A MOSQUITO BITE AGAINST THE ENACTIVE APPROACH TO BODILY EXPERIENCES*

The enactive approach to bodily experiences rejects the classical computational dichotomy between perception and action.[1] Perception is not merely a means to action and action a means to perception. Instead, proponents of the enactive approach argue for a stronger relation of constitutive interdependence. On this view, perceptual content constitutively depends on law-like relationships that hold between sensory input and motor output. Hence, perceptual experiences are said to be inseparable from the perceiver's bodily activities.

Enactivists take touch as paradigmatic of perception, because the act of exploring the shape of an object with one's fingers is said to constitutively determine the content of one's tactile perception.

> All perception is touch-like in this way: perceptual experience acquires content thanks to our possession of bodily skills. What we perceive is determined by what we do (or what we know how to do).[2]

> Touch acquires spatial content—comes to represent spatial qualities—thanks to the ways touch is linked to movement and to our implicit understanding of the relevant tactile-motor dependencies governing our interaction with objects.[3]

Although vision has received the most attention, it seems that the enactive approach is more likely to be true of tactile experiences than those of any other sense (such as gustatory experiences). For instance, in haptic touch, the tactile system does not passively receive bodily information, but consists in exploratory activities. However, what may be true for haptic touch, which is intrinsically active, may be more controversial for passive touch (for example, the sensation of a mosquito on your skin). If touch is to be the model for all perception, or

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[1] This view has been defended by, among others, Susan Hurley in *Consciousness in Action* (Cambridge: Harvard, 1998); Kevin O'Regan and Alva Noë, "A Sensorimotor Account of Vision and Visual Consciousness," *Behavioral and Brain Sciences*, XXIV, 5 (October 2001): 939–1031; Noë, *Action in Perception* (Cambridge: MIT, 2004); Evan Thompson, "Sensorimotor Subjectivity and the Enactive Approach to Experience," *Phenomenology and the Cognitive Sciences*, IV, 4 (2005): 407–27.

[2] Noë, *Action in Perception*, p. 1.

[3] *Ibid.*, p. 205.

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at least the less controversial application of the enactive approach, then it calls for a more thorough examination.

After drawing the agenda for an enactive view of tactile experiences, I shall highlight the difficulties it has to face, both conceptual and empirical. I shall conclude that what we do does not determine what we feel.

I. THE AGENDA FOR AN ENACTIVE APPROACH TO TACTILE EXPERIENCES

At the core of the enactive approach is the dynamic, constitutive relationship between sensory input and motor output. On this view, we are able to track their interdependence. This ability is grounded in the procedural knowledge of how the way we move affects the sensory signals we receive (or how the movement of objects will affect those signals). In this sense, Hurley talks of "active perception," and Noë describes perception as an "embodied activity."

One should, however, acknowledge the diversity of views that enactivism includes. Indeed, there is little agreement among the proponents of the enactive approach beyond the claim that perception and action are interdependent. One noteworthy difference is the variety of *explananda* among the enactive views. There are at least three phenomena that are thought to require an account in enactive terms: (i) the individuation of perceptual modalities (for example, sight versus audition); (ii) perceptual phenomenology (that is, what it is like to perceive); and (iii) perceptual content (that is, representational content). First, it has been argued that each sensory modality depends on its own, specific patterns of dynamic interdependence between sensory stimulation and movements. The set of patterns differs depending on whether one is seeing or touching an object, for instance, and as such would individuate the various sensory modalities, here, distinguishing sight from audition. Second, some versions of the enactive approach claim to account for consciousness, and more precisely for the qualitative phenomenology of perceptual experiences. For instance, what it is like to see a red tomato would consist in the procedural knowledge of the sensory effects of one's movements relative to the light. Finally, most enactive theories aim to explain the intentional content of perceptual experiences, and particularly how perceptual experiences represent spatial properties. Seeing that the table is round is to know that it looks more or less elliptical depending on where one is in relation to it.

Here I am not interested in the idiosyncrasies of the various enactive approaches.[4] Rather, I shall propose different ways to spell out

[4] For a review of the differences between versions of the enactive theory of vision, see Nivedita Gangopadhyay and Julian Kiverstein, "Enactivism and the Unity of Perception and Action," *Topoi*, XXVIII, 1 (2009): 63–73.

the enactive view of tactile experiences and focus on the most plausible ones. Following the distinctions above, an enactivist for tactile experiences can pursue three aims: (i) to individuate the tactile modality (for example, in contrast to a visual one); (ii) to explain the phenomenology of tactile sensations (for example, the conscious sensation of pressure on my skin); (iii) to explain the spatial content of tactile experiences (for example, the sensation that there is a round object touching my palm). In the last case, the enactivist will have to take into account the duality of the content of tactile experiences. In contrast to other sensory modalities, touch is both about the external world with which one is in contact and about one's body in contact with the external world. Hence, an enactive account of tactile experiences must accommodate both exteroceptive content and interoceptive content.

To add to the complexity, touch is a very comprehensive term, so much so that one may even deny that it refers to a unique sensory modality. On the one hand, there is active touch. It primarily is defined by movements of the body part that is in contact with an object. The movements can be of three types. Some are passive movements (for example, your hand is moved by another individual). Some are exploratory movements, voluntarily initiated by the perceiver (for example, you follow the contours of an object). Some are effortful movements (for example, you lift and manipulate an object with muscular effort). On the other hand, there is passive touch, which is merely cutaneous. Here again, one can distinguish between static passive touch (for example, the pressure of the cat on your knees) and kinematic passive touch (for example, the motion of the mosquito on your skin).

In virtue of their interoceptive content, tactile experiences are partly bodily experiences, or in more enactive terms, *embodied*. However, what matters for the enactive approach is not so much the embodiment of perception as its intrinsic relation to action. It is controversial whether tactile experiences consist in an embodied *activity*. True, in haptic touch, I move my body to retrieve information about an object when needed, and the movements of my hand over a surface induce shifting sensations. But can one generalize the enactive account of haptic experiences to any kind of tactile experiences, and even more generally, to bodily experiences? How can so-called passive touch be *active*?

Here I shall attempt to apply the enactive approach to instantaneous passive touch, which seems to be the most challenging case. Let us imagine that I consciously feel a short, nonpainful tap on my knee. The content of my experience is not very rich. I may not even

be able to know what touched me. Yet, I feel that I was touched briefly *on my knee*, and not anywhere else. What grounds my phenomenology and the spatial content of my tactile experience? If one succeeds in offering an enactive account of such an impoverished tactile experience, then there is a good chance that one can offer a more general enactive account of bodily experiences. Let us now see how this might work. We shall see that the task is not easy.

II. TACTILE-MOTOR EXPECTATIONS

Visual experiences are said to depend on eye movements, and haptic touch on exploratory hand movements. But I do not need to move to have a tactile experience, as in the case in passive touch. Yet, a proponent of the enactive approach may claim that even in passive touch, I master the procedural knowledge of the tactile consequences of potential movements (that is, sensorimotor contingencies). What matters is not the bodily exercise of procedural knowledge, but its mere possession. For instance, itching sensations would consist in the knowledge that if one scratches where one has been bitten by a mosquito, the stimulation will decrease. One does not need to scratch one's leg; it suffices that one knows the consequences of doing so. The same could be said for tactile experiences. What would constitute tactile experiences is not what you do, but what you expect to feel if you do it. But what kind of procedural knowledge is constitutive of passive touch?

Let me start with two possible tactile-motor expectations.[5]

(1) If I remove my knee from the object with which it is in contact, I shall stop receiving tactile signals.
(2) If I remove the object with my hand, I shall stop receiving tactile signals.

As basic and uncontroversial as these tactile-motor expectations are, they raise several worries. The closest equivalent in vision would be the expectation that if I close my eyes, I will no longer receive visual signals. Nobody in the computational community would deny this simple relation of causal dependence between vision and eye opening/closing, or between touch and bodily contact. However, not all causal relations between touch and action are of interest for the enactive view. According to Hurley, the interdependence of perception and action can be of two kinds. It is instrumental when action is just a means to perception, and it is noninstrumental when perception wholly or partly consists in action. Only the latter kind is relevant

[5] Many questions have been raised about the specific nature of sensorimotor knowledge. Here I shall not insist on these general difficulties about the enactive account, but focus on specific problems raised by tactile-motor knowledge. For a full review in the case of visual experiences, see the commentaries in O'Regan and Noë, *op. cit.*

for the enactive approach. The question, then, is which kind of sensorimotor expectations (1) and (2) are: instrumental or noninstrumental? In vision, the movement of eye opening/closing makes the visual experience possible or impossible, but this is a feature of any kind of visual experience. I could see a red tomato or a yellow lemon for all it matters. As such, this sensorimotor expectation cannot determine the specific phenomenology or the specific content of the visual experience that results from opening my eyes. Similarly, in touch, the movement of separating the body part from the object stops the tactile experience, but it would stop any kind of tactile experience, whether I feel a rough texture or a smooth one. Hence, it cannot be an individuative condition of the phenomenology of my tactile experience, nor of its descriptive content. At most, this type of sensorimotor contingency may individuate the sensory modality: vision would constitutively require stopping the flow of information by closing the eyes, and touch would constitutively require stopping the flow of information by withdrawing the body part in contact with the object. Yet, it seems that most enactive proponents want more.

They may argue, for instance, that the tactile-motor contingency (1) can individuate at least the bodily spatial content, which is at the core of our interests. Indeed, it is only if I remove my knee from the object with which it is in contact that I can expect the tactile signal to stop, and not any other body part. The tactile-motor contingency is body-part specific, and as such might provide the bodily spatial content. But how do I know that it is my knee I need to move? There is a threat of circularity similar to the one Jacob highlighted in the case of vision.[6] The enactive account claims that visuo-motor knowledge consists in the knowledge of how one's movements toward a visually seen object affect the way one perceives the object. But Jacob notices that in order to act upon an object, one first needs to be able to single it out, to pick it out from other objects. Hence, visuo-motor knowledge cannot allow one to individuate the relevant object. There must be another part to the story, which cannot be told in enactivist terms. Similarly, in the tactile case, it is not clear how one can individuate the body part on the basis of tactile-motor contingencies without falling into circularity. Tactile-motor knowledge requires a prior and independent way of singling out the body part that is in contact with the object, if one wants to avoid a circular account of bodily spatial content.

Tactile-motor expectations (1) and (2) do not work if they are supposed to constitute the phenomenology or the content of tactile

[6] Pierre Jacob, "The Scope and Limits of the Enactive Approaches to Visual Experiences," *Perception*, XXXVII, 3 (February 2008): 446–61.

experiences. But the problem is more fundamental, and not limited to these two examples. To give an enactive account of the content of tactile experiences, especially the interoceptive content, is indeed difficult. On some enactive views, what constitutes the content of perceptual experience is the procedural knowledge that gives access to objective properties based on the relation between the experience of perspectival properties and bodily activities. For instance, the table is round (objective property of the stimulus independent of the perceiver), but it appears elliptical to you (perspectival property, the way the stimulus appears to the perceiver). According to this enactive theory, your visual experience represents the table as round because you know how its perspectival property will change depending on how you move relative to the object (for example, you get closer to the table). However, on this account it is hard to see how there could be any kind of dependency between touch and action, as far as the interoceptive content of touch is concerned. When I feel the tap on my knee, it does not seem to make sense to distinguish between a perspectival bodily property and an objective bodily property, if perspectival properties depend on the spatial relation between the perceiver and the object. If the object is one's own body, then it cannot be blocked from tactile perception; nor can one change one's spatial relation to it. In other words, one cannot change the spatial conditions under which one's own body is felt. And if one cannot change the spatial conditions, then there is no corresponding tactile-motor knowledge of the way the perspectival properties will change depending on the way one moves relative to one's body. Faced with this difficulty, proponents of the enactive view have two choices: either restrict their account to the exteroceptive content of tactile experiences or offer an alternative enactive account of the interoceptive content that differs from the one provided for the exteroceptive content.

Finally, even if the tactile-motor contingencies outlined above were satisfactory, they could not work for every kind of touch, and so they fail to satisfy the enactive agenda. For example, they do not apply easily to *instantaneous* touch. When I receive a brief tap on my knee, I cannot remove my knee from the object (or remove the object from my knee) because the object is already gone. And if I try to do so, there will be no difference in tactile stimulation because the tactile signal has already stopped. More generally, it is difficult to imagine the interdependence of perception and action when perception is so temporary that it does not afford time to act. Most sensorimotor expectations require enduring perceptual experiences to make sense. If the object is no longer present, there can be no sensory consequences. Hence, there can be no sensorimotor contingencies. If

this is true, then there is no possible enactive account of instantaneous tactile experiences (or of any other kind of instantaneous perceptual experience).

The only way out is to include not only sensorimotor knowledge, but also mere motor knowledge in the enactive account. One could argue that it does not matter that I am too late in removing my knee from the object that briefly touched me. The action does not even need to be performed; it merely needs to be triggered by the tactile signal. The urge to move would constitute the perceptual experience independently of its bodily execution, its sensory feedback, and the remaining presence of the sensory input that elicited it. Procedural knowledge does not require that the object to which it applies still exists. Let us imagine that you tell me about a restaurant that you liked, which closed recently. If I ask you where the restaurant *was*, you may still know how to get there (although the restaurant is no longer there). Similarly, I can still act toward the location of the tactile stimulus, although the stimulus is no longer available. Feeling that I was briefly touched *on the knee* is to know how to get to where I was touched.[7] On this view, the spatial content of the tactile experience is determined by the procedural knowledge of how to get to the bodily location of the tactile stimulation. Hereafter, I shall refer to this type of procedural knowledge as "spatial know-how."[8] An account in terms of spatial know-how sounds plausible as a working hypothesis for the enactive approach for two reasons.[9] On the one hand, this kind of procedural knowledge seems to be consistent with the enactive view.[10]

[7] If I reach the body location that was touched and put my finger on it, then I shall receive tactile signals from the same place. In this latter case, there are tactile consequences.

[8] For a detailed account of the notion of bodily know-how, see Charles Siewert, "Attention and Sensorimotor Intentionality," in David Woodruff Smith and Amie L. Thomasson, eds., *Phenomenology and Philosophy of Mind* (New York: Oxford, 2005), pp. 270–94.

[9] However, one may argue that the spatial content of bodily experiences must be determined by the movements performed by the specific body part that is experienced. For instance, the tactile experience of my knee being touched should be determined by the movements of my knee only. On the contrary, pointing and reaching movements are performed with a body part that is not represented in the tactile content, namely, the hand. Should this type of movement be discounted for this reason? This would be too restrictive. Most of the actions that one can perform towards one's body are hand movements, and if one discounts them as irrelevant, then there are not many movements left over. Furthermore, there are some body parts that are not movable, and yet we can experience them being touched. Therefore, one might suggest that the spatial content of the tactile experience depends on the procedural knowledge of the body part that is touched with respect to the rest of the body.

[10] "What we perceive is determined by...what we know how to do." Noë, *Action in Perception*, p. 1.

On the other hand, I do not see any alternative type of procedural knowledge that could constitute instantaneous passive touch.

To sum up, the link between touch and bodily activity is supposed to be so obvious that it does not need a proper investigation; indeed, it is supposed to help us better understand the (less obvious) enactive view of vision. However, this might be true only for haptic touch, and only for its exteroceptive content. Enactivists still need to give a specific account of the relationship between tactile experiences and action in the case of instantaneous passive touch, and this is not an easy task. They may argue that it is precisely because the relation with action is so weak that the content of such tactile experiences is so poor. That might be true. Nonetheless, for the enactive account to be true, there needs to be at least one type of law-like relation with action if there is to be tactile experience at all. I suggest that the most plausible way to spell out an enactive account of tactile content is in terms of reaching movements made toward the bodily location that was touched. However, we shall see now that this view faces severe difficulties when confronted with the empirical literature on bodily experiences. I shall show that action and tactile experiences are independent, rather than interdependent, and that they can be dissociated in both pathological and normal cases.

III. DISSOCIATING BODILY EXPERIENCES AND SPATIAL KNOW-HOW

One of the most powerful empirical arguments made against the enactive approach to vision comes from the neuropsychological dissociation between optic ataxia and visual agnosia.[11] For example, the visual agnostic patient DF was presented with a set of various squares and rectangles. She was at chance when required to match the width of such simple geometrical forms by scaling the distance between her thumb and index finger (that is, by manual, nonverbal report).[12] By contrast, she was able to grasp the blocks accurately. The reverse pattern of performance was found in optic ataxic patients.

[11] For a comprehensive review of the empirical literature that supports the so-called Perception-Action model of vision, see David Milner and Mel Goodale, *The Visual Brain in Action* (New York: Oxford, 1995); and Jacob and Marc Jeannerod, *Ways of Seeing: The Scope and Limits of Visual Cognition* (New York: Oxford, 2003). For an extensive discussion of the relevance of this type of empirical evidence for the enactive approach, see Jacob, *op. cit.*; Ned Block, "Review of Alva Noë, *Action in Perception*," this JOURNAL, CII, 5 (May 2005): 259–72; Andy Clark, *Supersizing the Mind* (New York: Oxford, 2008).

[12] Some hand movements can count as perceptual reports. For instance, it was shown that the underlying processes of scaling the distance between thumb and index finger are very different, depending on whether it is for reporting a perceptual judgment or for the visuomotor task of grasping. Jeannerod, *The Cognitive Neuroscience of Action* (Cambridge: Blackwell, 1997).

These cases show that one can have visual experiences of an object without being able to act towards it, and vice versa. That is, visual awareness can operate independently of visually guided action.

A similar line of evidence against the enactive approach to vision comes from healthy individuals. It has been found that action can be immune to visual illusions such as the Müller-Lyer, Ponzo, Titchener, and Hollow Face illusions. For example, in the Hollow Face Illusion, a concave (or hollow) mask of a face is perceived as a normal, convex (protruding) face. It was found that if asked to quickly flick a magnet off the nose (as if it were a small insect), participants did not direct their finger movements to where the nose appeared to them (that is, to the protruding nose). Instead, they directed their movements to the actual location of the target in the hollow face, which was eight inches away from the apparent location. In other words, the content of the visual experience of the face did not correspond to the visually guided movements directed toward the face. This was taken as evidence that the content of visual experiences (for example, the convex face) is at variance with the content of action-oriented vision (for example, the hollow face). What we see is not determined by what we do, nor what we know how to do.

Is there equivalent empirical evidence against the enactive view of *bodily experiences*? The answer is yes.[13] On the basis of dissociations between tactile and proprioceptive experiences on the one hand and spatial know-how on the other, both in patients and in healthy individuals, I shall argue against the enactive view of (i) the phenomenology of bodily experiences and (ii) the spatial content of bodily experiences.

III.1. Action without Sensation. "But, I don't understand that. You put something there; I do not feel anything and yet I got there with my finger. How does that happen?"[14]

The patient, who was blindfolded, is amazed at her ability to point to where she was touched on her hand, although she felt absolutely no sensation of having been touched. She suffers from what is called "numbsense" in the neuropsychological literature (also "blind touch"). Following cortical or subcortical lesions, patients with numbsense

[13] For numbsense patients, see Jacques Paillard, Francois Michel, and George Stelmach, "Localization without Content: A Tactile Analogue of 'Blind Sight'," *Archives of Neurology*, XL, 9 (1983): 548–51; as well as Yves Rossetti, Gilles Rode, and Dominique Boisson, "Implicit Processing of Somaesthetic Information: A Dissociation between Where and How?" *Neuroreport*, VI, 3 (February 1995): 506–10. For a description of KE and JO, see Helen A. Anema et al., "A Double Dissociation between Somatosensory Processing for Perception and Action," *Neuropsychologia*, XLVII, 6 (May 2009): 1615–20.

[14] Report of a patient suffering from numbsense in Paillard, Michel, and Stelmach, *op. cit.*, p. 550.

become completely anaesthetized on their right side. They completely lack tactile experience. They are not able to detect, localize, or describe tactile stimuli on their right arm; nor are they able to indicate on a picture of an arm where the stimulus was applied, even in a verbal forced-choice condition. What is interesting is that despite their apparent numbness, they are able to accurately guide their opposite hand to the specific site where they were touched when so instructed, and to their own surprise. Their bodily movements do not improve their performance in verbal localization. When patients are asked to simultaneously verbally localize and point to where they have been touched, both responses become incorrect. In addition, they may be unaware of their arm's position and yet be able to reach it accurately. Interestingly, this type of dissociation was known to Merleau-Ponty. He described the case of the patient Schneider, who was unable to localize where a mosquito was stinging him and yet was able to scratch his leg where he was stung.[15]

When numbsense patients scratch their leg where they were stung, they must have mastered sensorimotor information about reaching their leg, scratching it, and the effects of these actions. Yet, despite this sensorimotor knowledge, they feel nothing. Here we have a clear case of a complete deficit of tactile and proprioceptive phenomenology with preserved spatial know-how. The case of numbsense therefore shows that spatial know-how (and its exercise) *per se* is not a sufficient condition of tactile and proprioceptive phenomenology.

III.2. Action without Perception, Perception without Action. As said earlier, some versions of enactivism aim to explain how perceptual experiences come to represent spatial properties, rather than how they come to have a conscious phenomenology. Hence, one might argue that the evidence provided by the numbsense case is irrelevant for these versions of the enactive view. More challenging for them is the case of the patients KE and JO, who have tactile experiences, but whose tactile experiences are dissociated from spatial know-how in the same way that visual experiences are dissociated in optic ataxia and visual agnosia.

Both KE and JO can consciously feel a touch. In addition, they can accurately report and point to the location of a visual target. Yet, when asked to point to where they were touched, they display a surprising double dissociation. They were asked either to point to where they were touched on the hand (tactile-motor task) or to point to the location of the tactile stimulus on a pictorial map of their hand (abstract

[15] Maurice Merleau-Ponty, *Phénoménologie de la perception* (Paris: Gallimard, 1945).

and detached perceptual report). It was found that JO failed to point accurately to the hand map, whereas she did point accurately to her own hand. Conversely, KE failed to point accurately to his own hand, but he did point accurately to the hand map.

In neither case does the spatial content of the tactile experiences match the possession (or deficit) of spatial know-how. JO experiences that she is touched, but she cannot report where. She merely experiences the touch "somewhere," with no determinate spatial content. Yet, like numbsense patients, she accurately gets to the location of the touch on her own body. Hence, her spatial know-how does not suffice for providing her tactile experience with spatial content. By contrast, KE experiences and reports that he is touched on the hand at a specific location, but he is unable to get to the location of the touch on his own hand. Hence, there is no spatial know-how that could provide the spatial content of his tactile experience, and the tactile spatial content must have a different ground.[16] The case of JO shows that spatial know-how *per se* is not a sufficient condition of tactile spatial content, whereas the case of KE shows that it is not a necessary condition.

To conclude, these dissociations show that the spatial information in the sensorimotor system can differ from the spatial information in the perceptual system. This leads us to infer that the sensorimotor system and the perceptual system cannot be reduced to one another. They are two distinct systems, one involved in action and the other involved in perceptual experiences. The dissociation between the two types of spatial information specific to each system can be made even more salient in the context of bodily illusions in healthy individuals.

III.3. Illusory Spatial Content. If spatial know-how provides the spatial content of perceptual experiences, then it should explain why this content can become illusory in healthy subjects. However, as said before, it was found that action can be immune to visual illusions. We shall see now that bodily illusions also cannot be explained by

[16] An enactivist may reply that there is no evidence of a deficit in spatial know-how in KE. There is only evidence of a deficit in spatial motor *performance*, and this does not systematically reveal a deficit in *competence*. If so, tactile spatial content could be accounted for in terms of the supposedly preserved spatial know-how. However, this explanation does not sound plausible. The patient KE has no motor deficit, as shown by his preserved ability to point to a hand map or to neutral visual targets. His results can neither be explained by a proprioceptive nor a memory deficit. In the study, the patients' hands were moved passively to a different location, and they were asked after two seconds to return their arms to the previously held position. KE's performance in this proprioceptive task was similar to JO's performance. It thus seems plausible to assume a deficit of spatial know-how in KE, which explains his poor motor performance when pointing to his own hand.

mistaken information encoded in spatial know-how. I shall describe here only the Rubber Hand Illusion, but similar results have been found with vibrotactile illusions (vibration of the bicep tendon induces an illusory kinesthetic experience that one's arm is stretching).[17]

In the Rubber Hand Illusion (RHI), participants sit with their left arm resting on a table, hidden behind a screen. They are asked to fixate on a rubber hand in front of them, and the experimenter simultaneously strokes the participant's hand and the fake hand with two paintbrushes. After a short while, the majority of participants report that they feel the touch of the paintbrush at the location where they see the rubber hand being touched. Even more surprisingly, some participants feel as if the rubber hand were their own hand. At the behavioral level, participants report their hand as closer to the rubber hand than it really is. This is true only when the two hands are in congruent positions and stimulated synchronously.

Now, the enactive view might account for the illusion in terms of erroneous spatial know-how. The explanation might run as follows: participants feel their hand closer to the rubber hand because they were misleadingly induced to expect that if they reach the location close to the rubber hand, they will touch their own hand. However, a recent experiment refutes this explanation of the RHI. It was found that participants accurately directed their opposite hand to the real location of their own hand that was touched, and not to the illusory location that they reported. Their reaching movements were not sensitive to the spatial illusion. Similarly, when they performed the reverse movement (that is, when they directed their touched hand toward their opposite hand), they had the right know-how of where their hand was. The complete absence of illusion was also confirmed in a bimanual task, where participants had to grasp a stick in front of them. Again, their bodily movements revealed accurate spatial information about the relationship between their two hands as well as the use of spatial know-how of their correct locations. However, when participants were asked a second time to make a perceptual judgment

[17] For a description of the standard Rubber Hand Illusion, see Matthew Botvinick and Jonathan Cohen, "Rubber Hands 'Feel' Touch that Eyes See," *Nature*, CCCXCI (February 19, 1998): 756. For a description of the standard vibrotactile illusion, see James R. Lackner and Paul A. DiZio, "Aspects of Body Self-Calibration," *Trends in Cognitive Sciences*, IV, 7 (July 1, 2000): 279–88. The immunity of action to the vibrotactile illusion was shown by M. P. Kammers, I. J. van der Ham, and H. C. Dijkerman, "Dissociating Body Representations in Healthy Individuals: Differential Effects of a Kinaesthetic Illusion on Perception and Action," *Neuropsychologia*, XLIV, 12 (2006): 2430–36. The immunity of action to the Rubber Hand Illusion was shown by Kammers, F. de Vignemont, L. Verhagen, and Dijkerman, "The Rubber Hand Illusion in Action," *Neuropsychologia*, XLVII, 1 (January 2009): 204–11.

about the location of their touched hand after having moved, they were still sensitive to the RHI, and they still experienced their hand as closer to the rubber hand than it was.

Although participants experienced their hand as closer to the rubber hand than it was, they knew how to reach it, and they knew where it was when asked to move it. Hence, the RHI cannot be explained by inaccurate spatial know-how. The illusory spatial content of the bodily experience is not determined by the illusion-immune spatial know-how, which retains an accurate sense of the position of the touched hand.

To sum up, in healthy individuals, like in patients, the spatial content of tactile and proprioceptive experiences can be dissociated from the spatial information encoded in spatial know-how used to guide reaching and pointing movements, such that one can be accurate in one and not the other. Numbsense patients even illustrate the possibility of preserved know-how with no associated tactile sensation. Hence, it seems that spatial know-how, as recruited by reaching, pointing, and grasping movements, is neither necessary nor sufficient for bodily experiences.

IV. THE DILEMMA

In touch, like in vision, these various cases raise interesting questions for the enactive approach. It seems that at this stage, the enactive approach faces a dilemma. In a nutshell, if the enactive account of bodily experiences is cast in terms of spatial know-how, then it is false, because spatial know-how is separable from bodily experiences. If the enactive account is not cast in terms of spatial know-how, then it is unclear what type of sensorimotor expectations could provide both the exteroceptive and the interoceptive spatial content of any kind of tactile experiences, including instantaneous passive touch. Let me briefly develop the two horns of the dilemma.

On the first horn of the dilemma, proponents of the enactive approach characterize the spatial content of tactile experiences in terms of spatial know-how relative to the bodily location that has been touched (how to reach it or move it). But we have seen that this enactive account is challenged by a series of empirical results that reveal that, contrary to what the enactive approach predicts, tactile experiences are separable from the perceiver's actions. On the one hand, the possession of accurate spatial know-how does not guarantee that one consciously feels a touch (as in numbsense). Nor does it guarantee that the spatial content of bodily experiences is accurate (as in the case of patient JO and the Rubber Hand Illusion). On the other hand, the lack of spatial know-how guarantees neither that one

lacks bodily experience, nor that one's bodily experience lacks spatial content (as in the case of patient KE). These results are difficult for the enactive approach to accommodate if it aims to explain tactile experiences in terms of the procedural knowledge involved in reaching, pointing, or scratching one's body. What we feel is not determined by what we do, nor by what we know how to do.

On the second horn of the dilemma, proponents of the enactive approach discount spatial know-how involved in such movements as irrelevant for an enactive account of bodily experiences. On this view, they claim to be interested in what grounds perceptual experiences, not in what they are for.[18] Hence, they reject these movements as mere "practical consequences" of bodily experiences. The link between perception and such types of action is said to be only instrumental. It thus is no surprise if this type of spatial know-how is independent and dissociable from bodily experiences. However, if proponents of the enactive view want to argue that spatial know-how does not involve the right kind of sensorimotor knowledge for bodily experiences, then they have to face several difficulties.

First, they must explain why this type of relationship between perception and action is merely instrumental, rather than constitutive. Why couldn't perceptual experiences be grounded in what they are for? It is unclear how to draw the line between the "right" type and the "wrong" type of procedural knowledge. As already mentioned, an enactivist may reject reaching and pointing movements because they do not affect tactile content in the same way that turning one's head affects visual content. This may be true of reaching, pointing, and grasping movements, but not of scratching, where there is a clearly corresponding sensory consequence of one's movements (that is, if one scratches where one has been bitten, the stimulation decreases). Yet, Merleau-Ponty's patient Schneider had no conscious experience of the itching, although he could accurately scratch his leg. If this type of sensorimotor contingency is not included in the set of patterns of interdependence between stimulation and movement that constitutes itching experiences, then it is hard to see what would be. On the other hand, it is not clear that enactivism can relinquish procedural knowledge that cannot be articulated in *sensori*motor terms. Consider the experience of a flash of light. What is the enactive account for the *temporal* content of the visual experience (that is, experience of

[18] For this line of argument see, for instance, Noë, "Vision without Representation," in Gangopadhyay, Michael Madary, and Finn Spicer, eds., *Perception, Action, and Consciousness: Sensorimotor Dynamics and Two Visual Systems* (New York: Oxford, 2010), pp. 245–56.

the brevity of the flash)? There is no corresponding sensory expectation of how one's movements would affect the flash of light, given that the flash is already in the past. Furthermore, one cannot appeal to a counterfactual of the type, "If the visual object were still here and if I did *x*, then it would have the visual consequence *y*." Indeed, this would not account for the brevity of the visual stimulus. Hence, enactive explanations must sometimes accept procedural knowledge with no possible modification of the sensory signal. And if this is true for temporal content, why not for spatial content as well? Especially since the enactivist is left empty handed with no sensorimotor account of the spatial content of bodily experiences. As I said in the beginning, it is unclear what sensorimotor contingencies are supposed to be in the case of passive touch, especially if the touch is very brief. One cannot simply highlight the importance of action for bodily experiences; one has to give a detailed account of the specific set of noninstrumental sensorimotor expectations that constitute bodily experiences. If the type of procedural knowledge that I have offered is not viewed as relevant for the enactive approach, then I invite the proponents of such an approach to provide an alternative, which should be empirically testable.

However, that might be an impossible task. As we have seen, the discounting of reaching, pointing, grasping, and scratching movements presupposes a distinction between two types of procedural knowledge (constitutive and instrumental), and thus a distinction between two action systems, one of which is constitutively linked to perceptual experiences and another which is not. If there are such dual sensorimotor systems, it should be possible to dissociate them, but one may wonder whether one sensorimotor system can be impaired while the other is preserved. Alternatively, the enactivist has to postulate that there is a unique action system, but that it exploits two distinct sets of spatial information about the location of the sensation, one of which is identical to the spatial content of bodily experiences.[19] For instance, in the RHI, the location of the hand that was stroked would be encoded as two centimeters farther for one type of action than for another. Thus, the spatial information exploited by the motor system would be internally inconsistent. This seems highly unlikely. As far as I know, there is no empirical validation of such a dissociation within the motor system. Any sensorimotor account of the specific location of a sensation must involve an action that pinpoints that location in the sensorimotor system. And it is unlikely that there

[19] We know that the same spatial information can be presented within two distinct frames of reference. But this is different from having two sets of spatial information.

can be two distinct sensorimotor systems, or even two distinct sets of spatial information exploited by the sensorimotor system.

To summarize, proponents of the enactive approach either claim that bodily experiences are determined by spatial know-how involved in reaching and pointing movements, or they do not make such a claim. If they do, then the most plausible version of the enactive account of bodily experiences is subject to the concerns I have raised in this paper. If they do not, then the burden of proof is on the enactive side to distinguish between sensorimotor knowledge that does constitute bodily experience and sensorimotor knowledge that does not. Further, enactivists must propose an alternative sensorimotor account of bodily experiences, which assumes the existence either of two sensorimotor systems or of two distinct sets of spatial information exploited by the sensorimotor system. The enactive approach to bodily experiences thus suffers from serious flaws. And if the enactive approach does not work for bodily experiences, which at first sight seem the less controversial example, then it is even less likely to work for visual experiences.

It has been suggested that vision first evolved not to provide conscious perceptual experiences, but to provide distal sensory control of movements. It was only later in evolution, with the emergence of increasingly complex behaviors, that vision came to provide internal models of the world, stored in memory and accessible to other cognitive systems. Perception and action require different transformations of the visual signal. For instance, action requires on-line adjustments, whereas perception, which allows us to recognize objects, is concerned with enduring visual properties. In addition, action requires the object one acts upon to be localized relative to oneself within an egocentric frame of reference, whereas there is no such requirement for perception, which is able to make allocentric judgments about the relative locations of two objects. These distinctions result in the evolution of two visual systems, which interact most of the time but are dissociable.

Similarly, it seems that bodily information processing first evolved for use in action. What is needed for action is different in many respects from what is needed for bodily experiences. As such, the same bodily information is encoded in two different formats, and only one of them is linked to action. For instance, what is needed for action is constantly updated bodily information such that from moment to moment one knows the posture of one's body parts. By contrast, we have seen in the RHI study that participants still experience their hand as closer to the rubber hand after having moved it. This shows that their bodily experience was not updated by proprioceptive information. These findings, among others, suggest that there

are two functionally defined somatosensory systems, which interact most of the time but are dissociable. One may further suggest that they lead to two distinct, functionally defined representations of the body: the body schema for action (that is, information about the body necessary for movement, such as posture, limb size, and strength) and the body image for perception (that is, judgment of one's own bodily properties). The dissociations in touch and proprioception show that vision is not an exception in the architecture of the mind. Other modalities, including touch and proprioception, use dual coding based on the functional distinction between perception and action. The brain encodes information in distinct formats, and the way the brain uses information determines the way it encodes it.

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