Bodily Spatial Content

Commentary on Acting on Bodily Experience by A.J.T. Smith

Abstract

The classic notion of an egocentric frame of reference cannot be easily applied to bodily space, given the difficulties in providing a center of such frame as well as axes on which one could compute distances and directions (Bermudez, 1998, 2005). Yet, Smith (this volume) tries to rehabilitate the egocentric account of bodily frame by switching from an anatomical definition of egocentricity (i.e. frame of reference that takes the body or part of the body as origin of its axes) to a more functional definition (i.e. the space of one’s own bodily actions). Here I will review some empirical evidence that shows that one cannot ground bodily experiences in action. There is more than one type of bodily spatial representations, and only one of them is linked to actions. How then to account for bodily spatial content? What is encoded in the spatial content and how? I will provide a tentative account based on two types of spatial content, namely, coordinate body space and categorical body space.

Frédérique de Vignemont

Institut Jean-Nicod

Merleau-Ponty (1945, p. 98) warned us that “ordinary spatial relations do not cross” the bodily space. It seems indeed that the way we experience the space of our body does not follow some basic spatial rules such as transitivity: The pain that I feel in my thumb is not felt in my mouth just because my thumb is in my mouth (Block, 1983). Nor can the classic notion of an egocentric frame of reference be easily applied to bodily space, as pointed out by Bermudez (1998, 2005). How can one even envisage accounting for the bodily space in terms of reference frame when one cannot provide a center of this frame, nor suggest axes on which one could compute distances and directions? It is indeed hard to make sense of the claim that the pain in my thumb is far from the pain in my foot.

Despite these peculiarities, there have been very few accounts of the specificity of what A.J.T. Smith calls the “intra-corporeal” space (hereafter called “bodily” space) and his paper Acting on (Bodily) Experience is more than welcome. Smith tries to rehabilitate the egocentric account of bodily frame by switching from an anatomical definition of egocentricity (i.e. frame of reference that takes the body or part of the body as origin of its axes) to a more functional definition based on Evans (1985) (i.e. space of one’s own bodily actions):

---

1 29 rue d’Ulm 75005 Paris France, Email : fvignemont@isc.cnrs.fr, Webpage : http://fvignemont.googlepages.com/home
at the sub-personal level sensory information has egocentric spatial content in virtue of directly priming detailed specifications for movement; whereas at the personal level sensory information has egocentric spatial content in virtue of priming the selection of particular types of action.” (Smith, p.93).

In his rich paper, Smith raises many interesting questions. Here I will focus only on two difficulties that he has to face. The first problem Smith encounters comes from the neuropsychological literature. It was shown that patients with ‘numbsense’ do not feel tactile sensations but are still able to point where they have been touched (Rossetti et al., 1995). In contrast, deafferented patients can identify their body part, but have difficulties in reaching it (Paillard, 1999). There seem to be more than one type of bodily spatial representations, and only one of them is linked to actions. A second problem comes from the fact that Smith eludes his own question. Instead of describing the spatial content of bodily experiences, he analyzes the origin of this content, namely, actions. The spatial content may be determined by action, but what does action determine? What is encoded in the spatial content and how? Here I will show that the notion of egocentric reference frame is just a mere camouflage of an entirely more complex reality.

1. Knowing where and knowing how to get there

The enactive approach of visual perception defends the view that the content of visual experiences is determined by actions and by the knowledge of sensorimotor contingencies (O’Regan & Noë, 2001; Noë, 2004). Similarly, Smith might be said to assume a kind of enactive view, but of bodily experiences. He is not the first to do so. Schilder (1935) repetitively emphasized in his book the intimacy between action and what he called ‘body image’. On the one hand, in order to act, one needs to single out the body parts relevant for the planned action. On the other hand, the body image is based on action and fed by kinesthetic inputs. Smith focuses on the spatial content that would be determined by actions. This would be true not only at the subpersonal level of the unconscious sensorimotor body representation (i.e. body schema), but also at the personal level of conscious experiences. Consequently, he postulates a single source of spatial bodily content, namely, action.

However, this goes in direct contradiction with several empirical results both from neuropsychology and psychology that show that (i) there are at least two kinds of bodily spatial contents, (ii) action determines only one of them, and (iii) the one determined by action is not the one used in conscious bodily experiences. In a way, Smith faces exactly the same type of problems that were raised against the enactive view of visual experiences (see Jacob, 2008).

Let me briefly recap these results. As said in the introduction, it all started with the neuropsychological double dissociation between numbsense and deafferentation: Some patients could reach where they were stimulated whereas they were not able to identify the stimulus locus, and vice-versa. However, for a long time, there was no evidence of such dissociation in healthy participants. It is only recently that the existence of multiple bodily spatial contents has been shown in non-pathological population with the help of the Rubber Hand Illusion (RHI). As already described by Smith, watching a rubber hand being stroked while one's own unseen hand is synchronously stroked, induces a relocation of the felt position of one’s own hand towards the rubber hand (Botvinick & Cohen, 1998). If indeed there were only a single type of spatial content and if it were tightly linked with actions, the spatial content of the conscious bodily experience (i.e. mislocation of one’s hand) should correspond to the spatial content of the body schema that guides actions, leading to
misreaching. However, it was shown that action is immune to the RHI (Kammers et al., 2009). Participants knew how to get to their stroked hand when asked to reach it and they knew where their stroked hand was when asked to move it. The conscious experience of mislocation did not find its origin in action, as action was accurate. In addition, despite having moved their stroked hand, updating thus the proprioceptive signals on the position of their hand, participants still reported experiencing the illusion and mislocalized their hand. This is strong evidence that the content of their conscious experiences was not determined by the movements that they performed.

These results teach us two lessons. First, there is more than one kind of bodily spatial content. Influenced by the Perception-Action model of vision, Paillard (1991) suggested distinguishing between ‘knowing where’ and ‘knowing how to get there’. These spatial processes are based on distinct neural bases (Dijkerman and de Haan, 2007). Second, there is a dissociation not only between knowing where and how to get there, but also between awareness and action (Rossetti et al., 1995). Patients with numbness have indeed no conscious experience of the touch, although the touch can “prime the selection of particular types of action” in Smith’s words. This was already known by Merleau-Ponty (1945) who described the patient Schneider who was unaware of mosquito bites, and yet, able to scratch his leg where he was bitten. Consequently, one cannot ground a theory of bodily conscious experiences on action.

At a more theoretical level, there are also deep puzzles. It is not clear how bodily experiences relate to actions. It is not even clear what one means by action: current actions, past actions or potential actions? In favor of the first interpretation, one could argue that proprioceptive signals become very weak if one does not move and that action only can update the sense of location and posture of one’s body parts. However, it does not make sense to imagine that one has a spatial bodily experience only if one moves. In addition, bodily conscious experiences refer not only to the sense of location and posture of body parts, but also to the sense of where I passively experience bodily properties like feeling cold, being in pain, or feeling an itch. I do not need to move to feel mosquito bites. Alternatively, one might argue that it is our past-executed actions that ground the spatial content of bodily experiences. I guess this is partly what Smith has in mind when he claims that structural affordances of the body provide ordering principles by constraining and enabling actions. By moving their limbs, infants would learn the spatial parameters of their body. This is most plausible; yet, that does not apply to other non-moving body parts; indeed not all body parts can afford actions. Fortunately, infants can also appeal to exploratory actions towards their own body to discover their whole bodily space. But then, this is a new type of relationship with action: The body is no longer conceived as a mean of the movement, but as its goal. Furthermore, this speculative developmental story cannot explain why we have multiple bodily spatial frames. Action cannot be the only source of bodily spatial content. One encounters the same difficulties (or even more) with future potential actions.

More fundamentally, one may notice that even if bodily spatial content were grounded in action, one still would not know what type of information it encodes, nor how it is encoded. It is one thing to describe the causal origin; it is another thing to describe the result. Here, Smith has privileged the former unto the latter. This is why we are left empty handed when we find that action cannot explain the spatial content of bodily experiences. What can we say then about it? In vision, one contrasts the egocentric frame with the allocentric frame (i.e. spatial encoding relative to other visual objects). What is the accurate contrast for bodily frames of reference? To say that bodily experiences are allocentric as defined above is
implausible.² To say that they are merely non-action related is to say nothing. One needs a positive detailed account of the spatial content of bodily experiences. This is why we need to step back from discussions about the possible link with actions, and analyze the content of our bodily experiences. Here I will focus on tactile experiences, leaving aside the experience of bodily posture.³

2. Detailing the spatial content of bodily experiences

Let us start with the most intuitive view of bodily spatial content. Dokic (2003) suggests the following basic specification of bodily experiences:

“Experience (a particular body part is F).”

This description assumes that the spatial content is merely the body part that instantiates the bodily property (e.g., I experience that my hand is touched). It requires mastering a kind of folk anatomy that segments the body into categorical parts such as hand, foot, leg, and so forth. There are of course many questions on the origin of folk anatomy (de Vignemont et al., 2005, 2008). How do we individuate body parts? Does folk anatomy come from the visual features of the body, such as shape, size, and spatial orientation, or “geons” delimited by visual discontinuities (Andersen, 1978; Biederman, 1987; Brown, 1976)? Or are body parts individuated by functional salience like joints (Morrison & Tversky, 2005)? These questions are especially puzzling, since recent cross-cultural studies have shown that linguistic categorization of body parts can vary substantially, although we all have relatively the same body (Majid et al., 2006). For instance, in some languages like the Papuan language of Rossel Island, there is just one term for hand and arm, referring to the whole upper limb (Levinson, 2006). If spatial bodily content were articulated in terms of categorical body parts that are part of the subject’s lexicon, then Papuan and French subjects would have two different bodily experiences.

Folk anatomy, however, is neither necessary nor sufficient for bodily spatial content. It is not necessary because one can envisage that young infants who have no anatomical knowledge are yet able to spatially experience their bodily sensations. It is not sufficient because the felt localization of bodily sensations is finer-grained that the categorization of body parts. This is true, for example, of internal organs. You may precisely know that you feel a pain ‘here’ although you do not know if you have a stomach pain or an inflamedappendicitis. More generally, when you feel a touch on a body part, your experience is not merely that this body part is touched. It is that you are touched somewhere specific within that body part. If you are touched a second time on the same body part, you can also feel the touch close or far from the first. Consequently, one needs not only a categorical representation, but also a more metric representation of the location of bodily sensations.

² The strict equivalent of allocentric frame for the body is called “extrinsic” (Schwoebel et al., 2001). For instance, a patient with autotopagnosia was unable to locate her body parts, except when she was in a small familiar room where she could use the external objects to locate her body parts.
³ I leave open here the question about the similarities and dissimilarities between the two types of bodily experiences.
⁴ Action cannot explain the segmentation of the body into parts, as it was shown that it tends to bring together body parts into functional units (de Vignemont et al., 2008).
Kosslyn and colleagues (1989) made a distinction in visual perception and imagery, which is of particular interest here. They distinguished between “coordinate” spatial representations, based on metric location information, and “categorical” spatial representations, based on more abstract spatial relations between objects or parts of objects that are supposedly non-metric, propositional, and that organize our environment in subjective groupings. Similarly, we can suggest that we have the two kinds of spatial representation for the body. The categorical representation of body space is based on abstract relationships like left, right, and subjective groupings like hand, leg. The coordinate representation of bodily space uses reference points, displays metric properties, and allows fine-grained localization of sensations. This latter type of spatial reference frame fits with Peacocke’s view:

> In giving the content of tactile experience, we would sometimes have to use as origin something labeled with the property of being the center of the palm of the human hand, with axes defined by relation to parts of the hand. (Peacocke, 1992, p. 106)

Empirical data indeed confirm that tactile localization is improved close to reference points, although not necessarily the center of the palm (Weber, 1826). For example, Cholewiak and Collins (2003) found improved tactile localization close to joints, but also close to arbitrary anchor points artificially induced by presenting stimuli of frequency different from those used for tactile loci. Bodily experiences can then be articulated as follows:

> “Experience (x is F),” where x is a specific location within the coordinate frame.

There are still many open questions, especially about the specific details of the coordinate frame: What is the center? What are the axes? And so forth. Those are empirical questions. Other questions concern the nature of the coordinate frame. First, how is the location x encoded? I do not have time here to fully address this issue. Let me just mention that one can refer to x either non-conceptually or by using spatial indexicals like here and there. Second, what is the scale of the coordinate frame? Is it local, restricted to the body part and its surrounding like on Peacocke’s view, or more global extending to the whole body? One way to answer is to analyze the notion of distance, which makes sense only in a coordinate system. If you apply a double tactile stimulation on your palm, you can feel the two touches close or far. If, however, the touches are on two non-contiguous body parts (e.g., leg and hand), there seems to be no corresponding experience of the distance between the two tactile sensations. Consequently, the coordinate system of bodily experiences is most probably merely local based on spatial contiguity along a single axis.\(^5\)

A third question, which Smith may raise, is whether the coordinate spatial content is properly bodily, instead of visuo-centric. In Smith’s words, could Touchy who was born only with proprioception and touch feel tactile distances? I do not want to claim here that visual information, when available, has no influence on the spatial content of bodily experiences (see for instance Taylor-Clarke et al., 2004). Nonetheless, there are several lines of evidence that show that tactile judgments of distance cannot be reduced to judgments of distances in the visual space. For instance, they are not sensitive to the same biases (de Vignemont et al., 2008). In addition, congenitally blind individuals can feel distances between tactile points as shown by their use of tactile vision-substitution systems (Bach-y-Rita et al., 1969). Most probably, Touchy would have a coordinate bodily system.

---

5 It is indeed interesting to note that one feels the distance between two tactile sensations on the hand and the shoulder if the arm is stretched, but not if the arm is bent. I suggest that this is due to a conflict between the external visual space and the bodily space.
So far, I have suggested that the content of bodily experiences can be specified either in a categorical space or in a coordinate space. However, I have not specified the relationship between the two types of bodily content. One possibility is that they are embedded in each other:

“Experience (x in a particular body part is F).”

This would assume that the spatial content of bodily experience is at least partially conceptual, as it would involve the use of body part concepts. However, if one wants to keep a non-conceptual account of conscious experiences (Dretske, 1995; Tye, 1995), one may argue that we have proto-concepts of body parts, whatever that might be. Alternatively, one may draw a strict boundary between the two kinds of spatial content. Bodily experiences would be localized only in a coordinate system, whereas bodily beliefs would be in a categorical system. I do not have time here to discuss these various alternatives, but it gives us a foretaste of the work that remains to be done if one wants to provide a full-fleshed account of bodily spatial content.

**Conclusion**

“We do not know much about the body unless we move it.” (Schilder, 1935, p. 112).

Nobody would deny that. Action plays a role in the developmental acquisition of body representations. Action also plays a role in updating postural information, although this does not always reach consciousness as shown in the RHI (Kammers et al., 2009). Nevertheless, this does not suffice to ground bodily experiences on action. An enactive theory of bodily experiences cannot predict that bodily experiences can be dissociated from action, nor explain it. It cannot provide a detailed account of the information encoded in the spatial content, nor of the way that information is encoded. It cannot reply to the series of questions I have raised about categorical and coordinate bodily space. There is, however, another way to understand the relationship between body representation and action:

“The beginning of every movement is dependent on the model of the body” (Schilder, 1935, p. 53).

Action is no longer conceived as the origin of bodily spatial content, but as its functional role. To act, one needs to know various types of information about the body, including spatial information. Once we have a good conceptual framework that allows understanding how the spatial content can be articulated, we will be able to determine what kind of spatial content is required for action. We can make some preliminary suggestions following the lines that I have briefly sketched here. We already know that the spatial content for action can differ from the spatial content of bodily experiences. Most probably, to act one needs to represent bodily properties within a coordinate system. This is because actions are encoded in precise metric parameters and cannot be satisfied with a rough-grained categorical system. Furthermore, to act one needs to represent bodily properties at a global scale. Although, as we said, it is hard to make sense of experiencing the pain in my thumb far from the pain in my foot, it makes sense to compute the distance between my thumb and my foot if I want to grab my foot with my hand. Consequently, action requires a global coordinate system, whereas the spatial content of conscious experiences is most probably more local and both coordinate and categorical.
References


