of acts)[31] nor with the positing of identity. Here, the "empty" positing of a regular (normal) running off of the adumbrations of the hidden sides of the thing in conformity with what is anticipated in advance of the flux of experience is sensorially fulfilled (or not fulfilled) with the production of new aspects "of the same thing." We are always waiting "to know more" about the object, an expectation of more that is nevertheless confined to aspects of the same type as before. My contention is that these new aspects are constantly provided and motivated by the sole free functioning of the kinesthetic system. Thus, we have to distinguish the physical stimulus from the thing in space: the first illustrates our passive sensibility, the second our active (transcendental) constitution of the sense of being.

Reassessing the Intentionality of Kinesthesia in Constitution Theory

Bearing in mind these findings concerning the constitution of the temporal object and the constitution of the spatial object, we would like to draw

attention to the fact that this theory of constitution is propelled in two contrary directions by the desire to satisfy two mutually conflicting, if not incompatible, requirements. A first requirement was for Husserl to found the meaning of being for any subject of experience upon the transcendental subject, the ultimate source of all meaning giving. For he saw it as necessary to maintain the transcendental dimension of the back-reference to the I-pole of all those acts constitutive of the value of being for . . . and so as not to mechanically pile up one layer of constitution upon another, in oblivion with respect to the organic tension by which all layers are referred to the I, a criticism that Husserl made to empirical psychology, but rather to recover the ultimate, subjective constituting sources of sense. The second requirement was to deploy the system of subjective operations in such a way as to bring to light the manner in which each product is constituted from scratch with the meaning of being that belongs to it for the subject of experience. Incorporating the constituting subject into the total system of kinesthetic activity was a matter of not allowing subjectivity to detach itself from the flux of constituting activity—and so precisely because a detached subjectivity would be incapable of expressing itself in such acts. These two requirements are incompatible at least in the following respect. The former requirement tends to refer all meaning giving activity to a unique transcendental subject by conferring an absolute value upon the latter through a species of abstraction—an abstraction which makes it difficult to understand the relation of this subject to the constituted formations of sense and so call in question its right to be regarded as constitutive of the latter. The second requirement tends to render the constitution of sense as operational as possible by grounding these constitutive processes in the immanence of an uncontroversial psychophysiological experience—a layer of experience which lends itself to be conceived as so primitive as to make its attribution to a subjectivity seem gratuitous. As a result, the fundamental dilemma for a theory of constitution which claims to have surmounted the subject–object opposition remains the following: that the process by which subjectivity gets objectified and that by which objectivity gets subjectified, instead of concurring to bring about the same result, seem torn between opposite trends.

In the direction of subjectification, the trend is to denaturalize subjectivity—a subjectivity reduced accordingly to its function of conferring (or refusing) validity upon the pretention of any possible entity to possess a value of being for someone. Such reference to an ultimate arbiter is so fatally drawn upward through reflection as to lose all effective support. In the direction of objectification, the trend is to incarnate the productive

activity in the immanence of natural life in which it is rooted and which furnishes its motivational preconditions. And again along this route there can be no halting point, for any and every motivational component, no matter what the level at which it contributes to the hierarchy of behavioral determinants—will, desire, effort, instinct, feeling, impulse, tendency, and so on—remains a possible candidate for the status of contingent somatic precondition of the transcendental.

However, what is truly remarkable is that Husserl refuses to make a choice as between these two requirements. Right to the end, he struggles to do justice to them both, thereby engaging in a sort of heroic confrontation with the tension imposed upon him by his attempt to remain true to his foundational program. In his kinesthetic theory of constitution, developed especially in unpublished manuscript material from the 1930s, he tried to retain the transcendental approach, even though he is, in effect, deepening his understanding of the rootedness of concrete experience in the structure of embodiment. He ceaselessly worked against himself (and against the transcendental tradition) by bringing the subjectivity of the transcendental subject back down into felt movements and the practical intentions of an acting body. "Qua primitive, consciousness is formed on the basis of the activity itself"[32]: this solution comes down to saying that the objective world is primarily that with which we stand in relation, that toward which we are consciously oriented in perception and action, to the extent that it remains the constant correlate of all those postures, movements intentions, and dispositions to action which give us access to the identity and the permanence of objects—and this solely by featuring as the horizon of perceptual presentations for an I and the field of its practical interventions, manipulations, and transformations.

For all that, in the constitution of the temporal object, the apprehension of identity which traverses the instantaneous temporal fields of the just having been is directly referred to an act of the I, an act which itself does not run off in time but enjoys the privilege of atemporality. We find a parallel presupposal in the constitution of the spatial thing concerning the grasping of the unity and identity of "the same thing": an intentional apprehension which runs through the definite manifold of the adumbrations of its sides to the extent that they are exhibited in the instantaneous visual fields associated with the running off of the kinesthesia relative to the different perceptual and motor organs. Such apprehension is also directly referred to an I which itself remains invariable. The progress made by Husserl in his ever deeper understanding of the incarnate character of the theory of constitution leads him to call in question such fixity of the

I—and to plunge the latter back into the dynamic process of the constitution of sense in which it nevertheless remains the pole of identity.

While appearing to remain faithful to the Cartesian ego, one notices several attempts at an immersion of the I in the constituting flux of the experience of an activity which is initially "without an I"—but an activity which remains such that it enables an I to arise, and so to bring to consciousness the existence of a unitary and self-identical I. Through the process of constitution, kinesthetic sensations begin to acquire a status which they did not enjoy before, for instance, in *Ding und Raum*, which explicitly refused to treat them as intentional.[33] All intentionality could claim then were images of the visual field, since it is only across these series of images and to the extent that they refer to each other in a progressively more adequate approximation to the point of an optimal presentation that something can be present as an appearance. With regard to this presentative function of visual images, the kinesthetic movements of the eyes, of the head, and of the whole body are reduced to a function of motivation, understood in a very narrow sense. Kinesthetic movement and rest had to take account of external and accompanying circumstances, circumstances[34] whose variation brought with them a diversification of those aspects of the field necessary for a satisfactory presentation of the thing. However, this diversity was subordinated to the intentionality of the perceptual apprehension, an apprehension which both dictated its realization and imposed upon it its own attentional orientation by selecting those kinesthetic routings capable of unfolding the series of adumbrations leading to the confirmation of its expectations.

Insofar as it is reduced to figuring as an optimum for a series of suboptimal presentations which tend toward this optimum, an optimum associated with quite determinate kinesthetic sensations, such an intentionality would remain purely visual,[35] a provisional limitation to be corrected by taking into consideration the role of touch and the sense of posture in conjunction with the movements accomplished by the body in its constituting activity, which latter is precisely tactilokinesthetic and not visual. Over and beyond the abstract apperceptive apprehension, over and beyond the regularity with which a series of adumbrations is connected in the visual field, it is in terms of the free possibilities of a running off of kinesthetic sensations for the return to the same thing in perception, or the positing of the same goal in action, that intentionality has to be rethought.

With regard to the period 1905–1907, the period 1930–1933 puts into effect a dramatic redirection of intentionality toward kinesthesia. *Ideen II* that could be cited as a work of transition does not bridge the gap because

it fails to compensate for the deficit in intentionality of kinesthesia. The significance of this evolution might be missed if one failed to take into account the specific use Husserl makes of the term *Kinästhese*, for he does not use the word in the sense of modern physiology, which gave James preference over Wundt. For physiologists, kinesthesia designates a proprioceptive sensibility, whether muscular or articulatory, which follows centripetal sensorial paths to keep the brain informed about the movements of the body once these movements have been carried out.[36] Husserl, on the contrary, does not even mean by kinesthesia sensations of movement, that is, physical movements relative to the displacements in space of the limbs and of the muscular masses of flesh that coat skeletal bones of which the limbs are composed. He means rather the feeling that the agent has in an immediate and continuous way of his or her intentions to move and of their conception and realization in effective movements. His kinesthesia is not the effects felt in the body with respect to movements actually completed but a drama, a Passion, or even a phenomenology (of Spirit)[37] of the development of an intention in and through its motor realization. Is this an archaic conception? Certainly, but one which has turned out to be premonitory, as will be convincingly shown hereinafter.

In spite of the peripheralist sensualist ideology which has impregnated physiology and psychology for some time now, evidence for such a feeling of acting and of the acting self and of its contribution to the functioning of the perceiving self has not been wanting. Now, that kinesthesia is attributable to an I and that the I is, before all else, the I of kinesthetic sensations was Husserl's main idea. What are kinesthesias in themselves, he asked?[38] And what relation do they bear to those acts of the I by which they are accompanied, of that I which includes them in their running off? Inasmuch as it consists in an "I move" rather than an "I feel," surely this form of kinesthesia already belongs to the I. But then what does the subjectivity in question here really mean?[39] Is the I anything at all over and above its concrete acts? And is a concrete act thinkable other than as a running off, or as something which unfolds actively and which could therefore also be unfolded inactively? Or again, could it consist in a core which is self-unfolding in an immediately active way?[40]

In the light of the above, one is in a better position to understand the intentionalization of kinesthesia, the fact that the meaning of being self-identical can be conferred upon things and upon the self not just by a law of association linking their images one with another but by the fully concrete sense we have of moving toward them. The thing proves to be the same because I can always come back to it and find myself again alongside

of it. No need to posit, in the abstract, an arrow of visual attention directed apperceptively toward . . . an attentional arrow which would be the privilege of a cogito without its being possible to say how the latter succeeds in materializing across the sensorial material and so conferring a unitary orientation upon it. This kinesthetic power grants being to beings: whatever simply is, is only meaningful as such by virtue of its *being actively made to be* itself. Kinesthesia is the unique sphere of a power whose exercise is immediately constitutive.[41] Just as perception interpreted as the reception of a sensory stimulus subjects us to the external object, so its reinterpretation as constituting the meaning of the being of the thing in its kinesthetic activities confirms our freedom. Obtaining what is identical depends upon my freedom of movement, upon the immediate evidence I have of being free in the course of exercising it.

A purely visual world remains a world of images devoid of materiality, due to the absence of forces and of resistances to these forces. It is still remote from being an inertial world composed of masses in movement defined in terms of their equilibrium or disequilibrium, their accelerations, torques, and so forth—and this for an agent who is himself or herself embodied and feels in his or her bones, sinews, and muscles the constantly changing strain of the surrounding field of forces as a reflex of his or her own intervention in this field. The transition from the former visual world to the latter real, fully material world depends, in effect, upon my active intervention through an effectuation of the entire system of kinesthesia over and beyond oculomotor kinesthesia. While I don't have to overcome an inertia to move my eyes, and might accordingly dream as if a pure spirit hovering over the world, suffice it that "I move my head, my body, and so forth" for me to acquire a fully material sense of the object as that object which stubbornly remains the same through the free realization of the totality of kinaesthesia.[42] As the unity and identity of the entire series of adumbrations unfolded for me by the sensorial fields of my organs in proportion as they are displaced through my exploratory and manipulative maneuvers, the real object becomes the point toward which all these paths lead. It turns out to be for me the index of my capacity to enter these paths as and when I want—hence, the solution to the problem of perceptive synthesis (*binding problem*): the aspects are only aspects of something to the extent that they are constantly available to me through my free kinesthetic activity.[43] By going back to my former posture, something unique and identical is given to me.[44] Thus, there can be no question of detaching such a thing from those subjective perceptive–motor activities which give me access to it, as had to be the case with the physical object of classical

physics.[45] In and through these modes of appearance of things, one finds the "I alongside" of the functioning of my perceptual organs.[46] That there is a world for the subject of experience therefore presupposes the freedom to run through such kinesthetic manifolds.[47] The thingliness of the world is the precipitate of human intentions. All that is issues from my (our, intersubjective) activity.[48]

Light might be cast on such intentionalization of kinesthesia if we fix the relationship of Husserl's theory of kinesthesia to the Dilthey–Scheler controversy on the origins of the reality of external world.[49] Dilthey aptly put forward the role of our experience of willing and of the will impulse's being countered by the resistance of the thing. However, he did not distinguish sufficiently clearly such experience from the sensory feeling of a feedback pressure exerted on the moving limb by the object, noted Scheler—a Scheler who, for his part, stressed the importance of an impulsory experience of the acting I, whose nonsensory intention went right through any accompanying sensory experience (an intention, he insisted, that was solely responsible for the giving of the thing itself to the perceiving subject). In this controversy, Husserl's position can be expressed quite straightforwardly: he agreed with both parts. And there is no paradox in that, because his "kinesthesia of the I" stems from the same source as the voluntary intention to act, while his "organ kinesthesia" derives either from peripheral sensations of limb postures and movements or from proprioceptive feelings. It is true that in the visual constitution of spatial things the arrow of attention is detached from the eye–head–body kinesthetic system and attributed to a still disincarnate I. However, in the tactilokinesthetic constitution of the body, the motor, voluntary kinesthesia of the I and the somatosensory, tactile organ kinesthesia are finally tightly intertwined, thanks to a full embodiment of the I in the *pulsional intentionality*[50] of motivation.

Correlating Phenomenology with New Findings in Neuroscience

The models of phenomenological description invoked above did not take into account the possibility of other fields than the complete visual field or the whole temporal field of the perceiving subject. Is this a limitation, and are these analyses out of date in consequence? The most important contribution of the neurosciences of vision[51] has certainly been to multiply and distribute these fields by relating the reception of the signal to the "receptive fields" (RFs) of the cells responsible for the different neuronal relays in the hierarchic processing of visual information (from V1, occipital

calcarine area, to the polar inferotemporal region). The functions said to be of a "high level" (attention, individuation, objectivation, binding, recognition of identity) were supposed to intervene at later stages in the process and not in the primary sensorial regions. The functional architecture of the latter seemed to be devoted to maintaining the topography of the receptors: retinotopy of V1, primary visual area; tonotopy of A1, primary acoustic area in the temporal cortex; somatotopy of SI, primary somesthesic area along the posterior margin of central sulcus. However, the widespread admission of a reentrant feedback hypothesis,[52] thanks to which the information extracted in superior regions would modify (facilitate or inhibit) the reception of the signal in primary sensorial regions, has called in question the uniqueness of this hierarchy, thereby inviting us to think again about the integral unity of the processing of sensory data.

Everything happens on the level of the neural correlates of attentive perception as if the cells of the primary receptive regions "refused to be" limited to simply encoding and decoding the relevant stimuli falling in their RF—and this because they "knew something" about what was going on outside this RF, therefore within the total field, which now also has to be taken into account. By indulging in such metaphors, we are not lapsing into the same bad habit of mentalistic renaming of the subpersonal substrate. On the contrary, the discharge rate of the cell which RF is localized on a segment of a curve on a screen in front of the monkey is modulated by the endpoint of this curve, despite the fact that it is situated outside the RF, if only this endpoint is the target of an ocular saccade that the monkey has learned to make at the fading of the fixation point.[53] Far from inflating mental language, such a way of bringing intelligence back down from the plane of supramodal (not visual nor auditory nor tactile) associations to the sensorial plane makes it possible to get by with fewer mental representations. This is because it becomes less tempting to introduce such representations if the receptive activities are already fully interpretative. But, by the way, any unitary theory (the theory of constitution included) which attempted to account for the continuing integration of perception in and through the dynamic of the global visuo-attentional or audio-attentional or tactilo-attentional field would also become more plausible.

Our vision of the (nonanatomical) functional architecture of the transitory activation patterns of the cerebral circuits recruited by the processing of visual or auditory perception is no longer limited to the the linear bottom–up retino–, or cochleo–, thalamo–cortical hierarchy. This func-

tional architecture is conceived as intersecting such hierarchy with a double feedback. A feedback of the superior stages onto the primary sensorial regions, on the one hand, and, on the other, upon the horizontal (corticocortical, i.e., frontoparietal) and oblique (cortico–subcortical) modifying factors. With regard to the biological significance of perception as the individuation of an external object, these processes stem from acts which intervene *in advance* of "the reality of the object" and of the cognitive or affective values which it bears. It is this precedence with regard to habitual reality which makes it possible to talk of a biological foundation for operations constitutive of perceptual experience. If these pre-empirical operations do not float in a vacuum, it is not enough to attribute them to "the transcendental subject." To provide them with a foundation, it suffices to attribute them to the patterns of transitory activation in the functional loops recruited by perceptual activity in the brain of a perceiving subject.

We will particularly stress the evidence for the modifying influence of *attention* on the primary visual and auditory cortex as well as the modifying influence of *action* and *intention* on the plasticity of maps of the somatosensory cortex.

Attention Modulates Audition

Electroencephalographic recordings show a negative deflection of the curve representing electric potentials in brain tissue reacting to an unpredictable interruption of regular patterns of alternation between two tones that differ in pitch. Until recently, such *mismatch negativity* (MMN) was considered to be automatic and so independent of attention.[54] The deviant stimulus was viewed as standing out against a background of representations of formerly regular series of stimuli retained in memory, thereby causing attention to be oriented toward this stimulus. A process of this kind tended to conceive of attention as purely passive in relation to external stimuli and to abstract attention from the interests, motivations, and intentions of the subject. In fact, what the combination of a deviant stimulus and a voluntary orientation of attention revealed is that when the subject has to attend to a sound in one ear while ignoring the sounds in the other, the MMN registered in the case of attention is no less than two times greater than in the case of inattention.[55]

Such results prove the early influence of an internal activity of the listener upon his of her perception of auditory regularities. This perception can no longer be attributed to a mechanism of automatic detection of irregularities released by the physical properties of stimuli. A special

recruitment of cognitive resources is required for the selection of the deviant stimulus, as the mere contrast it creates with the regular series of tones does not suffice for its perceptual recognition. Perceiving it implies that it is recognized *as deviant*, and this by a focusing of attention upon its occurrence. We can see here the importance of the notion of an identifying act in the theory of perception, an act without which a true realization of the identity of the object would be out of the question.

Magnetoencephalographic recordings confirm these findings by registering the electromagnetic fields evoked by the sounds perceived in the attentive, in contradistinction to the unattentive, ear.[56] It has been found that the activity evoked by attentive hearing of a tone is situated next to, not to say confounded with, the activity evoked by an inattentive audition. Both can be referred to the auditory primary cortex, that is, *planum temporale* in Heschl gyrus near the Sylvius fissure—a localization of the source that fuels the hypothesis of a control exercised by attention on the cortical treatment of the auditory signal, a control that bears upon the very first stages of this treatment, including that of stimulus selection at the point of entry of the auditory cortical system. In fact, some measurable incidence was registered in this auditory primary cortex no later than 20 milliseconds poststimulus.

Attention Modulates Vision

The functional organization of the primary visual area (V1) in the occipital cortex retains the topography of the retina (retinotopy), a structural homology that tends to disappear in the temporal and parietal cortical regions, deemed to be more concerned with interpretation than with the reception of visual information. Such a disposition was thought to be indicative of a purely receptive functioning of V1, where we find cells devoted to a passive detection of elementary signals impinging on their receptive field.

A recent piece of brain research using functional magnetic resonance imaging succeeded in disassociating and comparing the activations of the visual cortex correlated with shifts in visual attention and those evoked by passive exposure to identical stimuli.[57] Successive shifts of attention toward progressively more peripheral sectors of a circular target induce a transitory amplification of activation that sweeps the cortex from its occipital pole (V1) to ventromedial extrastriate regions. This progression conforms to the known retinotopic pattern of cortical representations of the visual field in the visual cortex, despite the fact that it reflects a movement of attention and not of the gaze, which remains fixed on the center of the target. A

remarkable locational concordance is observed between the enhancements of activations of whatever origin: passive exposure to stimuli or voluntary displacement of visual attention. Such "attentional retinotopy" suggests an influence of attention on the first stages of the cortical treatment of visual stimuli, and possibly even before the beginning of this treatment (20 milliseconds poststimulus again).

These data call for a reconsideration of the role of so-called "primary" or "inferior" visual areas. Far from being limited to the pure reception of an external signal, they prove to be the locus of *a decision to see* what the perceiving subject wants to see. At the very least, the same primary regions (V1, V2) are controlled in a feedback loop by modulatory influences from higher regions (V3, V4), influences that could be traced back to internal sources in the prefrontal and parietal cortex that are themselves relaying subcortical, *limbic*[58] sources. As regards the adaptive value of this *functional architecture*,[59] it is thought to speed up the recognition of objects in visual scenes by projecting onto the sensory material some kind of organizing preperceptions, informed by survival motives.

Attention and Intention Shape the Body Schema

Electroencephalographic recording of the fields of local intracortical potentials in the representational area of the hand has brought to light mutually coherent oscillations of a frequency of 25 to 35 Hz correlated with the execution of precise movements of the fingers requiring an effort of attention.[60] They appear most clearly in connection with the monkeys' attempts to retrieve grapes in the holes of a *Klüver board*.[61] However, their frequency does not vary as a function of the nature of the task. Not being synchronized with the bursts of electromyographic activity of the forearm muscles, these oscillations cannot be attributed to the motor order nor to the preparation of an action. The important fact is that such oscillations have been recorded in sites of implantation of electrodes located along an anteroposterior axis overlapping the central fissure. This suggests that they signal a synchronization of activities between the precentral regions devoted to the elaboration of motor orders and the postcentral regions of the somatosensory cortex where the sensorimotor signals are integrated. This frontoparietal synchronization does not necessarily intervene with each movement but only when the task requires a concerted effort of attention. In such circumstances, the sensorimotor integration could be facilitated by a coordination of the oscillatory activities of the somatosensory and motor cortices, a global activity whose coherent pattern organizes the contributions of the interactions of the large population of individual cells recruited for

the task. An analogous hypothesis was initially advanced in vision by C. von der Malsburg.[62]

Brain plasticity studies of hand maps in the somatosensory postcentral cortex have established a reorganization of these maps due to cortical *deafferentation*[63] by limb amputation or nerve injury. Recent experiments[64] evidenced an influence of attention on this map reshaping. An electric stimulation was applied to digits 1 and 5 of subjects while the other digits were anaesthetized by an injection, a condition that spontaneously focuses attention on the disagreeable sensation in the anaesthetized digits. Electroencephalographic recording of electric potentials elicited in the brain by these stimulations revealed that the cortical maps of hands tend to expand when the subjects attend to their anaesthetized digits and to retract when their attention is redirected toward a stimulus applied on the back of the hand.

The experience of one's arm's being prolonged by the use of a tool was correlated with the plasticity of the functional architecture.[65] A monkey was trained to retrieve food pellets using a rake. Electrodes were placed in the intraparietal sulcus, a region of convergence of somatosensory and visual information, in which neurons react not only to tactile stimuli applied to one hand but also to visual stimuli moving around the same hand. When the experimenter moves a food pellet over the monkey's hand, the places in the surrounding space at which a registered neuron fires are normally concentrated above the hand. However, surprisingly, the locus of these firings shifted along the axis of the rake when (and only when) the monkey actually used it, as if, suggest the authors, this visual field expansion were "associated with the monkey's immediate intention to use it."

After a stroke in the right hemisphere, patients frequently suffer from *hemineglect*[66] of space on the left, a deficit in attention, not in vision, that affects the *contralateral*[67] part of the visual field.[68] The influence of action and intention on attention was taken advantage of for the functional recuperation of the cortical representations of peripersonal space supposed to be deafferented, but not suppressed, by the lesion.[69] Patients were trained to seize a stick presented horizontally with the right hand and then to lift it repetitively. Tests of inattention (line bisection, letter cancellation, figure copying, drawing) evinced a sensible amelioration in performance due to the training. The conflict between the intention to seize a stick at its center and the sensorimotor feedback of the stick held, in fact, out of equilibrium prompts subjects to correct their skewed phenomenal space. Here again, the intention to act exerts a regulatory influence upon the body schema.

Conclusion

We concede willingly that we have not given above "an empirical proof" but have only made a gesture, even if a not merely symbolic one, in the direction of such a proof. The data that we gathered are, in effect, for the most part referring to the effects of attention and an extension of the conscious control of awareness on the precocious stage, low-level neural treatment of sensory signals, while the influence of the genesis of intention or action on perception is largely only in the offing.[70] However, as we track back their ultimate determinants, the correlates of attention in perception tend to requalify under a more inclusive category to the extent that they pertain to the same long-range circuit as the correlates of intention in action. Accordingly, to be honest, the present conclusions are more in the way of a bet on future research—but, for all we know at this time, this is not wishful thinking but a perfectly reasonable bet.

Thus, what we expect to see, in fact, is the emergence of a large-scale reorientation in neuroscience and cognitive science generally. Up to now, neuroscientific labs have been concentrating upon preattentional, rigid, automatic modular systems of perception and decision.[71] From now on, they will compete in finding preperceptive or proactive, dynamic interacting systems of attention and intention.[72] The former conception of a mind that is essentially unconscious in most, not to say all, of its functions[73] will be replaced by a new theory of the full embodiment, the rootedness of consciousness and intentionality in the body.[74] Inasmuch as one tends to find in the end what one is looking for, the cognitive impact of consciousness is likely to appear ever more precocious, contrary to the previous assumption that consciousness could only be encountered much later on in the hierarchy of cognitive functioning.

If our forecast is correct, this redirection of empirical research will change the terms of the relationship between cognitive science and phenomenology. As we have seen, the antinaturalism of the phenomenology of transcendental constitution was not, after all, incompatible with a physiology of anticipation and action—a physiology that would try to unearth the biological foundations of those constitutive operations without which an acting subject would be unable to attribute to objects of its experience the meaning of being distinct and independent of consciousness.[75] In fact, recent empirical research has already begun to implement just such a neurophysiology of constitutive consciousness, thereby heading in the same direction as Husserl when he called for a science of the constitution of any kind of objectivity by an essentially active, conscious being.

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Notes

1. In Gazzaniga (1995, p. 428), a warning that questions any advance toward a more liberal understanding of the coding theory of neurons, those particularly by Bach-y-Rita, Georgopoulos, Gilbert, Rolls, Singer, and Tanaka.

2. Berthoz (2003, pp. 40–41).

3. For the reader not familiar with phenomenology, we provide explanatory notes.

4. *Sinngebende Akte:* mental acts which confer to an objet the meaning it has for a subject.

5. *Konstituirende Leistungen:* the same acts, to the extent that they provide to their object any contributory layer of its "reality" for a subject.

6. *Seinssinn:* value of "reality" of something for a subject.

7. *Lebende Gegenwart:* proximal, peripersonal space and minimum length of time of experience in which any object has to appear or any event to occur in order to be dealt with by the subject.

8. *Horizont:* limit of the personal space–time which is finite, closed under the acts of the subject, but also open as source of novelty and the recess for things past to sink out of sight.

9. *Sinngebung:* the value "truly real" has to be given to the candidate object by acts that a subject accomplishes in interacting with it.

10. *Kinesis*: movement + *aesthesis*: sensation.

11. Feeling of innervations, a notion that confounded a sensitivity of motor nerves to the passing through of motor command that was disconfirmed and a now accepted "corollary discharge" or feedback of the motor command on sensory centers in brain—a feedback thanks to which the organism is aware of his action ahead of any returning signal from the moving limb.

12. For the reader not familiar with neuroscience, let us note that electophysiologists using intracerebral recordings evidenced a topologic, even if plastic, pattern of organization ("homunculus") of functional activity around central sulcus denoting some correspondence between the region of the skin covering each body part and its territory of representation in brain cortex tissue.

13. The neurodynamic school of neuroscientists registering global activities on the scalp have noted in certain bandwidths transitory coherent patterns of oscillations

in correlation with mental experiences such as the reversal of ambiguous figures (Necker cube).

14. *Umwelt*: the world of all objects of perception and aims of action for a given living being.

15. Ex. *Bereitschaftpotential*: potential of preparation of Kornhuber, a deflection of the curve representative of neural activity at scalp sites above premotor and motor areas a half second before the emission of a motor command.

16. Flow of neural modulatory influence oriented from higher cortical centers to primary areas and/or the periphery of muscular effectors or sensory captors. It is opposed to the "bottom–up" flow of treatment of sensory information from outside by progressively higher centers.

17. Brain circuit that links the frontal, motor area and the postcentral, parietal area, the latter a zone of convergence of visual and tactile and motor signals.

18. Corticocortical circuits that link together regions of cortex at different layers.

19. Thalamocortical connections by which sensory signals from the retina and other captors are relayed by the thalamus, an ontogenetically ancient nucleus of cerebrum, to their target of projection in the sensory primary areas of ontogenetically recent cortex.

20. Cortico–subcortical circuits connecting the higher cognitive regions of cortex to the lower, primitive brain nuclei of basal ganglia, that contribute to affective-conative motivation of behavior.

21. *Setzen, Setzung:* full, wholehearted assertion of belief in the reality of the object of perception or judgment, as opposed to doubt, delusion, or fiction.

22. A system to which Husserl devoted his 1905 lectures (Husserl 1966).

23. *Modifikation*: constant alteration of vivid sensation into past impression as retained in consciousness.

24. *Auffassung:* identity, or other formal property of an object of perception has to be imposed to the multiplicity of transitory aspects by an act of grasping, or relating, or unifying its sensorial diversity under the relevant ruling principle. A principle that could not possibly be found in the actual sensory content of consciousness.

25. *Transzendantal:* The scaffolding of all possibility of objective knowledge for the subject.

26. Referring to the analyses of the 1907 Lectures (Husserl 1973).

27. *Erscheinungsmodi*: aspects under which an object appears to a viewer as he or she moves around and changes his or her viewpoint in relation to this object.

28. *Abschattungen*: series of transitory, incomplete appearances bearing any pretention of objective validity beyond the limits of their actual sensory content.

29. *Noesis–noema*: from the act of perceiving we distinguish that which is aimed at by this act, that is, not the physical thing, but the object precisely as it is targeted and prefigured by the act oriented toward it.

30. *Kinästhetische Verlaufen*: free percourses of kinesthesia, the phases of which are prescribed by the anatomic constraints of our organs and go from a normal, rest posture to a maximum of tension and back to rest.

31. *Hyle:* matter of an act, its purely sensory content, so characterized despite the impossibility of taking this content apart from the formal aspect of this act.

32. Ms D 12 IV, p. 9.

33. Husserl (1973, p. 181): "Ganz anders verhält es sich mit der Reihe der K; sie weisen aufeinander nicht hin, sie laufen ab, sie sind aber nicht Träger durch sie hindurchgenhender Intentionen wie sie die f (Figuren im Feld) haben, nicht ein durch sie gehendes Einheitsbewusstsein."

34. An expression we find in *Ideen II* §18, texts that Husserl did revise up to 1928. See Husserl (1952, p. 57), where visual sensations are distinguished from kinaesthesia: the former being the objects of an (intentional) apprehension to the extent that they are functioning as sketches of the thing; the latter being the objects of *eine ganz andersartige Auffassung,* that is, a kind of apprehension devoid of intentional character because it all boils down to a quasi-causal *if–then* correlation—a correlation in virtue of which "*if* the eye orients itself in such and such manner, *then* the 'image' is modified in such and such manner" (p. 58).

35. Ms D 12 V, p. 3.

36. For a reassessment of the role of kinesthesia in neurophysiology, see J.-P. Roll in Petit (2003, pp. 49–66).

37. Referring to Hegel's dramatic stage setting of the experience of consciousness in *Phänomenologie des Geistes*.

38. Ms D 10 IV (dated 1932), p. 9.

39. Ibid., p. 11–12.

40. Ibid., p. 13–14.

41. Ms D 10 I (dated 1932), p. 25.

42. Ms D 10 III (dated 1932), p. 9.

43. Ms D 13 I, p. 14.

44. Ibid., p. 17.

45. Ms D 13 X (dated 1923), p. 27.

46. Ms D 10 I (dated 1932), p. 3.

47. Ms D 13 XV (dated 1918), p. 3.

48. Ms B I 16 (dated 1931), p. 8.

49. Dilthey (1890/1924); Scheler (1926).

50. *Triebintentionalität:* ultimate roots of motivation prior to the subject–object, will–desire, feeling–acting distinctions, albeit not without an orientation toward something.

51. Zeki (1993).

52. Edelman (1992).

53. Roelfsema et al. (1998).

54. Winkler and Czigler (1998).

55. Alain and Woods (1997).

56. Woldorff et al. (1993).

57. Brefczynski and DeYoe (1999).

58. The limbic system includes nuclei of lower brain important in affective-conative motivation of behavior.

59. Variable, but coherent patterns of activation that straddle the frontiers between different cell types of brain cortex rather than being enclosed in these frontiers.

60. Murthy and Fetz (1992).

61. A presentation board that provides to monkeys a gradual difficulty in the retrieving of grains with the digits from holes of different diameters.

62. As a solution to the "binding problem" of the various modalities of the visual scene or object: a transitory coordination of the cellular activations selected for different features and extracted from the visual signal by hierarchically ordered neuronal links in V1, V2, V3, and so forth could help to integrate these features in one unique percept (von der Malsburg and Schneider 1986).

63. An experimental disconnection of cortical areas of projection of sensory nerves from their sources of afferent signals, that is, from the region of skin supporting the receptor organs. Here a transsection or crushing of median nerve that innervates digits 1, 2, and 3 of the hand induces reorganizations of cortical hand maps.

64. Buchner et al. (1999).

65. Iriki et al. (1996).

66. Unilateral negligence of one half of visual space, a syndrome manifested in eating only the food on half of one's dish or drawing on half of the page or shaving half of one's face.

67. Contralateral–ipsilateral: hemifield of visual space of the opposed–same side to the lesioned brain hemisphere.

68. Bisiach and Luzzatti (1978, p. 132).

69. Robertson et al. (1995); Robertson et al. (1997); Harvey et al. (2003).

70. We cannot perceive any default of parallelism between phenomenology and neurobiology as regards the data on our awareness of embodiment in agency, on the one hand, and our conscious scanning of scenes in the outside world, on the other, because the two conditions belong equally to a nonreflexive prethematic consciousness.

71. For example, in attention research the literature on the MMN of electric potentials evoked in auditory cortex by a deviant tone in a series (Näätänen 1992).

72. See the above references.

73. In essence, the bulk of the modularity of mind paradigm, up to recently in fashion in labs (Fodor 1983).

74. Thompson and Varela (2001); Varela and Shear (1999); Petitot et al. (1999).

75. Berthoz and Petit (2008).

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