Beyond the internalism/externalism debate:

the constitution of the space of perception

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Abstract: This paper tackles the problem of the nature of the *space* of perception. Based both on philosophical arguments and on results obtained from original experimental situations, it attempts to show how space is constituted concretely, *before* any distinction between the "inner" and the "outer" can be made. It thus sheds light on the presuppositions of the well-known debate between internalism and externalism in the philosophy of mind; it argues in favor of the latter position, but with arguments that are foundationally antecedent to this debate. We call the position we defend *enactive* externalism. It is based on experimental settings which, in virtue of their minimalism, make it possible both to defend a sensori-motor/enactive theory of perception; and, especially, to inquire into the origin of the space of perception, showing how it is concretely enacted *before* the controversy between internalism and externalism can even take place.

Keywords: constitution; enaction; externalism; internalism; sensori-motor; sensory-substitution; space.

1. Introduction. The context of this article: the debate in the philosophy of cognition between internalism and externalism and the question of the space of perception

Quite recently, the object of the externalism/internalism debate has been moved from the referential properties of mental representations to the localisation of the vehicles and substrates on and through which thoughts, conscious experience, perception or problem solving are carried out. This is what is at stake in what is now diversely called *vehicle externalism* (Hurley, 1998), *active externalism* (Clark & Chalmers, 1998), *extended mind theory* (Clark 2008), *enactive* theory of perception (Noë, 2004), *psychotectonic externalism* (Rowlands, 2003) or again *locational externalism* (Wilson, 2004). Contrary to the old externalism, this new externalism brings up ontological issues and involves crucial methodological choices in the study of cognition (Adams and Aisawa, 2008).

In the philosophy of mind and cognitive science, externalism is first and foremost a critique of internalism. Adopting an internalist thesis concerning phenomenon *X* (perception, conscious experience, the content of a thought, the material substrate of a thought, problem-solving, …), amounts to maintaining that *X* supervenes *exclusively* on properties and processes that occur inside the body, even inside the head, of a cognitive agent[1]. By contrast, an externalist position calls into question the notion that *X* supervenes totally on parameters in the head or in the body: this difference between a domain inside the head and a domain outside the head is of no relevance for defining and explaining the nature and the functioning of cognitive phenomena, because at least in certain circumstances, the realizers of these

[1] See Fodor (1987) for an internalism of meaning; Block (2004), Prinz (2004) for the vehicles of perception; Adams and Aizawa (2008) for cognition in general.

phenomena take not only place in the organism but are also extended outside of it, notably in the bodily engagement of the organism in the environment, and in its coupling relations with technical devices, artifacts and other agents .

The position we shall defend here is in deep sympathy with an externalist approach to cognition, and in particular with a vehicle externalism concerning perception. However, our principal aim is not to place ourselves directly at the heart of the internalism versus externalism debate. Rather, we shall focus on an issue which lies upstream: the very terms of this debate *presuppose as given* the existence of a space in which the agents, their behaviours and the objects of their behaviours are all situated, a space which makes the question "is perception an internal state of the organism or is it rather also situated in the behaviour of the creature and in the environment?" meaningful in the first place. Still, if one admits right from the start the existence of this space, some foundational and insuperable problems immediately arise.

In the realist perspective that is most commonly adopted the prior existence of the space of physics, a space in which objects are situated independently of the presence of subjects, is taken for granted. It is only afterwards that one seeks to understand how subjects located *in* this space can perceive objects. A very general and classical problem in the whole field of perception is thus to understand how it is possible for a subject situated *here* to perceive an object situated *out there*; how can the subject, within the restricted volume of his organism (or more precisely of his brain), be conscious of that *immense* mountain over there, and of the *space* of the cosmos which contains both the mountain and the subject himself? How can the subject, from the point where he is situated, perceive the localisations and dispositions of objects which surround him, his position with respect to those objects, and also the space which separates him from them? This is the problem of the origin of the *space of perception,* the space proper to our perceptual experience of a world *out there*.

The classical answer to this question is that the subject, situated in a certain position, constructs *representations* of these objects, of these distances, of this encompassing space. It is supposed that sensory organs on the surface of the body receive a stream of information coming from objects in the external world; and that the processing of this information by the nervous system makes it possible to construct representations of these objects. We shall not enter here into a discussion of the format of these representations (whether they take the form of "mental images", whether they are contained in neuronal maps, or whether they take the form of symbolic "propositions"); we note simply that these representations of the external state of affairs are supposed to have substrates, vehicles, that are internal to the perceiving organism. Thus, on this view, if one wishes to understand the perception of the distance or the position of an object, it will be necessary to account for the representation of this distance or position. One is thus lead to make a distinction between an internal representation of space (or a set of several representations, for example corresponding to different perceptual modalities) on the one hand, and physical space itself on the other. "Lived space" – the space that we experience in the course of perception – is supposed to be produced on the basis of representations of physical space (and objects which are situated therein), possibly calibrated by sensori-motor data and representations. The experience of an "outside" space ultimately supervenes on a set of representations that occur *in the head*. We may also note that in this case, there is no difficulty in allowing "objective space" to remain hypothetical since the subject has no direct access to it – in the end there is only access to its representation. C.L. Colby gives a good summary of this internalist conception of the mechanisms which, in the last resort, constitute the lived space experienced by the subject:

"Neural representations of space are maintained over time and the brain must solve the problem of updating them when a receptor surface is moved. Every time we move our eyes, each object in our surroundings activates a new set of retinal neurons. Despite this constant change, we experience the

world as stable. This perceptual stability has long been understood to reflect the fact that what we perceive is not a direct impression of the external world but a construction, or internal representation, of it. It is this internal representation that is updated in conjunction with eye movements". (Colby, 1999, p.785).

Even if what we experience is a unified and stable space, according to certain theories (Rossetti, 1997) it is doubtful whether this experience can arise from a single supra-sensory representation of space, constructed in the brain of the basis of multi-modal information. At the very least, there seem to be a whole set of sub-personal representations which, together, somehow succeed in accounting for this unified experience of space. "Lived space" would emerge from a diverse set of spatial representations, many of which can be located in the parietal cortex. Within the latter, diverse zones of neuronal activation can be distinguished; consequently, there would seem to be diverse sorts of spatial representations, which give rise to a range of capacities such as locating an object, or moving towards it[2].

The ecological approach of Gibson and his followers attempts to escape from such a representationalist conception of perception. Instead, it proposes that perception consists of the *direct pickup* of physical invariants. Take the paradigmatic case of vision. At each point in space, the purely local structure of the ambient array of light is supposed to contain sufficient information to specify the properties of the environment, and in particular the properties which are relevant for the organism, what are called "affordances". In the course of its movements, the animal grasps the invariants of this local structure which are relevant for his activity; moreover, it grasps them "directly" because they are causally related to the affordances of the objects. We have a direct perception of the affordance of the distal object: *out there,* the slope seems to be climbable, the gap seems to be crossable, the tool seems to be

[2] Colby and Duhamel (1996); Goldberg, Colby, and Duhamel (1990); O'Keefe and Nadel (1978).

holdable, etc. The space inside of which objects are perceived corresponds to the environmental layout that makes sense in the concrete activity of organisms.

Still, the ecological approach does not consider as relevant the task of providing an account of the experience of space itself: that is, space as what separates us from objects, as the set of positions these objects *might* have had, and as the diversity of moves we *might* have made in order to reach these objects. Somehow, this is not surprising: starting from the (plausible) idea that geometrical space is a pure abstraction (and even a *ghost*), Gibson (1986, p.3) considers – and this is more debatable – that we can *visualize* the outer space, but not *see* it, so that it is not a part of our perceptual experience. For Gibson, « the concept of space has nothing to do with perception » (1986, p.3). Still, if one prefers to talk about *environmental layout* instead of *space* (as Gibson did), one must still explain how we can *experience* this layout (or some *arrangement* of objects) as being "*out there*".

The experience of the space that surrounds us is indeed real, and is not identical to the perception of spatial properties and relations. As already noted by Husserl (1907, appendix VII), space can be "seen-with" (*mitgesehen*), as a sort of *relief* with respect to perceived objects:

"If one plunges precisely into the phenomenon of the intuition of space, one cannot manage, with a minimum of sincerity (which is decidedly not easy to acquire), to get rid of the [idea] that one sees the intervening portions and space as a whole. If I look at this or that edge of a perceived cavity, or at the hollow formed by books, or tables, etc., and I go from one edge to the opposite [edges], I "see the air", the intervening space. I can fix my attention on this or that intermediate point or position, without concerning myself in any way with the shape and sort of object that forms the surround…"

It is necessary to account for this space, before possibly asking if it exists for other animals. However, that is difficult if one considers that the space of objects to be perceived *pre-exists* independently of the subjects who subsequently have experience of it (this realism

would bring us back to the representationalist position described above). To the best of our knowledge, the proponents of vehicle externalism have not yet explicitly taken a position with respect to these issues, nor about the more general problem of the space of perception. Should one envisage an internal representation of objective space, or should one consider that perceptual experience can somehow extend into this objective space?

In this article, we aim to show that an *enactive* approach to perception offers a way out of these symmetrical difficulties. Against the realist approach, our enactive approach holds that the space of perception that we experience is *constituted* (moreover, "physical" or "objective" space is itself a secondary human and technical constitution that derives from this primordial space that is constituted in experience)[3]. Against internalism, we hold that while this constitution is quite concrete, the processes involved are neither representational nor situated exclusively in the brain. The space of perceptual experience is constructed concretely, in the course of perceptual activity. Focussing our attention on the constitution of the space which will subsequently make it possible to distinguish an *inside* and an *outside*, our thesis is first and foremost *enactive*, before going on to defend an externalist theory of perception.

In order to provide this approach with a precise and unambiguous meaning, we will deploy it in a well-controlled perceptual situation with minimalist experiments of prosthetic perception. These experiments will allow us to illustrate our thesis by arguing for the intelligibility and relevance of a case where the *constitution* of the space of perception can in no wise be reduced to set of operations in the head. The minimalist and prosthetic nature of our experiments allows us to construct and to master a situation where there is absolutely no constitution of the space of perception without a sensori-motor involvement on the part of the perceiving subject; moreover, there is no need at all to invoke "mental representations" of the space, and indeed any such attempt would be positively misleading. We will not be concerned

[3] We will discuss the possible meanings of the term « constitution » in section 4.2. Here, we refer to the process of the production of the content of lived experience.

here to generalize this thesis. By illustrating its plausibility on the basis of one experimental example, we consider that we have *already* done enough to criticize the internalist thesis and moreover to question the foundational presuppositions of the internalism versus externalism debate in the philosophy of cognitive science.

To start with, in part 2, we present the simple experimental situations of cognitive coupling (prosthetic perception) which allow an explicit, unambiguous clarification of what an externalist conception of spatial localisation actually is; this will lead us to identify some problems posed by the externalist thesis. By noting certain ambiguities and inadequacies in this externalist conception of active perception, we will proceed in part 3 to propose an enactive description of the constitution of the space of perception that is *already* in play in part 2. On the basis of the same experiment we will propose a change in perspective, passing from the question of the externalism of the perception of an object to the question of the enaction of the space of perception (in which the object can be localized). Part 4 replies to two legitimate objections that our approach seems to occasion. In the conclusion, we explain how our enactive position leads to a specific kind of externalism. .

2. Prosthetic perception and externalist theories of perception

2.1 Sensory substitution

The « Tactile Vision Substitution System » of Paul Bach y Rita (the TVSS) is perhaps the best-known example of the so-called « sensory substitution » systems. In its standard version, developed in the late 1960's as an aid for blind persons, the TVSS converts an image captured by a video-camera into a "tactile image" produced by a matrix of 400 tactile stimulators in a 20 x 20 array (Collins and Bach y Rita, 1973). The matrix is place either on

the back, or on the chest (Bach y Rita, 1982), or more recently on the tongue (Bach y Rita, Danilov, Tyler & Grimm, 2005).

The initial trials with these devices provided two fundamental results, which are quite essential for the discussion which will follow:

(i) If the camera is immobile, placed on a table, the discriminatory capacities of the subjects remain very limited; and the stimuli are perceived on the surface of the skin.

(ii) If the camera is actively manipulated by the subject, the subjects exhibit spectacular capacities to recognize shapes; and the objects are perceived in a distal space, "out there" in front of the subject.

The *perception* of a stable object in front of the subject is quite distinct from the succession of highly variable *sensory stimuli* that the subject receives as she constantly moves the camera. During the initial phase when the device is first employed, the attention of the user is drawn to the tactile stimuli on the skin. In fact, as long as the stimuli are controlled by the experimenter, the user remains unable to detach his attention from the stimuli. However, if the user himself is able to move the camera, then progressively, after 10 to 15 hours of practice, he comes to perceive objects situated at a distance in front of him. At this point, there is a clear distinction for the subject between the tactile stimuli (which are sometimes a source of irritation) on one hand, and on the other the perception of an object out there in front of him. The device of Paul Bach y Rita therefore provides an exceptional opportunity for an empricial study of the constitution of a spatial content of experience (Auvray and al., 2004). The genesis of this phenomenon can be observed in a controlled manner; moreover, since the subjects are adults, it is possible to associate a psycho-physiological analysis with a phenomenological description from the point of view of the prosthetically equipped subject (Lenay and Sebbah, 2001).

Of course blindfolded subjects, like persons who are blind from birth or through injury, do already have a knowledge of space, even if it is only through the world of sound or the space of bodily action with tactile and kinaesthetic feedback. Nevertheless, with the radically novel mediation provided by the technical device, during the initial phase there is no lived space *in this modality*: the structure of objects with a three-dimensional shape perceived at a distance simply does not exist (yet)[4].

Following on from the early studies by Bach y Rita and his colleagues, we have developed several technical devices which are deliberately minimalist. The aim is to provide a detailed analysis of this sort of prosthetic perception, for shape recognition[5] as well as the spatial perception which is the focus of this article. We will present here the simplest of all these devices. This will enable us to propose a precise, in-depth description of the concepts and problems which are posed by active perception and externalism.

2.2 Minimalist spatial perception

We have seen that with the TVSS of Paul Bach y Rita, the constitution of a space of perception and the localisation of objects is possible. What happens if the mediation is simplified to the extreme? Is the constitution of a space of perception still possible? In order to answer these questions, we have built a minimal prosthetic device consisting of just a single photo-electric cell connected to a single tactile stimulator. When the amount of light in the incident field (a cone of about 20°) exceeds a certain threshold, the all-or-nothing tactile stimulus is triggered. At each moment, the subject therefore receives just one bit of sensory information, the presence or absence of tactile stimulation.

[4] Epstein et al. (1986) have studied, in very controlled conditions, the question of the awareness of the existence of an external space through the use of a sensory-substitution device – a question we considered again in Auvray et al. (2005).
[5] See Ziat et al. (2007).

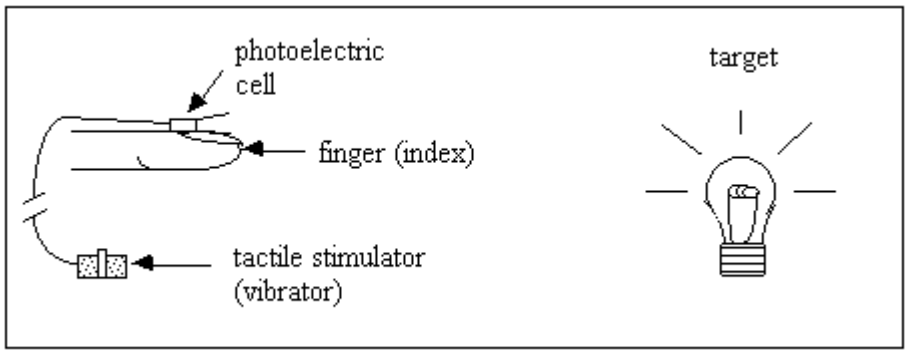


Figure 1: Minimalist experimental device for spatial localisation

The subject (a blind person or a blindfolded sighted person) can freely move the arm and the hand which holds the photoelectric cell. After several minutes of exploration, the subject is able to localize the luminous target, i.e. to indicate its direction and approximate distance. This can be verified, either by a direct pointing task, or verbally (on the basis of a set of previously learned positions). There is no appreciable difference between blind persons or sighted blindfolded subjects (Lenay and al., 1997). This experiment has recently been repeated in the USA and in England[6].

Here, it is clear that perception cannot be based on a simple internal analysis of the sensory information, if only because the latter has no intrinsic spatiality whatsoever, being merely a temporal sequence of sensations s0 and s1. With the TVSS of Bach y Rita, there were 400 points of stimulation, arranged in a 20 x 20 matrix corresponding directly to the receptor fields of the camera. In those conditions, the sensory input already contained specifically spatial two-dimensional information. By contrast, the experimental device employed here has been deliberately built so as to exclude this possibility. With just a single point of stimulation, space cannot be presupposed at the moment of the sensory input. In these conditions, if perception is possible it can only be through a synthesis of a succession of

[6] Siegle and Warren (2007); Froese and Spiers (2007). The work presented here has been motivated in part by a conversation with W. Warren during a meeting of the European Network "Enactive Interfaces" in Montpellier, France, in 2006.

sensations and actions. If there is no intrinsic spatiality in the sensory input, the perception of a target which is localized as to its direction and distance is only accessible by means of an active exploration. In these conditions, the perceptual activity can be studied on the basis of observable movements. Our device therefore forces *a spatial and temporal deployment of the perceptual activity.*

It is quite understandable that it is possible to locate the target, even if the movements of the subject are simplified, and reduced to movements of the arm around the shoulder articulation, and movements of the hand around the wrist articulation. In Figure 2a, we consider only movements in a horizontal plane (three-dimensional space can be recovered by integrating up-and-down movements in the vertical plane). The situation is represented in (x,y) co-ordinates, with the subject place at the origin (0,0). The target is a point source, S, situated at a distance L from the subject with co-ordinates (0, L). The point P designates the wrist of the subject; its co-ordinates are ($b.\cos\alpha$, $b.\sin\alpha$), where b is the length of the arm, and the angle α = (Ox, OP) indicates the orientation of the arm. The angle at the wrist, between the arm and the hand, is designated by β = (PO, PS).

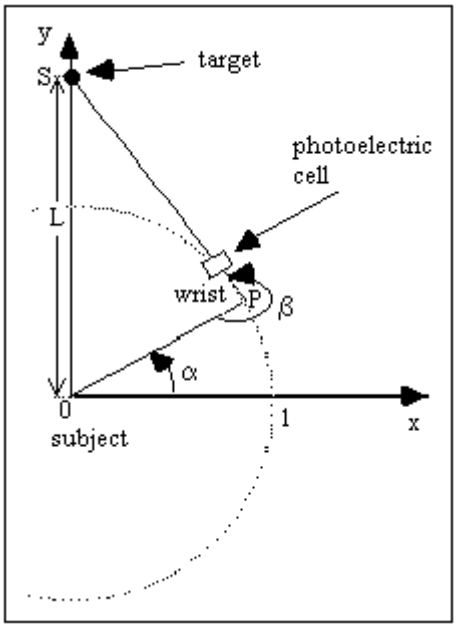


Figure 2a: The arm (forearm included) has a length b.

The distance to the target L (0S) is given by the trigonometric formula:

$L = b.(\sin \alpha - \cos \alpha \tan(\alpha+\beta))$ (Equation 1)

We may suppose that the subject is oriented with his chest facing the target, and finding a tactile stimulation with the arm point straight forwards and the finger aligned with the arm ($\alpha = 90°$, $\beta = 180°$). From a strictly mathematical point of view, a single pair of additional values (α, β) is then sufficient to determine the distance L. As shown in Figure 2a, L is given by a simple trigonometrical formula, if we consider that b, the length of the arm, is known (we will return to this point in section 4.3).

However, experimentally, it is observed that just one or two "contacts" with the target are not sufficient for the subjects to succeed in the task of location. There are at least two important reasons for this.

(1) Firstly, for the subject, from a phenomenological point of view, it is clear that if she remains motionless, the perception disappears. There are just two possibilities: either the subject points away from the target, in which case she only has the memory of a perception which fades away; or else the subject points towards the target, in which case she receives a continuous tactile stimulation and it is this stimulation which takes the place of the perception of an external object. In neither case is there any spatial perception.

(2) Secondly, from a physiological point of view, proprioception of the directions of the various segments of the arm and hand is not very precise, especially if the subject is immobile. Besides, the position of the photoelectric cell on the finger is not well known to the subject (the device was put in place when she was already blindfolded). It is therefore very difficult for the subject to know precisely, through proprioception, the direction of aim. We may add that the aperture of the photoelectric cell

(approximately 20°) is not very precise, variable according to the luminosity, and in any case unknown to the user.

In this experimental situation at least, there is no perception without action. One observes that the subjects perform regular oscillations around the target: generally small oscillations of the hand, accompanied by larger movements of the arm which cause progressive changes in the position of the wrist. It is as though the subjects seek to identify the functional relationship between α and β which must be respected in order to obtain a sensory feedback. In fact, it is indeed possible to rewrite equation (1) so as to express β as a determinate function of α :

$$\beta = 180 - \alpha + \text{atan}\left((b \sin\alpha - L) / b \cos\alpha \right) \quad \text{Equation (2)}$$

This relation is illustrated in Figure 2b.

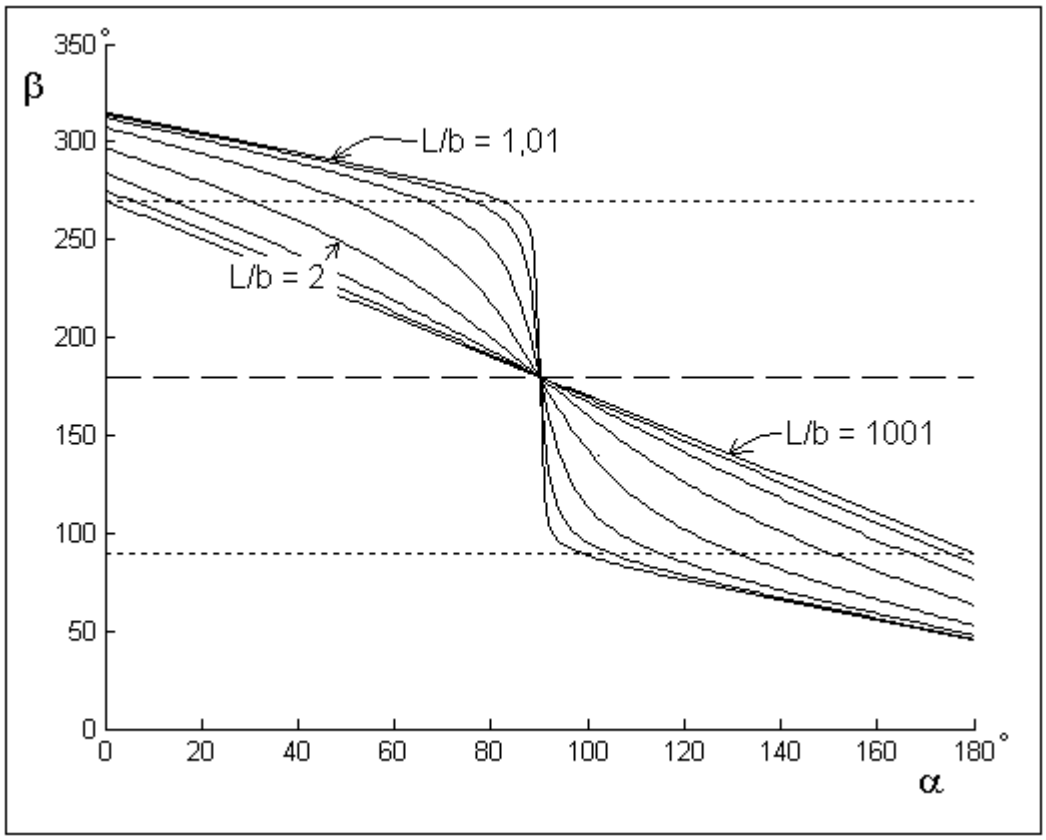


Figure 2b: The relation between α and β for values of L = 1.01, 1.03, 1.1, … 2, …1001.

The target is located in space to the extent that its position is defined by the relative rates of variation of the angles at the articulations of the subject when pointing in the general direction of the target. Each position of the target corresponds to a *sensori-motor invariant*, i.e. a law relating actions to sensations, a law which is itself stable relative to variations in these actions and sensations. This is a good illustration of a "law of sensori-motor contingency" is the sense of O'Regan and Noë (2001). This actually corresponds to a well-known conception of perception as an activity (Piaget, 1936; Paillard, 1971; Gibson, 1966, 1986): perceiving amounts to the mastery of invariants (Varela, Thompson and Rosch, 1991)[7].

We call the technical system that the subject is equipped with a "coupling device". This device defines the actions and the sensory inputs which are possible. We use the term "strategy" to denote the rules which the subject uses to command his actions as a function of the sensations that he receives: a = f(s), where "a" is the action produced for sensation "s". An intuitive strategy (a = f(s)) that we have often observed consists of associating a broad sweeping movement of the arm (α) with smaller, rapid oscillations at the wrist (β). The movement of the wrist is controlled by the sensations received: the strategy consists of changing the direction of the finger movement (inversing the angular acceleration) each time the tactile stimulator becomes activated. This ensures that the oscillation of the wrist will be centred on the direction of the target. The slower movement of the arm induces a shift in the wrist direction when the centre of wrist rotation is displaced. It is not difficult to understand that this shift in direction, $\delta\beta$, will be more rapid (for a given change in arm direction,

[7] Recent work nevertheless suggests that there may be some important differences between ecological theories of perception (Gibson-inspired) and sensori-motor theories of perception (Varela-Noë), especially concerning the nature of these invariants. See for instance O'Regan and Noë (2001, p.1019), Mossio and Taraborelli (2008), and Hurley (1998). If these differences turned out to be genuine, the present position, while clearly belonging to the sensori-motor tradition, would aim at overcoming these differences, since it deals with the foundational issue of the space of perception.

δ α) when the target is close than when it is further away. This relation is shown directly in Figure 2c.

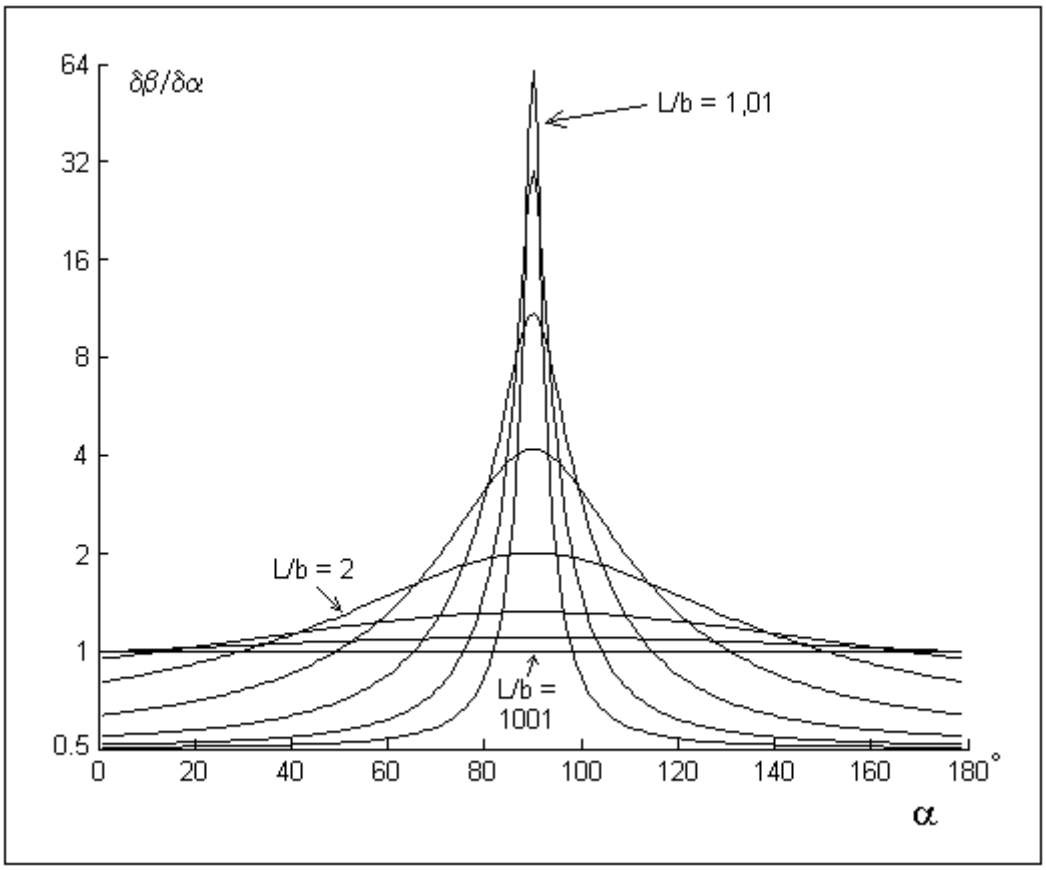


Figure 2c: The rate of change in wrist angle relative to change in arm angle, xx, for different values of the target distance L = 1.01, 1.03, 1.1, … 2, …1001.

This general strategy will always allow the subject to constitute a sensori-motor invariant specific to the direction and distance of the target, whatever its position. The perceptual content cannot therefore be reduced to the strategy that is employed; rather, the content corresponds to the law of sensori-motor contingency to which the strategy gives access. The point is that this law cannot be completely defined without taking into not only the strategy deployed by the subject, but also the coupling device which defines the range of actions and sensations which are available, and the environmental causality s = g(a) which defines the sensations s which the subject will receive as a function of the actions "a" that are

performed. This has an important consequence: *for one and the same strategy*, if the coupling device is modified, or if the causality s = g(a) is different (for example if the target is in a different position), the law of sensori-motor contingency will be different and the perceptual content should thus be different also.

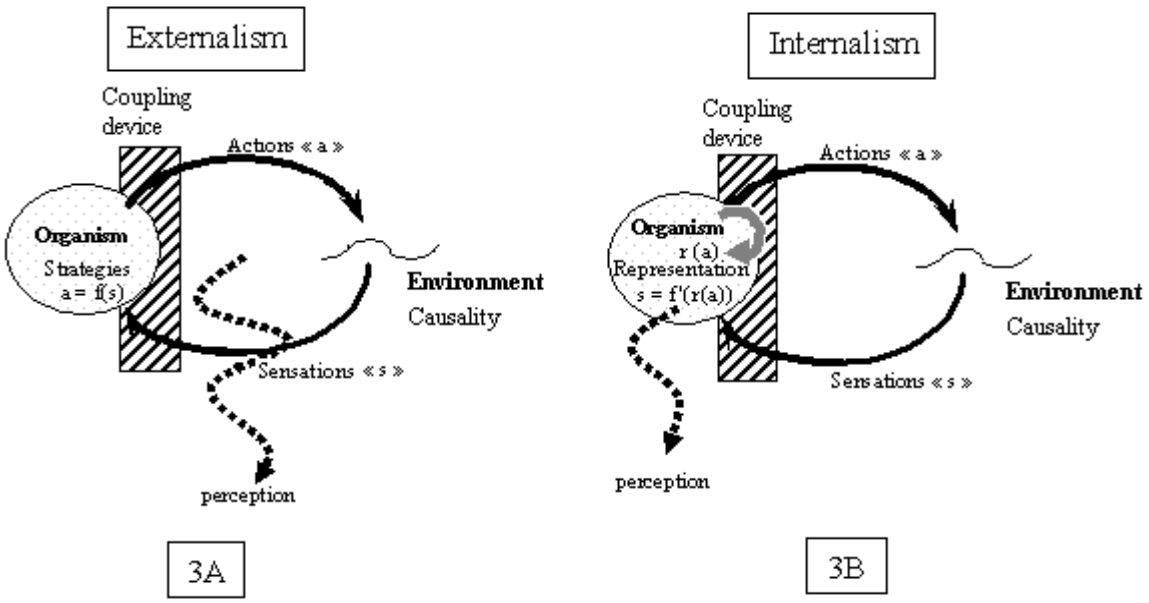
2.3 Problems concerning the interpretation of these results

The experimental set-up we have created forces a maximal externalisation of the perceptual activity. The generality of this approach is another question. Here, we seek solely to establish that at least in one case, even if it is a rather special one, an externalist approach to perception can be clearly exhibited: the perception of the position of the target is indeed constituted by the activity of the subject. Thus, the perception of a particular position cannot be reduced to knowledge merely of the perceptual strategy deployed, but depends on the specific sensori-motor law that the strategy reveals. In the framework of what we call here an externalist theory of perception, the substrate of the perceptual experience is not limited to the brain, but extends to the entire sensori-motor activity[8]. This active perception can be represented schematically as in Figure 3A below.

However, these remarks are not sufficient to ground an externalist position, because the debate can start all over again. The point is that an approach to perception in terms of activity can very well be accommodated within an internalist framework. When we say that the perception of a position of the target depends on "the mastery of an associated law of sensori-motor contingency", does this mean that the perception corresponds directly to the concrete *realisation* of that law; or rather that the perception consists of a *representation* or an *encoding* of that law?

[8] « At least for certain experiences, the physical substrate of experience *can* cross the frontiers, involving components that are neuronal, bodily and environmental» (Noë 2004: 221). We may note, however, that A. Noë admits *as already given* a spatial distinction between inside and outside.

In order to remain in an internalist perspective (see Figure 3B below), it is sufficient to affirm that the active perception we have described above could only give rise to a conscious experience if the subject also has at her disposal some supplementary internal knowledge, such as for example proprioceptive representations of the relative velocities of the articulatory movements. With knowledge both of the actions performed (α and β) and of the sensory returns (s) that result, the subject could very well construct a mental representation of the law which would enable her to anticipate the sensory consequences of her actions. In the last resort, her perception would consist only of the activation of an internal structure associated with this procedural representation (Pace, 2005). The construction of this perceptual representation would be causally dependent on the sensori-motor inputs and outputs; but the representation itself would consist solely of a set of activated brain-states in which the results of the actions and the sensations would be encoded.



Figures 3: The scheme of sensori-motor coupling. The system of prosthetic perception is a "coupling device" which modifies the lived body by defining the repertoires of actions and sensations available to the subject. There are two possible approaches to this active perception.

- On the one hand, externalism (3A). Via the environment, the actions “a” cause sensations “s”: s = g(a) ; and the organism defines the strategy which determines the actions as a function of the sensations received: a = f(s).
- On the other hand, internalism (3B). It is now necessary to add an additional arrow (in grey) which gives the organism access to the actions: there is a representation of the action, r(a), which is distinct from a, the action actually performed. The representation corresponding to perception is based on a law “s = f’(r(a))”, which makes it possible to anticipate the sensations as a function of the actions performed.

By contrast, if one maintains an externalist perspective (3A), close to the ecological theory of perception, the perception of a spatial position of the target consists directly of establishing and mastering a concrete relation of articulatory velocities, without having to double up by additional representations. In order for the subject to gain access to the content of perceptual consciousness, it is sufficient for the organism to bring to the coupling a “strategy” which determines its actions as a function of the sensations received and which leads, when it is employed, to pointing towards the target.

However – and this is the crucial point of our argument – it seems to us that as long as the distinction between perceiving organism and perceived object, and indeed the structure of space itself, are taken for granted as given in advance, each of these two approaches is confronted with great difficulties.

For internalism, it is necessary to suppose that there is internal access to the actions performed, immediate and sufficiently precise – either by proprioception or by efferent copy of the motor commands. The internal law which links these representations of action to exteroceptive sensations will then itself be a representation which reflects the external sensori-motor law. This internal representation is supposed to supervene on a neuronal

structure located in the brain. This poses the classical problem of the intentionality of internal representations (how is it possible for internal states of the organism to sustain an intentional content consisting of objects outside the organism?), and their capacity to carry a content of experience. Moreover, in the case of a representation corresponding to the perception of a spatial position, each specific representation must be defined as one of a set of representations corresponding to the diversity of possible positions. It thus seems necessary to account also for the existence of an internal representation of the space of perception itself, a representation of space within which objects, and the point of view on these objects, can themselves be situated.

For externalism, it is necessary in principle to admit that the perception of different positions of the target can occur without being associated with internal differences in the strategies of the perceiving organism. The point is that otherwise, if one were to admit that such internal differences always exist, it becomes impossible to refute the internalist, representationalist position according to which these internal differences are sufficient to explain the perceptual experience (Block, 2005; Prinz, 2006). But if indeed there are no such internal differences corresponding to the external differences, how can one explain that external differences actually correspond to perceptions *for* the organism in question? Here again, it is not possible to understand the possibility of an externalized perception of an object without having defined the nature of the space in which this perception occurs. Now, what would happen if we envisage this space as being itself actively constituted, *before* going on to examine the externalist position?

3. Constitution of the space of perception

We will maintain here that there is only one single space for objects and their perception, for the body and its actions. A unique space that cannot simply be given in advance but that must be constituted. Without using the idea of an internal representation of actions, we wish to take up the idea of the constitution of space as a "group of transformations" that is practical, concretely realised by the activity of the subject. Our inspiration comes here from a problem originally faced by Poincaré (1905, 1907).

Poincaré proposed to define our space of perception as the most convenient way of organizing the relationship between our motor commands and the sensory returns that they produce. The space of perception (that Poincaré calls the "representative space") is thus constructed by the subject, based on a fundamental distinction between changes in sensory input that she can compensate for by her own actions, versus changes that cannot be so compensated. Only the first sort of changes will be understood as movements; the second sort will be understood as essentially temporal changes of state. It is thus the principle of *reversibility* – the possibility of coming back to the same position – which makes it possible to construct a *space* of perception. Space is thus neither more nor less than the group of transformations (in the mathematical sense) which, just like spatial displacements, can be added, subtracted and combined. More precisely, the group in question is a "Lie group", i.e. a group which is continuous and differentiable (Rao et al., 1999). On this view geometry, and the dimensions of space as they appear to us in lived experience, thus correspond simply to a certain organisation that we find in the regularities which relate actions and sensory returns[9].

Still, Poincaré thought that if one straight away defines these actions as movements, one is trapped in a vicious circle. If the action that is constitutive of space is a movement, then that action is already spatial and we have just given ourselves from the outset what was supposed to be constituted! In order to avoid this circularity, Poincaré considered that in the

[9] David Philopona and collaborators have taken up these ideas in order to propose operational algorithms which make it possible to extract the dimensions of the space of perception and action of virtual organisms (Philipona, O'Regan and Nadal, 2003).

first instance the subject only has access to internal proprioceptive data (Poincaré, 1907, p.82). It is indeed possible to define a proprioception of an action before that action is constituted as a spatial movement. The difference between a central approach (efferent copies) and a peripheral approach (proprioception) does not seem to be important here. For the purposes of our argument, we may suppose that proprioception consists simply of the existence of a specific sort of sensation, such that for each possible articulatory action there is a different proprioceptive sensation. In this case, almost by definition, proprioception alone cannot have an intrinsic spatial meaning. The reason is that in order to be able to speak of space, it is necessary that the *same* actions can give rise to *different* sensations as a function of what one can then call *positions* in space. In other words, input sensations depend on position to the extent that they can be different for the same actions. This is precisely *not* the case in proprioception as just defined.

If we follow Poincaré's perspective, it is only afterwards, by the combining of this proprioceptive information with exteroceptive information, that it is possible to construct a space in which the actions can be understood as transformations in a Lie group. In our case, the sequences of exteroceptive tactile sensation would be compared to proprioceptive sensations of the movements of the wrist and arm, in order to construct a space of internal representation in which pointing towards objects can occur. By analysing the relations between on one hand a list of proprioceptive sensations informing us about our actions, and on the other hand a list of exteroceptive sensory data, we would discover a Lie group of transformations; and we would then be able to calculate a spatial organisation of external objects and events, as well as our position with respect to these objects. The space of perception would be an internal construction, quite distinct in principle from the "real" external space. This is the classical internalist position.

Let us tackle the problem differently. From a phenomenological point of view, such a problem of potential circularity (if the action that is constitutive of space is a movement, then space is already constituted) does not exist. In our lived experience, the space of perception is identical to the space of our body, of our actions, and of the other agents we meet; moreover, it is this same space that is used in order to develop a science we suppose to be *objective*. It is therefore interesting to understand how a phenomenological (first-person based) approach might help us to account for the constitution of this unique space. Methodologically, the phenomenological approach consists precisely of limiting oneself to the sphere of the way things appear to the subject, in order to understand how experience (because of its intentional character) is always the experience of something *objective* and *meaningful*, going beyond what is purely given in an array of sensations[10]. We will then consider if and how such an account can be used in relation with a classical (third-person based) psychological explanation.

3.1 Phenomenological constitution of the perceptual space

It seems that the problem is well posed in our experimental study. As we have seen, there is not the slightest intrinsic spatiality in the sensory inputs, and no intermodal synchronisation from different exteroceptive sensory inputs. Still, in these very special conditions, we see the bare bones of the constitution of a three-dimensional space of perception in which the target will be situated. Let us thus see what a phenomenological reading of that experimental situation could provide.

[10] The constitution of space – and in particular the phenomenon of "depth" – has been described at length by Husserl (1907) and Merleau-Ponty (1945).

In the beginning, when I was equipped with the device, I did of course already have the notion of space, and of my bodily space. Now, however, visual space is absent (I am blindfolded) and the space of sound is very limited (it is quite silent in the room)…

The experiment proper now begins. I have a limited time of 3 minutes, and within that period I must locate a target (there will be ten successive sessions of 3 minutes with different target locations). I am acting in the dark in an unknown situation. I rock my body; I move my arm and my hand all over the place. Suddenly, I feel a tactile stimulation (there is an activation of the vibrator that I am holding in the other hand). However, I don't really know what I did to obtain the stimulation. I try to find the stimulation again, but it is quite difficult. As long as I do not master the situation, all I get is occasional stimulations that appear as a temporal sequence. However, after trying for some time, I finally manage to make the stimulation come and go at will, and I begin to perceive something. My movements become smaller and I control them better. Practically simultaneously, I notice several things:

(1) I perceive the target *out there* in front of me, and I no longer pay much attention to the tactile vibration (indeed, paying attention to the vibrator is a pretty good way of losing the target again);

(2) At the same time as I perceive the target, I am conscious of perceiving it from a *"viewpoint"* that is situated at the end of my index finger. This "point of view" would actually be better named a "point of perception", since what I experience using this device is only remotely related to visual experience. This viewpoint is situated in the same space as the object. The perception of the object is at the same time an *immersion* in the space that contains it;

(3) The target appears to me to be stable, but I have to *act continually* to maintain my perception of it. If sensory inputs cease to vary because I remain stationary, my perception

disappears. The viewpoint corresponds to my *"point of action"*, the point from which I change my alterations in position and direction;

(4) Progressively, as the experiment proceeds, I feel that I am increasingly capable of making the tactile stimulus appear or disappear at will. I can play at deliberately increasing the amplitude and speed of my movements. I recognize this mastery of my sensations as related to *a reversibility* of the movements of my viewpoint with respect to the target;

(5) If I examine, in this first-person perspective, the actions that I accomplish in order to perceive the target, I have to note an important change that occurred when I managed to locate the target. Retrospectively, I have to admit that during the initial phase, my actions were only risky, haphazard movements made of the off-chance of encountering a stimulation; and during this period, the meaning of these movements remained *essentially bodily:* I *stretch*ed my arm, *shook* my wrist, and so on. But at the very moment when I begin to perceive the position of the target, I also begin to understand my actions as movements, i.e. spatial translations and rotations of my viewpoint with respect to the target;

(6) If I now consider the way in which the very space in which I perceive the target appears to me, I notice that this space presents itself to me as the set of all *possible* locations of the target and of my viewpoint. It is in this field of co-present possibilities that I can ask the question "where?": "where is the target?", "where am I with respect to the target?";

(7) In this space, the target is in front of me, *"exterior"*. By contrast, everything which is behind my viewpoint, and in particular everything which makes it possible for me to move, is « inside ». In fact, my body which I use to perceive is not itself perceived as an object in this space. My own body appears to me as "transparent": it is both situated in this space relatively to the objects of perception, and yet at the same time it is invisible to me precisely because it is the central viewpoint of my perception.

To sum up, from that first-person phenomenological perspective: I understand that I can only perceive the distance of the target by means of my engagement in depth. If, by contrast, I restrict my movements to rotations of the straightened arm around the shoulder, I only have access to a two-dimensional space of rotation. In this case, my viewpoint is merely a direction in a space of possible directions for the target. I can no longer perceive a distance in depth in front of me. It is the same if I restrict my movements to rotations of my hand at the wrist, my arm remaining stationary. However, if I can both rotate my arm and rotate my hand about my wrist at the end of my arm, then I regain a perception of the depth of the target.

The condition for being able to perceive the distance of the target is that I can advance towards it or to the side so that I can point at it from different positions. My actions, considered as bringing forth the dimensions of the space of perception, are actions which are reversible from my viewpoint in those dimensions. "Depth" is only "enacted" by perceptual activity, if I engage myself as a point of view in the space where "depth" exists. There is thus co-constitution of the space of the perceived object and the space of my actions considered as displacements of a viewpoint with respect to this object. This co-constitution comes about when my actions turn out to be reversible in the course of a sequence of movements in translation or rotation. It is never a question of *representation*, of reproducing a space or the position of an object. On the contrary, there is *enaction* of the position of the object and the space of perception: a single, global space where I am situated as a viewpoint. This constitution is effected by means of my *"concrete actions"*, i.e., for me, my bodily engagement in the dimensions of the space that my actions have thus constituted. My body, considered as a "capacity to act", corresponds here to the size of my arm which allows me to advance my point of view in the depth of the distance of the target. We find here, in the special case of our experiment, the fundamental elements of the description of the constitution of space proposed by Merleau-Ponty.

Merleau-Ponty showed that it must be admitted that a condition for the constitution of space is the pre-existence of an ancient relation, hitherto anonymous, between my body and the things of the world:

« Far from by body being for me only a fragment of space, there would be any space at all for me if I did not have a body. » (Merleau-Ponty, 1945, p.119)

There is no regress here: as Merleau-Ponty underlines, the spatiality of one's own body is not a spatiality of *position*, but a spatiality of *situation* (1945, p.116). The originary spatiality of the lived body is not at all that of a geometrical volume of movements and objective positions; it is only a power of having purchase on a situation. One has to recognize that upstream of constituted space there is a more original spatiality, non-thematic but bodily, which is that of our capacity to act in the world. This spatiality is "originary" in the sense that it is not initially thought of as objective, but rather as that which serves for the constitution of that objectivity.

3.2 Objective constitution of the perceptual space

If we now turn to the perspective of psycho-physiological explanation, what is the value of the phenomenological description that we have just proposed? Should it be relegated to the status of a simple subjective testimony defining phenomena which must then be explained by underlying mechanisms quite different from what occurs at the level of consciousness? Rather than that, it seems to us that it is possible to find, in the field of objectivity, genuine equivalents for the different aspects of the subjective constitution of lived perceptual experience. In a way, the matter is quite simple. In order to find objective equivalents for the engagement of the subject, it is enough to take the concrete movements of his organism; and to find objective equivalents of the originary spatiality of the subject's lived body, to take the articulations and dimensions of the limbs of his organism.

This does not amount to giving oneself in advance what one is trying to constitute. What we are trying to do, is to account for the constitution of the space of perception *as it appears to the subject.* We can very well do this in the objective space which corresponds here to the space of perception of the observer. As we have seen above, the observer can record and measure the movements during the initial phase (groping, oscillations and haphazard waving of arm and hand), and then the more systematic movements that are established when, in the end, the target is located and perceived. The observer can thus explain, in the third-person perspective that is his, how the subject perceives the spatial target, by showing that the target only exists for the subject when the latter is cleverly able to come and go around the target, alternatively leaving the target and then finding it again. In the same way, in the initial phase of the experiment, it is not difficult to understand that the movements of the subject are not yet defined in the space of the target. Besides, if the subject is constrained and limited in his possible movements (the arm and hand kept in straight alignment), he will no longer be able to perceive the distance of a target placed in front of him. By these constraints on the coupling, the perceptual space of the subject will be limited to a bi-dimensional space of directions.

It is only by advancing that the subject is able to construct, for himself, the depth in which he advances and where he situates the target. The perceptual space is constructed in terms of the size and the concrete actions of the articulated subject, from the moment that these actions make it possible to discover domains of reversibility. The most important consequence of this explanation is that the space that the subject constitutes in this way is, for the observer, similar to the very space in which the observer situates both the target and the body of the subject. This is why “concrete action” means both, on the side of the subject, an engagement of his viewpoint (and not a representation of the action), and on the side of the

observer, an observable movement in space and time and not a representation of this movement[11].

The group of transformations, which according to Poincaré defines the "representative space", is best mobilized to describe the way this space is constructed, not in the brain on the basis of representations of the actions, but rather in the coupling on the basis of the concrete actions themselves. It is a "practical group" (Piaget, 1936). Starting from the composition of actions of reversible displacements, the group of transformations is deployed as an encompassing space which includes the point of action. Insofar as this space is constituted by the concrete movements of the prosthetically equipped body of the subject, we can understand how it is that it covers the same system of relations as the space of the observer. The space of perception of the subject and the common space of objectivity are co-extensive, even though the points of view are different.

The same approach sheds light on the question of the co-presence of multiple possibilities in the space of lived experience. From a phenomenological point of view, to succeed in constituting a space of perception amounts to succeed in defining a field of possibilities in which the subject's own actions can be known and understood as determinate movements; a field of possibilities which is, as we have just shown, co-extensive with the objective space of the observer. When we pass over to the objective perspective, in which it is possible to observe the behaviour of the subject, all one finds at any one point of time is a determinate state of the coupling, a state of affairs that is unique and particular. If one were to remain at the level of this singular fact of the moment, there would be on the objective side anything equivalent to the subjective presence of a set of possibilities. However, this problem

[11] « Concrete », here, is opposed to « abstract ». An action is "concrete" if it is question of a definite spatial movement in the space of the observer *at a particular time and place.* However, as soon as a particular concrete action can be defined as a movement in space, it already becomes more abstract. The action becomes detached from a particular place and time to become a displacement which can be defined in general, as reproducible in the space of relative positions of a viewpoint and an object. The constitution of space as a field of possibilities is also constitution of the general, of the geometrical idea.

is resolved immediately once one recognizes that each of these particular facts is defined as one amongst a coherent set of possible positions and movements in the space of the observer. It then suffices to admit that this space of possibilities can be the objective equivalent of the field of subjective possibilities that are co-present to consciousness of the experimental subject. This actually becomes obvious once it is recognized that this "objective" space is in fact nothing other than the *subjective* space of the observer, i.e. the space of the co-presence of all the possible positions of the objects *for the observer*.

As soon as one adopts the viewpoint of objectivity, one places oneself *after* the constitution of space. For the observer space is already given, with the respective positions of the perceiving subject and the object to be perceived. This does not prevent the observer from redefining, in this objective space, the construction of the space of perception of the subject that he is observing; in fact this is exactly what we ourselves have just done. Space is only the general form of the coupling between and organism and its environment when this coupling gives rise to reversible transformations. This is a space that we share according to our diverse bodily engagements, such as those made possible by the coupling devices that we are provided with.

In the space constituted in this way, the "inside" of the subject can be distinguished as everything that moves together with his viewpoint (his point of action); and the "outside" is defined as everything with respect to which he moves. This limit between "inside" and "outside" does not necessarily correspond to the skin which separates the organism from its environment; it is endlessly renegotiated during the course of activity, according to the articulations and the mediations of the action. The distinction between inside and outside is thus defined functionally in the course of the very same constitution of space where it comes to have a meaning; this being so, it is not difficult to understand that this distinction depends

on the capacities of the lived body to act and to feel, capacities which are modified according to the coupling device that the subject takes in hand.

3.3 An enactive externalism

With respect to the ontological question posed above, the conception of spatial perception that we defend here is neither externalist, nor internalist, since the space of perception and its contents are constituted by the coupling between the living organism and its environment. It is only on the basis of this "in-between" that there is a perceptual space, i.e. a lived world for the organism. Space is a form of this coupling, the structured domain of invariants that can be constituted[12]. The internal structure of the organism only provides a *part* of the processes that intervene in the realisation of the strategies which allow the subject to stabilize reversible operations which participate in the constitution of this space.

However, if one situates oneself in this space in order to distinguish the viewpoint and to locate it with respect to objects, our approach becomes clearly externalist in the sense that the perception of objects occurs *out there* in front of the subject, in the same space as the viewpoint itself moves in.

In this space constituted by the activity of the subject, the difficulty in the externalist position that we identified above, concerning the perception of the position of the target, can now be resolved. The position of the target, defined as the place that different positions and orientations of the viewpoint all point at, is concretely constituted by the activity of the organism. Besides, just as in the spectacle of a mime, an external observer can quite easily guess what the subject is perceiving simply on the basis of his behaviour. The set of possible positions, like the global space that encompasses them, are constructed by concrete

[12] Other forms of coupling can give rise to different form of space, which may have different dimensions. An example of this might be found in video games: if the actions made possible by the game are limited to translations and rotations in two dimensions, we would then be immerged in a bi-dimensional space.

movements. The space of perceptual consciousness is not restricted to the space of the brain, nor even to the space of the body, but also extends to include all the objects that are perceived. The subject, as an organism in movement, belongs to this space in which it is situated with respect to the target. Perception is an activity inscribed in a body which gives a purchase on the world. There is no need to situate the perception of depth in an abstract space of representation inside the subject; it can perfectly well be situated in the concrete dynamics of the coupling between the subject and the environment. This conception accounts satisfactorily for our phenomenological experience of the unity of space: I have no consciousness of a "perception of things" as separate from the things themselves. Thus lived experience is not a particular, localized component within objectivity; rather, lived experience *overlaps* the things in the space that is constituted. Saying that there is only one space, is therefore saying that every objective space is to be understood on the basis of the space of possibilities for a conscious being.

In our approach, we posit from the outset that the space of perception *is* the space of objectivity itself – recalling immediately that the latter must (also) always already have been constituted by an embodied agent. In our lived experience, it is clear that for us there is indeed only one space, that in which objects appear to us. On the basis of interactions with other subjects, on the basis of shared social institutions and technical systems (in particular writing), this space can be defined more and more precisely, to the point where it respects the rules of Euclidean (or non-Euclidean) geometries.

3.4 The knowledge of actions

In the approach to perception that we propose here, it is important to suppose that although the subject has a certain know-how, she is nevertheless unable to know *immediately* what are the actions she has performed. Indeed, if one were to suppose that knowledge of our

own actions (i.e. their identification among a determinate set of possible actions) always had to *precede* knowledge of the space within which they are defined as movements, we would immediately be thrown back on the construction of an internal space as distinct from that of the objects of perception and the body. However, knowing how to act in order to perceive and to obtain knowledge does *not* presuppose knowing what the actions themselves actually are. It is sufficient to suppose that there is *co-constitution* of the position of the perceived objects, and the actions as movements of the viewpoint relative to these objects (this is, incidentally, the expression of the relativity of positions, and movements, in space). The knowledge of the action identified and determined *as movement* is secondary. The ultimate consequence of an enactive conception is thus that the perception of our own actions is itself first of all external: it arises as the perception of movement in a space which is defined precisely as the set of all possible displacements. The spatial value of the proprioceptive sensations attached to these actions must itself be acquired, and continually recalibrated, on the basis of this exteroceptive perception of movements relative to perceived objects.

4. Questions and answers

4.1 Question 1:

The subjects know and understand the device with which they are equipped. If they succeed in the task of localisation, it is by way a set of deductions, eminently cognitive, such as a calculation the relation relating sensory returns to actions performed (cf Figure 2b).

It is true that in terms of my lived experience using the experimental device, I locate the object as being external, in space, *outside me.* But that is always compatible with the idea that, at a sub-personal level, this lived impression is actually the result of a cognitive

construction that is exclusively internal, achieved on the basis of elementary sensory inputs and, if necessary, motor inputs.

Indeed, for most critics of vehicle externalism, the latter commits a basic category mistake when it holds that perception is actually *constituted* by the sensori-motor activity of the subject in the environment. For the internalist, even if it is important to recognize that quite often perceptual experience arises in causal interaction with our motor activity (blinking the eyes, gestures, and movements can all influence perceptual experience), that does not mean that such activity is properly constitutive of the perception (Prinz, 2006; Block, 2005).

We wish to propose a careful and detailed reply to this objection, in the context of the experience of space. First of all, we have to stop and take a close look at the meaning of the term *constitution* as it classically presupposed in the debate between internalism and externalism.

Constitution, an asymmetrical and non-reflexive relation, is considered as an ontological relation: of localisation, of mereological composition, of (partial or total) supervenience, or indeed of identity. This sense of mereological constitution has also been understood in the sense of supervenience: if *A supervenes on B*, then *A* is *constituted* by *B* (Block, 2005). However, the constitution we are dealing with in this article is a *process of bringing forth*. It is to be understood in a sense akin to that in classical phenomenology. This level is upstream of the level where the brain and physical space are seen as objectively given, and where the question of whether it is possible or impossible to reduce one to the other can even be posed. In the phenomenological sense of the term as defined by Husserl (1913, § 55), "constitution" does not denote an operation of construction or interpretation of a worldly or ideal object by a consciousness closed on itself; neither is it the reception or representation by consciousness of an object which already exists because already ontologically constituted. It is the process whereby an entity that is the focus of intentional activity acquires the meaning

of being an *objective unity* (*noematic unity*), and which henceforward becomes an *object of experience* for an embodied consciousness.

The reduction of the experience of spatiality to a set of events in the brain then amounts to a *double* mistake: the reduction of the whole (the distributed perceptual experience) to just one of its parts (the brain); and the reduction of the process of the *constitution* of the meaning of spatiality to the activity of an entity, the brain, that is *already spatial.*

However, be that as it may, are these methodological and metaphysical remarks about the nature of constitution fully adequate to counter the internalist? It might be possible to reply in a different way, by coming back to the relation between the experience of spatiality and cerebral phenomena. The internalist critic holds that if a proponent of perceptual externalism accepts to follow his position through to the full extent of its logical implications, the externalist must maintain (and demonstrate) that it is possible for there to be at least some alterations in perception *without* any changes in brain states (Block 2005; Prinz 2006). According to the internalist critic, an alteration in behaviour (sensori-motor engagement) can only have a causal influence on perception *via* an internal trace, which encodes the result of the behaviour. This is why the internalist challenges the externalist to exhibit at least one case where the correlation between external parameters and parameters of experience is *not* mediated by internal parameters.

But does the externalist-enactive position adopted here really forbid a partial supervenience of the constitution of space on brain events and processes? This position can quite well admit that there are never any changes in experience without changes in the brain, if only by the effects of changes in motor activity. But what actually constitutes spatial experience – in the mereological sense of analytic philosophy – is a whole of which the brain is only a part; a necessary part, certainly, but in no way sufficient by itself. In the framework

of constitution in the global, phenomenological sense that we ourselves adopt, there is not merely a simple causal dependence between the body, the technical devices and spatial experience; there is also, and above all, a primary constitution of spatial experience that is distributed over the central nervous system, the body, the sensori-motor engagement and the technical devices. Limiting oneself to changes in the brain in order to understand and localize perceptual experience, amounts to arbitrarily *cutting up* a distributed dynamics, and to put the onus on oneself to explain how brain dynamics *could possibly* be sufficient in themselves to produce the experience of spatiality.

4.2 Question 2:

The constitution of space requires the capacity to enter into an engagement with it. Now this capacity seems to require that the organism has a spatial extension. But this means that one gives oneself in advance the space that one is claiming to constitute.

It is quite clear that it is necessary to presuppose a certain sort of spatiality of the lived body; as we have seen above, this is what Merleau-Ponty calls “originary spatiality”. But care is required here: as said at the end of section 3.1, from a phenomenological point of view, this “originary spatiality” is a capacity to act in the world, and not in the first instance a measurable size, because that would presuppose that space is already given. It is only after the constitution has been accomplished that capacity to engage with space can be thought of as a size. The distance to the target, once I perceive it, gives me as much an idea of the size of my arm as of the position of my viewpoint. The scope of my movements with respect to perceived objects measures the size of my arm. This circularity does not pose a problem. It corresponds simply to a relativistic conception of space: subjective distance is measured by

my capacity of action, a capacity which is itself measured by the distance that makes it possible to perceive.

Even more precisely, in the experiment that we have taken as a reference, we have seen that in order for perception of depth to be possible, it is necessary that the centre of rotation of the wrist can itself be moved with respect to the target. This in turn requires a concrete size of the arm which sweeps the space by rotating around the shoulder articulation. This is just what is expressed by the equation (1) and (2). It would not however be correct to conclude that the subject calculates the distance to the target on the basis of an explicit knowledge of the length of his arm. It rather seems that at each moment, the size of the arm is constituted in terms of the distance to the target, just as much as the reverse. Thus, one could perfectly well rewrite equation (1) to show that it is the size of the arm that is measured by the distance to the target:

(3) $$b = L /(\sin \alpha - \cos \alpha \tan(\alpha+\beta))$$

Overall, we can summarize this situation by saying that what counts is L/b (or b/L)[13].

5. Conclusion: moving around in space

Our enactive thesis has focussed on the constitution of the encompassing space within which I can perceive particular objects, but also at an even more elementary level where I can move and experience myself as an agent – all this without having to reconstruct this space internally. Our enactive approach to space can give rise to a new sort of perceptual externalism, for which the space of perception is the *same* as the space of concrete actions. Thus, the constitution of the experience of the space of perception is accomplished in the

[13] We may note here that in Figures 2b and 2c, what is relevant is precisely the parameter L/b, i.e. the distance of the target measured in units of arm-length.

course of a concrete dynamics, and not in an internal representation of this dynamics. By virtue of its concrete character, the objective equivalents of this constitution are indeed brought about *in* the space of the observer. There is no objective space which could be considered as independent and prior to the space of lived experience which is constituted. This constitution of the space of experience is not, in the last resort, a matter of an internal construction or reconstruction of a space; we are dealing here with a concrete constitution. Whatever it is that happens inside, in the head, it is not a *representation* of space.

While it is possible to describe our approach as "externalist", this thesis is nevertheless original and particular, compared to other "externalist" approaches, on at least five points[14] :

1) This externalism endeavours first and foremost to think about the genesis of the originary space, which *subsequently* makes it possible to talk about cognition in terms of "internal" and "external";

2) This genesis takes place in the coupling between the organism and the environment, a coupling which can be mediated technically;

3) In the context of this space, this externalism proposes an original characterisation of what is "internal" and "external" in the perception;

4) This externalism is non-representationalist. It may well be that it is only at the level of an enactive theory of perceptual space that the links between externalism and non-representationalism can appear in all clarity. Cognitive representationalism is based on a distinction, between an internal *representing* entity, and an external *represented* entity, that it holds to be theoretically fundamental and at the origin of cognition. This distinction may only be overcome (and invalidated) by going back to the origin of the active constitution of spatiality, there where the character of perception as distributed and situated in and with the environment imposes itself most clearly.

[14] These five points make it quite clear that the enactive theory of the space of perception that we present here must be carefully distinguished from the « enactive » theory of perception of an author such as A.Noë (2004).

5) By confronting the question of space head-on, this externalism undertakes to reply explicitly to the internalist criticisms which attempt to show that externalism continually confuses coupling or causal dependence with constitutive dependence. The question of spatiality, as we have seen, introduces a phenomenological meaning of the term constitution that is quite different from the constitution as a relation of supervenience or mereological realisation that is *already* spatial[15].

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[15] We sincerely wish to thank the three anonymous reviewers for having taken the time to read, to comment and to criticize an initial version of this text. In particular, we thank them for their many remarks, criticisms and suggestions. We also warmly thank John Stewart for the English translation of this text.

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